education sciences

Reshaping Higher Education for a Post-COVID-19 World

Lessons Learned and Moving Forward

Edited by
Kelum Gamage

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Reshaping Higher Education for a Post-COVID-19 World: Lessons Learned and Moving Forward

Reshaping Higher Education for a Post-COVID-19 World: Lessons Learned and Moving Forward

Editor

Kelum Gamage

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About the Editor

Kelum Gamage

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Preface to ”Reshaping Higher Education for a Post-COVID-19 World: Lessons Learned and Moving Forward”

The rapid emergence of COVID-19 presented unprecedented challenges to the education sector. COVID-19 caused the full or partial closing of schools and universities, as well as the cancellation of face-to-face activities in most parts of the world. To conduct business as usual, many higher education providers have taken steps towards digital transformation, moving to online or hybrid learning and teaching delivery approaches. This reprint provides timely research on the impact of COVID-19 on education systems, including the lessons learned. It seeks to unite scholars, educators, policymakers and practitioners to collectively and critically identify, investigate and share the best practices that may lead to rethinking and reframing the way we deliver education in the future.

Kelum Gamage

Editor

education sciences

Article

Online and Hybrid Teaching and Learning: Enhance Effective Student Engagement and Experience

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Abstract: The COVID-19 pandemic has had an unprecedented impact on the global higher education system, where many universities have adapted to online and hybrid teaching and learning. They continue with some activities on campus, particularly laboratory-based teaching, but some content is delivered remotely. Significant adjustment to traditional face-to-face student engagement activities is crucial for the success of online and hybrid teaching and learning. This paper investigates the student engagement and experience in these environments. Engaged students are more likely to reach their full potential academically, and this paper identifies the areas for enhancement to student engagement activities. A survey was conducted (in Sri Lanka) to identify students' perceptions of engaging in activities during online and hybrid delivery. The results of the study illustrate a significant student engagement in learning whereas a pessimistic perception towards the transition to a completely online setting.

Keywords: online learning; hybrid learning; laboratory-based teaching; student engagement; student experience

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1. Introduction

In response to the unexpected outbreak of COVID-19, several precautions were taken worldwide. Among them, the transition from face-to-face conservative teaching learning methods to remote instruction through online and hybrid learning was a major leap that the education sector took. Traditional university structures centred on mass lectures and tutorials often foster such practices. The notion of conventional education has dramatically changed within the last couple of years, compounded by the changes in the nature of higher education: limited funding; increased student-to-staff ratios; and a shift in the profile of the student population to greater part-time enrolment [1] that increased the tendency for online learning. As a result, more ethnic minority and part-time students elect to take online courses instead of traditional classroom courses. Hence, it should be accepted that computers and the Internet have offered educational opportunities to many people who would otherwise be excluded from the traditional higher education system [2]. On the other hand, contemporary online learning technologies are having a significant influence on university education, and should thus be considered as an important aspect of course delivery in higher education today [3]. "The university education can be accessed at one's convenience at your own pace via internet and World Wide Web" [4]. With the expansion of advanced technology and the idea of e-learning—a type of learning conducted digitally through electronic media typically involving the internet—the delivery of post-secondary education and its strategies and methodologies correspond with the norms of online and hybrid teaching and learning at present.

Apart from that, engagement in academia and interaction with peers and instructors are two crucial factors that impact the success of academics both in the virtual world and the physical classroom [5]. Trowler (2010) mentions that student engagement has become an important topic in academic literature since the mid-1990s [6]. The delivery of the coursework always depends on the learner's engagement. When the learner is not actively involved, it affects the entire learning and teaching process. The author of [3] highlights a number of reasons to explore the significance of understanding online and general student engagement based on several studies in the field. According to that, student engagement information measures, individuals' intrinsic involvement with their learning and assessing students' engagement in key educational processes provides an indirect measure of educational outcomes. Moreover, engagement data provide a direct measure of students' involvement in key educational processes while the engagement perspective can help focus considerations of the quality of university education on student learning. Not only do the student engagement measures cut across a number of conventional theoretical or bureaucratic distinctions to reflect the wide range of educationally meaningful interactions that students have with their universities via student engagement information, they also provide coincident measures of student learning activities that can be used to evaluate and manage the quality, nature, levels and targeting of resource provision.

However, student engagement and interaction in the online/hybrid learning settings have become two challenging phenomena faced by university academics. The shift to online teaching requires adaptation in teaching practices and in the ways in which modules are designed and assembled. The primary challenge is then changing established routines, practices and expectations that have developed among teachers and students [7]. As Bundick et al., (2014) emphasise, "The student disengagement in schools is widespread" [8]. With the transition to the synchronous and asynchronous delivery methods during the COVID-19 pandemic, the focus is deflected to the topic "student engagement/disengagement". Since the predominant traditional view is that the learners are actively engaged and more interactive with physical educational methods, a larger amount of people tend to question the engagement/disengagement in online learning environments, even though a substantial amount of information can be seen regarding student engagement in online learning settings.

Currently, the approaches that have been taken by the educational institutes can be divided between two main mode: synchronous/asynchronous delivery and blended delivery. Synchronous learning, or distance learning, is online, based on real-time interactions between students and learning facilitators or instructors, whereas asynchronous learning occurs through online platforms without real-time interactions [7].

The previous literature suggests that learner engagement can be enhanced through hybrid or blended course delivery which is one of the most efficacious approaches. There has been much discussion over the term "blended learning" in recent years and the general consensus is that blended learning is a combination of face-to-face learning experiences, such as on-campus classroom contact, and online learning experiences [6]. Ref. [9] defined blended learning as the combination of tools embedded within an e-learning environment or the combination of a number of pedagogic approaches irrespective of the technology used. Ref. [7] has predicted that most online higher educational experiences for the 2020–2021 academic years will be based on a hybrid learning model which is a combination of both online and physical classroom environments that blend synchronous with asynchronous online learning. In a hybrid-oriented classroom, it blends both the traditional and the online delivery methods effectively with learner-centric approaches, instructor intervention, and significant peer interaction and communication.

The abrupt and forced decision to shut down all the higher education institutions (HEI) due to the pandemic had a massive impact on the education sector worldwide. Putting forward their response to the COVID-19, developing countries (e.g., Sri Lanka) also made a significant transformation to online or/and hybrid delivery methods in higher education after closing their educational institutes and opening their door to online education. Therefore, this study aims to:

- Investigate student engagement and experience in online and hybrid learning environments during the pandemic (during 2021).
- Identify areas for the enhancement of student engagement activities.
- Identify students' perceptions of engaging in activities during online and hybrid delivery.

The data obtained through a survey circulated among learners from different disciplines in HEI (in Sri Lanka) were analysed, focusing on the following key questions:

- How are academic success and achievements affected by learner engagement during the pandemic?
- What are the learner's academic experiences and attitudes toward the sudden transition and complete online learning?
- What areas are to be reconsidered when focusing on student engagement and academic success?

2. Background

The novel coronavirus, popularly called COVID-19, was declared a global public health emergency on 30 January 2020, and later as a pandemic on 11 March 2020 by The World Health Organization [10]. In view of the sudden spike in COVID-19 infections, immediate actions were taken by all the authorities globally to shut down schools, universities, and all other educational institutes to abide by all the COVID-19 health procedures and practices [11]. Later, educational institutions started to prepare for distance learning and teaching methods, postponing ongoing examinations and reorganising the existing structures of the education system until the COVID-19 situation subdued.

COVID-19 has created a plethora of issues in almost all divisions with its unpredictable nature and has affected both students and academics to a greater extent. Enduring emotional distress and fear make it extremely traumatic, particularly because of sudden drastic changes and the short time they had to adapt to said changes. Due to the potential risks to the psychological and physical health and wellbeing of individuals, it was mandatory to abide by all the strict health protocols while many of us are obligated to deal with a sense of isolation and loneliness. A substantial amount of evidence can be seen that demonstrates the severity of this concern since many people undergo a lot of aversive emotions such as uneasiness, fear stress, sadness, etc., because of the prevailing circumstances [12–14].

One of the major challenges faced by the education sector is the uncertainty about the best ways in which the prevailing situation can be addressed. Although the sudden transition to the complete online learning method is one of the major challenges faced by learners since the early 2000s, web-based applications have become the de facto standard platform for distance education courses and learning management systems [2]. The prior studies explore the costs and benefits of conducting course delivery complete online [15,16]. As the literature indicates, the learners show a positive attitude towards online learning while they enjoy the flexible schedule it creates [17]. Furthermore, an adequate number of studies show that the probability of students dropping out of educational institutes is high because of reasons such as attendance deficiency, course credit deficiency, and the poor academic and emotional support students receive from both loved ones and instructors [18,19]. On the other hand, the researchers show that typical disengaged learners, even in the physical setting, start missing and dropping out from the distance and remote learning process due to various reasons [20]. The United Nations proclaims that since new school/university attendees were forced to start largely with distance learning approaches [21,22], disconnected and underprivileged students faced the greatest challenge, lacking the connectivity and finances to engage, thus effectively ending their education. The most recent findings by numerous researchers demonstrate that many marginalised students chose to drop out of their relevant educational institutes since they were not able to cope with the abrupt transition [23,24]. Another complication is that students struggle to engage, and since students are not distinguishable from each other due to their learning differences, some students tend to become discouraged and show a poor academic success rate [25,26].

In addition, since the learner is not directly communicating with the teacher, there is a completely different approach when it comes to course delivery in the online setting rather than conventional face-to-face education [27], since the instructor's course preparation and assistance activities have a different impact on the student's altered learning experience [28]. On the other hand, teachers adopted and discovered numerous techniques to engage and interact with students on online platforms, merging both asynchronous and synchronous modes of instruction. In the asynchronous learning method, the facilitator uploads the relevant pre-recorded lessons with additional materials such as PowerPoint slides, additional notes, and recommended articles for the learner, in which learning occurs through online platforms without real-time interactions. Conversely, the synchronous method is featured with online, or distance learning, which used video conferencing platforms such as Zoom, Hangouts, and Teams to deliver the course in real-time, ensuring the interactions between students and learning facilitators or instructors continued [7]. Hence, unlike the asynchronous approach, the synchronous method mostly relies on the facilitator with "a new and extended skill set" [29]. The consequences of the transition to online/hybrid platforms are quite challenging for facilitators, since learners' attendance is low and direct communication is rare, most probably due to the lack of experience of both parties [30]. The principles of online course delivery should be focused on student-centred methods [31] regardless of the mode—synchronous or asynchronous (Bryson and Andres, 2020). The academic tasks and activities completed in the online environment should promote peer collaboration and enhance student engagement to improve student learning and experience [32,33]. The teaching staff is also challenged by the prevailing situation, where one of the biggest challenges they encountered during this period is making their online/hybrid classrooms more effective, interactive, and engaging. The redesigning of the course/program is the key to incorporating discussion forums, quizzes, groups, feedback, etc., to support and encourage students to engage in their academic work [34]. The sudden transition to online and hybrid platforms has encouraged the teaching staff to discover new approaches, techniques, and methodologies to deliver their courses. However, many teaching staff had their struggles when adopting and finding the right method to deliver the content while maintaining student engagement and interaction [35]. Hence, most of the teachers were overwhelmed by the situation, not knowing how to adjust to the new normal. The previous studies significantly demonstrate that the unforeseen and sudden transition has made a huge difference in academia while showing both students and teachers a new facet of education.

Although student engagement has also been the focus of numerous scholarly studies, there is no one standard definition of student engagement. Most researchers have their own ideas towards student engagement based on their different emphasis on their research [28]. Further, as the most accepted concept of student engagement, it has many dimensions: behavioural, emotional, or cognitive. Ref. [2] highlights the outcomes of several researches and, according to that, most studies on the topic of technology and student engagement have affirmed the utility of computers and information technology in promoting student engagement. Specifically, earlier research has confirmed that asynchronous instructional technology allows learners more time to think critically and reflectively, which in turn stimulates higher-order thinking such as analysis, synthesis, judgment, and application of knowledge.

Thus, the current study primarily concentrates on student engagement during the transition period, that is, from the traditional teaching–learning setting to the online/hybrid instructional setting, while bringing out the perspectives and attitudes of both students and teachers through their own experiences.

3. Methodology

A non-experimental research design was employed for this study.

3.1. Sampling and Instrumentation

This study was conducted through a student survey and academic interviews. The survey was circulated among 135 learners and the return was 100. The participants were both undergraduates and postgraduates from the state (37% of the sample) and non-state (63%) higher education institutes in Sri Lanka.

The primary data were collected using the student survey while the secondary data were collected through academic interviews. The student survey questionnaire focused on the demographics of students and their engagement, experience, satisfaction, and perception of online learning/hybrid learning when they transitioned from face-to-face education to online and hybrid education. Student engagement was the key focus of the questionnaire, and other areas such as student experience, satisfaction, and perspectives were also investigated. The questionnaire was designed using Google Forms and consists of a Likert scale approach ranging from "Never" to "Very often" for the statements.

All the participants represent higher educational institutes, and they indicated the degree of agreement or disagreement on statements given in the questionnaire, which covers the numerous phases of student engagement and experience. Most importantly, the questionnaire encouraged student feedback and perception towards student engagement and transition in particular at the end. Prior to administering the questionnaire, a pilot test was conducted and the results were checked for reliability. As the alpha value satisfied the acceptable alpha value, the questionnaire was administered. Participation in the questionnaire was entirely voluntary and no explanations were provided regarding any of the questions. Furthermore, to obtain a comprehensive idea about the perceptions and experience of online and/or hybrid learning, a series of academic interviews were also conducted. Six academics were interviewed who represented different subject disciplines such as engineering, technology, business management and communication skills. The academic interviews helped assess how student engagement has an impact on the success of academic work done by learners.

The collected data were organised, tabulated, and analysed using both quantitative and qualitative approaches. For the quantitative analysis, IBM SPSS V26 was used and qualitative data was analysed thematically.

3.2. Demographic Features

In this study, the data were collected by both undergraduates and postgraduates from the state (37% of the sample) and non-state (63%) higher education institutions in Sri Lanka. The majority of the sample was represented by undergraduates, which is 93% of the participants, while 7% of the sample was postgraduates. In general, a substantial number of participants, 76%, indicated that they were not previously exposed to any kind of online learning method, whereas 24% reported that they had previous experience with online learning. Of the participants, 61% were men and the remainder were women. Figure 1 shows the demographic characteristics of the learners who participated in the study.

Out of 100 participants, only 6% had a lower level of IT knowledge, whereas 42% and 52% had a higher level and moderate level of IT knowledge, respectively.

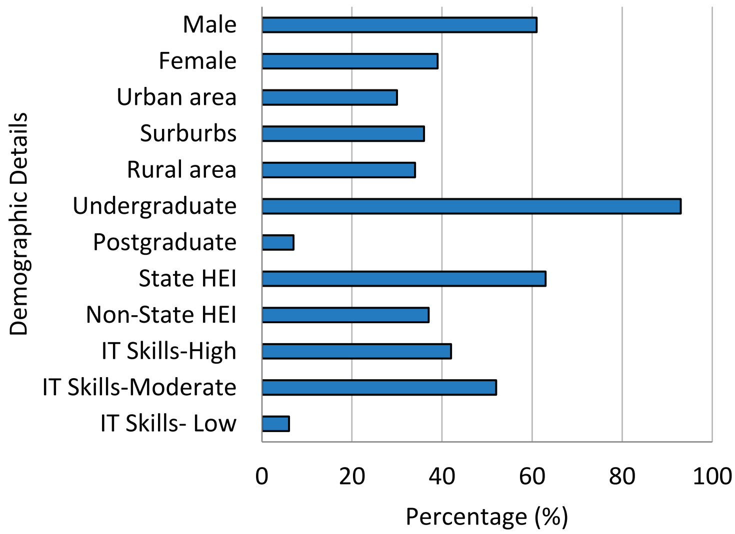

Figure 1. Demographic characteristics of participants who participated in the questionnaire.

4. Results

Independent variables such as location, level of education, affiliation, and the devices used and the quality of the network can affect student engagement in learning (ordinal dependent variable) at different degrees. The ordinal regression method is used to model the relationship between the ordinal dependent variable (categorical variable with four ordered categories ranging from "Never" (1) to "Very often" (4)) and the independent variables concerning demographic factors such as the location, affiliation, and level of education. The collected data demonstrate that the majority of the respondents use their laptops to take their courses while a considerable percentage, nearly 71% (Table 1) experienced a good and stable network connection. However, a little over one-fourth of the sample, 26.3%, has experienced a poor network connection.

Table 1. Quality of the network depending on the learner location.

Location	Good and Stable	Poor	Grand Total
Rural area	9.1%	21.2%	33.3%
Suburbs	32.3%	4.0%	36.4%
Urban area	29.3%	1.0%	30.3%
Grand Total	70.7%	26.3%	100.0%

Students also stated the lack of communication with academics, the high demand for self-study, the quantity of the assignments, and online assessment methods as areas that discouraged and depressed their studies.

The results shown in Table 2 consider the location as the dependent variable and student engagement (online presentation) as the factor. According to the results, learners in rural areas, which is 34% of the sample, stated their engagement in online presentations as 'Often' or 'Sometimes', while this number is 36% for suburbs. The learners in urban areas engaged in the particular task often or sometimes, at 20% and 10%, respectively.

Table 2. Student engagement (making an online presentation) depending on the learner location.

Location	Often	Sometimes	Grand Total
Rural area	13.0%	20.0%	34.0%
Suburbs	29.0%	7.0%	36.0%
Urban area	20.0%	10.0%	30.0%
Grand Total	62.0%	37.0%	100.0%

Figure 2 shows the results of the dependent variable—the location—and the factors—student engagement (used e-library facilities, attended classes having read materials, engaged in academic online classes on Zoom/Goggle meet or any other platform, used emails and other forums for academic purposes.) According to the data, the majority of the students, irrespective of the location, have stated either the option “Sometimes” or “Often”, which made up around 60% and 30%, respectively, of the whole sample. Therefore, the above case processing summary depicts that the majority of the respondents have engaged in a substantial amount of online work during the pandemic. A minority also demonstrates a strong engagement in their studies (i.e., “Very Often” (4) category in the Likert Scale), which makes up around 5–10% in each statement in the scale.

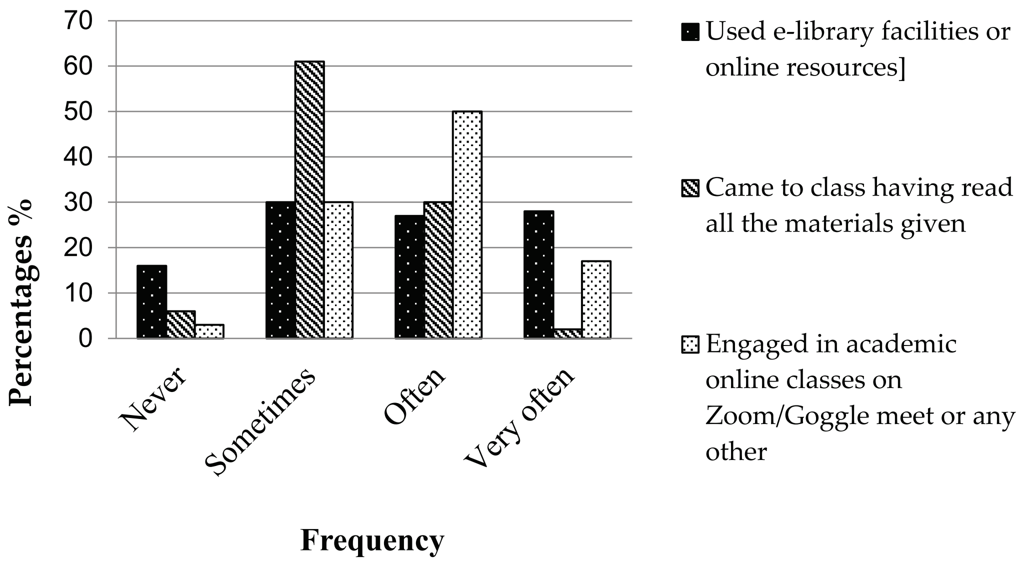

Figure 2. Student engagement in academics with teaching staff and peers.

Figure 2 further reveals that 16% of the respondents have not used e-library facilities, whereas a significant number of learners have used e-library facilities. Numerically, 29% mentioned doing so sometimes, 27% often, and 28% very often. The above data also depict that student engagement in online classes is at a higher rate (Often = 50%, Sometimes = 30% and Very Often = 17%). The disengagement can be considered negligible at 3%. The data indicate that the majority of the learners (Often = 30%, Sometimes = 61%) have made an effort to prepare for their respective classes.

According to the data, student engagement (from both state HEI and non-state HEI) in online classes was recorded as “Often = 50%” or “Very Often = 17%” (see Table 3). Notably, the non-state HEI learners have shown a higher level of engagement in comparison to state HEI learners, as 63% of the student engagement is recorded from non-state HEI.

Table 3. Student engagement (making an online presentation) depending on the learner location.

Frequency	Used e-Library Facilities or Online Resources	Came to Class Having Read All the Materials Given	Engaged in Academic Online Classes on Zoom/Goggle Meet or Any Other
Never	16%	6%	3%
Sometimes	30%	61%	30%
Often	27%	30%	50%
Very often	28%	2%	17%

Figure 3 represents the data of the weekly engagement in studies. According to the data, the majority of the learners, which is approximately 60%, state that they have not engaged in a lab class at all. The data indicate that a larger number of learners (approximately 70%) spend at least 1–2 h preparing for their classes, whereas this figure is 2–4 h for online classes (approximately 60%).

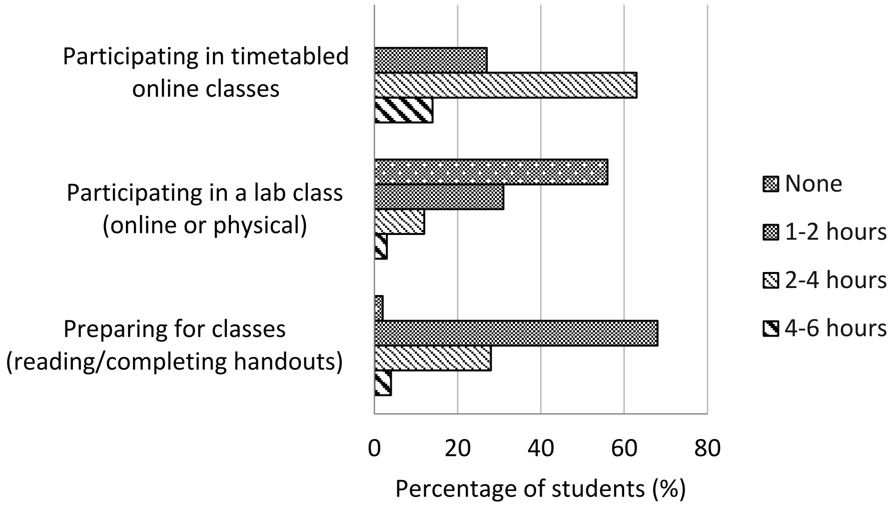

Figure 3. Learners' weekly engagement in academic work: Non-state HEI/State HEI.

When the participants were asked; "to what extent has your experience at your institution contributed to your knowledge, skills, or personal development?", a greater number showed a positive attitude towards it. This is shown in Figure 4.

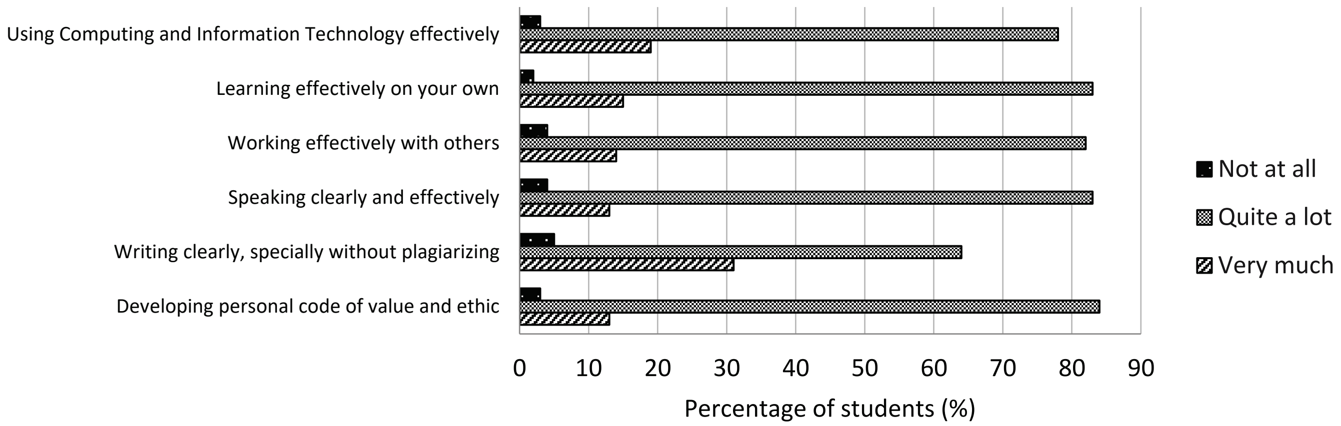

Figure 4. Contribution to Learner experience at their institution.

In the study, we noticed that the majority of learners (61%) have an interest in the hybrid method of learning, 28% of the participants are in favour of the traditional learning and teaching method, and 11% proclaim that they are in favour of online learning.

5. Discussion

Considering the above, it is evident that the learners and institutions have made a successful attempt at transitioning from conservative teaching and learning methods to virtual learning and teaching. In general, it is evident that student engagement in online learning during the pandemic is higher in the non-state sector. However, at the time of the questionnaire, even though the learners were receiving a substantial amount of synchronous and/or asynchronous education, they were still reluctant to engage in studies in a completely online environment, whereas they were comfortable in receiving the education in a hybrid manner. In contrast, the conservative perspective toward education has been gradually disappearing from the minds of young and adult learners equally.

Based on the research findings in [3], the author suggests that online learning management systems have the capacity to influence university education in many ways. For staff, these systems may influence the selection and development of basic online materials, affect traditional teaching practices, and introduce new dynamics into the management of teaching programs. Clearly, these systems have the capacity to influence university education in profound and perhaps unanticipated ways. In particular, for the current study, student engagement with academics during the pandemic via online platforms is optimal. Even though it seems their perception towards this is pessimistic, several drawbacks were highlighted. The students believe that complete online learning is only acceptable because of the uncertain time they are going through and, further, as a personal health safety measure. They also consider it as a new experience. Inversely, learners are concerned about the missing or uncompleted practical components of their courses. Students think that actual contact in real-time with peers and academic staff would give them more exposure and a less stressful university experience. Beyond this, the findings of [36] suggest that instructors also need to provide multiple ways of interacting with students themselves to create their own social presence, as it is an integral component of a successful online course.

Flexibility in the academic schedule, practicing to be responsible for one's own learning and maintaining self-discipline, facilitating self-learning, and availability of lecture records for future reference have been taken as the positive outcomes of the online learning experience. Additionally, online learning has been recognised as time-saving and as a way of developing time management skills. Notably, it has been seen as a way for learning how to communicate through an online platform for the future and a better means for postgraduates, since they can study while working. Conversely, one of the critical issues faced by students, as emerged through the discussion, was the shortcomings of telecommunication infrastructure, which resulted in an interrupted learning experience or total miss of lectures and examinations. This highlights the national requirement for the establishment and proper maintenance of digital communication facilities.

Due to the pandemic, many academics who teach in mainstream universities have been asked to adjust to online teaching in a matter of days throughout the world [37], which was challenging in many ways. In the event of an emergency remote transition, students' needs and challenges have likely changed, and instructors may want to take the time to familiarise themselves with their students' emerging concerns, questions, and situations [38] According to the views of academic staff, students are drained at the end of the academic year. "The students I worked with always come to the class at the beginning of the semester, but after the mid-semester examination, the attendance is low". The results extracted from the interviews completed with academics depict the enthusiasm a learner has at the beginning of the course gradually diminishes. According to them, the number of attendees increasingly declines after the mid-semester, and towards the end, half of the class or more than that would be left behind. "When I put students into breakout rooms on Zoom, I can see that they do not speak with each other, also when they are directed to the main session after the group work, a half of the class is missing". However, the results of [39] show that students gained significantly higher behavioural and cognitive engagement when teachers played a facilitation role during discussions. The academic also stated that even though individual student engagement can be seen, the lack of active and collaborative learning (which also includes not asking questions in the class, not responding to the questions, and not working as a group on a virtual platform) can be identified as a significant feature among learners. Both learners and academics were similarly concerned about the enrichment of the educational experience. Participation in learning communities, internships, research, and engagement in diversity within the learning community has been dramatically decreased among the university population.

In general, both learners and academic staff are in favour of the transition to online and hybrid platforms since they are effective and safe during the pandemic. Even though the abrupt transition has a lot of challenges and limitations, it has solved many problems; for instance, it has saved time and served the education process without leaving a permanent barrier in the future.

6. Conclusions and Recommendations

The results of this study further illustrate the significant impact of COVID-19 on student engagement in the HEI. In the comparison of state HEI learners and non-state HEI learners, student engagement in online learning is higher in the non-state sector during the pandemic, and is at a satisfactory level. The results display that the majority of students have accepted the synchronous and asynchronous learning methods during this confinement period. However, the student's perspective toward the transition cannot be identified as a positive perception. Significantly, student perception is a critical and essential factor in the success of their education and that cannot be disregarded. The lack of resources, lack of communication with relevant parties, self-discipline, network disruptions, stress, and lack of interaction is associated with the root cause of the fear and reluctance of students. As Weaver (2005) stated many factors can limit a learner's participation in online discussions such as time pressure, non-participation by others, and even fear of looking silly and a lack of confidence [40]. Ref. [37] pointed out, based on the research evidence, "what we have seen is that moving face-to-face teaching online is not e-learning but remote learning with some technology tools being made available, but without all the resources, methodologies and necessary training".

Both the cognitive and social presence of the instructor is important for the continued engagement of the students with the online content. Further, teachers' concern and involvement with the students have been seen to influence learners' intent to persist [40]. Hence, it is suggested that interpersonal connection and guidance should be increased in the online courses. On the other hand, research shows that students are mostly sufficiently skilled to take part in digital lessons, but the development of these lessons by teachers turns out to be a lot more difficult [41]. Hence, facilitators suggest that adopting the means and techniques of online education and providing training on the use of digital pedagogy for teachers and students would increase student engagement further. Both parties emphasise that moving to a hybrid method of learning and teaching would be a better decision, since the online platforms have drawbacks that are beyond human control.

Moreover, the quality of the course in terms of audio and video has to be good for the student to keep them engaged and reduce attrition. Students do enjoy interactive content, though it has not been directly related to increased learning outcomes [40]. However, the findings of this study concluded that both the learners and the academics were not prepared for a complete online learning method while they took a substantial amount of time to adjust to the sudden and rapid transition to remote learning and teaching. The learners (especially the learners in rural areas) were harshly affected by the disparities in accessing the internet, electronic devices, new learning environments, and mental health imbalances. Simultaneously, the faculty members were also exhausted due to the work-life imbalance; especially being unable to separate their professional life from their personal one. In conclusion, it is evident that "access to education" should be largely addressed and prioritised, especially in developing countries since the disparity is more apparent due to COVID-19. HEI should ensure equal opportunity to access relevant courses while introducing effective strategies and techniques to make the courses and delivery learner-centered and interactive to increase student engagement.

Concisely, it can be concluded that even though there is an adequate degree of student engagement, students and teaching staff had not been in favour of online learning due to various socioeconomic and emotional reasons. It may be also concluded that online learning is a useful method for coursework delivery. On the other hand, the results of the study show that the lack of lab sessions has made learners lose a considerable amount of the important workload of their relevant courses. Therefore, going forward with the pandemic, if the above gap can be filled, a vivid and constant level student engagement in online teaching delivery can be maintained.

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education sciences

Article

Caught in the Middle—Experiences of Student Peer Mentors in Nursing Education: A Qualitative Study

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Abstract: The use of digital and remote teaching has expanded in higher education and reached a peak during the COVID-19 pandemic. Reducing the social component of the learning process may increase students' isolation, loneliness, and dropout rates. This study aimed to investigate the experiences of student peer mentors who participated in a mentoring program that was implemented to increase student well-being and prevent dropping out among first-year Bachelor of Nursing students at a university in Norway during the COVID-19 pandemic. Eleven semi-structured interviews were carried out with student peer mentors. Using a thematic analysis, four themes were identified: being someone who can ease the transition, defining roles and boundaries, developing communication strategies, and developing their own professional competence. Knowing how difficult the transition to higher education was and being a student during the COVID-19 pandemic made it challenging for the mentors to set boundaries. It was also challenging to develop effective ways to communicate with the first-year students. Being a mentor was considered beneficial for developing professional skills such as empathy and communication and to gain self-confidence. There is a need for more knowledge about how to support mentors in clarifying the peer mentoring role, setting boundaries, and coping with the emotional labor involved in peer mentoring.

Keywords: distance learning; nursing education; COVID-19; social learning; peer mentor

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1. Introduction

The use of digital and remote teaching has increased in higher education and reached a peak during the COVID-19 pandemic. Mayer explored the connections between multimedia learning and cognitive processes and showed how multimedia learning increased the cognitive part of the learning process [1]. From our perspective, we are concerned by the social part of the education system, including how to create relations between students and thereby avoid the negative consequences of digital and remote teaching such as increased student isolation, loneliness, and dropout rates [2–5].

The COVID-19 pandemic severely affected all parts of Norwegian society from the moment the first case was detected in February 2020. Extensive measures were implemented to control the spread of the disease. In the higher education sector, this resulted in the closing of universities for prolonged periods of time across the world and a shift to online teaching and students working from home. Studies investigating the effects of the COVID-19 pandemic and the subsequent restrictions found that many students felt isolated and depressed [3,4]. As a response to these challenges, a three-year Bachelor of Nursing program in Norway implemented a student peer mentoring program for first-year nursing students in 2020 to increase student well-being and prevent students from dropping out. Senior students are often used as student peer mentors to assist first-year students in adapting to higher education [6]. Studies show that mentoring programs are often used in higher education, with positive results for both the mentors and mentees. These include preventing students from dropping out, reducing stress and anxiety, enhancing feelings of support for the mentees [7–10], and developing the mentors' leadership and communications skills [11–13]. However, the ways in which mentoring programs are implemented vary greatly. The mentors are either students or graduated nurses, and the aims of the programs vary greatly. This makes it difficult to draw definitive conclusions about the effects. To our knowledge, there have been a limited number of studies that have investigated the use of student peer mentoring programs during the COVID-19 pandemic that focused, in particular, on using the method as a tool to enhance student well-being during this period. This study aimed to investigate the experiences of the student peer mentors that participated in a program, focusing on aspects such as their motivations to become mentors, the skills that were acquired, and the challenges experienced as mentors.

The Mentoring Program at the University

The nursing program experienced an increased dropout rate during the COVID-19 pandemic. As a result, a peer mentoring program was initiated. Building on insights from theories of situated learning and communities of practice as well as theories of the socio-cultural learning perspective that underscore the importance of social inclusiveness, interaction, and identification in the leaning processes of students, the mentor program was a focused effort to reduce the dropout rate among first-year students as a consequence of the loss of the university campus as a practice and learning community [14,15]. Approximately 30 student peer mentors were recruited among second- and third-year nursing students to mentor first-year students from the start of the academic year. Each mentor was encouraged to contact 25–30 mentees once per month from the start of the academic year until the end of the first semester. For this, the mentors were paid a monthly salary by the university. The student peer mentors attended an introduction course before the start of the academic year, which was organized by the project coordinator (who was a faculty member), and received information about the scope of a mentor's role. The mentors' responsibility was to check in on the mentees and ask how they were doing and if there was anything the mentor could do to support the mentee with regards to practical issues. The mentors were to refer the mentee to the appropriate student support services for any issues beyond the scope of the mentor role or contact the project coordinator for guidance. The mentors met once per month with the project coordinator to share their experiences and discuss any challenges. In between meetings, the mentors communicated with each other on a group chat, where they shared information and advice.

2. Materials and Methods

The aim of this study was to obtain a deeper understanding of the experiences of the student peer mentors. A qualitative approach seemed appropriate to bring new knowledge to this topic. The data comprised individual semi-structured interviews with the student peer mentors who participated in the program. This approach contributed to developing detailed and nuanced descriptions of the students' experiences of being mentors. In the analysis process, we used the six-step model inspired by Braun and Clarke [16]. The 32-item checklist of the criteria for reporting qualitative research (COREQ) served as a reference for reporting the present study [17].

2.1. Setting

The participants were mentors for nursing students during their bachelor's degrees. Some of the participants were students in the second or third years of their bachelor's degrees, and some had graduated and were working as registered nurses when the interviews were conducted (Table 1).

Table 1. Characteristics of the participants.

Participant	Age	Number of Times Being a Mentor	Current Profession
1	21	2	third-year student
2	22	2	registered nurse
3	24	2	third-year student
4	22	1	registered nurse
5	24	1	third-year student
6	24	2	third-year student
7	21	2	third-year student
8	25	2	third-year student
9	22	1	third-year student
10	30	2	registered nurse
11	23	2	registered nurse

2.2. Recruitment and Participants

The inclusion criteria required that the participant was, or had been, a student peer mentor for students in the first year of the Bachelor of Nursing program. To recruit the participants, we received a list of names of mentors from the faculty staff responsible for coordinating the student peer mentor program of the Bachelor of Nursing program at the university. Based on that list, we contacted the mentors by email. However, we received few answers and decided to send the potential participants text messages on their mobile phones. This recruitment strategy was more effective, and we recruited 11 participants out of 24 current and former student peer mentors at the university, including three recently graduated registered nurses and nine students. While we aimed to recruit participants of all genders, the final sample comprised eleven women.

2.3. Data Collection

The data collection consisted of eleven semi-structured interviews based on an interview guide (Appendix A). The interviews were carried out using the videotelephony software program Zoom (nine interviews) or face to face (two interviews) on campus, depending on the preferences of the participants. The interviews were conducted by the first and last authors (SRL or HJ) in Norwegian. Each participant was interviewed once. We asked the participants to narrate their experiences from the time they were recruited as mentors to the present time. Their experiences as mentors were explored using questions such as "Can you talk about your motivation to be a mentor?", "Can you tell us about an experience you had with a first-year student that you remember particularly well?", "Has there been anything you've found challenging about being a mentor?", and "What was it like for you to be a mentor during the pandemic?". The interviews lasted between 20 and 45 min and were transcribed verbatim but de-identified by a professional language editor. The interviews were conducted between September and October 2022.

2.4. Data Analysis

Braun and Clarke's thematic analysis was used to analyze the data [14]. We analyzed the data in an inductive way, aiming to convey the perceived meaning of the participants that was relevant to the aim of the study. The first author listened to all the recorded interviews, and all authors read the transcribed interviews. During this first step, all the authors wrote down their first impressions from the dataset. We discussed the notes and talked about why we had these first impressions regarding the meaning of the dataset. In this phase, we identified four themes. In the second step, the first author generated initial codes using NVIVO 11 software [18]. All authors subsequently discussed which codes fit together, identifying potential themes, and decided whether they answered the research aim. In the fourth step, we modified the themes by reading the transcripts and reviewing the codes. As a final step in the analytic process, we finalized the themes, with an emphasis on developing themes that were *meaning-based interpretive stories* and ensured that they responded to the aim of the study(Table 2) [19]. All authors were involved in this process and agreed on the summarized themes shown in the findings.

Table 2. Illustration of the analytical process.

Data Extract	Codes	Theme
The way they described it was like, to have someone to ask and who can provide that additional support and stuff like that, especially in the beginning with the transition to becoming a student. And I just felt that I really wanted to be that person who can help with all of that.	Wanting to help	Being someone who can ease the transition
I felt I have developed an effective study technique and sort of wanted to help others and share tips and tricks. So that's why I thought it could be interesting to be a mentor.	Having skills that could benefit the first-year students	
As a first-year student, I had only online classes and it was a difficult transition, both because of the pandemic and the courses. So I thought it would be really good to have a mentor.	Felt the need for a mentor	

3. Ethical Considerations

The study was approved by the Norwegian Centre for Research Data (Sikt) in July 2022 (No. 686027). All the participants gave their written, voluntary consent to participate in the study. The participants were informed about their right to withdraw from the study at any time during the research process before the analysis. All participants received an email providing information about the study. While all the authors were faculty members of the Bachelor of Nursing program at the university, none had been involved in the mentoring program. As described above, we used text messages to recruit the participants as per approval by Sikt. This recruitment method might be considered more intrusive than receiving a request by email. However, the participants were young students that were used to communicating using text messages. Additionally, we did not consider the topic to be particularly sensitive. We ensured that the researchers did not know the participants being interviewed. The participants agreed to our use of the videotelephony software program Zoom (Santa Clara, CA, USA) or meeting face to face. We used an app connected to services for sensitive research data to record the interviews (Nettskjema–University of Oslo (https://www.uio.no/english/services/it/adm-services/nettskjema/, accessed on 21 March 2023)). The files with the recorded interviews were password-protected, and only the researchers were allowed to access the files. The data were anonymized and were stored in accordance with the current guidelines at the university and in accordance with the General Data Protection Regulation (GDPR).

4. Results

Four themes were identified: being someone who can ease the transition, defining roles and boundaries, developing communication strategies, and developing their own professional competence.

4.1. Being Someone Who Can Ease the Transition

The mentors were motivated by a strong wish to "be there" for the first-year nursing students and support them. Some of the mentors had experienced a need for a mentor as first-year students or felt that having had a mentor as a first-year student was a motivating factor for becoming one themselves. Others said they wanted to help the students with the transition from secondary to higher education, which was considered challenging:

> *When they presented the program to recruit new mentors, I thought it sounded very exciting (. . .) The way they described it was like, to have someone to ask and who can provide that additional support and stuff like that, especially in the beginning with the transition to becoming a student. And I just felt that I really wanted to be that person who can help with all of that.* (Participant 2)

Some of the mentors felt that they were academically strong, had mastered study techniques, or had other qualities that they believed could benefit the first-year students:

> *I felt that I have developed an effective study technique and wanted to help others and give them advice and tips if they were stuck. So that was the reason I thought it would be interesting to be a mentor.* (Participant 4)

Some of the mentors felt that their own experience of being a student during COVID-19 was particularly relevant for being a mentor:

> *There was a lot of COVID-19 both my first and second year. So in a way that's a good thing because I know what they are going through. So it was easy to give tips and advice. As a first-year student myself it was difficult for my mentor to understand what it was like. There wasn't really a lot of support in a way. At least when I think back to having a mentor my first year. So now I feel that I can provide guidance to the first-year students a lot more in that sense. Also about social stuff, there isn't really a lot of social gatherings organized at the university. So I provide advice about how to get in touch with the other students in their class.* (Participant 6)

4.2. Defining Roles and Boundaries

Many of the participants experienced situations where they had to set boundaries for the first-year students in terms of what they could and could not help them with. One participant had been contacted during the night on a weekend by a first-year student, which the student peer mentor brushed off as drunken shenanigans. Other mentors told stories of being asked to provide feedback on assignments or being confronted with first-year students with mental health issues:

> *It can be challenging to clarify my role towards the first-year students. Many believe I am there to provide feedback on assignments, that I am a teacher in a way. So, to clarify what I am not . . . I am not there to edit their assignments. I have had those questions in the past (. . .) I believe I am a quite good at setting boundaries. You feel a bit like "sorry I cannot help you with that". I don't feel guilty but it's a bit like "sorry that is not what I meant when I told you that I am here for you".* (Participant 6)

Knowing how challenging the COVID-19 pandemic was on the students made setting boundaries particularly difficult:

> *There will be things that are outside the role of the mentor. It is a matter of knowing your boundaries and refer to the right places and things like that. But I think it is easy to think that you can handle it and help them instead, but you have to know where to draw the line and where to refer them. You are not a psychologist. I know that was one of the concerns because of COVID-19. Because you can't hide the fact that it has been hard on the students. So, it is definitively a challenge.* (Participant 1)

The mentors also felt that the focus during their interactions with the students shifted because of the pandemic:

> *I did notice that the mood of the students and their motivation was affected each time new restrictions were implemented. When I spoke to them after the lockdown they were downhearted. There were also a lot of frustration about all the zoom lectures which they did not like. So you try to be positive. There were also a lot of reactions and they needed a lot of additional support when it was decided that the exam would be held on campus*

> *right before Christmas. So while we were supposed to help out with practical stuff, the focus became on COVID-19 which affected the entire society.* (Participant 11)

The mentors were often asked by the mentees which lectures to attend or opinions about faculty staff. These experiences made them feel squeezed between multiple roles as a mentor, fellow student, a friend, and someone representing the university. To balance this closeness and distance seemed to be difficult for some of the mentors. This was particularly apparent in challenging situations where the mentors held themselves accountable for situations outside their control and the scope of the student peer mentor role. When a first-year student dropped out of the nursing program, the mentor blamed herself for not doing enough to prevent it from happening:

> *I connected really well with one of the first-year students and she seemed really positive, but suddenly it changed and she had tried to call me when I was unavailable to talk. I tried returning her call later but she didn't answer. So I sent a text message and it was a bit of messages back and forth about her struggling with motivation to continue the nursing program and where to get counselling and stuff like that. I asked the other mentors who provided me with links to people she could get in touch with. Afterwards I didn't hear anything except that she had quit which made me feel that I had not done enough. That perhaps it was because I didn't answer the phone and didn't manage to reach her afterwards. Once we started texting I felt it was too late. So I felt the responsibility, that I had not been able to convince her to continue. Not that I am the cause, but I could have been a contributing factor in a positive direction. So that was difficult, I guess.* (Participant 2)

4.3. Developing Communication Strategies

During the introduction course for the mentors and the monthly mentor meetings, much time was spent on discussing the best ways to reach out to the mentees, as many mentors experienced students not responding to their messages and emails. The participants who had been mentors since the rollout of the initiative explained how the mentors had sent emails to the students' university email accounts but received limited responses. The mentors later found out that many students had problems logging into their university email accounts or did not know that they had one. Sending a message by SMS had generated a better response rate, and most mentors used this as the primary communication channel. Some of the mentors highlighted the importance of reaching out to the first-year students early in the first semester, preferably by September. They also timed their messages to the students around important "events" during the first year, such as exams or the first clinical placement. Some had also developed ways for the students to answer that required minimal effort, which they believed enhanced their chances of receiving a response:

> *It Is important to ask direct questions. Or if you don't get a response, write "send me an emoji if you are okay". Those kinds of things just to make sure the student is okay. It is easy to think that if they don't respond to your message, they are okay, but you can't be sure. Sometimes I can ask them to rate their motivation from one to ten, so they only need to send me a number.* (Participant 7)

It was also highlighted that the mentors were different and used different techniques, and so were the first-year students. Several mentors believed it was important to write personalized messages and remember the preferences of each student:

> *I send SMS to everyone, but I know that some don't like to receive messages in the evenings because it is stressful for them. Others prefer talking on the phone, so we chat for 15 min and that's enough for them. Others prefer email and doesn't want to be distracted by the phone while they are studying. So it is important to be flexible and able to meet a lot of different people with different needs.* (Participant 2)

Not receiving responses from the first-year students and feeling intrusive was considered to be particularly challenging. In these instances, some blamed themselves for not asking the right questions:

> *It was challenging during the periods where I would not get a lot of response. You feel like you are harassing people. We have spoken a lot about it during the meetings with the other mentors. When you send out a lot of messages and you don't get a response you can think that "I am that annoying person who pops up from time to time to invade your privacy" in way. It can feel like that when you don't get a response. And sometimes it feels like you're not asking the right questions or phrasing them in a way that makes the first-year students want to answer.* (Participant 8)

4.4. Developing Their Own Professional Competence

The mentors believed that being a mentor was also beneficial for developing skills that are important for practicing nursing, such as empathy and communication:

> *It is about how to communicate with different people with different needs. Not everyone says it directly so you might be able to understand it anyway based on a text message that there is actually a lot of worry here, this person seems quite stressed and worried and where it seems to be something more going on than just what is written in the message. So, to be able to respond to not only what is in the message but also to reassure in a way. So the response not only answers the question but also expresses understanding and supportiveness so they don't feel stupid for contacting me.* (Participant 8)

Some narrowed it down to obtaining experience supervising students, which was considered important when working as a nurse:

> *I have gotten a lot of practice in supervision of students and showing . . . or at least trying to show a genuine interest in others which in a way is important for a nurse. In general getting experience working with people, I guess.* (Participant 4)

Those who considered themselves to be introverted or shy said that being a mentor had helped them practice "putting themselves out there" and gaining confidence:

> *I have always considered it a bit scary to speak to new people. So, for me it was challenging to contact the first-year students. So, it was a good challenge for me to face. As a nurse and part of a work environment where professional development is important it is beneficial to have experience putting yourself out there, taking charge in a way.* (Participant 3)

The skills that these mentors described (empathy, communication, becoming less introverted, and being able to initiate social interaction) are all central to what one might call "people skills", which are important competencies in nursing practice.

5. Discussion

The study findings indicate that the student peer mentors were highly motivated to support the first-year students. However, the mentors experienced challenges both in defining the role of a mentor and setting boundaries for the first-year students. It was also challenging for the mentors to develop effective ways to communicate with the first-year students. Being a mentor was considered beneficial for developing professional skills, such as empathy and communication, as well as gaining their own self-confidence.

The societal circumstances in which the peer mentor program was implemented was characterized by closed university campuses, strict rules concerning the organizing of physical face-to-face social interactions, unpredictable learning environments, and scarce contact with teachers and other faculty. In other words, three of the most important aspects and/or preconditions for well-functioning learning communities (a safe environment, predictability, and regular interaction and collaboration between students and faculty) were absent. The absence of these factors is not exclusively related to COVID-19-affected societies. These issues might very well be found in distance learning environments and in an increasingly digitalized system of higher education [20]. Our findings show that the mentoring program might have compensated for some of the problems related to social distance and the lack of social interaction in such contexts/circumstances [21]. Mayer pointed out that multimedia learning has a great impact on cognitive learning processes [1]. In nursing education, both cognitive and social processes are important dimensions of learning processes. When learning biosciences, cognitive learning is of great interest, and therefore multimedia learning might contribute to students' learning outcomes. Our findings indicate that the social dimension of the learning process should be emphasized in any learning environment, and we believe there is a need to expand the knowledge about multimedia learning in this regard.

The student peer mentors experienced challenges in defining their role and establishing boundaries for their support of the first-year students. Being paid by the university might also have put the student peer mentors in a moral squeeze between being a peer for the mentees when listening to the mentees' complaints and critiques of teachers and exams while at the same time maintaining a level of neutrality as an employee of the university. The mentors were motivated by a strong wish to help the first-year students. This was supported by previous studies that found that most mentors were motivated to be a mentor for altruistic reasons and that being a mentor created a sense of gratification and meaning [22–24]. Combined with the motivation to be there for the first-year students was also a perception that it was difficult to draw a line in terms of what they could not help the mentees with, which was in line with previous studies. In particular, striking a balance between not providing enough support and providing too much support has been found to be especially difficult [3,6,25]. Knowing how difficult both the transition to higher education and being a student during the COVID-19 pandemic was for the first-year students made it particularly challenging for the student peer mentors to set boundaries. The moral squeeze, combined with the difficulties in managing expectations from the students as well as defining the role of a student peer mentor, seemed to be taking an emotional toll. While the mentors stated that their role was to assist the students only with practical issues, in some instances where they had been actively involved with the mentee, the mentor also felt responsible and blamed themselves for not doing enough to improve the situation for their mentee. A lack of understanding of the role of a mentor may lead to the mentor becoming overprotective and taking over responsibilities that lie with the mentees [26]. While there is extensive research about the challenges of being a student peer mentor [6,27–29], this and other challenges related to the so-called "dark side of mentoring" [30] should be investigated further. Based on our findings, there also seems to be a need to emphasize ways of coping with the emotional labor involved in peer mentoring when preparing students for the role and ensuring that the student peer mentors receive continuous follow-up and support to clarify the mentoring role and the setting of boundaries. Our findings also highlight that the moral, ethical, and legal issues of using student peer mentors should be carefully considered before initiating student peer mentoring programs to avoid putting students in potentially demanding "squeeze roles".

The participants in this study believed that being a mentor contributed to developing skills valuable to the practice of nursing. This included being able to "put yourself out there" and gaining self-confidence as well as developing communication skills. For the participants who considered themselves to be introverted, shy, or simply not used to speaking out due to the passive nature of online lectures, being a mentor was a way to push themselves out of their comfort zone while engaging and interacting with the mentees. These mentors also saw this, from a meta-perspective, as a way for them to practice persuasion and taking charge, which they believed to be important in their future profession as a nurse. Benefits for mentors related to self-confidence and building leadership and communication skills as well as the strengthening of clinical competence were also found in other studies [13,31]. The applicability to future professional practice might be particularly relevant for student nurses, as the supervision and mentoring of student nurses is a key component of nursing practice.

Strengths and Limitations

To our knowledge, few studies have investigated student peer mentors' experiences in nursing education during the COVID-19 pandemic. This study therefore fills a much-needed knowledge gap, as we recruited eleven participants that were willing to share their experiences in a way that gave rich and nuanced pictures of their perspectives of being mentors during the COVID-19 pandemic. The participants were students in the second and third years of their education, and some of them worked as registered nurses, which contributed to a more nuanced picture of the participants' experiences of being mentors. We recruited the participants using text messages, a recruitment technique that turned out to be the same method that the participants preferred for reaching out to the mentees. One might ask if this recruitment procedure might entail a certain pressure on the participants. However, we ensured that the participants had read and understood the information about their free and voluntary consent to take part in the interviews. All the participants were female. At the time of recruitment, 22 female mentors and 2 male mentors were involved in the mentor program. This sample is typical for the gender composition in nursing education, but it might have affected the results. Although we are experienced researchers and educators, we had preconceptions regarding the importance of the mentoring program. We reflected and discussed these preconceptions during the analytic process and tried to be open-minded when reading and analyzing the data.

6. Conclusions

The student peer mentors in this study experienced challenges, both in defining the role of a mentor and setting boundaries for the first-year students. They also found it challenging to develop effective ways to communicate with the first-year students. Being a mentor was considered beneficial for developing professional skills, such as empathy and communication, as well as gaining self-confidence. The mentors, who were themselves affected by the changes in the learning environment due to the COVID-19 restrictions, believed that they were well positioned to support the first-year students, who were adapting to higher education during a challenging time. Our findings show that the mentor program might compensate for some of the problems experienced due to social distance and a lack of social interaction and that the social dimension of the learning process should be emphasized in any learning environment. However, there were challenges on multiple levels due to putting student mentors in such demanding roles, the extent of which the institution did not necessarily acknowledge. Our findings show the moral squeeze and emotional toll experienced by the mentors. This highlights a need to emphasize methods of coping with the emotional labor involved in peer mentoring when preparing students for the role and ensuring that the student peer mentors receive continuous follow-up and support to clarify the role and set boundaries when implementing mentoring programs in higher education.

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Appendix A

Interview guide (translated from Norwegian)

How old are you?
Which year of the Bachelor of Nursing program are you?
How long have you been a mentor?
What were the reasons why you wanted to be a mentor?
What was the first year like for you? Did you take advantage of the mentorship program yourself?
What training and follow-up did you receive as a mentor along the way?
How did you go about contacting and following up with the students? How did you go about reaching those who didn't respond the first time?
Can you tell us about an experience you had with a first-year student that you remember particularly well?
Has there been anything you've found challenging about being a mentor? Can you give an example?
What was it like for you to be a mentor during the pandemic?
What skills would you say you have acquired or further developed through mentoring?
When you think back to being a mentor, what have you learned that you want to take with you in your future profession as a nurse?
Is there anything about being a mentor or mentorship that I haven't asked about that you'd like to add?

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education sciences

Article

Contextual Changes and Shifts in Pedagogical Paradigms: Post-COVID-19 Blended Learning as a Negotiation Space in Teacher Education

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Abstract: This study investigates a post-COVID-19 curricular change in the blended learning (BL) academic timetable of a teacher education college where, pre-COVID-19, most academic courses were taught face-to-face (F2F) on campus. At present, the meetings are F2F for three weeks, followed by a week of remote learning, combining synchronous and asynchronous pedagogies. This study explores these two aspects of the online component and the considerations for their implementation. In a mixed-method approach, the data were collected using a closed questionnaire and two focus groups involving 76 lecturers and 553 students altogether. Of the wide range of pedagogies identified, the highest success rating was accorded to synchronous frontal lectures via Zoom by the students and to integrating MOOCs, YouTube, and Podcasts by the lecturers. Moreover, compared to the lecturers, the students rated the success of asynchronous self-directed learning considerably higher. Qualitative analysis revealed that pedagogies slated for the online module were frequently negotiated between students and teachers. Findings suggest that a structural change in the curriculum could be a first step in rethinking pedagogies in the post-COVID-19 education arena. The next step should focus on narrowing the gap between lecturers' and students' perceptions regarding the success of the various pedagogies.

Keywords: blended learning; curriculum; post-COVID-19; teacher education

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1. Introduction

In the wake of the recent COVID-19 pandemic, scholars have increasingly come to regard blended learning (BL) as the new normal in higher education [1,2]; while in and of itself, BL is not a new educational approach [3,4], it is only during the pandemic that it became, as Zhao and Watterson [5] put it, "the de facto method of education provision for varying periods" (p. 2). Today, post-COVID-19, academic staff go to great lengths to sustain the BL competencies that the pandemic had compelled them to master.

The current study explores a structural, BL-related change introduced during the pandemic to the curriculum of an Israeli teacher education college. The overall aim is to endorse what Zhao and Watterson [5] consider as one of the positive elements brought to higher education by the force of harsh circumstances.

The college timetable pre-COVID-19 comprised two twelve-week semesters, with three to four days of learning per week. With very few exceptions, all academic college-based courses were conducted on campus in face-to-face (F2F) sessions. The new timetable, constructed in the wake of COVID-19, comprises three weeks of F2F on-campus sessions followed by a week of remote learning at the discretion of teacher educators (TEs), who are given full autonomy to arrange the module. To implement the BL design, the college rector asked all TEs to modify their syllabi, detailing the online components of their respective courses. In this task, the TEs were offered the assistance of techno-pedagogical experts, albeit with no infringement of their academic autonomy, including the mode of teaching:

they could teach synchronously via Zoom or upload asynchronous assignments to the course website on Moodle. According to [6], these changes in the timetable may be viewed as two critical success factors for BL implementation: the educational institution's strategy and receiving organizational support.

A preliminary study (Biberman-Shalev et.al, submitted) found that both TEs and student teachers (STs) were highly satisfied with this new BL timetable. Gauging the extent of their satisfaction, however, is only a starting point in understanding BL as a promising post-COVID-19 change.

Of the various elements of BL as an educational context of curriculum design [7], the current study focuses on the pedagogical aspect of the online module, based on the new BL timetable of the college sampled as a case study. Following Megahed and Ghoneim [8], this study operates with a wider definition of the concept of pedagogy, incorporating not only the technicalities of teaching but also the instructors' rationales and values, as well as the theoretical foundations and evidence base of their teaching choices and practices, and the relevance of the latter to the real world. All these aspects are explored with reference to STs' evaluations regarding the success of the pedagogies implemented.

Examining both TEs' and STs' attitudes and evaluations regarding the success of the pedagogies may help promote this new, post-crisis educational approach [9]. At the same time, a closer look at the pedagogies as such will enrich the hitherto sparse and inconclusive evidence as concerns the online module of the new BL modality—a need identified and highlighted by Rasheed and colleagues [10].

2. Literature Review

2.1. BL in Teacher Education

During the COVID-19 pandemic, all schools implemented substantive changes, the foremost of which was switching to remote learning, thus necessitating and precipitating modifications in teacher education. BL was empirically found to support an effective teaching–learning process for different kinds of learners by increasing interaction between teachers and their students, offering flexibility, boosting learning engagement and motivation, and more [10]. However, the corpus of studies on integrating BL in teacher education is still deplorably small [11]. Howard [12] describes how general education faculty staff, for all intents neophytes of BL, navigate the contextual shift from F2F to BL and negotiate their professional identities. She found that attitudes toward BL among the staff are largely negative, owing to a sense of ineffectiveness, uncertainty, personal disharmony, and devaluation of their pedagogical worth. This mindset resulted in the erosion of their professional identity, which in turn reduced their self-efficacy and caused them to underutilize subject expertise, while at the same time increasing administrative roles and widening divisions between faculty and students. On a more optimistic note, other studies point to the unique opportunity created by the pandemic to embrace positive changes in the education systems, including teacher education institutions [1].

2.2. Considerations in Activating BL

The potential of BL, defined as the "organic integration of thoughtfully selected and complementary F2F and online approaches and technologies" [13] (p. 148), lies in creating rich learning opportunities for diverse students to actively engage in shaping their learning [14].

While, as of late, BL has occupied a center stage in teacher education as a viable means of rendering teaching practices more flexible, relevant, and attractive, its implementation in practice is still a matter of trial and error [15–18]. As challenges, studies highlight course management, workload, overlaps, and achieving harmony between the two modules, in terms of media and technologies, on the one hand, and the design and learning approaches on the other [19].

As caveats that blended course developers should be aware of, Graham [20] identifies six points: "(1) the role of live interaction, (2) the role of learner choice and self-regulation,

(3) models for support and training, (4) finding balance between innovation and production, (5) cultural adaptation, and (6) dealing with the digital divide" (p. 14).

Graham's findings [19] largely dovetail with those of Gedik et al. [19], who investigated instructors' experiences in designing and implementing a blended course in teacher education. These authors propose three main categories: (1) considerations regarding the pedagogical approach: creating harmony between the F2F and online components; promoting learner-centered and authentic learning; (2) considerations regarding course organization and preparation of materials: balancing the F2F and the online portions of the course, gathering the F2F and online materials, uploading and organizing the online documents and links for further group discussion and reflection, and preparing the F2F meeting for important new content; (3) considerations regarding interaction and roles: instructor–student interactions took place mostly in F2F meetings via question–answer and discussion sessions; the only online venue where the students could actively interact with the content and their peers was an online forum. The instructor's aims were to make the students active participants, facilitate discussions, arrange course activities, provide information, coordinate group work, etc.

Like Gedik et al. [19], Oliver and Stallings [21] also present three broad considerations behind BL implementation: (1) contextual considerations: such as the suitability of topics and subjects for blending; learner challenges; and available scaffolds; (2) instructional strategy and teaching considerations: the right mix of student-centered, project-based instruction and collaborative activities that are well supported by BL; and (3) technology considerations: appropriate resources for best support.

Conceptually, all the above-listed considerations regarding implementing BL in education are based on fundamental learning principles such as meaningful learning, activation, collaboration, and connections between content-based knowledge learned with the instructor F2F and its application in online environments.

2.3. The Role of Context in Curriculum Development

In its broader definition, a curriculum encompasses ideological, cultural, and contextual facets. Moreover, structurally affected by technological, economic, and social transformations, it is necessarily dynamic. Cahapay [1] defines a curriculum as "a plan that has elements" (p. 1), which he identifies based on Tyler's [22] classic model of curriculum studies and proposes as lenses for curriculum development in any circumstance or context: (1) goal, (2) content, (3) approach, and (4) evaluation. Exemplifying these elements in the post-COVID-19 arena, Cahapay [1] suggests examining curriculum contents for the possibility of reduction and integration, focusing approaches on shifting to the online mode, and ensuring that the evaluation is cohesive and logical. As surveyed in the previous section, research into BL deals mainly with the rationale for designing the curriculum. Since pedagogy is a major aspect of a curriculum, pedagogical concerns in BL are related to the context, content, and learning environment. In keeping with these guidelines, any examination of BL should first and foremost address the question, Which of the above core facets of a curriculum does it target and in what way?

Saavedra and Steele [23] likewise advocate a broader definition of a curriculum that incorporates conditions of time, space, and methodology, arguing that these aspects have an explicit impact on how a curriculum is designed and realized. The situational context is also central to Fullan's [24] conception of a curriculum, whose implementation, he argues, is largely determined by the available means to accomplish desired objectives, and therefore it needs to be translated to classroom practices. In a similar way, in discussing the interface between curriculum and context, Luke [25] regards the idea "[t]hat curriculum sits within context [as] a central axion of curriculum theory, development and implementation" (p. 145). In such an understanding, "context", as a key concept in curriculum implementation, encompasses all the conditions in which the educational process takes place. This approach takes count of the diversity and complexity of cultural contexts embedded in school life, in teacher education, and in instruction in general. It is thus not incidental that the discourse on curriculums is central to the post-COVID-19 agenda. In the current study, BL is perceived as the new context of the post-COVID-19 curriculum design in the teacher education college's timetable. In particular, this study focuses on the pedagogical aspect of this curriculum design, i.e., the TEs' preferences and their considerations for instruction in the synchronous and asynchronous modes of the online module.

Zhao and Watterston [5] argue that today's uncertain and rapidly changing reality requires a reconceptualization of curriculums at their core. Although it is important to define a curriculum framework at the system level, it should be sufficiently flexible to afford autonomy to schools to introduce changes. In teacher education, this would entail that TEs and STs should jointly rethink the purposes of teaching within the new curriculum design, and where and when learning should take place. The focus should thus be put on preparing teachers and lecturers for a new role, no longer as deliverers of content and skills alone, but as educators, consultants, and resource curators. In this regard, three research questions were phrased as follows:

1. What pedagogies do TEs opt for in the online component of the new BL timetable?
2. What considerations guide TEs in activating these pedagogies?
3. How did TEs and STs evaluate the success of these pedagogies?

3. Materials and Methods

3.1. Research Design

This study used a methodological-triangulation research design to assess TEs' and STs' attitudes, considerations, and evaluations of the success of various pedagogies, which were activated across the online component of the new BL timetable. The concept of data triangulation refers to the use of multiple data sources in the same study for interpretation and validation purposes. Hussein [26] views triangulation as a "classical type of combining qualitative and quantitative methods in studying the same research phenomenon" (p. 106). The current study is based predominantly on quantitative data, with qualitative input used to support the interpretations thereof, with the main object of uncovering TEs' considerations for activating the various teaching tools.

The new BL timetable was integrated post-COVID-19 into the 2021–2022 academic year. The attitudes of both TEs and STs regarding the new BL timetable were gauged based on a non-probability convenience sampling. At the end of the first semester of the academic year, after experiencing structural changes for at least three months, all the TEs and STs in the college received a link to an anonymous Google Form online questionnaire. To keep more ethical aspects, the filling of the questionnaire was voluntary.

3.2. Participants

Two populations were targeted: the entire academic staff and all STs in the college, of all levels and affiliations. The survey was completed by 76 TEs and 553 STs, with a return rate of 25% for TEs and 28% for STs—a relatively large percentage considering that TEs and STs typically do not cooperate in filling out surveys. The gender distribution among both TEs and STs is representative of the college as a whole.

Of the ST respondents, 90% were native Hebrew speakers; 5% were native Arabic speakers; 3% were native Russian speakers, and 2% did not specify their native language. Of the B.Ed. STs, 43% were in their second academic year; 26% were in their first year; 18% were in the third, and 13% were in their last academic year. Of the M.Ed. STs, 62% were in their second year and 38% in their first year. The main demographic data for STs and TEs are demonstrated in Table 1.

Table 1. Main demographic characteristics of the ST and TE participants.

Characteristics	Frequency (%)	
	STs (N = 553)	TEs (N = 76)
Gender		
Female	509 (92)	63 (83)
Male	44 (8)	13 (17)
Academic program		
B.Ed.	357 (65)	59 (78)
M.Ed.	77 (14)	6 (8)
Career changers	119 (21)	11(14)
Disciplinary Specialization (B.Ed.)		
Mathematics and Science	75 (14)	14 (18)
Humanities	134 (25)	17 (22)
Art and Music	195 (35)	9 (12)
English (as a foreign language)	52 (9)	6 (8)
Special education	58 (10)	12 (16)
Pre-school education	39 (7)	18 (24)

The mean number of years on the job for TE participants stood at 12 years (S.D. = 8.4); only 7% of the TEs were lecturers in the M.Ed. programs, while 68% lectured in the B.Ed. programs, and 25% were pedagogy instructors in the practicum (kindergarten and schools).

In addition to the survey, 10 TEs participated in two focus groups, 5 in each. These TEs were selected using a snowball convenience sample, such that each of the three researchers, who work at the same college, approached colleagues whom they knew personally and who reported having filled out the survey questionnaire, and suggested they participate in the focus groups. Seven of these TEs were lecturers in the B.Ed. and M.Ed. programs, teaching courses and research seminars in education, mathematics, science, and Hebrew literature, and three were pedagogy instructors. All 10 participants gave their informed consent for inclusion before participating in the focus groups. This study was conducted in accordance with the Helsinki Declaration, and the protocol was approved by the Ethics Committee of the college sampled (ethics approval code 2023010401).

3.3. Data Collection

Adopting a mixed-method approach, this study used a questionnaire and two focus groups. The questionnaire was based on a unique survey that was developed by the Institutional Research Authority of the college. The main aims of the survey were to evaluate the TEs' and STs' extent of satisfaction with the new college timetable and to explore the participants' needs and concerns. This survey was validated by four scholars who work in the college. The validation of the assertions included in the questionnaire was approved by a full agreement. Assertions that were not received a full agreement were removed from the questionnaire. The survey to assess the TEs' and STs' attitudes towards the pedagogical aspects of the online component of the new BL timetable was structured as follows. The first part comprised demographic items adjusted to each target population (e.g., training program affiliation and seniority). The second part contained a list of six pedagogies, to be rated in terms of their frequency in the online component of the BL timetable, and success (using a 3-point scale, ranging from 1: not successful to 3: extremely successful). In addition, the version presented to the TEs included two additional items. One targeted the time allowed for completing an asynchronous assignment, based on four answer options, e.g., "one to two days before the ensuing F2F course meeting" and "by the end of the semester". The second item was likewise categorial, gauging the way the above asynchronous assignment was assessed based on six answer options, e.g., grading some assignments and marking down the rest as submitted/unsubmitted, and discussing the assignment F2F in the upcoming course meeting.

The aim of the two focus groups was to shed light on the TEs' considerations and preferences in activating the various pedagogies in the online component of the BL timetable.

Accordingly, the discussion revolved around two main questions: (1) What pedagogies do you opt for in the online component of the BL timetable? and (2) What are your considerations in activating these pedagogies? Each group discussed these issues for 60 min, and then for 10 more minutes, summarized the issues and ideas during the discussions.

3.4. Data Analysis

First, data were analyzed quantitatively using the SPSS 24th version. The quantitative analysis was based on descriptive statistics and T-tests measuring the differences between the evaluations by TEs and STs of the success of the pedagogies on the list. Next, TEs' considerations discussed in focus groups were subjected to a thematic analysis [27], and the reliability of the themes that emerged therefrom was confirmed by researchers' independent interpretations. Any minor differences were resolved through discussion [28]. The purpose of the qualitative analysis was to illuminate the quantitative results and to ensure their reliability.

4. Results

Regarding the six pedagogies targeted in the online component, 86% of the TEs reported utilizing asynchronous self-learning based on reading theoretical resources; 84% utilized asynchronous meetings integrating MOOCs, YouTube, Podcasts, and gamification; 74% utilized synchronous lectures via Zoom; and 67% utilized synchronous group learning on Zoom. TEs' and STs' evaluations regarding the success of the six pedagogies are presented in Table 2.

Table 2. Descriptive analysis of TEs' and STs' evaluations regarding the success of the six pedagogies targeted.

Pedagogies	Extent of Success	
	STs N = 553 M (S.D.)	TEs N = 76 M (S.D.)
Synchronous lecture via Zoom	2.59 (0.67)	2.66 (0.55)
Integrating MOOCs, YouTube, Podcasts, and gamification	2.56 (0.72)	2.73 (0.57)
Asynchronous self-learning based on theoretical resources	2.48 (0.76) *	2.20 (0.73) *
Synchronous group learning via Zoom	2.36 (0.77)	2.51 (0.74)

Scale: Low = 1; High = 3; * $p < 0.01$

With the exception of asynchronous self-learning based on reading theoretical resources {$t(627) = 2.87$; $p = 0.004$}, all the differences between the mean scores of the *t*-tests for TEs and STs emerged as non-significant. Overall, the results indicate that the pedagogy regarded as more successful among TEs was integrating MOOCs, YouTube, Podcasts, and gamification, while among the STs, it was synchronous lecture via Zoom.

The results for the item gauging TEs' preferences regarding the time for completing an asynchronous assignment geared for the distance module are presented in Table 3.

Table 3. Distribution (%) of the time ranges allowed by TEs (N = 76) to complete asynchronous assignments.

The Time Range for Completing Asynchronous Assignments	Frequency (%)
	TEs N = 76
Finishing the assignment one to two days before the upcoming F2F meeting	58 (76)
Finishing the assignment by the end of the semester	15 (20)
Finishing the assignment by the end of the current meeting	3 (4)

The above results indicate that, overall, TEs were flexible and allowed STs to take charge of and manage their workloads. They may also point to a connection between the remote and the F2F module, as the replies of most TEs imply that STs managed to finish the assignments close to the upcoming F2F meeting.

TEs' responses as to the ways they evaluated the asynchronous assignments are displayed in Table 4.

Table 4. Distribution (%) of TEs' (N = 76) preferences in evaluating asynchronous assignments.

Ways to Evaluate the Asynchronous Assignments	Frequency (%)
	TEs N = 76
Grading some assignments and marking the rest as submitted/unsubmitted	31 (40)
Discussing the assignment F2F in the upcoming meeting	17 (22)
Grading all assignments and weighing them in the final course grade	14 (19)
The assignments' solutions were uploaded to the course MOODLE website, but were neither graded nor discussed	7 (9)
The assignments were not evaluated but only marked down as submitted/unsubmitted	5 (7)
The assignments were neither graded nor registered in any way	2 (3)

The above results suggest that TEs saw the importance of evaluating tasks and assignments, but were flexible as to the proportion of assignments they graded in every given case. Only a few TEs reported assigning a task without any follow up.

Data from the two focus groups attest to a variety of synchronous and asynchronous pedagogies implemented in the online component, following a range of rationales. The pedagogies and considerations for using them are presented in Table 5. It is noteworthy that the same rationale could govern the use of more than one pedagogy. For example, the one-on-one consultation and group project pedagogies were motivated by the same consideration of shifting learning responsibility to the STs. Furthermore, most of the activated pedagogies were guided by STs' needs—a finding that sparked stormy discussions in the focus groups. It is evident that, essentially, the process of selecting the pedagogies for the online module was negotiated jointly by TEs and STs—a circumstance that TEs described as a new and unfamiliar phase in their relationship with their STs, ascribing it to the post-COVID-19 shift to BL. They further relayed that STs had expressly inquired about the pedagogies slated for the online component and had often debated with the TEs whether to opt for synchronous or asynchronous learning, and how much time should be allocated for the asynchronous assignments.

Some of the TEs reported that, to better cater to their STs' needs, they usually asked them at the end of a F2F meeting if they preferred the next session to be synchronous or asynchronous. For example, one of the TEs said, "I ask them [the STs] if other TEs will teach them via Zoom and if they prefer that I upload an asynchronous assignment to the course Moodle. I am worried that the STs will be overworked in the distance module and that the week's learning will be ineffective and also annoying." Other TEs mentioned the importance of modeling: "When I take into account their [the STs] preferences, I think that this is good modeling, and hope they will be attentive to their future students' needs"; and "I think it is important to model for them how to design an effective asynchronous meeting in case they will need to teach their students remotely." These examples elucidate the quantitative results in which most TEs rated integrating MOOCs, YouTube, Podcasts, and gamification as the most successful remote pedagogy. In this, however, they differed from STs, who preferred synchronous meetings via zoom by a large margin.

Moreover, some TEs stated that, in a F2F meeting, they always previewed the next asynchronous assignment and informed their STs if it would be graded. In the next F2F session, they asked them if they had found the assignment useful and/or fair. These TEs felt that expressing interest in the needs and attitudes of their STs contributed to a congenial learning climate, boosted motivation, and improved the continuity of the course. These qualitative findings are in keeping with the quantitative data to the effect that most TEs requested that the asynchronous assignments should be completed a couple of days before the ensuing F2F meeting.

Table 5. TEs' considerations for activating synchronous and asynchronous pedagogies in the online component of the new BL timetable.

Considerations	Synchronous Pedagogies			Asynchronous Pedagogies				
	Frontal Lecture via Zoom	Breakout Rooms via Zoom	One-on-One Consultation	Presentation and Drill Activity	External Media Resource and Posting in a Blog or Forum	Activity Based on Relating Theory to Practice	Group Project	Reading Theoretical Resources
STs' needs								
Focused uninterrupted learning			+	+	+	+		+
Ventilating the meeting		+					+	
Decreasing the workload	+		+	+	+			
Perceiving long Zoom meetings as not effective			+	+	+	+	+	+
Understanding the relation between theory and practice				+	+	+		
Experiencing integration of media in teaching and learning				+	+			
Practicing the material taught F2F when and where deemed convenient				+	+	+	+	
TEs' needs								
Lecturer's convenience	+	+			+	+	+	+
Allocating time for TEs' pedagogical/academic development					+	+	+	+
Avoiding bad experiences in STs' self-directed learning	+							
Responsibility for the academic institution's timetable	+	+						
Disciplinary content needs								
Material outcome	+			+				+
Course content can be learned only through frontal teaching	+			+				
Pedagogy approaches and Roles								
Shifting learning responsibility to the STs		+	+	+	+	+	+	+
Fostering TEs–STs relationship		+	+		+			
Advancing differential teaching		+	+				+	
Modeling of scaffolding, communal learning, and social interaction in online spaces		+			+		+	
Developing critical thinking and a multi-perspective orientation		+			+		+	+
Flipped classroom	+			+	+	+	+	+
	7	9	6	11	15	9	12	9

Other TEs in the focus group argued that, to the extent that pedagogies applied in F2F sessions are not negotiable, the ones used in the online module need not be discussed with STs either. The online component is not a "marketplace," they quipped, and enabling STs to decide which pedagogies to use may cause chaos and undermine the importance of the distance module. These TEs claimed that a pedagogy should be suited to the course contents (e.g., "Mathematics can be taught only frontally via Zoom"). Several TEs contended that a pedagogy must necessarily be contingent on the character of the course (i.e., introductory course, seminar, or workshop), e.g., "In my science course, I have no choice but to meet them via Zoom as I need to cover the course contents. But in my seminar course, I am more flexible: I can utilize the distance meetings to personally guide the STs who need this, and instruct the rest to continue independently." A TE who teaches quantitative research methods shared, "At the beginning, I didn't think that the course could be taught online; I only knew that I had to find the best way to do it for my STs." She described designing a 25 min presentation and drill activity—a pedagogy whose success, according to her, was manifested in the STs' grades: "Their grades were higher than when only F2F sessions had been offered." She argued there was no room for negotiating: "I explain the character of the online component at the beginning of the course—and that's that!"

5. Discussion

This study investigated a new BL academic timetable designed and implemented post-COVID-19 in a teacher education college. A prior investigation found that both TEs and STs were highly satisfied with this timetable (Authors, submitted). Most research hitherto has explored BL as a whole; the current study adopted an innovative approach in isolating the online module and focusing on its pedagogical aspects, in an endeavor to better understand how to effectively integrate BL in post-COVID-19 education [10]. Using a teacher education college as a case study, the current research used a combination of quantitative and qualitative analyses to identify the pedagogies TEs activated in the distance module, their considerations in selecting them, and evaluations of both TEs and STs regarding their success.

A variety of synchronous and asynchronous pedagogies were identified. Of the synchronous pedagogies, the three most common were as follows: (1) frontal lecture via Zoom, (2) breakout rooms via Zoom, and (3) one-on-one consultations. The five most common asynchronous pedagogies were as follows: (1) presentation and activity, (2) reading external media resources and posting responses in a blog or forum, (3) drill with the object of relating theory to practice, (4) group project, and (5) reading theoretical resources. The asynchronous pedagogies utilized the most frequently were (1) self-learning-oriented assignments based on reading theoretical resources and (2) integrating media resources. The most frequent synchronous pedagogy was frontal lecture via Zoom. Overall, both TEs and STs rated the success of the pedagogies implemented in the online component as medium-high.

It is noteworthy that TEs and STs diverged in their perceptions of the most successful pedagogy: for TEs, this was the asynchronous integration of media resources, while for STs, a synchronous frontal Zoom lecture. This finding could be attributed to the perceptions of the two populations regarding their roles. It stands to reason that, in teaching the online module, TEs feel that they should act as role models for their students, while the students focus their efforts on mastering the material. Thus, the differing pedagogies rated as the most successful by TEs and STs may indicate the absence of a shift in STs' perceptions of their traditional role as passive learners. On the other hand, TEs' choices regarding the most successful pedagogy, as well as their objective to promote self-directed learning (see Table 5), suggest that, in the new post-COVID-19 educational arena, they recognize the need to prepare STs for online teaching. Furthermore, TEs' responses point to a degree of ambivalence about the online component. On the one hand, their ratings reflect an emerging understanding that the distance module can be marshaled to self-directed learning, while on the other, in their lower ratings of asynchronous pedagogies compared to STs, one discerns skepticism as to whether STs will be able to learn remotely.

Most of the TEs' considerations in selecting and implementing the various pedagogies were anchored in the classic precepts of curriculum planning: (1) STs' needs, (2) TEs' needs, (3) content requirements of the discipline, and (4) pedagogical approaches and roles. These underpinnings are in keeping with the classic model of curriculum development proposed by Tyler [22]. According to Tyler's framework, curriculum development is mainly influenced by society, students, and the subject specialist. In teaching remotely, TEs' considerations were primarily guided by their perceptions of STs' needs. Their responses may also suggest that TEs judged self-directed learning as the uppermost of such needs. Indeed, the most common synchronous and asynchronous pedagogies they reported implementing were motivated by the consideration that we categorized as shifting learning responsibility to the STs; the one exception, frontal lecture via Zoom, was related to TEs' bad experiences as concerns STs' self-directed learning, stemming in large part from misgivings that STs' difficulties in understanding complex material taught online might result in low teacher evaluations and complaints.

TEs' perceptions of STs' needs may have also shaped their understanding of the learning process in the online component of BL. The relevant considerations pertain to STs as learners (e.g., learning without interference), on the one hand, and as future teachers, on the other (e.g., experiencing the integration of media in teaching and learning). In the area of teacher education, these two dimensions in TEs' perceptions of STs' needs are apparent in their rating of the asynchronous pedagogy of integrating MOOCs, YouTube, Podcasts, and gamification as the most successful. STs' orientation as learners rather than teachers, on the other hand, can be inferred from their rating of the synchronous pedagogy of frontal lecture via Zoom as the most successful. Yet, this finding may also imply that STs believed TEs performed better when lecturing via Zoom, a traditional and familiar mode of teaching F2F, thus pointing to a need for professional pedagogical development.

TEs' views on the link between the two BL components can be inferred from their responses about asynchronous online assignments. Most TEs required their STs to finish such assignments one to two days before the ensuing F2F meeting. Moreover, most TEs graded some of the assignments while marking down the rest as submitted/unsubmitted; several TEs did not grade online assignments but only discussed them in F2F meetings. These findings suggest that TEs saw the two BL components as mutually complementary—consistent with Graham's [3,20] argument that, through their pedagogical choices, BL instructors should harmonize the F2F and the online modules. The TEs' grading styles may also reflect the flexibility afforded by the BL timetable, an advantage for both TEs and STs [18]. The flexible evaluation style may also alleviate TEs' and STs' overwork, thus meeting the needs of both populations. Singh et al. [28] advocate the use of formative assessments to supplement other assessment methods in BL, as they offer more flexibility and support tracking students' progress, as well as teachers' efficacy, during the semester. As considerations of time figured prominently in TEs' perceptions of STs' needs in the distance learning module, flexibility must necessarily be of importance. All in all, with the advent of BL, a shift seems to have occurred in TEs' understanding of curriculums, with the questions of when, where, and how teaching can and should be carried out increasingly gaining prominence [5].

Consistent with this change, a sizeable proportion of TEs seemed to regard the online component of BL as a negotiable space. While some of the TEs refused to negotiate with STs over the pedagogies for online learning, most felt this to be essential in the BL context. The attitudes of the latter group dovetail with Tyler's [22] argument that curriculum development is affected by both teachers and students. Those TEs who objected to such negotiation likely held onto traditional hierarchical and teacher-centered paradigms, still entrenched in academia [29].

As stated, a number of TEs felt that negotiating with STs over pedagogies is essential for promoting meaningful learning. Such a stand attests to a shift towards a more progressive pedagogical paradigm that focuses on the learner's growth and on making the learning experience meaningful to learners as individuals by allowing self-expression [30]. For many TEs, heeding STs' voices in an endeavor to understand their needs, be it the workload, the level of difficulty, or pedagogical preferences, was a key factor in making BL successful. In remote learning, the physical distance between TEs and STs may encourage TEs to shift to more student-centered pedagogies and move away from the traditional hierarchical conception of their roles. This idea is shared by Howard [12], who focused on the change in lecturers' roles and professional identity in online learning. Howard [13] defines "role" as "the framework of what a teacher is required and expected to do in the execution of their professional responsibilities" (p. 656). She cites several empirical studies which support her conclusion that, in remote learning, teacher roles tend to shift from imparting knowledge to raising learner autonomy, thus becoming facilitative-collaborative. She emphasizes, however, that the move to online learning does not automatically entail the adoption of a more progressive student-centric constructivist approach; moreover, there is evidence that lecturers may implement this approach also in the F2F component.

Insofar as context plays a substantive role in curriculum development, the perception of the distance module in BL as a negotiating space may also be a function of a contextual change, specifically, a transition from the pre- to the post-COVID-19 reality. Pre-COVID-19, STs learned mostly in F2F meetings, with no possibility for negotiation to speak of, as TEs determined what would be learned, how, where, and when. However, their experience in distance learning during COVID-19 may have revealed to both TEs and STs its advantages, such as flexibility and TE availability [31]. It may also have been conducive to negotiating some curricular aspects in the new, post-COVID-19 arena. If this tendency continues, it could put STs in a more equal position in developing the curriculum and deciding on the learning process [32].

This study has several limitations. First, teacher education is an area with distinctive characteristics in which TEs also act as role models in selecting and implementing various pedagogies, an aspect manifested by such thematic rubrics as modeling of scaffolding, communal learning, and social interaction in online spaces. One may argue that, in other academic contexts, the activation of pedagogies may be governed by different or additional considerations (see, for example, Attarbashi [33] and Orji et al. [34] regarding online components of BL in vocational and technical education, and in lab-based courses). In fact, this supposition is borne out by the insights derived from the focus groups, in the sense that the various courses in the same academic department or program may act as micro-contexts within the context of BL. This insight reinforces a conclusion of the current study that pedagogies for the online component, or indeed a judgment as to whether a course can be meaningfully taught online, are contingent on TEs' perceptions of their respective courses and how they should be taught.

Another limitation is related to the ecological context of this study. All the participating TEs and STs had direct access to requisite technology and the internet. Yet, investigating developing South Asian countries where such access is limited, Ahmed et al. [35] found that students who used mobile internet preferred offline classes, whereas students with access to broadband internet preferred studying online. Finally, a methodological limitation of this study is related to using existent survey data that were not directly related to the TEs' consideration for activating pedagogies. Thus, future research should develop a questionnaire that directly examines this important aspect.

Policymakers and stakeholders who advocate for and promote BL as a constructive post-COVID-19 curricular change need to take count of distance learning models implemented in a wide range of higher education areas. The online component of the new BL timetable discussed in the current study acted as a negotiation space in which learners' needs are put at the center. It is important to realize, however, that such negotiations can be narrowed down to instrumental and/or pragmatic issues, and raise the following question: why is it important to learn a particular material F2F if it can be learned remotely, saving time and money? The current study addressed TEs' considerations regarding pedagogy, including more questions that are raised, such as the following: what content in a course should be learned F2F and which online, and why? What are the advantages of learning specific content online? How can scaffolds be provided in online modules? What kind of scaffolding would promote self-directed learning of a given content? How can course continuity through appropriate sequencing of the two BL components be achieved?

Promoting meaningful negotiations over the above and a ream of other issues requires rigorous scrutiny of multiple pedagogies implemented in remote learning and of their contribution to the learning process. Such investigations can address a combination of generic curricular elements such as what, why, how, and the situation-specific aspects of where and when. However, the two related overarching considerations in any given case should be as follows: whether or not to resort to BL and what aims can be achieved by doing so. The current study focused on the reasons for the move to BL that was undertaken in a specific pedagogical paradigm.

Overall, within a new BL academic timetable inaugurated in education institutions following the transition to the post-COVID-19 era, the use of both synchronous and asynchronous pedagogies has been motivated by a variety of considerations, the uppermost of which were those pertaining to contextual changes. In the case study examined in this research, the context in which BL—and particularly its online component—took place was found to contribute substantively to a shift in pedagogical paradigms and roles.

In sum, this study may present two main contributions: (1) when exploring the pedagogies activated in BL, one should refer to 'pedagogy' as a wide concept, i.e., not just practices or strategies, but rather the rationale and considerations that facilitate practices, and (2) understanding the significant role of context in shaping pedagogy, in its broad sense. In the current study, BL, as an educational context shift that was unprepared and mandatory, was still found to encourage a positive change in pedagogies, i.e., TEs' practices and the considerations to activate them.

6. Conclusions

The current study investigated a new BL academic timetable designed in a teacher education college following the transition to the post-COVID-19 reality. The findings lend themselves to four main conclusions: (1) in college courses, the choice and application of pedagogies are responsive to changes in the curricular structure of the college timetable (2); a gap may arise in the perceptions of lecturers and students regarding the success of pedagogies implemented in the online component of BL; (3) the distant learning module may serve as a negotiation space for lecturers and students to discuss pedagogies and the rationales thereof; and (4) the design of the online component of BL should support students' positive and meaningful experience of self-directed learning, thereby tempering their preferences for pedagogies endorsing passive learning.

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education sciences

Article

Effects of COVID-19 Pandemic on Students' Written Outcomes: An Interior Architecture Research/Theory Module Case Study in the UK

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Abstract: Different learning methods (online, blended, blended-online and face-to-face) have been examined widely since the late 1990s. Although many design studies discuss engagement with these new methods in relation to studio modules, research/theory modules have not been investigated yet for interior architecture with both qualitative and quantitative data as a holistic approach. This study reveals how the new blended online learning method and the COVID-19 pandemic affected students' written outcomes in a research/theory module that accompanied their design module. For this purpose, the final written submissions of two year groups (2019–2020 vs. 2020–2021) are compared with both qualitative and quantitative analyses: their grades (performance), image (visual productivity) and reference (engagement with research) numbers and NVivo word count analyses (semantic analyses). The results show no significant difference between these two groups for both qualitative and quantitative analyses. Moreover, the study reveals that the numbers of images and references are good predictors for the grades of final-year students, thus showing their contribution to overall performance. Final-year research/theory modules in interior architecture might therefore be taught with blended online learning methods and can challenge, innovate and tailor studio teaching to contemporary needs. The study findings will be beneficial for educators and professionals, as well as managers, institution administrators, policymakers and decision-holders in HE who aim to employ blended online learning.

Keywords: interior architecture; blended online learning; COVID-19; research modules

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1. Introduction

Until late 2019, 'pandemic' was not a familiar word for many people. Now, we are all affected and shaped by the COVID-19 outbreak (a.k.a. the pandemic) and its effects on our everyday lives: it changed us, our lives and our societies forever. There is no area that has not been affected by the pandemic and its consequences. While lockdowns and self-isolations were becoming normal parts of our lives, we learned to adapt ourselves to our residential interiors. We worked, studied, socialized and exercised in them and that changed how we experience interiors [1]. For design education, Marshalsey and Sclater [2] (p. 832) discussed the intersection of "physical and online environments with home/domestic environments". Higher education (HE) has been changing since early 2020 because the COVID-19 outbreak forced lecturers across the globe to convert their teaching strategies to fully online lessons while requiring their students to practice teaching and learning (T and L) activities in their homes and dormitories. Thus, our residential interiors quickly became our T and L interiors [3]. Almost all education institutions switched their traditional education systems online after the COVID-19 outbreak in March 2020. Their students, who previously had access to campus spaces, had to learn how to manage their learning in their residential interiors without any physical contact with lecturers, other students, a classroom and so on [3,4]. Meanwhile, lecturers struggled to adapt their teaching to the limitations of new and existing online platforms. Such facilities existed long before the pandemic, but engagement with them was poor and uneven, meaning lecturers that had under-utilised such platforms struggled more than their more experienced colleagues. But the change had to happen within days for most educators and students. Without exception, students, parents and educators are affected by this shift. Yet, HE experienced some positive outcomes and experienced the advantages of online education e.g., instant feedback [5]. Marshalsey and Sclater [2] (p. 826) claimed that the "technological campuses of tomorrow have manifested" with the pandemic. Therefore, despite its tragically negative effects on education, the pandemic indirectly contributed to the future of T and L.

Most technologies frantically employed during the pandemic had been available for some time, but educators hesitated to use them in their teaching. Prensky [6] defined two groups: digital natives and digital immigrants. Digital natives refers to the generations that spent their formative years with technological innovations. On the other hand, digital immigrants were not born into a digital world and had to learn about this world later in their lives [6]. According to his study, these two groups are as different as people who are natives to a language and immigrants who have accents in those natives' language. Prensky [6] described digital immigrants as fascinated by new technologies despite only meeting them later in their lives. Yet, the last two decades proved that not all digital immigrants are fascinated by technology. On the contrary, some digital immigrants resist such technologies in their teaching, even if they are simultaneously using them for convenience in their daily lives. Mitra [7] states that the students of today are more familiar with and comfortable using online tools; therefore, online collaborative learning activities are more acceptable to them. Considering that online learning technologies will continue to advance, and contemporary students will become more skilful in using them, it can be predicted that using online learning tools will be a permanent and imperative part of HE in the future.

2. Literature Review

2.1. Face-to-Face (F2F) versus Online Design and Delivery (ODD)

There are several terms that might be used to define different online delivery methods. To avoid confusion, Power's [8] framework is embraced in this study (see Figure 1): online learning (OL), blending learning (BL) and blended online learning (BOL) as different learning methods for ODD (see Figure 1). Power [8] defined blended learning as both synchronous—a real-time interaction [7]—and asynchronous—offline activities that are sourced for an online course [7].

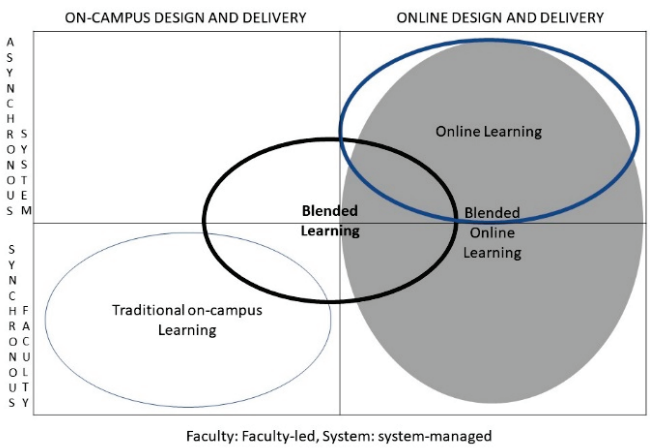

Figure 1. Blended online learning and its relationship to other learning methods (adapted from Power [8] (p. 510), which has a Creative Commons license).

Mitra [7] pointed out that online T and L is rooted in distance learning, a phenomenon with almost 300 years of history (see Figure 2). Distance learning has evolved with improvements to communication technologies, from radio to the internet [9], while it provides equal access to underrepresented groups (non-traditional students as mentioned by [10]. Similarly, Sagun et al. [11] (p. 334) discussed how online T and L supports "disabled students who cannot physically attend in the classroom" and inclusiveness on a sociological level. Miller and Lu [10] reported many advantages of OL courses for non-traditional students before the pandemic (such as working students and people from lower economic classes) and their contribution to growing enrolment.

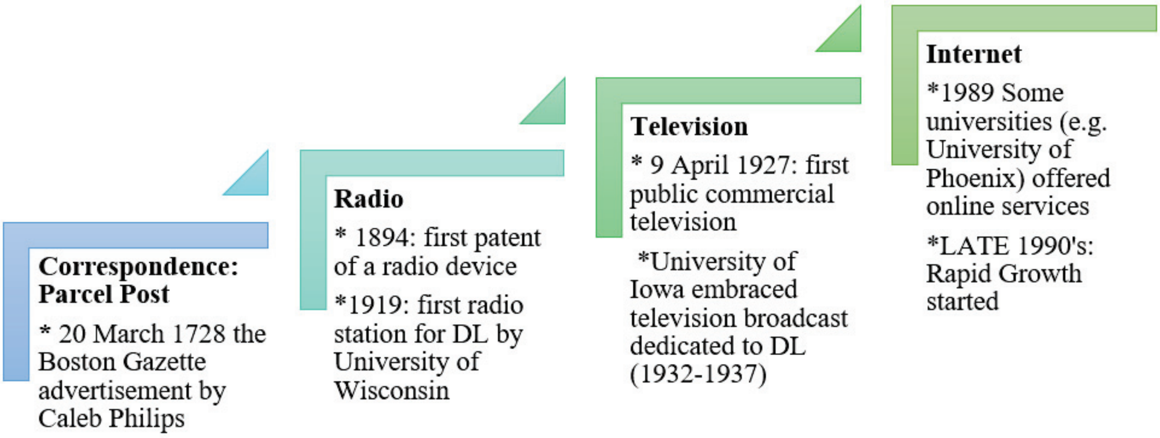

Figure 2. Evolution of Distance Learning (sourced from [9]).

One very visible and immersive change due to the pandemic was the migration from F2F to OL or BOL, and then (mostly after September 2020) for some institutions to BL. Within a relatively short time research studies emerged focused on its effects [12,13]. Lei and So [14] (p. 5) stated that even though online education is disadvantageous for students lacking discipline, its positive effects cannot be ignored. Online T and L requires fewer resources and staff and a smaller budget for HE institutions; thus, it is practically desirable [15]. Yakin and Linden [5] mentioned the negative effects (mostly technical problems and limited content) and positive effects (instant feedback and independent learning) of ODD on students and proposed that adaptive lessons enhance student engagement, motivation and performance. Online design and delivery provides flexibility (both time and space), opportunities for learners to repeat the same content as much as they need to and can benefit students even in hands-on courses such as dentistry [5].

An early study demonstrates that ODD has short-term (facilitating learning and improving curricula) and long-term (enhancing technology skills that increase employability) benefits for students [16]. Baker and Unni [17] (p. 46) revealed no differences in student satisfaction between online and F2F courses for both Asian and American students, which might be interpreted as a universal consideration of ODD. Moreover, they revealed the similar extended advantages of OL for traditional students, such as "enhanced communication among the learners" [17] (p. 50). Many studies mentioned the successful and smooth transition to ODD (with its learning methods: OL/BL/BOL) during the pandemic [5,12,18,19], with their success relying on teachers' engagement [20] and investment in technology and systems [12]. Marshalsey and Sclater [2], Dreamson [21] and Marshalsey [3] reported that previous experience with ODD provided benefits during the pandemic. Likewise, Park [22] suggested that teachers' capacity determined the success of OL courses, without taking into account the emergency transferring of design education to online formats during the pandemic. This proves the vital role of lecturers in the learning process.

Luckily, these novel learning methods were not totally new for HE. Some institutions had already transferred distance learning to OL and/or BOL after the internet had become an accessible option for their students [8]. A vast number of studies explore the difference between ODD and F2F learning, concluding that there is not any significant difference between the two (e.g., [23]). The website (No Significant Difference, available online: http://www.nosignificantdifference.org/ (accessed on 15 November 2021)) provides a number of sources that prove any differences between ODD and F2F methods are insignificant. Although the website and the literature presented rigorous and consistent results, studies are relatively rare for the interior architecture and design (IAD) discipline before the pandemic [24]. There is no study comparing F2F and BOL methods with both qualitative and quantitative data as a holistic approach for research/theory module deliveries in IAD courses. One reason is that many IAD lecturers were not accustomed to ODD methods before the pandemic and their resistance meant the discipline could not adapt to changing technologies and skills for the interior architects/designers of the 21st century. Their unwillingness to embrace online elements in F2F teaching created a more challenging migration to ODD during the unpredictable and emergency conditions of the pandemic. From this perspective, the pandemic might be a blessing for those courses whose staff has reservations about ODD methods. More research studies can contribute to resolving their qualms.

2.2. Online Design and Delivery in Design and Architecture Education

A growing trend in education has seen more students enrolling in online courses every year [9]; however, only a "few fully online design courses" were available before 2020 [24] (p. 2). For example, The Open University has offered design courses for decades, the planning of which took years, which shows that the challenge design educators faced during the pandemic was overwhelming [25]. The pandemic accelerated the spread of online education across the globe, especially in disciplines such as design/architecture that were not taught mostly online [26]. Until the pandemic, IAD courses had relied on F2F methods, as was the case with many other design/architecture disciplines. Nevertheless, a substantial number of research studies before the pandemic explored and discussed online design studio education in several countries [11,15,22,27,28]. For example, Sagun et al. [11] discussed web-based education in an IAD course in Ankara, Turkey, more than two decades ago and one of the first MOOCs (massive open online course) in product design was launched in Delft, the Netherlands (Delft Design Approach MOOC), just a few years before the pandemic [15]. As Marshalsey and Sclater explain, "studio education is considered a signature pedagogy and has a distinct set of guiding principles such as facilitating critical play, thinking and making, and a pedagogy of ambiguity" [2] (p. 826). Dreamson [21] (p. 495) challenged the execution of traditional F2F studio teaching:

> *"In essence, the atelier model is often romanticised for design studios, yet its apprenticeship system could not be a sound approach in the digitally networked world where the speed of updating knowledge and skills through the network is tremendously faster than the transition from masters to apprentices . . . This means that design studios could no longer be the mainstream route for career development."*

One prominent reason for design education's lack of engagement with ODD was the lecturers' reluctance to deal with the challenges of these methods [10,21,26,27,29] before the pandemic, which forced them to improve and update their teaching skills under unprecedented conditions. Dreamson [21] (p. 485) stated that George [30] revealed critical barriers, one of which was "instructors' beliefs—studio-based learning cannot be replicated" and Dreamson [21] concluded that ODD's barriers and challenges are social components. Considering previous studies (e.g., [20,22]), lecturers and their commitment are very important for T and L and students, and their resistance and reluctance cost HE (socially and financially) and, potentially, come at the cost of student employability.

2.2.1. Online Design and Delivery in the Design Studio

The studio is the main part of design education [22], and IAD learning, as with other design/architecture disciplines, consists of studio and lecture sessions [11]. The BOL and BL methods in the design studio have been embraced by interior architecture [11,27,28] and architecture disciplines [31]. One study before the pandemic [11] revealed the social, ideological, epistemological and pedagogical advantages of combining asynchronous and synchronous learning methods, which apply to BOL. Several research studies about online design education [2,3,11,15,22] reported positive effects from flexibility, accessibility, recorded sessions, low budget, in-depth engagement, less distraction, avoiding everyday life necessities (e.g., commutes), better individual/group communication, personalisation, less formal communication with peers and lecturers and the easing of formality. After only two weeks, interior design studio students reported these advantages of online collaboration (most liked): ease of use/access; ease of sharing info and comments; convenience; the organization of materials in one place; and ease of reference [28] (pp. 483–484). Fleischmann [24] (p. 4) listed the further advantages of the online design studio, such as receiving feedback from outside experts, while claiming that there was no 'one size fits all' model. On the other hand, Jones and Lotz [4] (p. 4) mentioned several disadvantages and limitations of ODD such as the lack of "informal breakout spaces, etc.", which are hard to replace, alongside advantages such as international collaborations, making space for more voices than a traditional design studio and so on.

Sagun et al. [11] explained that online tools provide more control for students compared to physical studios, and shift students' engagement as they move from being passive listeners to more active learners. Ismail et al. [32] stated that the digital studio encourages dynamic and complex ideas. Iranmanesh and Onur [26] showed that the VDS (Virtual Design Studio) is superior to the PDS (Physical Design Studio) as it promotes self-dependence, a research-oriented approach, and provides more control for students (which underpins a student-oriented learning process). However, they did not propose the VDS as an alternative to the PDS, instead stating that a hybrid of the two with virtual reality might be the future of the design studio. Amro [20] and Alawad [29] explored the online interior architecture studio experience, Amro [20] stating that, although the pandemic caused a loss of motivation and high anxiety for design students whose online T and L required different approaches than other disciplines, that was overcome by their teachers' empathy, and students reported a positive experience in their overall design studio modules. Alawad [29] claimed that online the design studio is an attractive option that could enable the creative processes, and proposed combining the F2F and ODD methods' best properties, as do Pektaş [27] and Iranmanesh and Onur [26].

2.2.2. Online Design and Delivery in Research/Theory Modules

The BOL and BL methods in online research/theory modules have not been investigated as much as design studio modules in design education. Urban design [18] and fashion [33] disciplines reported positive changes in their T and L for research/theory modules with ODD. Peimani and Kamalipour [18] analysed their delivery before and after migration to online platforms due to the pandemic and the effects of BOL on T and L and concluded that challenging a fixed pedagogical framework is important for HE. Fernandes [33] focused on Millennials and GenZ—digital natives as defined by Prensky [6]—and aimed to integrate online group work as an innovative and productive assignment for a theoretical fashion module where they recorded positive effects on students. Online Design and Delivery offers many benefits, and previous studies show its positive effects on design/architecture disciplines. Interestingly, Marshalsey and Sclater [2] (p. 832) reported something that may appeal to lecturers who teach research/theory modules in IAD: "the student participants observed that online education had allowed them to study topics in more depth and detail, and that theoretical work was easier to comprehend".

Pektaş [27] proposed the blended studio environment, which sits well with the new generations' needs (a.k.a. digital natives) in design education and corresponds to social constructivist learning theories. They write that "social constructivist learning refers to an educational process that enables groups to create knowledge and meaning through co-creation" [27] (p. 694); thus, students become more active and independent participants in their own learning, as suggested by Sagun et al. [11] and Iranmanesh and Onur [26]. This also corresponds to Kolb's [34] experimental learning theory. A prior experimental interior architecture study [35], based on students' performance, revealed that all the learning styles from Kolb's theory [34] occur in design education and underscored that, through different design stages, all learning styles can be supported. Moreover, Zapalska and Brozik [36] stated that all learning styles can be applied to online environments as well. Daalhuizen and Schoormans [15] discussed Kolb [34] as a prerequisite for design education, proving it could be successfully applied to fully online courses with dedicated didactic tools for reflective online teaching. As with these previous studies, Kolb's [34] experimental learning theory and social constructivist learning theory provide the theoretical framework for this paper. There remains a gap in the literature over how learning methods affect students' written work in IAD research/theory modules, yet the pandemic enabled a comparison of the written work of the 2019–2020 and 2020–2021 year groups. Dreamson [21] points out that there is a need to engage pedagogically now the peak of the pandemic has passed. This study aims to contribute to this pedagogical engagement by exploring the effects of the pandemic and BOL on student written outcomes. For this purpose, the BOL and F2F methods were compared through students' grades, the number of images and the number of references used in their submissions and semantic analyses of their final year written work in an IAD course. The following research question was asked in this study:

Research Question: How did the conversion of T and L from F2F to BOL during the pandemic affect overall student performance and their written work in a research/theory module within an IAD course?

Sub-questions:

1. How were the semantic aspects of students' written work affected in the final year research/theory module for an IAD course, as a consequence of the pandemic?
2. How was students' visual productivity affected during the final year research/theory module for an IAD course, as a consequence of the pandemic?
3. How was students' engagement with research affected during the final year research/theory module for an IAD course, as a consequence of the pandemic?
4. How were students' final grades affected during the final year research/theory module for an IAD course, as a consequence of the pandemic?
5. How were students' grades and their number of visuals and references related to each other as an indicator of overall performance?

3. Methodology

This study aims to explore how the move to ODD enforced by the pandemic affected the written outcomes of student work using a single research/theory IAD module as a case study. Case studies, as a research method, have been employed by previous research studies from the entry-level [25] to the postgraduate level [37] and are proved to be a successful research method for design education studies in HE. Qualitative and quantitative methods were employed together to compare final year IAD final individual submissions for two different year groups (2019–2020, also known as 2020-year group: 30 students and 2020–2021, also known as 2021-year group: 19 students). All student works were examined, unless they submitted their work in the summer term as EC (extenuating circumstances) students.

3.1. The Research/Theory Module

Accompanying design modules, the aforementioned research module is taught throughout the academic year (see Figure 3), and it succeeds research modules of the first and second years (the course's website: https://www.lincoln.ac.uk/course/intintub/ (accessed on 12 December 2022)). It includes theoretical knowledge alongside research skills, through which students are asked to underpin their design process/outcomes with systematic research, and end with a submission of an academic research study as a written document with rich visuals corresponding to the IAD discipline (the course's website: https://www.lincoln.ac.uk/course/intintub/).

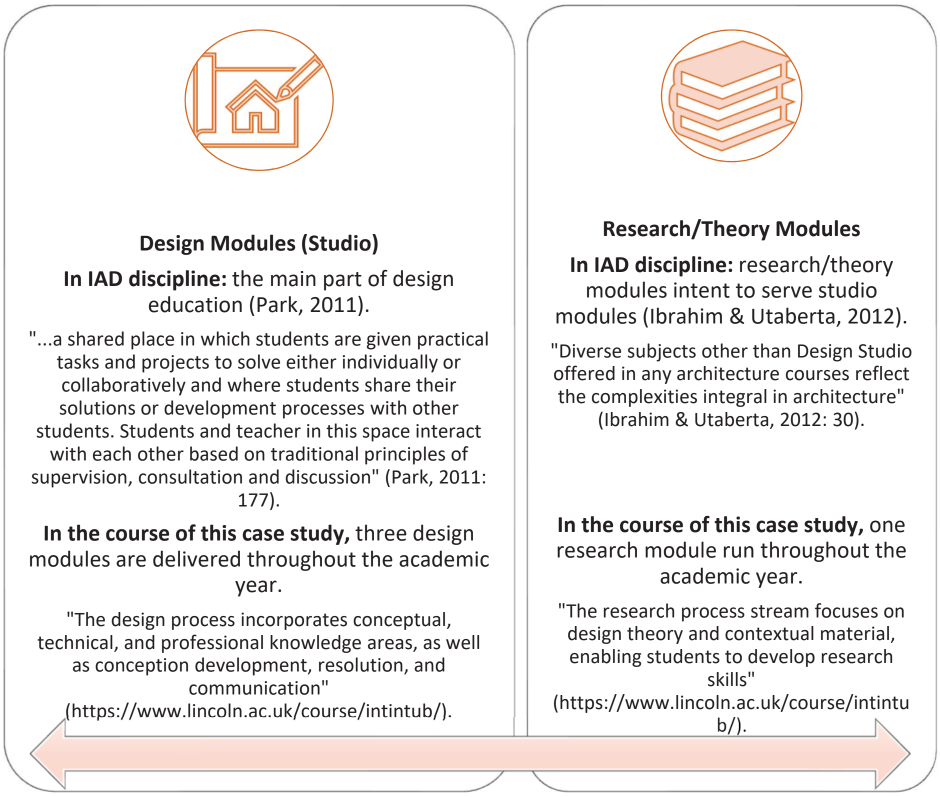

Figure 3. Relation of research and design modules (the course's website: https://www.lincoln.ac.uk/course/intintub/).

Both year groups used Blackboard (a digital learning platform) for auxiliary services (lecture PowerPoint presentations, etc.) before the pandemic, as many other institutions had [13]. In addition to asynchronous sources on Blackboard, the 2021-year group started to use Microsoft Teams, which provides synchronous sessions (lectures/seminars/group and one-to-one tutorials) and its chat option for group and one-to-one confidential communication with their lecturers and peers. Synchronous sessions were recorded (except tutorials), and students were able to re-read chat communications, which minimized miscommunication and maximized students' access to content. Peimani and Kamalipour [18] state that Microsoft Teams is very user-friendly and supports lectures and seminar sessions and improves communication with reticent students. Its chat option contributes to further discussion before, during and after the sessions and improves the engagement of reticent students. Marshalsey and Sclater [2] revealed that students engage with chat boxes more than vocally (via the 'raising hand' option), which requires turning on their microphones. The chat option on Microsoft Teams, therefore, enables more student participation and benefits reticent students, as proposed by the literature [2,18] and observed in this module. Students were systematically taught and encouraged to have peer review, a fundamental skill for designers [18], from their first year on the course through their successive research modules. Daalhuizen and Schoormans [15] stated that receiving feedback and seeing other work provides an insightful opportunity for students to reflect and observe during their experimental learning process in a MOOC. For the 2021-year group, online meetings were recommended to students for peer review, which is a skill for the industry now.

The university enforces blind double-marking procedures, with two lecturers independently grading until finalizing their marks with the inclusion of a third lecturer if needed, ensuring the fair and objective assessment of student work. Both year groups in this study followed the same grading process; thus, any possible unconscious bias of the researcher, who is also the module leader, was avoided. Lei and So [14] stated that lecturers' teaching styles had prominent effects on student satisfaction and ensuring constant communication was essential. In this study, the 2021-year group had regular access to their lecturers via emails, team meetings and online Q&A sessions. They were encouraged to communicate and raise their questions instantly to ensure their learning was not interrupted by the pandemic. Moreover, the university library provided uninterrupted support from the first lockdown in March 2020 and provided asynchronous sources that were already available (e.g., Harvard referencing handbooks), similarly to student support provided in previous studies [18]. Furthermore, the subject librarian had an academic writing session, and their team was available for both year groups.

3.2. Data Collection/Analyses

Both year groups submitted their documents on similar dates during their respective academic years (5 April 2020 and 30 March 2021). For both groups, only texts in students' works were analysed against their grades, number of images and number of references. Visual analyses (colour, content, etc.) of images were excluded since some of them were created for design modules that were in BL modules outside of lockdown periods. The study used data collected during the normal course of university business (grades, student work, etc.) to inform its findings. The decision to conduct this study began after teaching commenced, and data analysis began after the course ended. Students were therefore informed about the study after the completion of their course via an email with a brief summary of results. Because the study drew only on students' grades and the final outcomes of the module, and not experimentation with teaching delivery, their T and L was not affected by the study. However, it was shaped, changed and affected by the pandemic. Full ethical approval for this work with the Ethics Reference UoLReview Reference 2021_4026 (University of Lincoln) was received before the study began.

The data were analysed with both qualitative and quantitative approaches [38]. In the qualitative approach, the final outcomes of both groups were analysed and compared for both generalization and exact match results. The exact match provided some specific words such as 'pandemic' that were expected to be raised with the COVID-19 outbreak, whereas generalisations revealed concepts (see Figure 4). For quantitative analyses in both year groups, the first 1000 terms were compared through paired samples t-test in SPSS, which was used to reveal differences between the two groups. In generalisation word counts, some words were interchangeable unless they affected meaning (such as singulars-plurals, e.g., user vs. users). Moreover, grades and the number of images and references were analysed in order to reveal any significant relationship between them that revealed a holistic approach with the qualitative and quantitative data [39] of semantics (NVivo results with *t*-test for word counts) (see Figure 4).

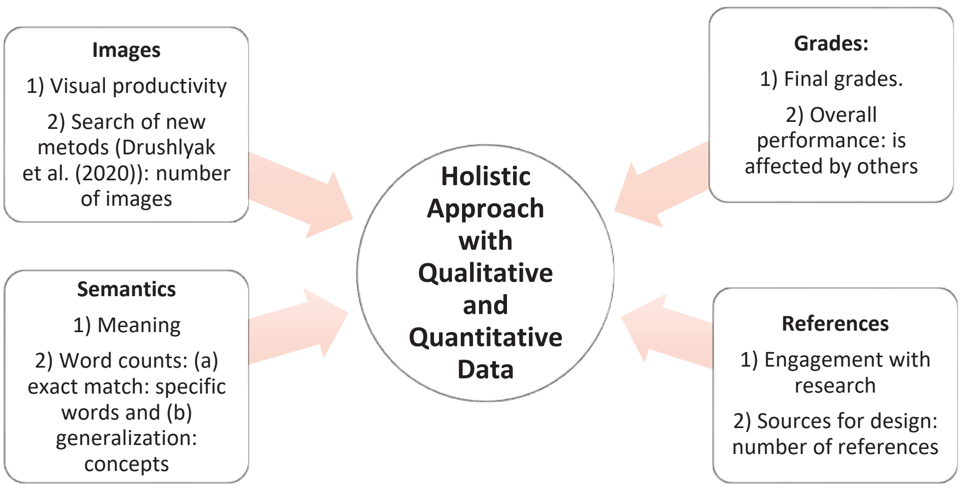

Figure 4. Analyses of students' written outcomes as a holistic approach.

3.3. Holistic Approach

For the research question (with sub-questions 1, 2, 3 and 4), students' written work was analysed in order to reveal its semantic aspects (semantics: "the study of meanings" according to the Merriam-Webster Dictionary, Semantics, available online: https://www.merriam-webster.com/dictionary/semantics (accessed on 12 December 2022)), their word counts, and a comparison of word counts between the two year groups alongside their grades and the number of images and references. In order to provide a neutral comparison, all student work was analysed through NVivo 12 as a reliable and objective qualitative data analysis software [40]. Word count analyses were used to understand "differences among participants" and were employed for at least three reasons: "(a) to identify patterns more easily, (b) to verify a hypothesis and (c) to maintain analytic integrity" [40] (p. 76). Each data set was grouped by 'word frequency' according to its semantic relationships, revealing word groups that provided context. The number of words and the number of images and references, compared against final grades, provided quantitative data. IBM SPSS Statistics 25 was used to analyse and compare word count outcomes (paired *t*-test) across the two groups.

Moreover, the research question (with sub-question 5) examined the relationship between performance, visual productivity and engagement with research within the research/theory module. For that purpose, students' final grades and the number of images (tables, drawings, etc.) and references were analysed, first with Pearson correlation and then Multiple Linear Regression. Final grades represent overall performance (i.e., [41]), which might be affected by images and references in the written work of students. Visual productivity "is associated with the search for new methods of solving problems" [42] (p. 151) and emerges from the human brain [43] (p. 251). Since in the scope of this study other aspects of images (forms, colours, etc.) cannot be analysed, the number of images were analysed to investigate visual productivity. Engagement with research is an essential part of the design process and an inseparable element of good design practice [44]; in this module, students' grades are inherently related to their research activities; therefore, a connection between engagement with research and their overall performance was investigated through the number of references as quantitative data. All these elements provide a holistic approach to students' outcomes and explore the design/research process for IAD with performance, visual productivity and engagement with research, and they underpin the comparison of the 2020 and 2021 year groups' semantic analyses (see Figure 4). This holistic approach, which embraces the triangulation of the data, ensures credibility in architectural research studies [44,45].

It should be noted that there are other variable factors aside from the pandemic, such as students' personalities, slight staff changes, etc. Nevertheless, because both student groups had the same brief and support from their lecturers, their submissions provide good data to investigate how migration to ODD affected their work. The 2021-year group had full BOL for the same module and were affected by the pandemic (i.e., no access to printed sources) and its other consequences. For example, the literature review shows that the pandemic affected the mental health of students with similar demographics [46] and they experienced anxiety [20]. This significant difference (moving to BOL due to the pandemic) between the two year groups overwhelms other contaminating effects; thus, students' final submissions are comparable in order to reveal the effects of the pandemic (and its consequences: ODD) on T and L. The brief, its criteria, learning outcomes and the content of the calendars of both years were the same; some major changes in design and delivery are revealed in Figure A1. Given that this module was not changed except for regular updates in lectures, presentations, etc., and converting its content to a BOL method, the 2020-year group functioned as a control group for this comparative study [7].

It was hypothesised that: (1) student written work would be affected due to ODD as a consequence of the pandemic and the two different year groups would differ in their outcomes; for example, semantic analyses would reveal statistically significant difference (quantitative data) and different concepts (qualitative data) in word counts; and (2) the number of images and number of references used in assessments would have a positive correlation with grades.

4. Results and Discussion

4.1. Qualitative Analyses

Table 1 presents the only eight concepts that did not appear in the first one hundred terms for one of the groups after the first word count analyses. Figures and words for numbers are excluded, such as 2019, five, etc., for generalisation analysis, whereas only figures are excluded, such as twenty-five, for exact analysis. Moreover, the first 1000 terms of the initial analyses were word counted again by a generalisation feature. Table 2 presents the first 20 terms in which only 'cerebral' is not matched to the rest of the list. Word clouds were created after these analyses, presenting common concepts (see Figure 5). These results show that there are strong design-related elements that students embraced: artefacts, activities, content, etc., which were affected by neither the change in learning methods, nor the pandemic.

Figure 5. 2020 (**left**) vs. 2021 (**right**) word clouds of NVivo 12 analyses.

Table 1. Terms not revealed in the first word count analyses with generalisation function of NVivo 12.

Word (Absent)	During the Pandemic (%)	Before the Pandemic (%)
think	0.23	-
municipal	0.19	-
organisation	0.14	-
cerebral	-	0.25
collection	-	0.16
status	-	0.13
ethical	-	0.11
utilise	-	0.10

Table 2. First 20 words after the second word count analyses of NVivo 12 (ranking order).

Word 2020	Word 2021	Word 2020	Word 2021
artefacts	artefacts	community	knowledge
act	act	events	alteration
activities	activities	instruments	attributes
contents	united	cerebral	events
united	change	knowledge	abstract
change	content	abstract	create
attributes	beings	region	move
being	community	move	area
alteration	construction	work	hold
construction	conditions	create	number

4.2. Quantitative Analyses

4.2.1. Word Counts

Word count analyses for the first 1000 words (based on weighted percentage) of both groups were compared through paired *t*-tests that revealed a comparison of their distribution based on their weightings. Only the matched terms of the initial analyses of both groups were used (see Table 3).

Table 3. Results of paired *t*-tests of word counts.

Exact words (714 terms)	2020-year group (M = 0.06 (2 dp), SD = 0.08) 2021-year group (M = 0.06 (2 dp), SD = 0.08	No significant difference 0.0020, 95%CI [0.0040, 0.0000], t(712) = (1.92), p = 0.055
Generalisation (708 terms)	2020-year group (M = 0.05 (2 dp), SD = 0.06) 2021-year group (M = 0.05 (2 dp), SD = 0.06)	No significant difference 0.0000, 95%CI [0.0021, 0.0020], t(706) = (0.07), p = 0.947.

The paired *t*-test reveals that there is no significant difference between year groups on word count results (exact and generalisations independently), although there are new vocabularies, such as pandemic (999th with 0.02 per cent) and COVID (808th with 0.02 per cent) in the 2021-year group's work. It can be ostensibly stated that BOL and F2F reveal similar outcomes in terms of research/theory modules in IAD and their written work semantically. The word lists were mostly dominated by design terms, common terms and pragmatic words (see Table 2 and Figure 5). It is important to note that these results showed no significant difference between the module's outcomes of the 2020 and 2021-year groups, although the pandemic affected students' perception, mental health and lifestyles as the literature suggested [20,46,47]. Savage et al. [46] stated that students' mental health was affected by the pandemic and their perceived stress increased during the first five weeks of the lockdown, with 214 university student participants examined whose demographics were very similar to this study's demographics (East Midlands, UK, mean age: 20, female percentage: 72) (see Table 4).

4.2.2. Grades versus Images or References

In order to explore student outcomes, their grades and the number of images and number of references were analysed separately (see Table 5). It is fruitful to note that the number of images and grades are not as different as the number of references, and the 2021-year group employed more sources than the 2020-year group. That might be an effect of the pandemic, during which students could not visit the library and did not have physical site visits, and they therefore tried to compensate by exploring more sources. For both groups, the Pearson correlation showed that grades and the number of images, and grades and the number of references, were significantly related (see Table 5).

Table 4. Demographics for both year groups.

	2020	2021
Gender	Male: 20% Female: 80%	Male: 16% Female: 84%
Mean age (at the time of this study)	22.06	22.26
Nationality	UK: 73% Malaysia: 17% Syria: 3.3% India: 3.3% Zimbabwe: 3.3%	UK: 79% Saudi Arabia: 5.2 Poland: 15.8

Table 5. Results of grades, number of visuals, number of references.

	Average	Pearson Correlation	Multiple Regression with Enter Method		
2020-year group	Final grades: 68.03 Number of images: 59.86 Number of references: 40.13	Significantly related	The model explained a statistically significant amount of variance in grades	F(2, 27) = 7.12, p = 0.003, R2 = 0.35, R2adjusted = 0.30.	An increase in one image corresponded, on average, to an increase grade 0.15 points, B = 0.15, SD = 0.08. For each reference, a grade increased 0.25 points, B = 0.25, SD = 0.11.
		r = 0.47, p = 0.008, N = 30 (number of images)	Number of images is a significant predictor of grades	β = 0.34, t(27) = 2.02, p = 0.053.	
		r = 0.50, p = 0.005, N = 30 (number of references)	Number of references also significantly predicted grades	β =.37, t(27) = 2.24, p = 0.034.	
2021-year group	Final grades: 59.94 Number of images: 60.94 Number of references: 54.94	Significantly related	The model explained a statistically significant amount of variance in grades	F(2, 16) = 7.80, p = 0.004, R2= 0.50, R2adjusted = 0.43.	An increase in one image corresponded, on average, to an increase in grade of 0.12 points, B = 0.12, SD = 0.14. For each reference, a grade increased 0.28 points, B = 0.28, SD = 0.17.
		r = 0.63, p = 0.003, N = 19 (number of images)	Number of images are a significant predictor of grades	β = 0.25, t(16) = 0.85, p = 0.41.	
		r = 0.69, p = 0.001, N = 19 (number of references)	Number of references also significantly predicted grades	β = 0.50, t(16) = 1.67, p = 0.12.	

Since correlation does not signify causation, further analyses were conducted to reveal their relationship. A multiple regression with the enter method was used to predict the grades of written documents from the number of their images and number of their references, separately for the two year groups. For the 2021-year group, the model is significant, which means the number of images and number of references can be used to predict grades, but they are not significant individually. Therefore, in order to predict grades, both the number of images and the number of references are required in the 2021-year group. For the 2020-year group, the model is significant, and both the number of images and the references are needed to predict a grade, although the number of references can be used as a good predicter independently in the 2020-year group unlike the 2021-year group (see Table 5). They are inherently related to overall performance as essential parts of this module. However, it is important to note that these causations between grades and the number of images or references are case specific and they should not be generalized for other cases (i.e., first year students). Further research is needed to uncover how visual productivity and engagement with research are related to overall performance in IAD.

It can be assumed that the pandemic was not ignored by students throughout this module. Yet, they were able to prioritize their work and control their perspectives towards the pandemic and its uncertainty, instead of letting this global disaster affect their learning fundamentally. The first hypothesis, which stated that the two groups would be significantly different, is rejected with these results. The second hypothesis, which suggested that grades are related to the number of images and number of references, cannot be rejected. This study's results are in line with the literature arguing that the teaching method does not affect students' performance [23,28] and that students "can learn in any type of environment and will gain new knowledge from their experiences regardless of the teaching modality" [48] (p. 6). Ergo, we should be focusing on "the assistance to learning aspect" instead of technology, as suggested by Larson and Sung [23] (p. 41). We need to embrace the positive effects of ODD, such as online discussions that mitigate student anxiety and increase their participation while encouraging critical thinking [16,23,26,28,48] and aim to mitigate the challenges and limitations of ODD such as the disadvantages of students lacking discipline [14] and technical problems and limited content [5]. Pektaş [27], Alawad [29] and Iranmanesh and Onur [26] discussed ODD should be embedded in the design studio, and research/theory modules, which were originally intended to serve studio learning [49], supposed to be following this approach. This study showed that students could accomplish similar results with the BOL method and its integration through their final year research/theory module(s) and its use in supporting IAD education might be a good practice during post-pandemic.

5. Conclusions

Distance learning, and its latest descendent, ODD, has long been offering advantages for both traditional and non-traditional students. Many researchers have argued that design disciplines including but not limited to IAD have fallen behind in embracing these new learning methods compared to other disciplines. Although the reasons can be discussed further, the contributions of distance learning to design learning are observable and prominent. Adding new activities online to existing courses improves the performance of students [5,7] and develops student engagement, motivation and perceived knowledge [5]. Many researchers (e.g., [20,27–29]) reported positive outcomes of online design studios, similar to Iranmanesh and Onur's [26] VDS. Nevertheless, previous studies showed converting the design studio is not a simple copy-paste task; there are several failed examples, and conversion requires the collaboration of all parties and rigorous hard work over several years [4]. Furthermore, in other design disciplines (e.g., fashion) researchers revealed good results for ODD methods in research/theory modules during the pandemic [18,33]. Online Design and Delivery comes with its shortcomings: Miller and Lu [10] point out the need for intentional and well-informed change in order to respect and protect intellectual knowledge, integrity and knowledge capacity and the management of HE while embedding ODD into F2F.

The pandemic forced educators to teach fully online (OL/BOL) in spring 2020 and then they all, voluntarily or involuntarily, migrated to these new methods (OL/BOL/BL) and had to intensively test ODD in design education.

> *"In geography—which is all but ignored these days—there is no reason why a generation that can memorize over 100 Pokémon characters with all their characteristics, history and evolution can't learn the names, populations, capitals and relationships of all the 101 nations in the world. It just depends on how it is presented"* [6] (p. 6).

The generation that Prensky referred to in this quote are young professionals now after more than 20 years and the technological changes are mind-blowing compared to 2001. However, the rationale is still very relevant and important: the generation that can create the most inspiring videos on TikTok, Instagram, etc., should not be struggling to engage with the creative process of IAD because of methodology. Peimani and Kamalipour [18] (p. 4) stated that "the technology advocates echoed how the enforced online migration has contributed to the professionalisation of academics as pedagogues", which can bring them to a better practice and digital transformation. One can argue that the digital transformation of design and architecture courses could have been achieved earlier, considering Prensky (and other researchers such as [11]) mentioned this in 2001 [6]. However, there was strong resistance from lecturers who are mostly digital immigrants (those who are not engaging with technology in their teaching), and their resistance could only be beaten by something as powerful as a pandemic. More recently, Dreamson [21] (p. 495) reacted to that resistance fairly:

> *"Rapid technological advancement has changed the landscape of education to be integrated with educational technology, and the worldwide pandemic has further accelerated its transition to digital learning and teaching. This process has not given educators and practitioners room for raising their resistant affection and making a pathetic excuse for not getting out of unfamiliarity and unawareness. Rather, they have been cast into the new learning environment."*

Despite resistance from some design and architecture lecturers, ODD in the design studio is possible. We must revisit the concept of the studio and how realistic it is to claim that current formats mimic the industry and its work environment. Teaching, in particular, has not changed since the Ecole Des Beaux Arts or Bauhaus [22], despite some visible adaptations from students, such as the use of laptops, and some technological developments, such as printers/3D printers in studios. As Dreamson [21] suggested, instructors may cling to a romantic idea of the atelier and lose the real purpose of design education: appropriately representing innovative industry applications (the design studio) with strong theoretical content (research/theory modules). Daalhuizen and Schoormans [15] showed that their dedicated learning tools had motivated students in fully online courses (OL in Figure 1) in terms of the experimental learning of Kolb [34]. Their tools included benchmark videos, sofa session videos, expert videos, peer reviews, which not only mimicked the physical design studio but engaged with the virtual nature of fully online teaching, which can be an inspirational step to the future of design education for IAD. For example, students experienced the positive effects of the benchmark (two master's students discussing and applying the same project as the students) and expert videos [15]. Challenging studio teaching inherently changes research/theory modules. Groat and Wang [44] (p. 21) stated that "the design and research constitute neither polar opposites nor equivalent domains of activity. Rather, the relationship between the two is far more nuanced, complementary, and robust". Design and research modules are closely related but are delivered differently, and in doing so advantage research modules in ODD, which contributes to the grasp of theoretical knowledge in depth and in detail [2]. This study's results show that research/theory modules might be taught fully online with BOL while innovating and tailoring IAD teaching to contemporary needs.

This study explored the effects and consequences of the pandemic on an IAD course, revealing the effects of ODD on final year students' work in the semantic content of their written submissions, their grades, the number of images included and the number of references. The study findings show no significant difference in the outcomes of the two year groups' work and the number of images and references included in their written submissions are good predictors of their final grades. However, it is important to note that both lecturers and students, working under the extraordinary conditions of the pandemic, might perform better if they were asked to migrate ODD under less exceptional circumstances. It is possible that both students and lecturers performed well because the extraordinary circumstances encouraged additional effort to compensate. Yet, HE has nevertheless changed significantly because of the pandemic and the new normal will require extra effort in areas of BOL. For the delivery of research/theory modules, BOL and F2F reveal similar results in terms of written student outcomes; thus, they could be converted to BOL permanently. However, future studies are needed for both design and research/theory modules in IAD, which reveal different perspectives from all parties: educators, students, decision-makers, policymakers, managers, etc. Moreover, the study did not investigate students' experiences through feedback and comments, which is a limitation of the method that can be investigated in future studies in relation to students' written outcomes. In terms of the delivery of research/theory modules, future studies should focus on different year groups and their responses to ODD, and/or the combined effects of ODD on design and research modules in IAD. In doing so, more in-depth analyses can be conducted for visual productivity and engagement in relation to overall performance within IAD courses. The study findings will be beneficial for educators and professionals, as well as managers, institution administrators, policymakers and decision-holders in HE.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki, and approved by the Research Ethics Committee (REC) (Human Ethics Committee (PR)) of UNIVERSITY OF LINCOLN (UoLReview Reference 2021_4026 and 6 May 2021).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study via email. Because the study drew only on students' grades and the final outcomes of the module, and not experimentation with teaching delivery, their T and L was not affected by the study and they cannot be identified.

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy and ethical restrictions.

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Appendix A. Major Changes Because of ODD

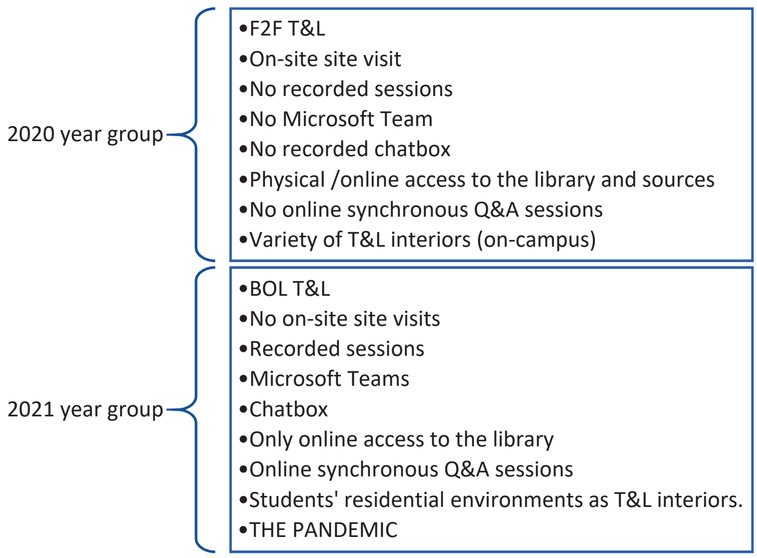

Figure A1. Major changes due to ODD enforced by the pandemic.

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education sciences

Review

Systematic Review and Annotated Bibliography on Teaching in Higher Education Academies (HEAs) via Group Learning to Adapt with COVID-19

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Abstract: Student learning has been affected by the recent shift in education globally which has been attributed to adaptation to the recent COVID-19 pandemic. This study will look at these characteristics to better understand gender differences in e-learners' self-efficacy, satisfaction, motivation, attitude, and performance on a worldwide scale. Due to the rapid COVID-19 pandemic, many educational institutions had to close, forcing many students to stay at home and enrol in online courses. Due to the practical laboratory sessions and workshops demanded by Science, Technology, Engineering, and Mathematics (STEM) modules and other related fields, education has faced difficulties during the COVID-19 pandemic. Understanding student involvement and its role in promoting a number of desirable outcomes, including academic outcomes like greater achievement, lower dropout rates, as well as various well-being and life outcomes, has therefore become increasingly important. This paper presents the scientometric review with an annotated bibliography on teaching styles through group learning in the higher education academies (HEAs) directed towards sustainable education. The current work also gives an annotated bibliography that seeks to compile and integrate the research on student participation, group learning, instructional strategies, equality, and diversity. Some evaluations and suggestions are also made in the study.

Keywords: teaching; higher education academy (HEA); learning; COVID-19; education; diversity; group learning; sustainability; systematic review; annotated bibliography; student engagement

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1. Introduction

Education has been identified as one of the key elements of the United Nations Sustainable Development Goals, which should be promoted amidst various challenges. However, all facets of peoples' life have been impacted by the COVID-19 pandemic on a global scale. Different people have different levels of resilience and abilities to cope and adapt to difficulties as well as events that are traumatic and that may have happened during this recent pandemic. Due to the pandemic, the year 2020/2021 marked a turning point in the history of digital technology in education, enabling a sustainable education even while the world dealt with an unprecedented pandemic disaster [1–3]. As a result, the transition from traditional classroom instruction to online instruction will take place, forcing students to adopt digital learning [4–6]. Aside from e-learning, which has increased in popularity since the occurrence of COVID-19, there are other areas of teaching and learning that have been adapted to the transition [7–10]. This study will look at these characteristics to better understand student engagements, diversity, and cultural differences in e-learners' self-efficacy, satisfaction, motivation, attitude, and performance on a worldwide scale. Due to the unexpected COVID-19 outbreak, many educational institutions were compelled to close, forcing many students to stay at home and attend online courses [11–14]. STEM (Science, Technology, Engineering, and Mathematics) curricula had difficulties due to the recent COVID-19 pandemic because they require practical laboratory sessions and workshops; hence, the educators have to be trained [15–20]. Although there are other methodologies that have been very effective, group learning has always been among the best methods [20], and social distancing rules involving staying 2 m apart, closures of schools during the lockdowns in most countries, and restrictions on group gatherings were some limitations to group learning during the recent COVID-19 pandemic.

From a bibliographic perspective, the shortage of annotated bibliographies on teaching methods in higher education academies (HEAs) is one of the biggest problems that libraries and educational institutions have to deal with. Annotated bibliographies can be used to pinpoint knowledge gaps, such as how to comprehend student interactions by contrasting studies on low and high levels of student participation. There is a gap for general teaching in HEAs in various areas, as seen from the annotated bibliographies studied. Some of these annotated bibliographies cover various levels of course-based education in English [21–27]. Other annotated bibliographies cover various ranges of topics including those on teaching [28], virtual exchange [29], STEM teacher education [30,31], gender bias [32], digital library [33], plagiarism in engineering [34], online learning [35], technical education career [36], curriculum design [37], engaged learning [38], group works [39], business models [40,41], the economics of education [42], scheduling [43], forecasting [44], algorithms [45], distance learning [46,47], sociology [48,49], search optimisation [50], geological lineation [51], the health response to COVID-19 [52], and teaching methods [53].

The teaching standards in HEAs must be maintained, as teaching supports the United Nations' goal on sustainable education. Resilience, adaptability, and flexibility have always been necessary for teachers, but COVID-19 took those requirements to totally new levels [54–57]. Although challenging, the recent COVID-19 pandemic has provided us with an opportunity to reset and reassess. Schools, educators, and organisations that prepare future educators have had the opportunity to reflect on their past practices and plan how they will enhance and modify their teaching and learning in the future. The pandemic has given us new perspectives, and institutions as well as their teacher-educators have learnt lessons throughout COVID-19 [58–62]. Despite the significant challenges faced during the epidemic, certain positives will last for some time. Our entire educational system and organisational structure had to change to entirely remote communication and online learning as a result of COVID-19 [63–66]. An earlier part of this annotated bibliography has been conducted on online learning as a teaching style [67]. However, there is the need to consider group learning in HEAs. Finally, these annotated bibliographies explore the instructor's role in promoting a dialogue on diversity, instructional reflections, student interactions, and ways for doing so successfully. As a result, one will develop as a teacher and learn how to impart knowledge in a way that will aid students in comprehending a module. The primary concerns of an excellent teacher are for their achievement and interest. They will make sure to cooperate in an atmosphere of love and fairness while upholding the principles of equality and diversity. Their academic success is given first attention, and the instructor ensures that students engage fairly while upholding teaching morals such as equality and diversity. The instructor might also ask some of them to try out some of the problems that are put on the board in order to increase their confidence in their capacity to answer challenges. These teaching and learning experiences are covered in some systematic reviews conducted by earlier researchers [68–83].

This paper presents the scientific review with annotated bibliography on teaching in HEA for group learning. Section 1 introduces the work with themes of group learning, student engagement, diversity, and teaching with their frontiers towards sustainable education. Section 2 presents the methodology of the current work, which aims to consolidate and synthesise the literature on teaching in HEAs. Section 3 introduces group learning, while Section 4 covers lessons learnt from the COVID-19 pandemic. Section 5 presents the systematic and scientometric reviews of the subject area. Section 6 presents the annotated bibliography, while the conclusions drawn from this study are given in Section 7.

2. Materials and Methods

This section covers the materials and methods adopted for this annotated bibliography on the teaching style in higher education academies (HEAs). To obtain this data, search was obtained from existing repositories from various institutions on annotated bibliography and from the SCOPUS database. Using the SCOPUS database, 88 documents were obtained and included in this annotated bibliography in this subject area. The search syntax used in SCOPUS was "teaching AND higher AND education AND academy AND online AND learning OR COVID-19", as shown in Figure 1, which shows the methodology for obtaining the data used. The search results from the SCOPUS database are in Figure 2. It is noteworthy to state that SCOPUS was used among other databases because of the ease of sorting the relevance, classifying the search, extracting the required results, and profiling the literature.

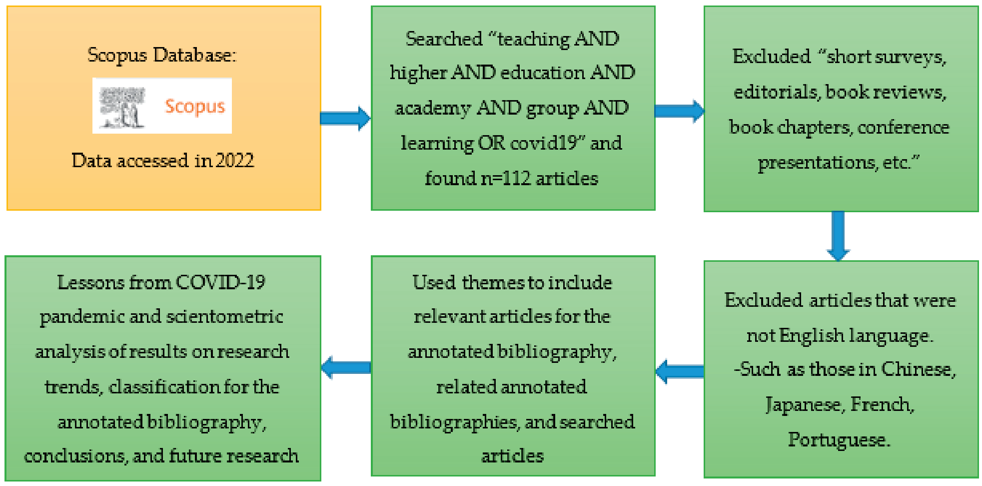

Figure 1. Methodology for the annotated bibliography on the search phrase "teaching AND higher AND education AND academy AND group AND learning OR COVID-19".

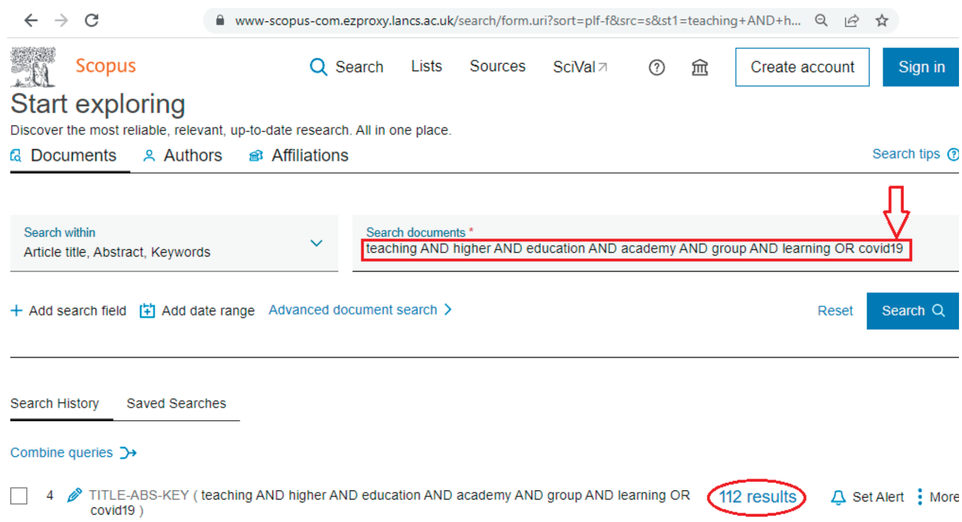

Figure 2. SCOPUS database supplied by Lancaster University UK showing the used search phrase on "teaching AND higher AND education AND academy AND online AND learning OR COVID-19" with 112 publications and other search phrases for the research area.

3. Systematic Review and Scientometric Analysis on the Annotated Bibliography

In this section, a systematic review and scientometric analysis of our annotated bibliography on teaching in higher education academy was conducted based on the research themes. In this study, the research trends were investigated from the publication history, the publication classification, the subject area, the publication by country, journal range, the publication by affiliations, and the author keywords. To understand the research patterns in teaching in HEAs, data were retrieved from SCOPUS to be presented in the findings in Figures 3–10.

Figure 3. Result of publication records for research on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19" (data retrieved from SCOPUS database on 22 August 2022).

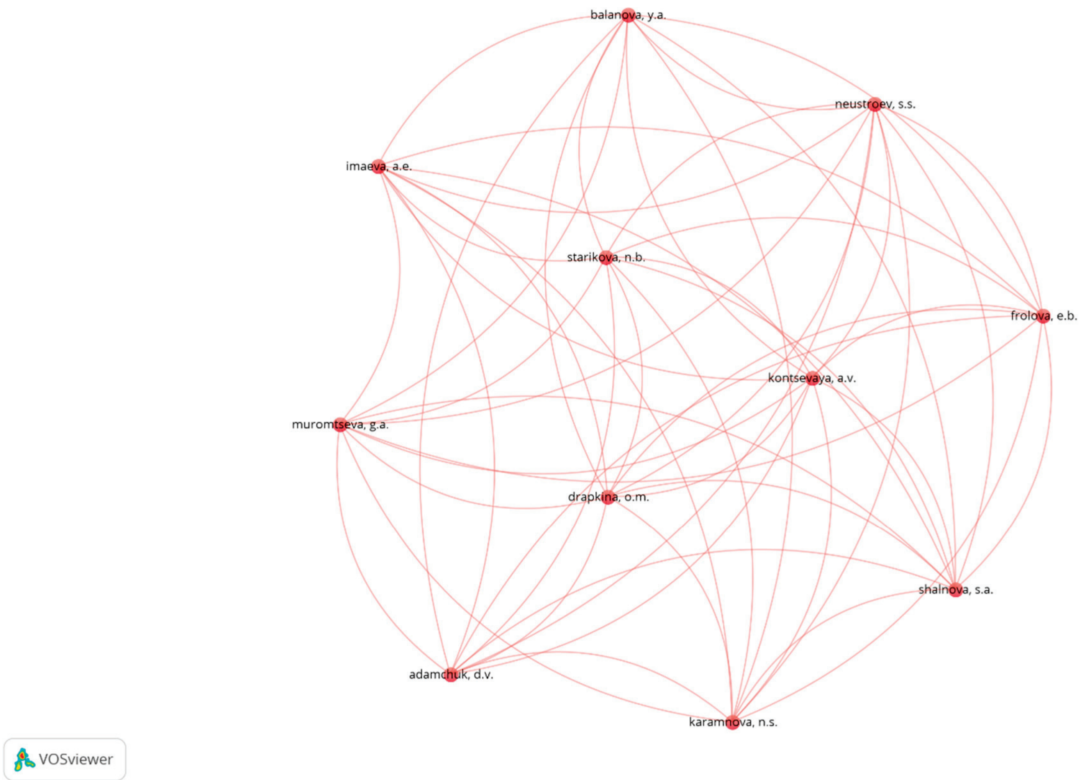

Figure 4. Visualisation mapping showing network of citations from publications on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19" (data retrieved from SCOPUS database, and visualised on VOS Viewer).

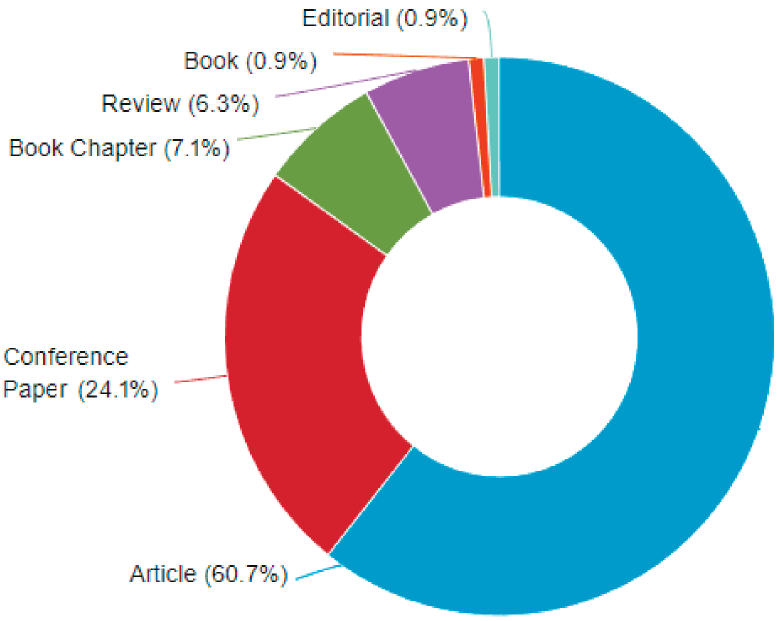

Figure 5. Result of publications by subject area for the research on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19" (data retrieved from SCOPUS database on 22 August 2022).

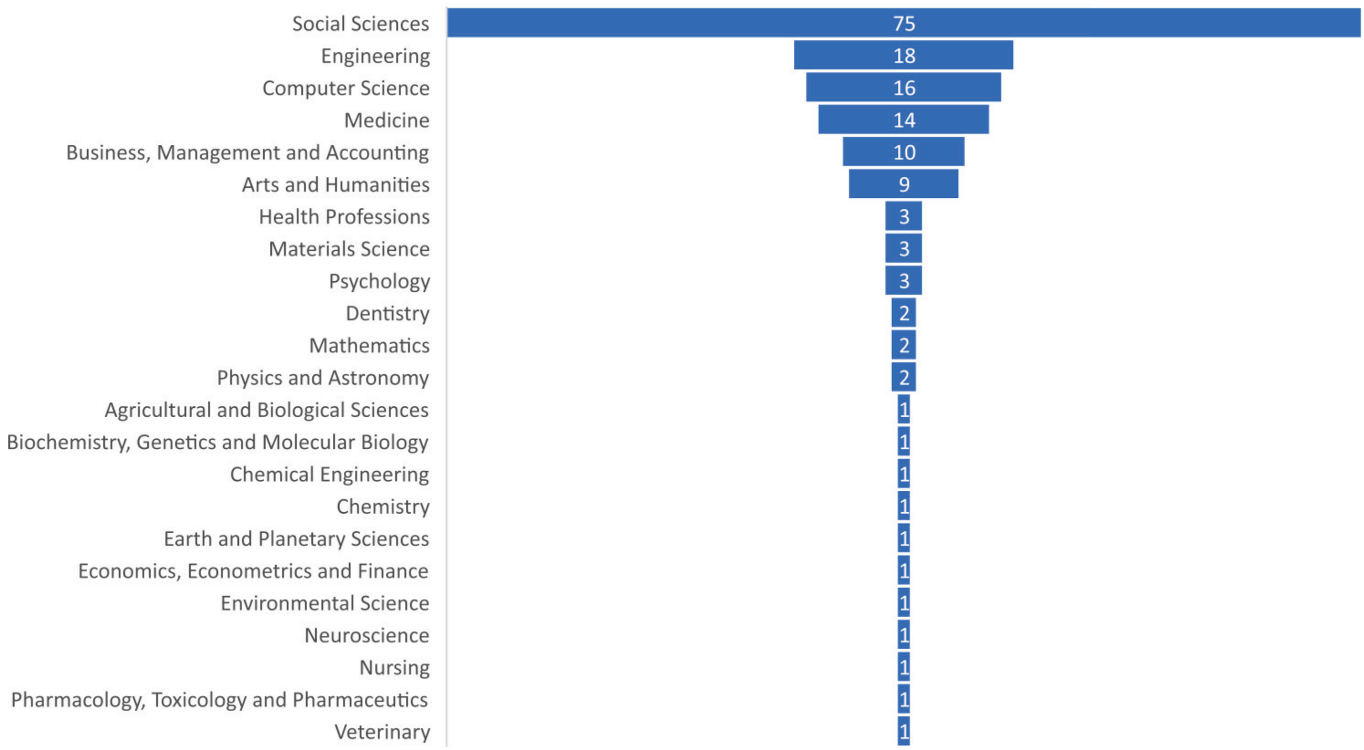

Figure 6. Result of publications by classification (or type) for the research on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19" (data retrieved from SCOPUS database on 22 August 2022).

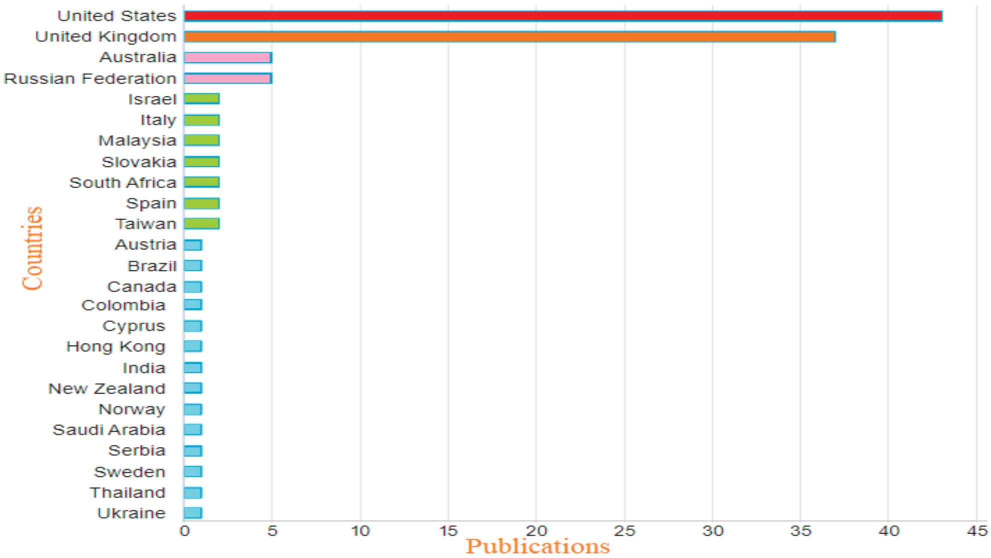

Figure 7. Result of publications by countries for the research on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19" (data retrieved from SCOPUS database on 22 August 2022).

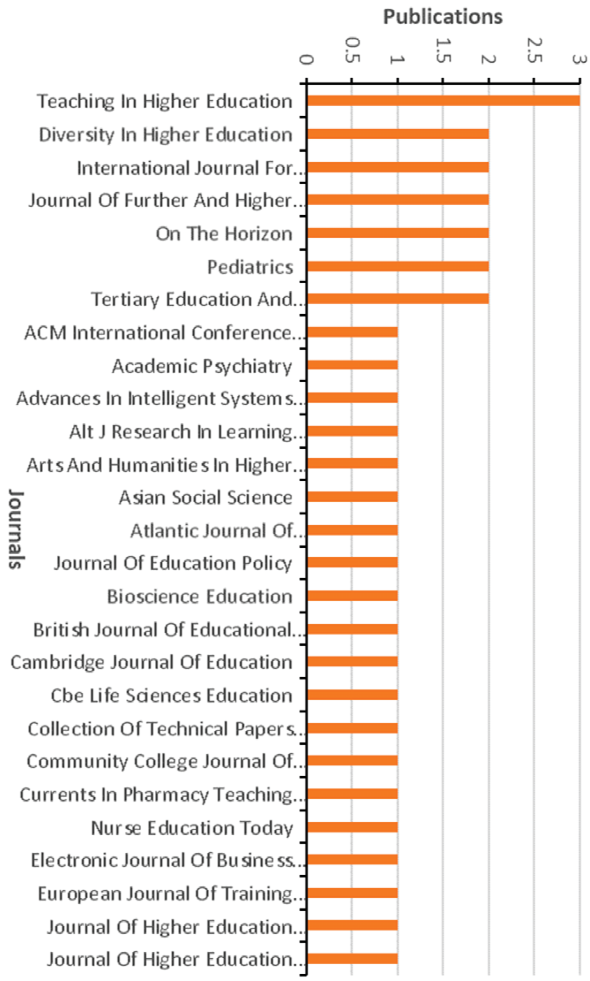

Figure 8. Result on the range of journal publications for the research showing the top journals on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19" (data retrieved from SCOPUS database on 22 August 2022).

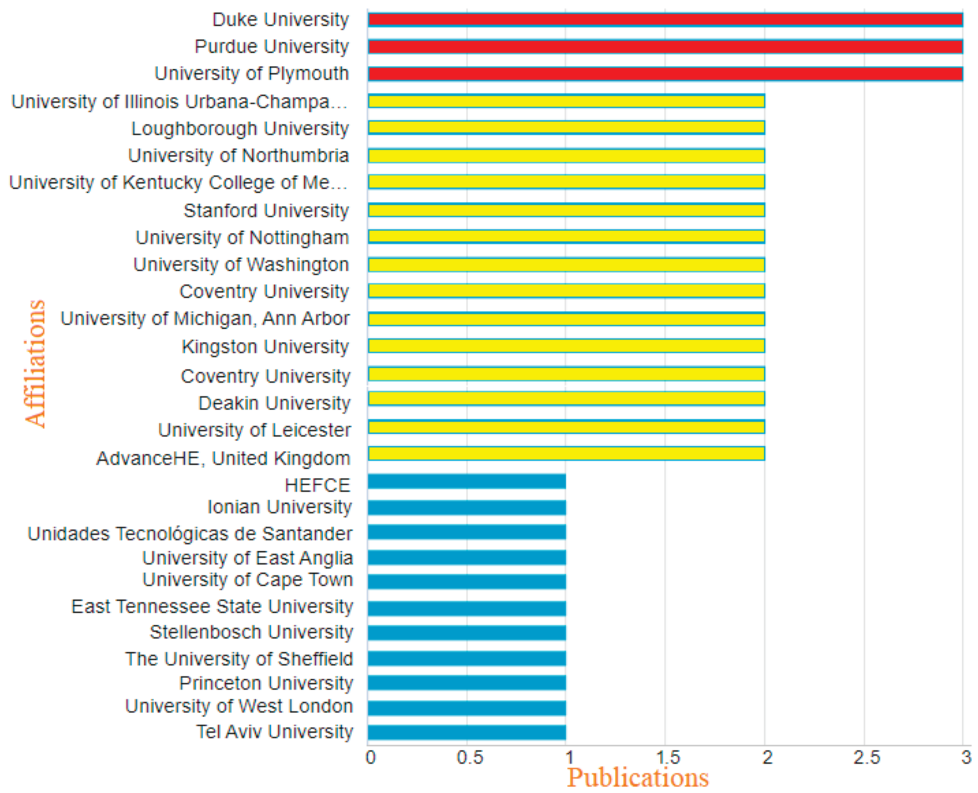

Figure 9. Result of publications by affiliations for the research on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19" (data retrieved from SCOPUS database on 22 August 2022).

Figure 10. Word cloud for the author keywords research on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19" using Voyant tools.

From Figure 3, it was observed that there were different shifts in this subject area, as seen in the pattern of publications from 1993 to 2022. The highest publications were 11 publications in 2014, followed by 10 publications in 2012, followed by 9 publications in 2010, followed by 8 publications in 2018 and 2019, followed by 7 publications in 2016. The second highest occurrence by years was one publication, which appeared five times in 1993, 1997, 1998, 2000, and 2001. The second highest occurrence by years was six publications, which appeared four times in 2010, 2013, 2020, and 2021. It was observed that different global occurrences could have affected the research trends noticed on this subject area, such as the 2008 global economic recession, 2016 drop in oil price, and 2020/2021 COVID-19 pandemic. It was observed that the publications did not increase around these times, but further evidence is required to support this pattern.

It was observed that the publications did not increase around these times, but further evidence is required to support this pattern. With the increase in online learning, there is a decrease in group learning due to the COVID-19 pandemic. It should be noted that group meetings were shunned by the World Health Organisation (WHO), schools were closed during the COVID-19 outbreak globally, and there were national lockdowns which led to fewer peer-to-peer interactions physically. Due to the recent COVID-19 pandemic, which has seen social distancing rules involving remaining 2 m apart and the use of nose masks and hand sanitizers, there has been an increase in online learning as presented in another study [67]. Hence, the publications dropped from eight publications in 2019 to six publications in 2020 and remained as six publications in 2021, and slightly dropped to five publications in mid-2022. This is envisaged to increase as schools have resumed and the post-COVID-19-pandemic era is approaching.

It was observed that the citations from publications on this research showed that there are 11 items from one cluster, as seen in Figure 4. These data were postprocessed using normalization by the association-of-strength method, with a clustering factor of 1.0. The map was generated from bibliometric data using the full counting method for analysing the co-authorship. To avoid bias, the data ignored documents with a large number of authors, with a maximum of 25 authors per document. There were 351 authors with a minimum of one document per author, so the threshold limit was selected With a minimum of five citations per author, 148 citations met this threshold. With the minimum of 10 citations per authors, 75 citations met this threshold. With a minimum of 15 citations per author, 51 citations met this threshold. Using the latter consideration, the total strength of the links for the citations was obtained. It showed that 11 authors had more than five citations in this research area. The authors identified were: Adamchuk D.V., Balanova Y.A., Drapkina O.M., Frolova E.B., Imaeva A.E., Karamnova N.S., Kontsevaya A.V., Muromtseva G.A., Neutroev S.S., Shalnova S.A., and Starikova N.B. However, there are other authors with one document and many citations as identified in Table 1.

Table 1. List of the highest-cited authors per publication showing the citations and total link strength for authors with 1 publication.

Author	Citations	Total Link Strength	Author	Citations	Total Link Strength
Bouldin A.	7	9	Eways S.	7	6
Creekmore F.M.	7	9	Freeman S.J.	8	6
Hammer D.	7	9	Gutteridge C.	8	6
Medina M.	7	9	Hamilton S.C.	8	6
Piascik P.	7	9	Jensen D.	7	6
Pittenger A.	7	9	Kuhr R.	7	6

Table 1. *Cont.*

Author	Citations	Total Link Strength	Author	Citations	Total Link Strength
Rose R.	7	9	Linsey J.	7	6
Schwarz I.	7	9	Orr K.e.	8	6
Scott S.	7	9	Schmidt K.	7	6
Soltis R.	7	9	Suresh P.	8	6
Balik C.	10	8	Talley A.	7	6
Damary I.	10	8	Wood K.	7	6
Golan-Hadari D.	10	8	Ales J.D.	5	4
Hovav B.	10	8	Baygents J.C.	6	4
Kalishek S.	10	8	Bernstein B.A.	27	4
Khaikin R.	10	8	Bright N.S.	27	4
Mayer D.	10	8	Darling J.	7	4
Rozani V.	10	8	Dexter P.	6	4
Segal G.	10	8	Drew B.	7	4
Adi M.Y.	8	6	Gavin C.	7	4
Clarke R.	8	6	Gregg C.S.	5	4

From Figure 5, it was observed that the publications of the search were mostly journal papers or articles (60.7%) which were 68 publications, followed by conference papers (24.1%) which were 27 publications. This was then followed by book chapters (7.1%) which were 8 publications, followed by reviews (6.3%) which were 7 publications. There was also one publication that was a full book and one editorial which were both the least (0.9%). This shows that the most publications on this subject area were available as journal papers.

From Figure 6, it was observed that the subject area of the search with the highest number of publications was social sciences (44.6%) with 75 publications, followed by engineering (10.7%) with 18 publications, then computer science (9.5%) with 16 publications, followed by medicine (8.3%) with 14 publications, followed by business, management and accounting (6.0%) with 10 publications, followed by arts and humanities (5.4%) with 9 publications. The next set each produced 3 publications: health professions (1.8%), materials science (1.8%), and psychology (1.8%), followed by the next set which produced 2 publications each–dentistry (1.2%), mathematics (1.2%), physics and astronomy (1.2%). The rest have one publication each, and include nursing and chemistry, as seen in the funnel chart in Figure 6.

From Figure 7, it was observed that the country with the highest publications is the United States of America (U.S.A.), with 43 publications, followed by the United Kingdom (U.K.) with 37 publications. The next publications were much lower as Australia and the Russian Federation each had 5 publications, followed by the next set of publications whereby each nation had 2 publications (Israel, Italy, Malaysia, Slovakia, South Africa, Spain and Taiwan). The countries with the least publications had 1 publication each (Austria, Brazil, Canada, Columbia, Cyprus, Hong Kong, India, New Zealand, Norway, Saudi Arabia, Serbia, Sweden, Thailand and Ukraine). However, there were five publications that were undefined from the SCOPUS data retrieved from this search. It was also gathered that the U.S.A. and the U.K. are the top two nations from this study, and they are both developed nations that also invest heavily in research into education.

Another aspect of the research trend is seen from the publications where these articles were published as given in Figure 8. This research shows that education is covered across the range of publications. It also shows that education is published by different publishers under different subject titles for the journals on this subject area. With the widespread across different areas, the highest number of publications found from Scopus database on this area were 3 articles published in the journal called *Teaching in Higher Education*. Additionally, there were other journals that had two publications each, which include various educational research journals listed in Appendix A.

The next aspect looked at are the result of publications by affiliations for the research on "teaching AND higher AND education AND academy AND group AND learning OR COVID-19", as represented in Figure 9. It can be observed that highest publications by affiliations were from Duke University, Purdue University, and the University of Plymouth, as each produced three publications. It was followed by the set of affiliations that produced two publications, which are the University of Illinois, Loughborough University, University of Northumbria, University of Kentucky, Stanford University, University of Nottingham, University of Washington, Coventry University, Deakin University, University of Leicester, and AdvanceHE. The last set of affiliations had one publication each, are detailed in Appendix B.

The last parameter looked at are the author keywords from the search using data retrieved from SCOPUS. It was identified in Figure 10 that the most frequent keywords in the corpus for the word cloud using Voyant tools were education (48); learning (47); higher (23); teaching (19); and practice (11). This can be identified in the word cloud depicted in Figure 10 which was developed using 755 words and 394 unique word forms. From the cirrus on Voyant tools, the word cloud was generated and identified to have a vocabulary density of 0.522, readability index of 32.268, and an average words per sentence of 377.5. Using the most frequent words, a trend was identified as depicted in Figure 11, showing that education is the keyword with the highest relative frequency.

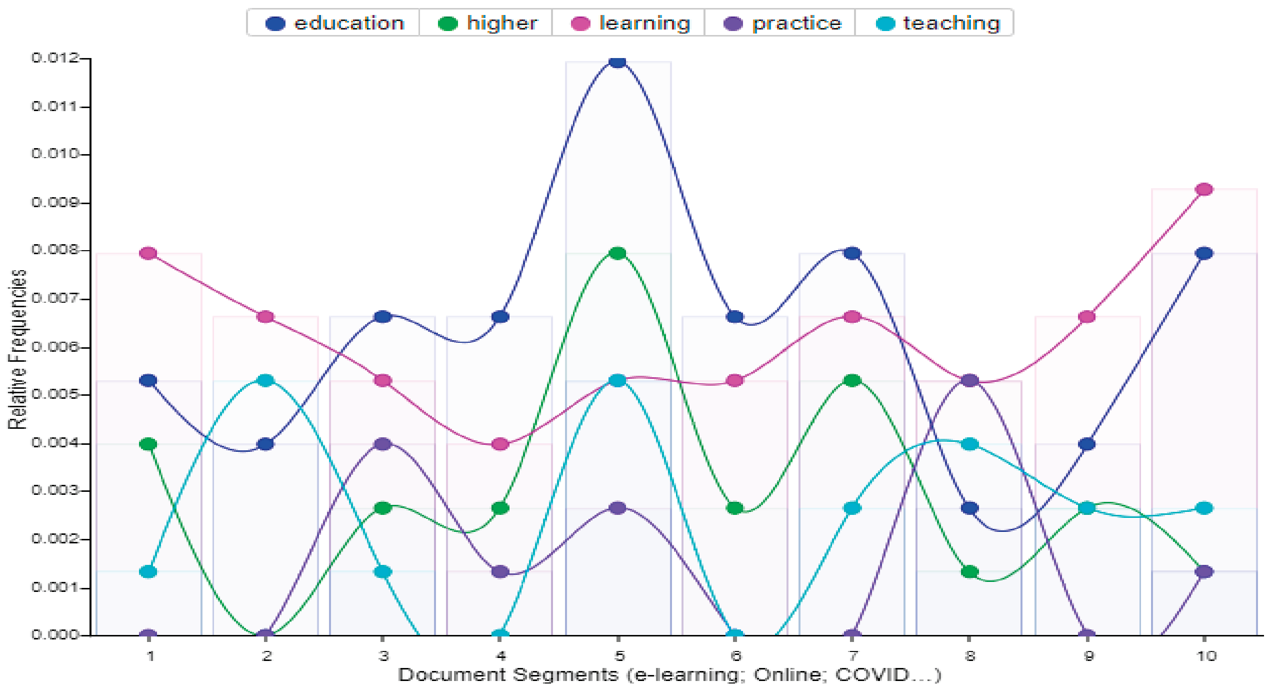

Figure 11. Result of relative frequency and trend from the most frequent author keywords generated using Voyant tools.

4. Group Learning as an Effective Technique

The term "group learning" describes a group of people who are actively working together to solve problems, produce goods, and make sense of the world. Each person participates in group learning both independently and by seeing how others learn. The current article discusses how to introduce group learning, lists its essential characteristics, examines its benefits, describes general tactics for incorporating group work, and describes how to evaluate group work. In group learning, some skills are developed and practised by learners, such as communication, teamwork dispute resolution, negotiation, critical thinking, values clarity, accommodation, and understanding [20].

In principle, there are two fundamental components to learning: learning on one's own with the aid of one's own understanding and knowledge, and learning in groups or socially within groups. Working in small groups gives students the chance to express their thoughts and understandings, dispel misunderstandings and presumptions, and bargain with others to produce something or come to an agreement. Through group activities, students can learn the material more deeply and develop their thinking abilities. The best group projects involve students in higher-level material that is challenging to comprehend, open to numerous interpretations, or both.

The word "group" means both individual learning that stresses group interaction and the more dispersed type of learning that does not exist inside the head of any one person. Building a communal body of knowledge is the aim, rather than concentrating just on the individual's expertise; learning groups work to produce widely accepted understandings. On the other hand, the word "learning" means the procedures and results involved in resolving issues and producing things that are valued in a culture. This kind of learning places an emphasis on real-world problem solving and engages pupils cognitively, emotionally, and aesthetically rather than concentrating on discrete information that may be created via simple-answer questions.

According to Niharika Gautam [20], group learning is a method of instruction that necessitates meticulous planning and typically employs a facilitator to monitor group progress. It is important to monitor and evaluate how well the group functions and how well the group members learn. The ability of the group to accomplish a common objective is just as crucial as the knowledge and comprehension of the material. Facilitative abilities are crucial, and they call for the teacher to make sure that the task is completed and that functionality and integrity are upheld.

Students are encouraged to build a variety of interpersonal, intrapersonal, presentational, and communicational skills through group learning, all of which are useful in the real world. These crucial abilities are challenging to develop on an individual basis and require constant feedback and contact with group members, which is impossible if the group dynamic is not utilised. Small group learning, particularly that which involves extremely small groups, has drawn criticism from some experts for minimising learner responsibilities and, as a result, decreasing learner motivation. Individuals may neglect their own learning goals in favour of those they share in common with other group members when participating in group learning. In groups with a few highly skilled members, they could also be impacted by the free rider effect.

There are numerous instructional strategies that are ideal for group learning. However, the teaching method which a teacher chooses to employ is entirely up to them. There are several methods for group learning, as summarised in Table 2.

In view of the above, there are some identifiable advantages of group learning in HEIs. By fostering cooperative and collaborative abilities as well as lifetime learning abilities, learners are encouraged to become active rather than passive learners. Secondly, it improves the growth of critical thinking abilities. It also promotes students' academic success and learning. Students have the chance to benefit from and impart knowledge to one another. The students are also motivated by depth rather than superficial learning strategies. It helps learners transfer their prior knowledge and learning more effectively.

Other benefits include learner-centered teaching and learning, with a strong emphasis on assessment. Students actively participate in their own education with group learning. It improves social connections and skills. Additionally, the learning's results are enhanced. There are large groups of students that can be served as well as students that can work on projects simultaneously. The ability to interact and work together on a smaller scale is increased, which lessens the isolation some people feel. Working effectively and efficiently in a group is a necessary skill in the current economic world. The capacity to collaborate with others is frequently cited by employers as one of the most crucial skills business school grads should have. The factors that affect group dynamics, outcomes, and students' attitudes about group experiences are crucial for teachers to comprehend.

Table 2. Different group-learning methods and their descriptions.

Group Learning Method	Description
Seminars run by students	It is possible for small groups of students (or couples) to lead class (usually tutorials). This is also known as cooperative learning, and this method tries to foster student and teacher collaboration. However, it lessens the teacher's lecture time and promotes student interaction. It can also be applied as a method of evaluation
Games and simulations	Give practise opportunities in "real world" situations when group safety is assured.
Debate or Constructive Arguments	Critic versus defender, prosecutor versus defendant, affirmative versus negative are typical cases to discuss a topic online with a friend or as a group.
Roleplaying	Give a small group of people a scenario or role model to act out. Roleplaying has benefits and drawbacks; be cautious of the subject matter and the activities given to kids. Roleplaying can take many different shapes. Allocating roles to perform to groups or people within groups can be done online.
The Ice-Breakers approach to team building	Icebreakers are a great method to get students acquainted with one another and to feel more at ease in the classroom. They are engaging sessions that take place at the start of the semester. Students can discuss ideas and engage in class more actively due to icebreakers' laid-back atmosphere. As a result of their increased engagement, students are better able to contribute to the success of the lesson.
Brainstorming	In order to generate a list of possible answers, possibilities, and ideas, or provide a trigger, notion, question, or idea.
The fish-bowling method	One group completes a task while another watches it (for example, watching an educational exercise, a roleplay, or a performance), comments on it, and then reacts.
Jigsaw Technique	This is a cooperative learning method with a three-decade track record of successfully minimising racial conflict and raising academic success rates. Similar to a jigsaw puzzle, each student's contribution is necessary for the completion and comprehension of the overall project. Every student is necessary if they are to play their part effectively, which is exactly why this technique works so well. The class for this exercise is called a jigsaw classroom.
SWOT analysis	For brainstorming or concept mapping, use a grid with the headers SWOT (Strengths, Weaknesses, Opportunities, and Threats) analysis to organise your thoughts. used to pinpoint and address specific components of the problem
The snowball method	This is described as consolidating groupings of concepts related to the same issue and giving them themes as part of a group activity. Patterns and connections between the groups are noticed per idea conceived or suggested solution; one slip of paper is used and duplicates avoided. A typical instance involves a minimum of five people conducting the meeting who are given five slips of paper, categorised in patterns together such as "similar to similar" or "like to like".
Action Learning	With the help of a small group of about six individuals, action learning is a method for dealing with problems in the workplace. Individuals are able to concentrate on actual problems affecting their work performance and find answers by using the knowledge and abilities of a small group along with persuading questions.
Problem-based instruction (PBL)	PBL varies in definition, but generally speaking involves students working on issues or "Using a question-based or inquiry-based approach to learning, by using scenarios. After being given a scenario, students must use their critical thinking and analysis abilities to investigate or "deal" with it. A great approach to vocational degrees.
The writing game	For the game of writing, a student transmits a message to another student, who then expands on it before transmitting it to a third student. A story unfolds like a mosaic.

In small groups, introverted learners have the chance to speak up and be heard, overcoming the anonymity and passivity associated with large groups. In this approach, the options for instruction, learning, and assessment are expanded. As a result of improved teaching efficiency and effectiveness, faculty members are more enthusiastic about their work (and the students). Students have the opportunity to work on significant projects (larger in scope or complexity than individual tasks). Learners from various backgrounds are given the chance to speak up, share knowledge and abilities, and take part in various ways (this may provide a new perspective). Time can be saved, but a shared task is necessary. In group learning, there is no individualism but alternative thoughts and viewpoints can be generated. It offers a structured learning environment that can help students get ready for the diversity and realities of the workplace, including working with people from all backgrounds and with varied abilities, cultures, and perspectives.

5. Lessons from the COVID-19 Pandemic

In this section, the lessons learnt from COVID-19 are presented.

5.1. Policy Implications

Teaching assistants and teachers have been in the public limelight during the pandemic, dealing with anything from school closures and home schooling to being praised as national heroes. Without a doubt, teachers have had a difficult time. From being important frontline workers to adjusting to new work practises, they have demonstrated commitment and bravery by putting the needs of the country's children first during a moment of genuine crisis. Teaching has always required resiliency, adaptability, and flexibility, but COVID-19 pushed those skills to entirely new heights [52–57]. Although difficult, the epidemic has given us a chance to reset and recalibrate. Schools, teachers, and institutions that train future teachers have been able to examine what they have done in the past and how they will improve and adapt their teaching and learning in the future.

The pandemic has availed us of new perspectives, and lessons have been learned by institutions as well as their teacher educators during COVID-19 [58–62]. Despite the enormous hurdles during the pandemic, there are positives that will endure over the long term. Due to COVID-19, our entire educational system and organisational structure had to transition to fully remote communication and online learning [63–65]. This means that all the teachers, instructors, and students had to understand that technological improvements are needed to urgently and significantly help address our sustainability challenges given how swiftly they have spread around the world. However, it seemed that educators across a range of subject areas needed to work together with many other disciplines, both inside and outside of business, for academic and professional purposes. In order to provide students with the tools of social power and influence so they may transformatively promote sustainability in their lifetimes, they urged the creation of an integrative curriculum and extracurricular projects that yield tangible and beneficial consequences in each of these sectors.

In order to create and deliver teaching lessons that are in line with interdisciplinary learning outcomes and the United Nations Sustainable Development Goals (SDGs), the teacher could apply blended learning, or building-based learning (BBL), or typical approaches. Complexity, awareness, presentation abilities and confidence, and teamwork(or groupwork) are among the learning objectives that are covered in the article. The recommendations for customising online workshops and webinars using tools like Microsoft Teams, Skype, and Zoom reflect a digital age. Additionally, the teachers have to adapt and acquire more skills to fit the era of this pandemic. To ensure that the students engage appropriately, teachers have had to adopt lesson plans using flip-chart tools or digital tools like Kharhoot! to ensure more student engagement. However, the challenge is that the time that teachers have available for this purpose must be judiciously utilised. The importance of this work lies in its emphasis on and promotion of scenario planning as a teaching tool. As we move into a very uncertain future due to the recent COVID-19 pandemic, scenario planning may prove to be a critical tool for identifying risks and opportunities related to sustainability for teachers, students, individuals, communities, organisations, and, possibly, entire societies.

Training by mentorship enables teachers to communicate better with students via internet correspondence, email, bulletin boards, and online chat, regardless of their physical location. Online tools like Microsoft Teams, Zoom, and Skype are also useful in setting the video meetings. This helps the students to become better equipped to acquire their own information when they feel involved in an activity. The feedback from students is also helpful to the teachers, to improve their teaching skills. Understanding learners' attitudes toward online mentoring is essential to ensuring that learners can benefit from it. Both students and mentors may provide feedback. Higher education institutions (HEI) place a strong emphasis on reflecting on student input and using digital teaching aids like e-boards, projectors, public address systems, and cutting-edge lecture e-kits. With these teaching aids, the student can record the lecture notes on their tablets, mobile phones, and laptop computers, or download them as electronic files so they can be revised at a later time.

Additionally, COVID-19 taught us lessons that intend to identify the shifts in student responsibilities, digital literacy, and learning achievement in online learning environments. There are also online tools that are used in the evolving society, especially with the recent COVID-19 pandemic which led to a national lockdown in most nations. Hence, there was the need to adapt new teaching methods like blended learning and having e-mentorships. E-mentoring aims to increase the less-skilled person's knowledge, confidence, and awareness of other cultures by using electronic communications. It also offers both a context for how it could be better understood in the classroom and a broader understanding of its significance, and gives room for more development of digital tools and the application of technology in learning spaces, HEAs, and also the creation of more online courses.

5.2. Proposed HE Policy Framework for COVID-19 Pandemic

Teaching in HEAs during the pandemic faced challenges in ensuring that students' grades were maintained, while keeping the students' motivation up. However, while the students had a willingness to study, the education sector was dealing with school closures due to the rate of COVID-19 spreading from 2019–2021. Thus, many homes had to resort to home schooling, online learning, social distancing, and the avoidance of group gatherings. In higher education, the idea of active learning is problematic and unacceptable. The following are the most concerning worries. First and foremost, the online mode often results in fabricated grades, reflecting higher education as a market-driven good; second, it profits off the good name of HE without developing or producing new knowledge and skills that future generations need; and third, this so-called online mode only values the idea of active learning in higher education if it increases the bottom line. Although solutions to these issues are required to guarantee active learning in higher education, we should always make sure that HE is in place, especially in times of emergency. Significant policy responses to the COVID-19 pandemic and associated emergencies are described in various studies [59,68].

In the twenty-first century, quitting higher education in the middle of a life-or-death scenario is not an option. To maintain operations, a different approach is offered, but it is not a full substitution or replacement. The fundamental ideas of education, which are the result of a protracted development process and have passed through stringent testing, should not be destroyed by an alternate technique. It is crucial to remember that an educational system needs constant modification and updating, thus any ad hoc or contingent model should not be fully applied until it has received validation. In such cases, Alam and Parvin [68] proposed a policy framework that can handle the provision of education in an emergency. Figure 12 shows the specialised policy framework for HE during a crisis.

To confirm that the higher education sector must continue to function and provide active learning during a crisis, a dedicated taskforce with experts from various sectors (such as higher education, public policy and legislative bodies, ICT, private and public sector leaders, elites, etc.) should be established. This taskforce should ideally design an ad hoc initiative that is properly planned and timed and is able to address current issues. The government should fund and oversee the ad hoc initiative, and it should be one "in which the governance and regulatory systems are not compromised" to prevent the profit-making mentality from taking hold. Only institutions with a proven track record of value should be allowed to participate. Ad-hoc project completion must be followed by a number of evaluations, both internal and external. A fair ad hoc initiative might assist prevent market players from altering how the HE sector acts during a crisis based on the suggestions of these evaluations. The idea of active learning in higher education could be in risk from a wholly market-driven strategy.

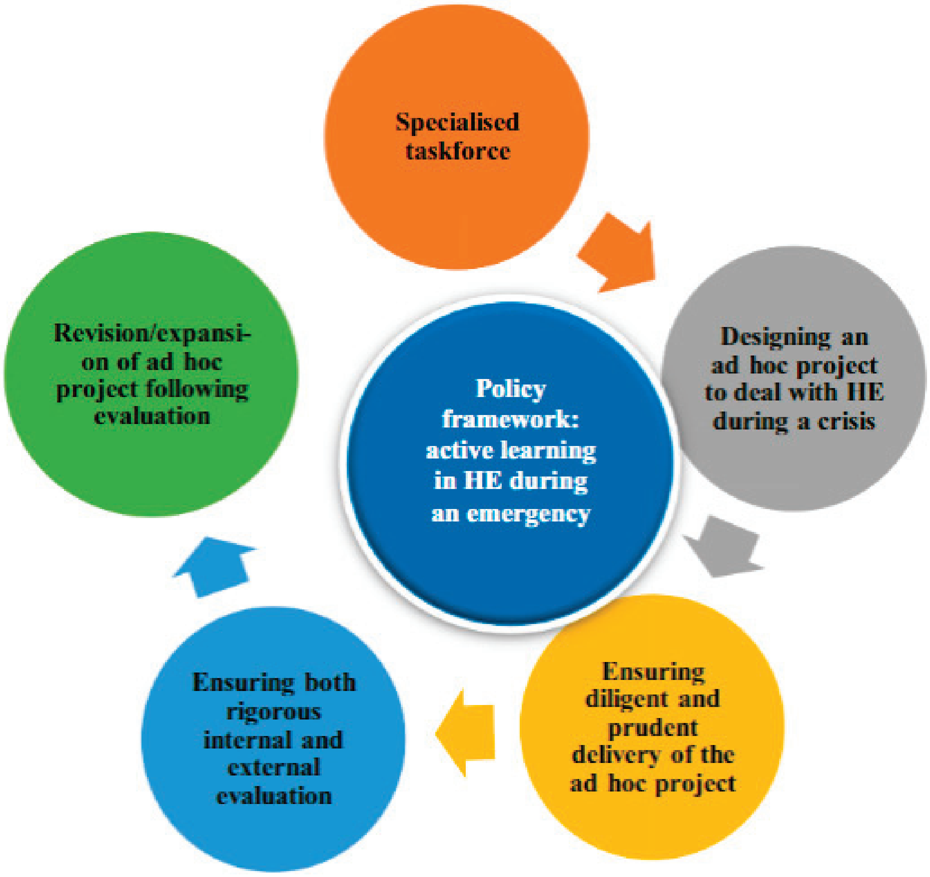

Figure 12. Specialised policy framework for Higher Education during a crisis such as COVID-19 pandemic (Reused with permission from Elsevier Publisher. Copyright year: 2021, Source: [68]).

Policy frameworks for teaching in HE should consider the main components of emergency response, technology adaptation, specialized teachers, training of staff, online support systems, external evaluation, and efficient delivery. It gives credence to the significance of e-platforms and other digital tools. Mobile applications have also been developed to support the application of technology in learning platforms for HEAs and also the creation of more online courses. Presently, online courses like Udemy, Coursera, EdX, Future Learn, and Alison have had increased patronage due to the recent spread of COVID-19 and CoV-2-SARS. These online courses have the advantages of being available at any time, safer as there is no social distancing required, easier because they can be approached at comfort, more flexible for people to learn from, and utilise simpler teaching contents for learners to easily adapt/learn.

6. Annotated Bibliography

In this section, an annotated bibliography on teaching in higher education academies (HEAs) is presented in this paper together with their frontiers in sustainable education. In Tables 3–5 and 8–10, the annotated bibliography from a plethora of publications were listed based on the classifications based on different categories.

Table 3. Some studies related to systematic reviews on teaching in HEAs.

Author	Year	Title	Summary	Ref.
Alam, G.M.; Parvin, M.	2020	Can online higher education be an active agent for change? —comparison of academic success and job-readiness before and during COVID-19	The paper presents a literature review on active learning in education by considering distance and open learning (DOL) during the recent COVID-19 pandemic.	[68]
Sousa, M.J., Marôco, A.L., Gonçalves, S.P., Machado, A.B.	2022	Digital Learning Is an Educational Format towards Sustainable Education	The paper examines how digital learning can be a teaching strategy that emphasises sustainable education.	[69]
Yu, Z.	2022	Sustaining student roles, digital literacy, learning achievements, and motivation in online learning environments during the COVID-19 pandemic	This paper shows that a rapid evidence assessment review study based on the PRISMA protocol can be used to determine student roles.	[70]
Yu, Z.; Deng, X.	2022	A meta-analysis of gender differences in e-learners' self-efficacy, satisfaction, motivation, attitude, and performance across the world	This study presents gender variations from the study's meta-analysis and systematic review.	[71]
Krstikj, A., Sosa Godina, J., García Bañuelos, L., et al.	2022	Analysis of Competency Assessment of Educational Innovation in Upper Secondary School and Higher Education: A Mapping Review	The paper gives light to "educational innovation in teaching" and the "assessment of competencies" in upper-secondary and higher education.	[72]
Suarez, L.M.C.; Nunez-Valdes, K.; Alpera, S.Q.Y.	2021	A systemic perspective for understanding digital transformation in higher education: Overview and subregional context in Latin America as evidence.	This paper gives an understanding of the digital transition in higher education by employing comparative data analysis and archival references. However, the data are based on Latin America.	[73]
Huang, X.Y.; Zou, D.; Cheng, G.; Xie, H.R.	2021	A systematic review of AR and VR enhanced language learning	This paper assesses earlier studies on language acquisition using augmented reality (AR) and virtual reality (VR)	[74]
Crawford, C.; Boyd, C.; Jain, S.; Khorsan, R.; Jonas, W.	2015	Rapid evidence assessment of the literature (REAL): Streamlining the systematic review process and creating utility for evidence-based health care	The paper uses the Rapid Evidence Assessment of the Literature (REAL) SR procedure to analyse clinical research.	[75]
Deng, X., Yu, Z.	2022	A Systematic Review of Machine-Translation-Assisted Language Learning for Sustainable Education	The paper uses machine translation (MT) for the development of artificial intelligence in sustainable education.	[76]
Greenwood, L., and Kelly, C.	2019	A systematic literature review to explore how staff in schools describe how a sense of belonging is created for their pupils	The paper gives a systematic study on how secondary school staff members foster a feeling of community among students.	[77]
Bond, M., Buntins, K., Bedenlier, S., et al.	2020	Mapping research in student engagement and educational technology in higher education: A systematic evidence map.	This paper visualized research on digital technologies and student involvement in 2007–2016 with text-based framework	[78]
Huang, C.	2018	Social network site use and academic achievement: A meta-analysis.	The paper uses social networking sites (SNSs) and academic achievement	[79]

Table 3. *Cont.*

Author	Year	Title	Summary	Ref.
Fehrman, S. and Watson, S. L.	2020	A systematic review of asynchronous online discussions in online higher education.	This paper presents as a main theme the asynchronous online discussions in higher education for 2010–2020.	[80]
Guajardo-Leal, B.E., Navarro-Corona, C., and González, J.R.V.	2019	Systematic mapping study of academic engagement in MOOC.	This is a synthesis of research on student engagement in MOOCs undertaken in 2015–2018.	[81]
Moher, D., Liberati, A., Tetzlaff, J., Altman, D.G.	2010	Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA statement.	Introduces PRISMA (preferred reporting items for systematic reviews and meta-analyses) and QUOROM (quality of reporting of meta-analyses).	[82]
Safipour, J., Wenneberg, S., and Hadziabdic, E.	2017	Experience of Education in the International Classroom -A Systematic Literature Review	The paper examines the teaching and learning processes in the global classroom from the viewpoints of both the teachers and the students.	[83]
Mitchell, V., Gredley, S., and Carette, L.	2022	Participatory Relationships Matter: Doctoral Students Traversing the Academy	This paper discusses three distinct doctoral paths and interactions with the post philosophies and some webinars	[84]
Carl, M.; Worsfold, L.	2021	The implementation and embedding of digital skills and digital literacy into the curriculum considering the COVID-19 pandemic and the new SQE	The paper presents the development of new digital teaching and resource-delivery models during the COVID-19 pandemic.	[85]
Pearson, J., Giacumo, L.A., Farid, A., Sadegh, M.	2022	A Systematic Multiple Studies Review of Low-Income, First-Generation, and Underrepresented, STEM-Degree Support Programs: Emerging Evidence-Based Models and Recommendations.	The paper uses an empirical method of multi-systematic analysis of 31 articles in 2005–2020. It presents a guide for developing and executing future projects on teaching	[86]

Table 4. Educational research on teaching systematic reviews.

Author	Year	Title	Summary	Ref.
Newman, M., Gough, D.	2020	*Systematic Reviews in Educational Research: Methodology, Perspectives and Application*. In: Systematic Reviews in Educational Research	This chapter examines the steps involved in using literature reviews as a research strategy. The chapter highlights additional reading on important topics in the systematic review process and illustrates the fundamental differences between aggregative and configurative techniques.	[87]
Nind, M.	2020	*Teaching Systematic Review*. In: Systematic Reviews in Educational Research	This chapter is about teaching systematic review that incorporates and expands on knowledge gained from two distinct sets of research experiences. The chapter promotes using in-depth knowledge of the approach and a readiness to be reflective and honest about its messy reality to teach systematic review in ways that foster critical thinking.	[88]

Table 4. *Cont.*

Author	Year	Title	Summary	Ref.
Lloyd-Williams, M., MacLeod, R.D.	2004	A systematic review of teaching and learning in palliative care within the medical undergraduate curriculum	The study is on developing an integrated curriculum for palliative care, with due consideration of the multidisciplinary aspect of palliative care, which is advised to be established within each medical school	[89]
Martin, F., Sun, T., Westine, C.D.	2020	A systematic review of research on online teaching and learning from 2009 to 2018	In the 1990s, 2000s, and 2010s, systematic reviews of online learning research were carried out but no evaluation that looks at the larger scope of research themes in online learning from the previous ten years from 619 research publications	[90]
Shahrol, S.J.M., Sulaiman, S., Samingan, M.R.Z.S.A., Mohamed, H.	2020	A Systematic Literature Review on Teaching and Learning English Using Mobile Technology	To find significant influences on the teaching and learning of English utilising mobile technology as well as existing research that address the problems, a systematic literature review, or SLR, is undertaken. The findings demonstrate that one of the most important success elements for improving English teaching and learning is the use of appropriate educational technology.	[91]
Gamage, S.H.P.W., Ayres, J.R. and Behrend, M.B.	2022	A systematic review on trends in using Moodle for teaching and learning	In STEM education, the Moodle Learning Management System (LMS) is frequently utilised in online teaching and learning. Moodle-related academic research is, however, dispersed across the literature. In order to help three groups of stakeholders—educators, researchers, and software developers—this review summarises this research.	[92]
Noetel, M., Griffith, S., Delaney, O., Sanders, T., Parker, P., del Pozo Cruz, B., and Lonsdale, C.	2021	Video Improves Learning in Higher Education: A Systematic Review.	The impacts of video (asynchronous multimedia) on learning in higher education were carefully reviewed. The review found randomised trials that assessed the learning effects of video among college students by searching five databases using 27 keywords for data extraction, bias testing, and full-text screening.	[93]
Noetel, M., Griffith, S., Delaney, O., Harris, N.R., Sanders, T., Parker, P., del Pozo Cruz, B., and Lonsdale, C.	2022	Multimedia Design for Learning: An Overview of Reviews With Meta-Meta-Analysis.	The review aimed to determine the best practises for multimedia design and assess how well certain learning theories fared in meta-analyses. An analysis of systematic reviews that looked at how multimedia design affected learning or cognitive load was undertaken.	[94]

Table 4. *Cont.*

Author	Year	Title	Summary	Ref.
Pigott, T.D., and Polanin, J.R.	2020	Methodological Guidance Paper: High-Quality Meta-Analysis in a Systematic Review.	This article on methodological guidance goes over the components of a top-notch meta-analysis that is carried out as part of a systematic review. When the overarching research issue concentrates on a quantitative synthesis of study data, meta-analysis, a collection of statistical techniques for synthesising the findings of several studies, is applied.	[95]
Fitton, L., McIlraith, A.L., and Wood, C.L.	2018	Shared Book Reading Interventions With English Learners: A Meta-Analysis.	The objective of this meta-analysis was to determine how shared book reading impacts young children learning English as a second language's literacy and language development. The impact of methodological requirements was investigated using sensitivity analyses, and intervention features and child characteristics were assessed as potential moderators.	[96]
Zawacki-Richter, O., Kerres, M., Bedenlier, S., Bond, M., Buntins, K.	2020	*Systematic Reviews in Educational Research: Methodology, Perspectives and Application.*	The book teaches how to do systematic reviews by conducting research on the pedagogy of methodological learning and research methods. It involved teachers and students in the process of enhancing competence and capacity in the collaborative production of understandings of what matters in instructing and learning cutting-edge social science research techniques, such as systematic reviews.	[97]
Newman, M., Bird, K.S., Kwan, I., Shemilt, I., Richardson, M., Hoo, H.	2020	The impact of Feedback Approaches on educational attainment in children and young people. (Protocol for a Systematic Review: Post-Peer review).	This offers a systematic review protocol on the effect of feedback approaches for young people's educational achievement. Teachers place a high importance on feedback in the classroom because it has the ability to significantly influence student results. Feedback is information conveyed to a student with the intention of altering their way of thinking or behaviour in order to enhance their learning.	[98]
Polanin, J.R., Maynard, B.R., and Dell, N.A.	2017	Overviews in Education Research: A Systematic Review and Analysis.	A common method for summarising the constantly growing amount of research and systematic reviews is to use overviews or the synthesis of research syntheses. This study's objectives are to describe the prevalence and state of overviews of education research, to offer more advice for conducting overviews, and to advance the development of overview methodologies.	[99]

Table 4. *Cont.*

Author	Year	Title	Summary	Ref.
Ahn, S., Ames, A.J., and Myers, N.D.	2012	A Review of Meta-Analyses in Education: Methodological Strengths and Weaknesses.	The current review examines the validity of published meta-analyses in education that assess the veracity and generalizability of study findings. The study is used to assess the present meta-analytic procedures in education, identify methodological strengths and limitations, and offer ideas for changes.	[100]
Kluger, A.N., and DeNisi, A.	1996	The effects of feedback interventions on performance: A historical review, a meta-analysis, and a preliminary feedback intervention theory	The feedback on performance from meta-analyses in education is the topic of the current review. Since the turn of the century, feedback interventions (FIs) have had detrimental consequences on performance that have gone mostly unnoticed. Sampling mistakes, feedback signs, or pre-existing theories are all insufficient from a preliminary FI theory (FIT).	[101]
Kyndt, E., and Baert, H.	2013	Antecedents of Employees' Involvement in Work-Related Learning: A Systematic Review.	Participation in workplace learning appears to be more complicated than a straightforward supply–demand match. This involvement can be influenced at various phases of the employee's decision-making process by the interaction of a number of elements. The purpose of this systematic review is to determine those factors that have been linked to work-related learning in earlier studies.	[102]
Lee, S.M.-K., Cui, Y., and Tong, S.X.	2022	Toward a Model of Statistical Learning and Reading: Evidence From a Meta-Analysis.	The human ability to automatically recognise and integrate statistical patterns of complicated environmental data is a convincing example of implicit learning. This skill, known as statistical learning, has been studied in dyslexics using a variety of tasks written in various orthographies. Conclusions about dyslexia's damaged or intact statistical learning, however, are still up for debate. This study used several learning paradigms and distinct orthographies to compare statistical learning across individuals with and without dyslexia from a systematic study.	[103]
Van der Kleij, F.M., Feskens, R.C.W., and Eggen, T.J.H.M.	2015	Effects of Feedback in a Computer-Based Learning Environment on Students' Learning Outcomes: A Meta-Analysis.	The effects of techniques for providing item-based feedback in a computer-based environment on students' learning outcomes were examined in this meta-analysis. Despite the fact that the data revealed that rapid feedback was superior to delayed input for lower order learning and vice versa, no significant interaction was discovered.	[104]

Table 5. Related studies on group learning in HEAs.

Author	Year	Title	Summary	Ref.
Shin, S., Kwon, K., Jung, J.	2022	Collaborative Learning in the Flipped University Classroom: Identifying Team Process Factors.	The aim of this study was to investigate how team-process characteristics in flipped learning connect to students' self-efficacy, attitude, and learning satisfaction. This study investigates how students' choices for collaborative work versus solo work affect their self-efficacy, attitude, and learning satisfaction in a flipped classroom. Lone-wolf students typically lack organisational commitment and have limited patience for the group work process of 34 undergraduate students at a business school from a university in Seoul, South Korea.	[105]
Mohammed, S.S., Baysen, E.	2022	Peer Assessment of Curriculum Content of Group Games in Physical Education: A Systematic Literature Review of the Last Seven Years.	The objective of the study is to comprehensively review the literature on the group game curriculum in physical education (PE) in northern Iraq. Two research questions, "What were the primary research objectives, techniques, and outcomes of the selected studies in this systematic review?" and "What were the major research objectives, methodologies, and outcomes of the studies published between 2015 and 2021?" drove the analysis of eight investigations.	[106]
Fellenz, M.R.	2006	Toward Fairness in Assessing Student Groupwork: A Protocol for Peer Evaluation of Individual Contributions.	The Groupwork Peer-Evaluation Protocol (GPEP), which facilitates the evaluation of individual contributions to graded student groupwork, is presented in this article. The three goals of encouraging student learning, delivering accurate and fair assessment, and facilitating group self-management are what the GPEP is meant to do.	[107]
O'Connor, D., and Yballe, L.	2007	Team Leadership: Critical Steps To Great Projects	This article provides a brief overview of the context for team projects and advances a constructive vision of teams and leadership in response to the difficulty of assigning and carrying out group tasks. The authors present a model that broadens the traditional view of the student-team leadership challenge as well as some guiding principles, resources, and objectives. The writers also provide a number of project worksheets that they have created over the years and that have aided in enhancing group project learning.	[108]

Table 5. *Cont.*

Author	Year	Title	Summary	Ref.
Almond, R.L.	2009	Group assessment: comparing group and individual under-graduate module marks	This article presents a modest study that examined the module grades of a group of science undergraduates over the course of one academic year. It investigated how group summative assessment marking differed from individual assessment in terms of its impact on overall scores. A single cohort of undergraduate science students underwent a group summative assessment (GSA). It is crucial that students are assigned to tutors in a way that reflects the workplace realities, where self-selected teams are uncommon.	[109]
Bacon, D.R.	2005	The effect of group projects on content-related learning	Business schools frequently give their students group projects to help them grasp the course material and develop collaborative skills. However, group goals and individual accountability are two features of efficient collaborative learning tasks that are frequently absent from student group assignments given in business classes. According to the latest study, collaborative projects actually hinder content learning.	[110]
Bacon, D.R., Stewart, K.A., and Silver, W.S.	1999	Lessons from the Best and Worst Student Team Experiences: How a Teacher can make the Difference.	This study empirically pinpoints which teacher-controlled (contextual) factors most strongly influence whether a student will have a positive or negative team experience. The findings show that team experiences are positively influenced by colleagues' self-selection, the duration of the team's experience, and the clarity of instructions given to the team. Peer evaluation utilisation was connected negatively with positive team experiences, contrary to earlier empirical findings and accepted knowledge.	[111]
Holtham, C.W., Melville, R.R., and Sodhi, M.S.	2006	Designing Student Groupwork in Management Education: Widening the Palette of Options.	The authors use the atypical team deployment in a master's in management core course to illustrate innovation in practise. The jigsaw team approach was used in two parallel team uses, one of which involved the team supporting individual effort. The experiences are consistent with the need for faculty teams and individual academics to address the issue of diversifying the groupwork models utilised in management education.	[112]

Table 5. *Cont.*

Author	Year	Title	Summary	Ref.
Baker, T., and Clark, J.	2010	Cooperative learning–A double-edged sword: a coopera-tive learning model for use with diverse student groups.	The study uses surveys and focus groups with local and international students as well as New Zealand (NZ) tertiary instructors who include cooperative learning (CL) in their curricula that were used to gather data. The results show that there is a significant cultural divide in how international students, who have little prior experience with CL, and NZ lecturers, who frequently lack the necessary training to assist international students in bridging the gaps between their previous educational experiences and typical educational practises in NZ.	[113]
Barfield, R.L.	2003	Students' perceptions of and satisfaction with group grades and the group experience in the college classroom.	Higher education academics generally agree that the group-learning approach is a useful teaching and learning technique. While using group projects in the college classroom has many educational, learning, and social communication benefits for both students and teachers, there is a need for a deeper knowledge of group projects from the student's point of view. This study set out to gauge how college students felt about their peers' performance on group assignments and their happiness as a group.	[114]
Cooper, J.	2003	*Group formation in cooperative learning: What the experts say.* In: Small group instruction in higher education: Lessons from the past, visions of the future	The survey on group work is summarised in this chapter. Depending on work time, groups of four are advised (two for shorter tasks). However, the need for groups that require lecturer or tutor management are also discussed.	[115]
Chapman, K.J., Meuter, M., Toy, D., and Wright, L.	2006	Can't We Pick our Own Groups? The Influence of Group Selection Method on Group Dynamics and Outcomes.	This study aims to determine whether group dynamics, outcomes, and students' views toward the group experience are affected by the manner of member assignment (random or self-selected).	[116]
Zeff, L.E., Higby, M.A., and Bossman, L.J.	2006	Permanent or Temporary Classroom Groups: A Field Study	The article outlines the different project kinds that permanent and ad hoc groups will work well for. The results also point to the need for further faculty training on how to design suitable learning environments and projects. Students will need further training in areas like group dynamics and leadership in order to reinforce course content.	[117]

Table 5. *Cont.*

Author	Year	Title	Summary	Ref.
Baixinho, C.L., Ferreira, Ó.R., Medeiros, M., Oliveira, E.S.F.	2022	Sense of Belonging and Evidence Learning: A Focus Group Study.	The achievement of nursing students on the professional and clinical levels requires a sense of belonging. This study sought to determine students' involvement in projects for putting knowledge into practise, which generated a sense of community and facilitated their incorporation into clinical practise services. The study was conducted utilising semi-structured interviews with a group of 15 students divided into two focus groups, using the research question as a springboard for discussion on more focused subjects.	[118]

Table 6. Related studies on teaching and learning to adapt to COVID-19.

Author	Year	Title	Summary	Ref.
Ricaurte, M., Ordóñez, P.E., Navas-Cárdenas, C., Meneses, M.A., Tafur, J.P., Viloria, A.	2022	Industrial Processes Online Teaching: A Good Practice for Undergraduate Engineering Students in Times of COVID-19	Higher education institutions were forced to abruptly switch from face-to-face to online learning due of the COVID-19 pandemic. It was necessary to make adjustments, especially in industrial process training for chemical engineering and associated fields. In order to allow undergraduate students to witness the work of process engineers in professional settings, students were not allowed access to businesses and industries for internships or industrial tours. This essay outlines a teaching tactic to get around this drawback.	[119]
Bamrungsin, P., Khampirat, B.	2022	Improving Professional Skills of Pre-Service Teachers Using Online Training: Applying Work-Integrated Learning Approaches through a Quasi-Experimental Study.	Over the past few decades, there has been a lot of focus on preparing preservice teachers for professional involvement. Finding efficient coaching and training to help preservice teachers (PSTs) improve their professional abilities is crucial. In this study, a proactive online training programme (POTP) was created using a model of work-integrated learning (WIL) activities and teacher preparation. The goal was to assess how POTP had improved the professional abilities of PSTs.	[120]

Table 6. *Cont.*

Author	Year	Title	Summary	Ref.
Avsec, S., Jagiełło-Kowalczyk, M., Żabicka, A.	2022	Enhancing Transformative Learning and Innovation Skills Using Remote Learning for Sustainable Architecture Design.	Although rather useful, current educational technology with artificial intelligence-powered solutions may cause learning to stop because it lacks the social and emotional value that is a crucial component of education for sustainable development and produces an immersive experience through which higher-order thinking skills can be adopted. This study examines a 16-week distance learning course for transformational learning (TL) and developing innovative skills.	[121]
Brumann, S., Ohl, U., Schulz. J.	2022	Inquiry-Based Learning on Climate Change in Upper Secondary Education: A Design-Based Approach.	Inquiry-based learning (IBL) is a viable strategy for overcoming different challenges, according to this study. However, there are many scientifically tested instructional strategies available today, particularly for climate change-related IBL. To promote effective learning processes, the study reported here asks how a science educational seminar for upper secondary schools on the regional effects of climate change should be structured.	[122]
Alyahya, M.A., Elshaer, I.A., Abunasser, F., Hassan, O.H.M., Sobaih, A.E.E.	2022	E-Learning Experience in Higher Education amid COVID-19: Does Gender Really Matter in A Gender-Segregated Culture?	There has been little research on how gender affects students' experiences with electronic (e-) learning at higher education institutions (HEI) despite the abundance of studies on this topic; thus, this paper. In a gender-segregated culture where female students often have more access to technology-based learning than their male counterparts, this research seeks to examine how students differ in terms of their experiences with e-learning while participating in COVID-19.	[123]
Rodrigues, C., Costa, J.M., Moro, S.	2022	Assessment Patterns during Portuguese Emergency Remote Teaching.	Emergency remote teaching (ERT) created significant difficulties for grading student work. This study shows that there is no doubt that COVID-19 has had more detrimental effects on schooling than beneficial ones. Numerous lockdowns caused by the pandemic crisis required millions of students and teachers to continue their studies at home. In Portugal, where the ERT lasted many months in the previous two years, we conducted a survey to better understand the assessment issues teachers encounter during the ERT and their patterns for evaluation.	[124]

Table 7. Related studies on teaching and learning to adapt to COVID-19.

Author	Year	Title	Summary	Ref.
Torres-Díaz, J.C., Rivera-Rogel, D., Beltrán-Flandoli, A.M., Andrade-Vargas, L.	2022	Effects of COVID-19 on the Perception of Virtual Education in University Students in Ecuador; Technical and Methodological Principles at the Universidad Técnica Particular de Loja.	Due to the confinement and migration from face-to-face to open access, online, or blended/hybrid education modes brought on by the coronavirus crisis, education has been compelled to change, although there are severe shortcomings at every level. This work analyses the perspective of a group of students regarding the current state of emergency from a descriptive and correlational quantitative methodological conception of ICT. The primary findings show that students are not yet persuaded that a virtual modality is superior to face-to-face instruction.	[125]
Ota, E., Murakami-Suzuki, R.	2022	Effects of Online Problem-Based Learning to Increase Global Competencies for First-Year Undergraduate Students Majoring in Science and Engineering in Japan.	The goal of this study is to evaluate the learning outcomes and the process of creating skill sets for students majoring in science and engineering at a technical university in Japan. The assessment will be done through online problem-based learning (PBL). The subjects chosen by the group members were all consistent with the SDGs (SDGs). The three skill sets that will be cultivated through this PBL course are multicultural communication and understanding, problem-solving and finding, and global awareness.	[126]
Zhu, Y., Tan, J., Cao, Y., Liu, Y., Liu, Y., Zhang, Q., Liu, Q.	2022	Application of Fuzzy Analytic Hierarchy Process in Environmental Economics Education: Under the Online and Offline Blended Teaching Mode.	The fuzzy analytic hierarchy process (FAHP) was employed in this study to assess students' performance in an online and offline blended environmental economics course (OOBT). OOBT was a brand-new teaching approach that combined traditional offline instruction with an online learning management system. It had the potential to increase students' after-class learning effectiveness and do away with the drawbacks of conventional classroom instruction by utilising an online learning management system. However, there are not many ways to currently assess OOBT pupils' performance.	[127]

Table 8. Related studies on teaching and learning to adapt to COVID-19.

Author	Year	Title	Summary	Ref.
Moustakas, L., Kalina, L.	2022	Learning Football for Good: The Development and Evaluation of the Football3 MOOC.	Sport is becoming a recognised tool for achieving sustainable development goals over the past 20 years. This strategy, often known as sport for development or SFD, is the deliberate use of sport to accomplish development goals. Many SFD organisations use strategies that refocus sport away from its competitive features and promote participation, fair play, and communication in an effort to meet developmental goals. Football3 is a popular Massive Open Online Course (MOOC) technique—“football3 for everyone”—created and freely available for all.	[128]
Galkienė, A., Monkevičienė, O., Kaminskienė, L., Krikštolaitis, R., Käsper, M., Ivanova, I.	2022	Modeling the Sustainable Educational Process for Pupils from Vulnerable Groups in Critical Situations: COVID-19 Context in Lithuania, Latvia, and Estonia.	The COVID-19-induced crisis in education has dramatically decreased the participation of students from vulnerable groups, especially those with low academic achievement. The purpose of this study is to identify the elements that support the best learning outcomes for students from vulnerable groups in general education schools during times of significant educational reform. The study’s findings show that self-regulatory collaborative learning improves students’ academic performance in a variety of (stable and unstable) educational situations across all three nations for students with emotional and learning challenges.	[129]

Table 9. Related studies on digital literacy on teaching in HEAs.

Author	Year	Title	Summary	Ref.
Hui, J., Zhou, Y., Oubibi, M., Di, W., Zhang, L., Zhang, S.	2022	Research on Art Teaching Practice Supported by Virtual Reality (VR) Technology in the Primary Schools.	Currently, as information technology develops and becomes more widely used, teaching and learning methodologies are continually evolving. The incorporation of virtual technologies is being investigated in several teaching activities. However, it can be difficult to confirm the precise impacts of VR. This research showed that it is simpler to enter mental flow in virtual reality and that the use of virtual reality technology is positively connected with learning engagement after examining the experimental data from the experimental group and the control group.	[130]

Table 9. *Cont.*

Author	Year	Title	Summary	Ref.
Li, M., Yu, Z.	2022	Teachers' Satisfaction, Role, and Digital Literacy during the COVID-19 Pandemic.	Teachers and students across the globe have been forced to switch to an online teaching and learning model as a result of the COVID-19 pandemic. The COVID-19 health crisis has posed challenges to teachers' professional roles, levels of career satisfaction, and digital literacy as compared to traditional face-to-face education methods. The critical appraisal tools to carry out a systematic review included improving the results, by eliminating irrelevant and poorer quality results. They scored each chosen paper with STARLITE to obtain high-quality studies.	[131]
Johnson, C.C., Walton, J.B., Strickler, L., and Elliott, J.B.	2022	Online Teaching in K-12 Education in the United States: A Systematic Review	The 2020 COVID-19 pandemic's requirement that K–12 students receive all or some of their instruction online brought to light the current lack of knowledge of practises that support K–12 student learning in online settings in emergency situations, but more concerningly, in K–12 online teaching and learning more generally. In order to fill this knowledge gap, a systematic review of the literature on K–12 online teaching and learning in the United States was conducted.	[132]
Chen, C.-M., Li, M.-C., and Chen, T.-C.	2020	A web-based collaborative reading annotation system with gamification mechanisms to improve reading performance.	A web-based collaborative reading annotation system (WCRAS) with gamification mechanisms is presented in this study as a means of encouraging students' annotation practises and enhancing their reading comprehension abilities. Using WCRAS with and without gamification mechanisms to encourage digital reading, an evaluation of the effects of the experimental and control groups on students' annotation behaviours, collaborative interaction relationships, reading comprehension performance, and immersion experience was conducted.	[133]

Table 9. *Cont.*

Author	Year	Title	Summary	Ref.
Cardinal, A.	2019	Participatory video: An apparatus for ethically researching literacy, power and embodiment.	The study theorizes participatory video as a means for examining first-year college students' embodied literate practises as they move through various environments. It examines first-year writing students' video diaries and video literacy narratives as part of a 4-year longitudinal study that incorporates feminist pedagogies and decolonizing approaches to educational research. It examines how two women of colour used the camera as a rhetorical tool to address racist occurrences from their literary pasts and to conceal themselves from white audiences' gaze by donning digital personas while generating knowledge about literacy.	[134]
Morris, P., and Sarapin, S.	2020	Mobile phones in the classroom: Policies and potential pedagogy	Mobile phones are allowed for basic classroom activities, according to respondents (74%) but there is no meaningful integration with teaching and learning. Due to the distractions of unrestricted use, many university teachers (76% of those surveyed) have a mobile phone policy in their classes. However, only approximately half of those who enforce phone-free zones for students claim that their regulations are successful.	[135]
Wang, A., and Tahir, R.	2020	The effect of using Kahoot! for learning: A literature review.	A game-based learning platform called Kahoot! can be used to check students' knowledge, for formative evaluation, or as a diversion from routine lessons. With 70 million active unique users per month and 50% of US K–12 students using it, it is one of the most well-known game-based learning systems. Numerous studies on the impact of utilising Kahoot! in the classroom have been published since the platform's inception in 2013; however, there hasn't yet been a thorough review of the findings. The findings of a study of the literature on the impact of Kahoot! for learning are presented in this article, with a focus on how Kahoot! impacts learning performance, classroom dynamics, attitudes and views of students and teachers, and student anxiety.	[136]

Table 9. *Cont.*

Author	Year	Title	Summary	Ref.
Liu, C.-C., Yang, C.-Y., and Chao, P.-Y.	2019	A longitudinal analysis of student participation in a digital collaborative storytelling activity.	Despite the good potential of online social networking sites, there is presently little longitudinal research about how kids engage in digital storytelling communities. According to the social network analysis, students regarded collaboration, language skills, and multiple literacies—including the ability to comprehend multimedia—as key factors in selecting a partner with whom to engage on a collaborative digital storytelling project from educational practise.	[137]
Hou, H.-T., Yu, T.-F., Chiang, F.-D., Lin, Y.-H., Chang, K.-E., and Kuo, C.-C.	2020	Development and evaluation of mindtool-based blogs to promote learners' higher order cognitive thinking in online discussions: An analysis of learning effects and cognitive process.	Blogs are helpful tools for fostering learner involvement and knowledge creation in online educational activities. Contrarily, whereas several studies demonstrate how mindtools support learners' cognitive processes, little study has been done on how these tools affect learners' higher order cognitive thinking in blogs. In order to encourage learners' higher order cognitive thinking in their online interactions and to evaluate their learning impacts, this research created a learning environment utilising a blog that was built using a mindtool and the control group from a quasi-experiment.	[138]
Cheston, C.C., Flickinger, T.E., and Chisolm, M.S.	2013	Social media use in medical education: A systematic review.	In order to respond to two issues, the authors carried out a systematic evaluation of the published literature on social media use in medical education. (1) How have social media initiatives impacted the satisfaction, knowledge, attitudes, and skills of doctors and medical students? and (2) What particular social media-related difficulties and chances have educators run across while putting these interventions into practise?	[139]
Connolly, T.M., Boyle, E.A., MacArthur, E., Hainey, T., and Boyle, J.M.	2012	A systematic literature review of empirical evidence on computer games and serious games.	This study looks at the research on computer games and serious games in relation to the possible benefits of gaming for users 14 years of age and older, particularly in terms of learning, skill development, and engagement. The systematic review involved a comprehensive strategy by using search terms for categorising games.	[140]

Table 9. *Cont.*

Author	Year	Title	Summary	Ref.
Crompton, H., Burke, D., Gregory, K.H., and Gräbe, C.	2016	The use of mobile learning in science: A systematic review.	Mobile learning is becoming increasingly prevalent in the classroom. It is critical to develop a shared knowledge of the research that has been conducted in order to understand how mobile learning is being used most effectively. This systematic review uses a thorough analysis and synthesis of papers from the year 2000 onwards to show the trends in mobile learning in science. The majority of the studies concentrated on creating systems for mobile learning, which was followed by a combination of analysing the outcomes of mobile learning and researching the affective domain while learning on the go.	[141]
Hunsu, N.J., Adesope, O., and Bayly, D.J.	2016	A meta-analysis of the effects of audience response systems (clicker-based technologies) on cognition and affect.	Many instructors who want to boost academic achievement through student involvement have adopted audience-response systems (ARS), which are regarded as an effective technique to use technology to encourage engagement in the classroom. Researchers have looked at how much they support both cognitive and non-cognitive learning outcomes in the classroom, but the majority of their findings are conflicting and ambiguous. This meta-analysis aims to reconcile the divergent results from utilising ARS.	[142]
Kaliisa, R., and Picard, M.	2017	A systematic review on mobile learning in higher education: The African perspective	Mobile devices are now used more frequently in higher education as a result of their popularity and widespread adoption. Studies have examined mobile learning efforts in a variety of settings, but none have looked into this topic in Africa. In order to examine the use, consequences, and difficulties of mobile technology-supported learning, this systematic review compiles and contrasts papers on mobile learning in higher education in the African context that were published between 2010 and 2016.	[143]

Table 9. *Cont.*

Author	Year	Title	Summary	Ref.
Huang, C.	2017	Time spent on social network sites use and psychological well-being: A meta-analysis.	The association between social networking site use and psychological well-being variables like depression, loneliness, and life satisfaction is examined in this meta-analysis. While there was little to no link between time spent on social networking sites and good indicators (such as life satisfaction and self-esteem), there was a slight correlation between time spent on social networking sites and negative indicators (such as sadness and loneliness).	[144]
Hwang G.J., Tsai C.C.	2011	Research trends in mobile and ubiquitous learning: a review of publication in selected journals from 2001 to 2010.	A survey of publications in particular journals from 2001 to 2010 was used to analyse research trends in mobile and ubiquitous learning. Many teachers who want to boost academic performance through student engagement have accepted the usage of mobile learning in science as a good technology-based strategy to increase engagement in the classroom. This meta-analysis aims to reconcile the divergent results. The use of mobile phones in classrooms that used and did not employ mobile learning in science and technologies was specifically taken into consideration from various studies.	[145]

Table 10. Related studies on diversity and cultural differences on teaching in HEAs.

Author	Year	Title	Summary	Ref.
Hines, M., and Fallace, T.	2022	Pedagogical Progressivism and Black Education: A Historiographical Review, 1880–1957	This article provides a critical overview of the literature on the historical development of educational progressivism in the United States throughout the late 19th and early 20th centuries. Others have emphasised how pedagogical progressivism supported movements for liberation and social justice, particularly when adopted by Black educators. While many historians have focused on the overt and covert racism inherent in much progressive pedagogy as advocated by White educators, others have focused on this support. Thus, by include the work of Black researchers, school administrators, curriculum designers, and teachers, the historical approach of pedagogical progressivism is becoming more nuanced.	[146]

Table 10. *Cont.*

Author	Year	Title	Summary	Ref.
Casinader, N., and Walsh, L.	2019	Investigating the cultural understandings of International Baccalaureate Primary Years Programme teachers from a transcultural perspective	The research examining from a transcultural perspective the cultural perceptions of instructors who teach the International Baccalaureate Primary Years Programme. Through teachers' responses to four different facets of transculturalism in pedagogical practise, this study employed an online survey to explore PYP instructors' transcultural attitudes. The findings imply that using the transcultural paradigm, which is more inclusive, will significantly enhance cultural education.	[147]
Caraballo, L.	2016	Students' critical meta-awareness in a figured world of achievement toward a culturally sustaining stance in curriculum, pedagogy, and research	This study presents the junction of student identities and discourses of achievement within an English curriculum in a diverse urban middle school, which is based on a semester-long mixed-methods multicase study. It examines how student identities, languages, and literacies impact learning experiences in the classroom, how teachers react to these factors, and what else—such as youth-led participatory action research—can actively challenge conventional ideas about what constitutes literacy in the curriculum, pedagogy, and research to increase students' awareness.	[148]
Givens, J.R.	2015	*A grammar for black education beyond borders*: Exploring technologies of schooling in the African Diaspora.	The study presents the idea of educational diasporic practise by drawing on research at the intersections of education and the African Diaspora. It discusses how white supremacy has contributed to the misrecognition and (re)production of black people as undeserving of holding the status of human by using Mills' "The Racial Contract" and Althusser's theory of the ideological state apparatuses via a racial lens. It advocates the study of the restorative and epistemological writings of diasporic thinkers like Chinua Achebe and Carter G. Woodson that support the creation of a humanising and liberating language for blackness globally in education and resistance to colonial educational practises.	[149]

Table 10. *Cont.*

Author	Year	Title	Summary	Ref.
Matias, C.E., and Grosland, T.J.	2016	Digital storytelling as racial justice: Digital hopes for deconstructing whiteness in teacher education	This paper uses digital storytelling to investigate the emotionality surrounding race that is pervasive in teacher-education-programme classrooms. It draws on a combination of critical race theory, critical emotion studies, and critical whiteness studies. Teacher candidates used digital storytelling to reflect on how participation in racial discourse in education allowed them to deconstruct their own identities. The need to challenge and question initiatives that advance social justice while excluding whiteness as a topic of inquiry has implications for teacher education pedagogy and creates a space for discussion of the pervasive racism that purports to be socially just and culturally sensitive.	[150]
Mosley Wetzel, M., and Rogers, R.	2015	Constructing racial literacy through critical language awareness: A case study of a beginning literacy teacher.	Utilizes critical language awareness to assess racial literacy throughout three literacy events (a teacher's reflection on white privilege, a literacy lesson exploring race, and a debriefing with colleagues) in a year-long case study of a white preservice teacher and her black pupil. It demonstrates how a key component of becoming a teacher is becoming conscious of race, racism, and white privilege. Using critical literacy as a framework, this example shows how critical discourse analysis and critical language awareness may be used to dismantle prevailing forms of literacy and investigate, critique, and reconstruct understandings of race.	[151]
Ohito, E.O., and Khoja-Moolji, S.	2018	Reparative readings: re-claiming black feminised bodies as sites of somatic pleasures and possibilities	The study challenges the prevailing discourses that ignore and erase black female bodies, especially in curriculum and pedagogical practises, by using the idea of reparative reading. It examines the curriculum using feminist writing techniques and self-reflection to reconsider works like *Caucasia (1999)* and *Sarah Phillips (1984)* as alternate representations of black female bodies that contain pleasure and possibilities. Its conclusion is that examining bodies as texts enables the development of curricula and pedagogies that heal the minds and bodies of people who are vulnerable to and disenfranchised by hegemonic frameworks of racism and gender.	[152]

Table 10. *Cont.*

Author	Year	Title	Summary	Ref.
Pane, D.M.	2015	The story of drama club: A contemporary counternarrative of a transformative culture of teaching and learning for disenfranchised black youth in the school-to-prison pipeline.	This study looks into how three white teachers in an urban educational alternative outreach school are using drama club as a culturally responsive pedagogical tool as part of a year-long programme to validate students' cultures, understand the varied experiences of the community, and transform instruction and learning. There is the use of teachers' narratives and critical reflections on teaching and learning, students' journaling, essay writing, and note-taking, as well as editorials and articles written for the monthly school newspaper that is produced by the students, and (auto)biographical and (auto)ethnographic methods. It investigates the metaphors developed in a student-centered classroom that promote critical thinking and a counternarrative for teaching and learning with and for marginalised black teens.	[153]
Scharrer, E., and Ramasubramanian, S.	2015	Intervening in the media's influence on stereotypes of race and ethnicity: The role of media literacy education.	The question of whether media literacy can act to lessen racial, gender, and ethnic stereotypes is raised by reviewing quantitative and qualitative media literacy studies. It examines a qualitative curricular investigation of violence and stereotypes in the media, looking at writing from 60 primarily white sixth graders who struggled with how media shapes and expands conceptions of oneself and others. The implications for extended class periods, intergroup interactions using stereotypes and counterstereotypes, youth-constructed curricula, and explicit racial and ethnic profiling are discussed in the conclusion.	[154]
Zhang, G., Jia, Z., Yan, S.	2022	Does Gender Matter? The Relationship Comparison of Strategic Leadership on Organizational Ambidextrous Behavior between Male and Female CEOs.	This study intends to investigate how organisational ambidextrous behaviour differs between male and female CEOs in terms of strategic leadership, taking into account the balancing effect and combined effect of exploratory and exploitative behaviours. From 2016 to 2020, a quantitative analysis of male and female CEOs of publicly traded firms was performed using demographic information and pertinent organisational ambidextrous data. The results showed that ambidextrous female strategic leaders do not act differently from their male counterparts.	[155]

Table 10. *Cont.*

Author	Year	Title	Summary	Ref.
Ohta, R., Yata, A., Sano, C.	2022	Students' Learning on Sustainable Development Goals through Interactive Lectures and Fieldwork in Rural Communities: Grounded Theory Approach.	SDG education is essential to inspire people to continue engaging in activities that are in line with the SDGs. Sustainable social resource-based community management and sustainable development objectives (SDGs) are essential for community sustainability and sustainable development, respectively. This strategy divides SDG instruction into three topics and eleven concepts for students. Participants in SDG education that combines interactive lectures with rural fieldwork re-evaluate community and society notions within an SDG-focused perspective.	[156]
Viner, R.M., Russell, S.J., Croker, H., et al.	2020	School closure and management practices during coronavirus outbreaks including COVID-19: A rapid systematic review	The paper presents management strategies for school closures during the recent COVID-19 pandemic.	[157]

7. Conclusions

In this paper, a scientific review with annotated bibliography on teaching in higher education academies (HEAs) is presented together with their frontiers in sustainable education. This study covers literature on reflecting comments, reflective thinking, and reflective behaviour in the classroom. This annotated bibliography is made up of references and their summaries with the authors' views on the collected literature to aid academics, such as professors, workshop tutors, teaching assistants, laboratory demonstrators, postgraduate researchers, and educators in obtaining a comprehensive overview of the literature on the subject to enhance their teaching abilities. Different studies demonstrate how a teacher's teaching skills and assessments may affect the mode of students learning. This is evident based on the studies conducted on teaching styles, student assessment, and group learning. The literature utilised for the annotated bibliography shows that the learner's attitude and the teacher's skills have an effect on the students' learning process.

The scientific review and scientometric analysis conducted was used to understand the research pattern in this area. It is evident that there are key indicators that affect the research pattern on teaching in HEAs. Based on the publication records from 1993 to mid-2022, it was observed that different global occurrences could have affected the research trends noticed in this subject area, such as the 2008 global economic recession, 2016 drop in oil price, and the 2020/2021 COVID-19 pandemic. It was observed that the publications did not increase around these times, but further evidence is required to support this pattern. With the increase in online learning, there is a decrease in group learning due to the COVID-19 pandemic. It should be noted that group meetings were shunned by the World Health Organisation (WHO), schools were closed during the COVID-19 outbreak globally, and there were national lockdowns which led to fewer peer-to-peer interactions physically. Due to this recent COVID-19 pandemic, which has seen social distancing rules involving remaining 2 m apart and the use of nose masks and hand sanitizers, there has been an increase in online learning. Hence, the publications dropped from eight publications in 2019 to six publications in 2020 and remained six publications in 2021, and slightly dropped to five publications in mid-2022, which is envisaged to increase as schools have resumed and the post-COVID-19 pandemic era is approaching. On the one hand, the international lockdowns revealed new loopholes and difficulties, such as the challenge of providing

Chromebooks and laptops for students to use at home during the lockdown. On the other hand, the relationship between technology and education has been growing, which has given education the chance to advance and improve the use of digital technologies in the classroom. In addition, there are advantages adapted from the COVID-19 pandemic leading to learning-readiness and job-readiness in higher education [68,157,158].

It was also observed that the highest publications were produced in the U.S.A. Additionally, it was also gathered that the U.S.A. and the U.K. are the top two nations, and they are both developed nations that also invest heavily on research into education. These affiliations are from various locations, demonstrating that research on education is being undertaken with a focus on teaching in higher education academy. However, the rates of production per affiliation are not very high, which may indicate that there is little funding for this field of study. The survey also reveals that articles and journal papers made up the majority of publications on this topic. Using the most frequent words, a trend was identified as depicted in Figure 10, showing that 'education' is the keyword with highest relative frequency, namely, as education (48); learning (47); higher (23); teaching (19); and practice (11). However, future research can include an annotated biography on teaching in HEAs with themes like student participation, diversity, teaching pedagogy, and blended learning in HEAs. Additionally, detailed scientific literature reviews can be conducted on teaching in HEAs. Further studies should include inclusive learning, teaching pedagogy, socio-cultural differences, and advanced teaching techniques for STEM courses.

Supplementary Materials: The supplementary data used in the study can be downloaded at: Amaechi, Chiemela Victor (2022), "Data on Scientometrics of Teaching in HEA and adapting to COVID-19 (group learning)- Paper 2", *Mendeley Data*, V2, https://data.mendeley.com/datasets/hnjmzhskz3, accessed on 6 September 2022.

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Appendix A. List of Some Journals on Teaching and Education in Higher Education

From this study, the list of journals include: *Teaching in Higher Education*, *Diversity In Higher Education*, *International Journal For Academic Development*, *Journal Of Further And*

Higher Education, *On The Horizon, Pediatrics*, and *Tertiary Education and Management*, all having two publications each, except *Teaching in Higher Education*, which has three publications. The last set of publications had one article each, and include journals like *Academic Psychiatry*, *Advances In Intelligent Systems And Computing*, *Alt J Research In Learning Technology*, *Arts And Humanities In Higher Education*, *Asian Social Science*, *Atlantic Journal Of Communication*, *Journal Of Education Policy*, *Bioscience Education*, *British Journal Of Educational Studies*, *Cambridge Journal Of Education*, *Cbe Life Sciences Education*, *Community College Journal Of Research And Practice*, *Currents In Pharmacy Teaching And Learning*, *Nurse Education Today*, *Electronic Journal Of Business Research Methods*, *European Journal Of Training And Development*, *Journal Of Higher Education Policy And Management*, *Journal Of Higher Education Theory And Practice*, *Foot And Ankle International*, *Head And Neck Russian Journal*, Health *Information And Libraries Journal*, *International Journal Of Adult Community And Professional Learning*, *International Journal Of Art And Design Education*, *International Journal Of Early Years Education*, *International Journal Of Innovation Science*, *International Journal Of* Learning *Teaching And Educational Research*, *International Journal Of Technology And Design Education*, *International Journal Of Technology Enhanced Learning*, *Journal Of Chemical Education*, *Journal Of Criminal Justice Education*, and *Journal Of Dental Education*.

Appendix B. List of Some Universities and Related Higher Education Institutions (HEIs) on Teaching

From this study, it was observed that highest publications by affiliations were from Duke University, Purdue University and the University of Plymouth, as each produced three publications. This was followed by the set of affiliations that produced two publications, which are the University of Illinois, Loughborough University, University of Northumbria, University of Kentucky, Stanford University, University of Nottingham, University of Washington, Coventry University, Deakin University, University of Leicester and AdvanceHE. The last set of affiliations had one publication each, and include HEFCE, Ionian University, Unidades Tecnológicas de Santander, University of East Anglia, University of Cape Town, University of Massachusetts Chan Medical School, East Tennessee State University, Stellenbosch University, Princeton University, Norfolk State University, Western Washington University, The University of Manchester, Uppsala Universitet, Washington State University Vancouver, University of West London, Tel Aviv University, The University of Auckland, University of Houston, Nottingham Trent University, UCL Institute of Education, University of Oklahoma College of Pharmacy, National Changhua University of Education, University of Wolverhampton, Louisiana State University, and Glasgow Caledonian University.

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Article

STEM Faculty's Support of Togetherness during Mandated Separation: Accommodations, Caring, Crisis Management, and Powerlessness

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Abstract: The emergence of the COVID-19 pandemic initiated major disruptions to higher education systems. Physical spaces that previously supported interpersonal interaction and community were abruptly inactivated, and faculty largely took on the responsibility of accommodating classroom structures in rapidly changing situations. This study employed interviews to examine how undergraduate Science, Technology, Engineering, and Mathematics (STEM) instructors adapted instruction to accommodate the mandated transition to virtual learning and how these accommodations supported or hindered community and belonging during the onset of the pandemic. Interviews with 25 STEM faculty at an undergraduate Hispanic Serving Institution revealed a wide range of accommodations they made to their courses and how they managed communication with students. Faculty strived to support student belonging with responses ranging from caring to crisis management, though some faculty expressed feelings of powerlessness when unable to accommodate certain challenges. The case of a responsive and flexible instructor is presented to highlight a productive response to a crisis. These retrospective findings point to strategies to support faculty teaching in virtual learning environments in the future; increasing opportunities for student–student and student–faculty interaction, supporting faculty in learning technologies that support these interactions and addressing faculty's feelings of powerlessness.

Keywords: belonging; COVID-19; online instruction; STEM education; higher education

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1. Introduction

The emergence of the COVID-19 pandemic initiated major disruptions to higher education systems [1–3]. Physical spaces that previously supported interpersonal interaction and community were abruptly inactivated, and faculty largely took on the responsibility of accommodating classroom structures in rapidly changing situations. Educators across the world made efforts to adapt to the rapidly changing circumstances of COVID-19 to support their students through academic and life challenges [1], while educators themselves experienced unprecedented personal and professional challenges [4,5]. Instructors in STEM disciplines faced unique challenges, some of whom had previously relied on physical spaces for conducting lab assignments, leading field experiences, or writing equations; and the ways in which faculty adapted to these challenges and supported students personally and academically had significant impacts on student engagement and feelings of togetherness [3,6]. The lens of online learning communities is considered to be foundational to the advancement of research and practice in online learning contexts [7,8].

Despite this prior empirical research, which largely focuses on student outcomes, little is known about the experiences of STEM faculty, the specific instructional methods they used to adapt to ever-changing circumstances from the pandemic, and the various strategies and general responses to support the classroom community during this time of need. The purpose of this study was to identify online teaching practices that undergraduate STEM instructors at a Hispanic Serving Institution (HSI) employed after the mandated transition to online instruction and the specific strategies and responses they used to support classroom community and relatedness. Now that more than two years have passed since the start of the pandemic, we can learn from the responses of STEM faculty to better inform current practices, given that distance learning is becoming more commonplace at postsecondary institutions [9].

Theoretical Framework

To examine different accommodations for supporting classroom relatedness and community, we drew from the literature on belonging from Self-Determination Theory (SDT). Self-Determination Theory posits that students are motivated to learn when three psychological needs are satisfied: competence, autonomy, and relatedness [10]. Consequently, faculty can provide motivational support that focuses on satisfying these needs. Specifically, instructors can: (a) organize classroom structure, scaffold lessons, and provide feedback to support students' feelings of competence; (b) provide choices, personal relevance, and use non-controlling language to support feelings of autonomy; and (c) take time to interact with students and facilitate interactions between students to support feelings of relatedness and belonging [11,12].

Of the three fundamental needs in SDT, the need for relatedness is central to this study. Relatedness is the need to feel connected with others, including with instructors and other students [10,13–15]. Feelings of belonging and academic engagement can be supported in multiple ways, such as teacher–student relationships [16,17] and student–student relationships [18]—both of which can contribute to students' sense of community [19,20]. Undergraduate STEM students' feelings of belonging to their academic and classroom community predict persistence, achievement, and degree completion, particularly for historically underrepresented groups of students in STEM [15,21–30].

When the COVID-19 pandemic forced universities to transition to virtual instruction and introduce online modalities, new challenges emerged with respect to building learning communities [3,8]. Learning online tends to require a greater degree of self-regulation than face-to-face interaction [31] and demands greater "presence" from instructors and students. Namely, according to the New Community of Inquiry model [8], productive online learning communities require strong social, cognitive, learning, and teaching presences, which are structured by the online setting, content, and means for communication enabled by the online environment. The online learning community and the forms of "presence" are considered to be distributed among students and instructors and is enhanced through student–student and student–faculty interactions, building of relationships, and online discourse, whether interactions occur asynchronously, synchronously, or a combination of the two (bi-synchronously).

University instructors can play a critical role in facilitating relationships and online learning communities. Faculty can act as community organizers who help develop feelings of efficacy, belonging to one's institution, and classroom community, which are key factors that motivate students to pursue and persist through undergraduate STEM programs and are associated with motivational and achievement outcomes [15,21,25–28,32]. For example, a multi-method study surveying and interviewing undergraduate STEM students during the onset of the pandemic at a HSI revealed that students who reported receiving more interactive and synchronous virtual instruction (i.e., synchronous lectures and breakout groups) also experienced greater feelings of belonging, engagement, and STEM interest, with stronger relationships among students who identified as African American and Hispanic/Latinx [6]. Interviews with these students also revealed that they derived feelings of classroom belonging and engagement from the faculty's efforts to support student–student and student–faculty interaction, as well as from experiences outside of class, such as campus communities and feelings of belonging related to their own confidence and competencies [6]. As such, the specific ways in which faculty adapted their classrooms were linked with consequential outcomes for students.

However, additional research conducted during the onset of COVID-19 suggests that STEM instructors in higher education faced challenges of their own [3–5,33–36], which may have interfered with their ability to establish and maintain community in the classroom. STEM faculty reported encountering issues of inequitable technology access among students, difficulties engaging students in class and in lab activities, and high levels of stress during the early stages of the pandemic [8,35,36], all of which may have contributed to stifling community development. For example, Cheirichetti and Backer [34] collected survey and interview data from engineering faculty in California during the onset of the pandemic. Faculty reported high levels of stress stemming from concerns about their family and students' well-being. They concentrated the majority of their pedagogical efforts on adapting assessments to accommodate the mandated transition to virtual learning, leaving little time to rebuild classroom community. Colclasure et al. (2021) [4] conducted interviews with 14 faculty at a predominantly undergraduate institution in the Midwestern United States and identified that they faced specific teaching challenges (pedagogical, work–life balance, interactions with students, and physical/mental health) and student challenges (lack of motivation and learning patterns, issues with technology access, additional responsibilities students had to attend to, student mental health, and lack of learning community). With regards to the identified lack of learning communities, the authors found that faculty tended to attribute the dissolution of learning communities to the loss of face-to-face learning. Donham et al. (2022) [33] investigated barriers and supports to student learning during the transition to remote teaching at a minority-serving institution in the United States. Interviews with 31 STEM instructors and surveys of 69 students in May of 2020 revealed specific supports and barriers that faculty and students perceived for teaching and learning in STEM. Faculty found interpersonal communication with colleagues to be supportive of their teaching and identified academic integrity concerns and technological difficulties as teaching barriers. Students identified course structure, classroom technology, and community as supports for their learning and identified the virtual classroom environment, student availability, and lack of student–student intercommunication as learning barriers. Further, a review of the literature on school responses to COVID-19 found that students' and instructors' proficiency and training in using technology for distance learning was important for knowledge building [37], and the authors concluded that institutions should create structures for knowledge sharing in this regard (c.f. [38]). Although these studies did not specifically investigate specific practices that faculty used to respond to the issue of student belonging in the classroom, they do begin to underline the presence of numerous personal and professional obstacles along their path during the virtual transition to online learning.

In addition to identifying faculty challenges, some researchers have investigated specific approaches and strategies that faculty adopted during the pandemic. Kim et al. (2021) [5] interviewed 37 college instructors across multiple disciplines about whether they were able to focus on addressing the development of "whole students", along with teaching the subject matter. Findings revealed that faculty adopted three different approaches: empathy and caring, reflectivity and facilitating of inquiry, and adaptability and flexibility in supporting students. Nearly all faculty engaged in practices to support classroom community, such as helping students to "get to know each other".

Despite this research covering the breadth of faculty experiences of stress and hardship during the onset of the pandemic and the general approaches to modifying instruction that they adopted, few studies specifically investigated the concrete tools and techniques faculty employed to build community among students in STEM, and even fewer were conducted at HSIs representing historically under-represented groups of students in STEM.

We therefore asked:

1. How did STEM faculty adapt instruction and communication with students to accommodate the mandated transition to virtual instruction?
2. How did STEM faculty respond to challenges during the virtual transition to support classroom community and relatedness?

2. Methods

To answer these research questions, we conducted 25 interviews with STEM faculty at an HSI in the southwestern United States during the early days of the COVID-19 pandemic (May of 2020). This study was also conducted in tandem with a related study led by our team that concentrated on student perspectives and outcomes conducted in STEM courses at the same institution [6].

2.1. Participants

One-on-one interviews were conducted with 25 STEM faculty; 40% were non-tenure track (lecturers, adjunct professors, or assistant adjunct professors) and 60% were tenured/tenure line (assistant professor, associate professor, professor, professor and associate chair, professor emeritus). Faculty were mostly men (72%), and from the colleges of science (60%) or engineering (40%). Faculty had a median age of 42 years old and identified as White (60%), Asian (28%), Black/African American (8%), or another race (4%), and 12% indicated that their ethnicity was Hispanic. All faculty were provided with informed consent forms prior to participating and were compensated USD 50 (funding for their on-campus account) for participation. All study procedures, materials, and informed consent forms were registered and approved by the Institutional Review Board of California State Polytechnic University (IRB-20-83).

2.2. Faculty Interviews

STEM faculty were interviewed from 11–21 May 2020, during the week immediately following the end of the semester. Interviews were conducted in a one-on-one setting via Zoom by five different interviewers: three faculty, one project evaluator, and one graduate student. Interviewers asked faculty 10 questions with follow-up questions and probes about how they were coping with the pandemic, specific changes they have made to their courses as a result of the pandemic, challenges and successes during the transition, and about how students' sense of belonging and classroom community have changed as a result of the pandemic, if at all (see Appendix A for interview questions). These interviews had an average duration of 47 min (SD = 8.5 min).

2.3. Qualitative Analytic Strategy

All interviews were recorded through Zoom. They were transcribed, open coded, and then analytical memos were constructed by the research team [39,40]. Through iterative coding and reflection [41], a number of themes emerged that highlighted dimensions of classroom accommodations made by faculty to support student feelings of connectedness and belonging. Codes were created, compared, consolidated, and used to create a codebook before it was used by two undergraduate research assistants who independently coded all transcripts. An NVivo query revealed that all central codes had interrater agreement greater than 95% at the sentence level. Incidents of codes were included in the analyses if they had been coded by one or more of the coders. The final codebook with definitions is presented in Appendix B. Lastly, we conducted a case-study analysis [42,43] and assessed the entire body of analyses produced during the study in order to refine, confirm, or refute our preliminary codes and themes.

3. Results

3.1. Accommodations to Instruction (RQ1)

To answer our first research question, we present frequency counts of codes from faculty interviews (Table 1). Results show that instructors used a variety of synchronous and asynchronous teaching modes and methods to keep in contact with students, with the most frequent mode of instruction being asynchronous pre-recorded lectures, followed by student–teacher interaction during whole-class discussion.

Table 1. Teaching Practices and Responses to Challenges to Supporting Student Relatedness Reported by Faculty During Interviews (*N* = 25).

Variable	**%**
Accommodations (RQ1)	
Asynchronous Use of Pre-Recorded Lecture	96%
Student–Teacher Interactions During Whole-Class Discussion	92%
Communication with Students via Email	72%
Student–student Interactions During Whole-Class Discussion	56%
Synchronous Office Hours	52%
Asynchronous Discussion Boards	28%
Breakout Groups for Formal Interaction	12%
Survey Distributed to Class	12%
Texting with Students	8%
Breakout Groups for Informal Interaction	4%
Responses to Challenges (RQ2)	
Caring for Students	100%
Crisis Management	100%
Powerlessness	32%

Faculty also communicated with students via email, synchronous office hours, and two faculty reported that they kept in contact with students via text messaging. Faculty also supported inter-student communication by creating opportunities for whole-class discussions, breakout groups for formal and informal interactions, and through asynchronous discussion boards. Some faculty also distributed surveys to students to check up on them and inform their practice. All faculty engaged in efforts to communicate with students and accommodate their academic and personal needs during this time of crisis, with some faculty dedicating specific efforts to creating spaces for students to interact with each other.

3.2. How Did STEM Faculty Respond to Challenges during the Virtual Transition to Support Classroom Community and Relatedness? (RQ2)

A theme that emerged from STEM faculty interviews regarded their general responses to challenges to supporting student relatedness during the transition to online learning (see Table 1 for a summary). Ultimately, the interview data revealed that responses fell into three categories: faculty expressed that they cared for their students (100%), expressed that they took action to manage crises and solve problems (100%), and expressed a sense of powerlessness over some student challenges that they were unable to address (32%). Below, we elaborate on each response and provide examples.

3.2.1. Caring

All faculty expressed a sense of caring about students in statements emphasizing that they like, respect, accept, take seriously and show concern for students affected by the pandemic. For example, one STEM faculty noted that she would check in with students during the first few minutes of her synchronous lecture:

> I will simply say, 'Hey, guys, how are you doing? Hopefully, everybody is safe. Hopefully everybody is staying home. Hopefully everybody is practicing safety guidelines. Hopefully everybody's family and friends are safe.' . . . Towards the end of the semester, [a student] told me, 'I really appreciate those little things you say at the beginning of the class. It makes me feel so much better.'

Other faculty showed increased levels of encouragement and compassion. One faculty member said, "I always try and tell them how great they are. But I've amped it up about

100 fold [after the lockdown]". Another said that the crisis "...has made me much more patient, and not that I wasn't understanding or compassionate before, but much more so than I was and understanding and lenient". Other faculty increased the amount of contact they made with students. One faculty member said:

> I also decided that, when I got the feeling that they needed me the most. I left my cell phone number so they can text me, especially if they have difficulties with those online quizzes . . . Just, you know, I don't want them to stress.

This finding is consistent with Kim et al. (2021) [5], who conducted interviews with 23 faculty from across multiple disciplines and found that many approached their students with empathy, care, and by centering student emotions.

3.2.2. Crisis Management

All faculty shared instances when they had to make quick decisions and take action to accommodate the transition to virtual learning. A common problem that many STEM faculty encountered was the challenge of writing complicated equations in an online environment without the use of chalkboards or whiteboards. One faculty member noted,

> My normal presentation style involves a lot of drawing on the blackboard, which unfortunately the Zoom tool for doing that is terrible. So, actually, early on I went out and bought a whiteboard and set it up in my closet. I've been working it, I've been doing most of my lectures from the closet because it's the room that has a door on it and keeps the toddler out.

This situation highlights an instance where faculty rapidly adapted to emerging personal and professional crises. While this instructor adapted remote instruction to replicate face-to-face situations, other faculty responded to crises by developing new ways of engaging students (see Section 3.3 Case Study for an example), as found in prior research [3].

Faculty also reported responding to crises by adopting new technologies to replicate face-to-face situations. Faculty purchased document projectors, downloaded apps for tablets, and scanned pdfs of handwritten equations on paper to accommodate this challenge (c.f. [37]). However, while not all STEM disciplines encounter the issue of equation-writing, other disciplines encountered their own unique challenges. For example, an earth sciences professor discussed the challenge of adapting a field-based geology course for online instruction, noting that for the main field experience:

> I did it synchronously, actually, on Zoom. We did like four hours a day, two days in a row . . . And so, you know, basically we alternated between having the students watch YouTube videos and then some Q&A sessions. And, you know, sometimes I throw a few extra slides or do like a Google Earth tour of the field site or something like that.

In addition to using visualization technology to replicate the learning content from a field experience, this instructor also shared that they aimed to replicate social experiences, for example, by displaying a campfire animation on Zoom fifteen minutes before class began to encourage informal student–student conversation. Despite these efforts to manage this crisis and support student belonging, this instructor noted that the field experience simply "wasn't the same". Many of the STEM faculty that we interviewed mentioned the challenges of adapting lab and field experiences for an online environment, oftentimes lamenting the inadequacies of virtual environments for their subject matter. The challenge of adapting lab experiences for remote instruction was also a common theme among studies on STEM faculty responses to the pandemic [3]; and supporting faculty in this regard remains an ongoing concern [37,38].

3.2.3. Powerlessness

Although all instructors expressed care for students and took active steps to manage students' learning needs and crises in the context, some instructors described certain challenges as seeming insurmountable and approached these situations by attributing external causes and expressing a general sense of powerlessness to overcome them. Feelings of powerlessness were often expressed in terms of situations in which faculty felt that they could do nothing to change the situation, as evidenced by statements from faculty indicating that some student situations were outside of their control or that some situations were the students' responsibility to handle.

Some faculty shared that creating spaces for student–student interaction was particularly difficult because of the transition to online learning and implied that addressing the issue was outside of their control. For example, when explaining that students were no longer working together on group projects, a faculty member said, "Every person ha[d] a partner and that has pretty much fallen away . . . I don't think they really see much of a sense of working in partnership if they're not together in the lab. So I think that's been a loss". Other STEM faculty described the challenges of recreating socially interactive classroom and lab environments as "really hard", "disconnected", "absolutely frustrating", "a real loss", with some lamenting that they simply "have no information" about student interactions. This suggests that STEM faculty who felt unable to support student–student interactions in their classes also tended to experience a depleted sense of agency and powerlessness.

In addition to declining student–student interactions, some faculty commented on a general decrease in teacher–student interactions and class participation in their courses after the transition to virtual learning. Some noted the hopeless feeling of seeing unresponsive "black rectangles" on a screen and declining attendance and participation in class. One instructor said, "I will be spending an hour talking and the only thing you hear is that silence". Another said:

> I am asking myself, are they still there? So, I keep on checking the participants and I see that, a couple of things, 80 in one class, 60 in another [out of 120], they have stopped coming altogether after one week. But it's nothing I could really do.

Some professors were very distraught about declining participation and opportunities to interact with students, some even expressing that they intended to change professions due to the associated anxiety. Instructor powerlessness over supporting students' sense of community may be one (of many) potential factors that explain feelings of stress and anxiety expressed by faculty in prior research conducted during the onset of the pandemic [4,34].

3.3. Case Study: Terry's Synchronous Physics Course

To illustrate the themes and codes related to STEM faculty's accommodations and approaches during the virtual transition, we present the case of Terry, the pseudonym of a STEM faculty member who responded to emerging crises with flexibility and caring. Terry was an adjunct instructor of physics and taught several synchronous introductory physics courses. Terry was in good spirits during the interview. When asked how their life was impacted by the pandemic, Terry said, "I don't mind not driving everywhere", expressing relief that their six-hour commute between multiple universities was eliminated due to the transition to virtual learning.

Terry enjoyed teaching online better than in person and viewed the transition to virtual learning as an opportunity to improve their approach to teaching. When redesigning the course, Terry borrowed ideas from the gaming community to improve the accessibility and quality of online instruction and adopted a host of technologies to make it work. Terry made use of various software and online platforms. While revamping synchronous lectures, Terry used live-streaming through YouTube, which allowed for multiple levels of video quality for students with poor internet as well as protection of the audio and video feed against "Zoombombers". Terry also used Xplicit to quickly switch between multiple cameras to capture the lecture and written equations and mentioned regularly using Gradescope and Top Hat for assessment and classroom management. Terry shared that, during this revamping, the main focus was on ensuring that students have the tools to master the course content: "I just want to get students to learn the stuff they need to be okay next semester, and not really worrying about grades".

Terry noticed changes in student–student and student–instructor interactions as a result of the transition to virtual learning and thought it was important to create comfortable spaces for students to maintain personal connections with each other. In response to increasing feelings of isolation among students, Terry said,

> I've tried to sort of cheer everyone up. You know, I'll bring my cat in front of the camera every now and then and make a joke or tell something about my personal life at the beginning of every lecture for just a minute or two. Just try to make life and not just business. And the students seem to appreciate that.

Another strategy Terry used to support student–student interaction was opening the course 20 min early to allow students to interact in the chat, "sometimes students will join, and they'll be talking to each other in the chat".

However, there were tradeoffs that Terry experienced by opening the classroom up to student interaction. Terry had initially used Zoom to run the classroom, allowing the class to contribute to the audio and video experience of the class, but transitioned to YouTube after experiences of "Zoombombing". Terry noted that YouTube "makes it fairly easy to block any Zoombombing, you know, as they're calling it now. There's just no way for them to add any audio or video into my stream. They're only there on the chat and then on the chat it only takes one button to hide the chat or kick the person out. So, it's fairly easy to control the environment on YouTube . . . .". Terry switched instructional platforms to limit students' means of interaction but was careful to ensure that they still had a way to interact. As with Terry, many faculty members were thrust into situations requiring crisis management and had to resolve tensions between too much and too little control over the environment.

Terry represents an instructor who cared about the students, showed substantial grading flexibility and adaptability, and responded swiftly to crises with action. Terry also seemed to have background knowledge of technologies that were transferred to the current context. Like Terry, all faculty also expressed care for their students and made accommodations for their courses, although not all were as technology-savvy as Terry, nor as quick to respond to challenges and ever-changing circumstances. Terry's pedagogical decisions and skills seemed to effectively nurture the students' feelings of inclusion and connectedness, which we discuss in the next section.

4. Discussion

We sought to learn how faculty adapted their classrooms to accommodate the pandemic and what approaches they took to support classroom community and relatedness. We found that faculty made numerous accommodations to their courses by adjusting how they communicate with students and by creating new opportunities for students to communicate with each other and occurred in both synchronous and asynchronous settings.

Interviews also revealed that STEM faculty unanimously showed deep care for their students, which was expressed as empathy, liking, respect, acceptance, or taking students seriously. Consistent with Kim et al. (2021) [5], we found that faculty approached the pandemic crisis and transition to virtual learning by centering student emotions, checking in regularly with students, and adapting and accommodating instruction to meet students' learning needs, including providing increased academic support, flexibility, adding effort to improve instruction, or reaching out to students personally.

Such efforts on the part of faculty have been shown to have meaningful impacts on students' motivation and engagement, as shown in our parallel study surveying and interviewing students at the same institution during the same time frame [6]. Namely, in our multi-method study, we surveyed and interviewed undergraduate STEM students during the onset of the pandemic at an HSI. Findings revealed that students who reported receiving more interactive and synchronous virtual instruction (i.e., synchronous lectures and breakout groups) also experienced greater feelings of belonging, engagement, and STEM interest, with stronger relationships among students who identified as African American and Hispanic/Latinx [6]. Interviews with these students also revealed that they derived feelings of classroom belonging and engagement from the faculty's efforts to support student–student and student–faculty interaction, as well as from experiences outside of class, such as campus communities and feelings of belonging related to their own confidence and competencies [6]. The current study investigated faculty perspectives behind the efforts to support togetherness during the transition to online learning and illustrated effective strategies and responses to major challenges.

As such, our findings may be useful for college instructors and policymakers redesigning online learning environments to foster relatedness. Faculty efforts to support interpersonal relations and classroom community have a meaningful impact on students. Although faculty efforts in the current study occurred spontaneously as a result of necessity imposed by the pandemic, institutional structures should be put into place to add additional support for interpersonal relations in virtual learning spaces [38]. As distance learning becomes more commonplace in higher education [7], enhancing synchronous and asynchronous interactions between students and their peers and instructors may be important at many levels (e.g., for belonging, self-efficacy, and academic performance), particularly for under-represented groups in STEM (c.f. [6,44–46]).

Faculty also demonstrated strong crisis management abilities in handling unanticipated challenges as they arose. Consistent with prior research, we found that flexibility was a major hallmark of effective crisis management [5], yet our findings provide a more nuanced illustration of the STEM-specific crises that arose as a result of the virtual transition to online learning. Faculty needed to rapidly make accommodations due to prohibited use of laboratory spaces, field experiences, and physical tools for writing mathematical equations. Such pressures led faculty to generate innovative solutions such as rearranging physical spaces in their homes, adopting new technologies, or enhancing their knowledge of existing technologies. However, many faculty mentioned that some of the virtual substitutes for in-person laboratory or field experiences were inadequate (c.f., [3,6,34,36]). As such, administrators, policymakers, and curriculum designers in higher education should take into account the unique needs of STEM faculty in online learning settings and prepare more detailed plans and invest in unearthing innovative strategies for accommodating discipline-specific laboratory experiences in online settings. In this way, it would alleviate the burden and responsibility for faculty to facilitate student success in virtual settings.

We also found that challenges associated with fostering an online community—such as the lack of participation on Zoom and persistent absences—appeared to some faculty as impossible to overcome, which manifested as a sense of powerlessness. Feelings of control are related to self-determined motivation and persistence [10], and faculty need to be supported in feeling in control of their course environment to avoid feelings of powerlessness. Higher education institutions should therefore attend to both students and faculty with the goal of supporting their feelings of agency and reducing a sense of powerlessness (also see Bensimon et al., 2019 [47]).

4.1. Limitations

As with all research, this study has necessary limitations that we would like to acknowledge. Namely, there is a possibility that our sample was not fully representative of STEM faculty experiences during the lockdown. This study was conducted approximately two months after the lockdown mandates and transition to online learning, and there may have been faculty who chose not to participate in our study because severe COVID-19 threats (e.g., economic, health, or childcare demands) outweighed the benefits of participating in our study. Although we made efforts to incentivize faculty to participate in the study and contacted faculty across all departments, sampling bias may still be an issue.

4.2. Implications

Despite the limitations, this study has implications for college instructors and policymakers redesigning online learning environments to best support student feelings of belonging and community.

First, increasing opportunities for synchronous peer–peer and student–faculty interactions may be key for helping students navigate the feelings of isolation and lack of belonging that can result from a purely virtual college experience. In our parallel study, we found that many students in STEM courses relied on synchronous modalities such as interactive lectures, office hours, and synchronous chat features to feel connected to their class, with prominent benefits for students who identified as black or Hispanic [6]. Interactive lectures, chat windows, synchronous office hours, and breakout rooms are standard options for online teaching, but our findings suggest that rates of instructor use of these options could be significantly increased. Professional development geared towards supporting faculty as they use technology to enable student–student and student–faculty interactions is one possible remedy for this issue. However, further research is still warranted to investigate effective discipline-specific strategies that STEM faculty can employ to help engage and foster a sense of community, social interaction, and belonging for students studying STEM in online settings. These insights would be useful to share with any faculty who find themselves having to transition to online learning in the future.

Second, our findings highlight the importance of investing in technology training for faculty and developing strategies to promote flexibility in educational delivery. Terry illustrates the case of faculty who showed high levels of adaptability and innovation in acting fast to synthesize multiple technologies to support student interaction. This quick action was dependent on Terry having a high level of technology proficiency and skillset that could be incentivized by institutions of higher education in professional development.

Third, faculty themselves experienced stress and anxiety as a result of feeling powerless against low levels of student participation and attendance rates. Institutions of higher education might anticipate this issue in the future by systematically encouraging student–faculty communication, student–student communication, supporting students who may have issues with technology or connectivity, and providing faculty with physical and mental health support to cope with a sense of powerlessness. Another means of preventing feelings of powerlessness among STEM faculty might be to provide them with special training around STEM-specific teaching methods for increasing student participation and community in online learning spaces. If equipped with effective tools and strategies for enabling and facilitating classroom interactions, STEM faculty may feel a heightened sense of empowerment and agency when teaching online.

Fourth, our findings showed that STEM faculty rose to the situation and showed high levels of empathy and care for students during a time of crisis. Future research might follow up with faculty to assess whether such high levels of care have endured in the years that have passed since the onset of the pandemic and what effect this may have had on students.

5. Conclusions

In sum, our study suggests that STEM faculty strived to support togetherness and classroom community by managing crises and expressing care for students during times of mandated physical separation. Our findings generally suggest that increasing opportunities for student–student and student–faculty interactions may be key for helping students and faculty navigate feelings of isolation that can result from a purely virtual college experience. STEM faculty accommodations and responses to crises offer lessons learned that might inform STEM instructors and administrators. Briefly, between this study and our related study [6], findings suggest:

- STEM faculty efforts to support social interaction between students and faculty seemed to have important benefits for student engagement and belonging. This was true for both asynchronous and synchronous practices and was consistent across faculty and student reports.

- Technology proficiency seemed to be related to faculty adaptability. Institutions of higher education should consider directing resources toward supporting classroom technology proficient STEM faculty with a focus on enhancing social interactivity.
- Helping STEM faculty create or re-create classroom communities and lab environments in online spaces might also help them feel increased agency and efficacy, and decrease powerlessness during times of crisis.

Practitioners and researchers should consider the unique challenges facing STEM faculty when building online classroom communities—such as replicating laboratory and field experiences—and designing and testing professional development programs to empower them with the skills to persist through and overcome those challenges.

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Institutional Review Board Statement: All interview materials are provided in the Appendices A and B. The study was conducted in accordance with the Declaration of Helsinki, and approved by the Institutional Review Board of California State Polytechnic University, Pomona (IRB-20-83, 4-23-2020).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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Appendix A

Faculty Interview Prompts
(Note, sub-items represent potential follow-up questions.)

1. How has your life changed as a result of the pandemic?

a. How are you coping?
b. How do you feel about it?

2. How are you balancing the needs of yourself, your family, and loved ones with the needs of your students and the university?
3. How has your course changed as a result of the pandemic and the online transition?

a. How do you feel about it?

4. How was the transition to online teaching?

a. What has been going well in this transition?
b. What has been a challenge in this transition?

5. What kinds of accommodations have you made to your course to support students during the pandemic?

a. How effective has [this accommodation] been so far?
b. Any other accommodations you have made?
c. [If not mentioned] How have you modified exams and/or handwritten homework assignments?

6. How do you think students' sense of belonging in the course (classroom community) has changed due to the online transition and the pandemic, if at all?
7. Is there anything that you have done to support students' social connections and sense of community during this online transition?
[If participant simply replies "yes"] What specifically have you done to support students' social connections and sense of community during this transition?
8. What is your biggest worry right now?
9. What are you hopeful for right now?
10. We would love to hear anything additional you think is important for us to know about how you are coping with the pandemic and teaching during this time.

Potential Probing Questions Applicable to all Items
a. *Can you tell me more about . . . ?* b. *Can you give me an example?* c. *How do you know?* d. *I don't understand.*

Appendix B

Codebook for Faculty Interviews	
	Synchronous Practices
Texting	Evidence that the instructor was texting or receiving texts from students about coursework (e.g., upcoming assignments, quizzes, etc.) or outside of regular coursework (e.g., health, safety, housing, family issues, etc).
Synchronous, Whole-Class Interactions (S-T)	Evidence that the instructor was using live-stream technology to deliver formal instruction and assignments to their class (e.g., gave lectures through Zoom or through a live YouTube feed) or informal content (e.g., to have a conversation to check in with students to see "how they are doing").
Synchronous, Whole-Class Interactions (S-S)	Nudges, activities, or spaces created by the instructor to intentionally support group building and inter-student connections (e.g., instructor put up animation of campfire and walked away from computer to allow students to chat). This also includes evidence that the instructor was aware of students live-chatting about course topics with each other about formal or informal topics during synchronous interactions.
Breakout Groups	Evidence that the instructor used breakout groups to encourage students to discuss course material or to discuss topics outside of course material (e.g., used breakout groups for informal check-ins).
Office Hours	Evidence that instructor held live office hours to support students' academic or personal needs
	Asynchronous Practices
Email	Evidence that the instructor emailed students about coursework (e.g., quiz grades, upcoming assignments) or informal topics (e.g., about health, safety, housing, family situations, etc.)
Asynchronous Interaction (S-T)	Evidence that faculty used technology to asynchronously deliver instruction (e.g., using blackboard to post pre-recorded lectures, receive assignments, give feedback on assignments, administer quizzes or exams, etc.) or about informal topics
Asynchronous Interaction (Discussion Boards) (S-S)	Evidence that faculty required students to use asynchronous technology to interact with each other about coursework (e.g., participate in student-led discussion boards about course topics) or about informal topics (e.g., respond to the prompt, "what is your favorite pizza topping")
Surveys & Responses	Evidence that instructors gathered formative feedback from students (e.g., surveys, class-emails, discussion board, asynchronous poll) to assess formal aspects of instruction and coursework (e.g., assessed whether students enjoyed online assignments or whether lecture is "moving too fast", etc.) or informal aspects of students' lives that fall outside of normal coursework (e.g., to assess students' emotional state, ask about how students are coping, or about safety issues, etc.)

Codebook for Faculty Interviews	
Approaches, Behaviors, Feelings	
Caring	Evidence that faculty expressed thoughts, behaviors, or feelings that they care about students and want them to feel as if they belong or are accepted (e.g., statement showing that they like, respect, accept a student, take students seriously or show concern for students who may be lonely).
Crisis-management/Problem-Solving	Evidence that faculty member reacted to pandemic-specific situations or crises (e.g., responding to a technology issue with online testing that was not present before the pandemic, cold call students or ask intense questions to get a rise out of unresponsive "black boxes", emails to students that have critical absences or who have missed crucial assignment due to the pandemic).
Inaction due to a sense of powerlessness	Evidence that faculty member did not take action in on a particular issue because they felt that they could not control the situation (e.g., talks about declining student interaction and togetherness due to absences as if it is outside of their control, there is nothing they can do about it, or as if it is the students' responsibility).

Note. S-T indicates that the code refers to student–teacher interactions. S-S indicates that the code refers to student–student interactions.

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Article

Post-COVID-19 Transition in University Physics Courses: A Case of Study in a Mexican University

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Abstract: The extended confinement imposed by the COVID-19 pandemic lockdowns resulted in the imposition of online education for two years. Many students experienced their transitions to higher educative levels during this time, surely losing some academic learning as a consequence. On the other hand, this context could have promoted different types of competencies, until recently not explored, as a function of students' personalities or academic profiles. Physics teaching is among those areas which have changed from its traditional methods during this period. The return to school during the 'New Normal' has resulted in certain concerns about students' adaptability due to their possible lack of learning over this time. We analyse, in the current research, the transitions of three generations crossing several pandemic stages during their time participating in university physics courses during the first year, a common entry point for engineering programs. In addition, we analyse several academic traits as causal factors of academic success in order to understand how performance could be affected during online education and during the 'New Normal'. The results highlight a general high level of adaptation for the most of the students, but still, some of them were affected in terms of the functioning of their learning styles or regarding their personality profiles. Notably, no meaningful losses were detected among the last transition; instead, several interesting aspects were found relating to academic profile appearing to have an effect on the students' performance during the first transition to online education, and then during the second transition back to face-to-face education in the 'New Normal'.

Keywords: higher education; educational innovation; 'New Normal' transition; face-to-face education; online education; physics; COVID-19.

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1. Introduction

Higher education during the COVID-19 pandemic encountered many disruptions and obstacles that needed to be overcome. These did not occur uniformly in all countries, universities, or programs, nor were they the same for all students and areas of learning. Underneath the generic reality of online education are many aspects that have not been considered. These are not limited to education and predate the period of lockdown. Issues include not only the design and planning of online education, but also the accessibility of resources, appropriate environment, availability of services, discipline for dedication, and the previous non-curricular learning of each student at the pandemic time. Those aspects were intensified during the lockdown period, despite the implementation of student monitoring and large number of new teaching techniques. For many, if not most students, this period will mark education and generations for many years into the future. Some students will have abandoned or truncated their studies due to the lack of inclusion in education; others will suffer from organizational deficiencies in learning for the rest of their lives [1].

On 16 March 2020, forced confinement in schools and most non-essential activities was announced in Mexico. The schools suddenly closed. It took between a week and months for each school and educational level to organize and establish an alternative educative plan. Primary public education was the most affected because of the absence of experience, perspective, and a technological base. In Mexico, the government's late reaction was implementing a national television education plan that operated for over a year. In contrast, private primary education schools reacted more quickly, implementing existing videoconferencing technologies, usually within two or three weeks. Despite this experience, the average student population had never used such technology for educational purposes [2].

With an evident lack of preparation, the online education system was finally implemented nationwide. However, this happened without essential considerations for this type of education and with poor support or even ignorance about complementary computer applications and methodologies. This was due to a generalized lack of previous and sustained teacher training [3]. In another trend, differences could be seen in higher education, not only in the ability to implement an online teaching system but also in the previous training of teachers. Such teaching methods were more common in private universities. For public ones, the absence of technological culture was an issue for students, although it can be considered that the new generations are more experienced and attached to technology. Another of the most notorious problems was the lack of personal resources, computers, and home internet connection. Moreover, the domestic conditions that enabled students to receive online education were highly diverse, revealing profound differences between private and public higher education in Mexico [4]. The best-adapted sector was private higher education, where teacher training programs have existed for almost two decades [5,6]. A notable contrast in these results in Latin America could be perceived when Mexico was recognized for its national plan of educational implementation during the lockdown period [2].

However, two years later, the return to the 'New Normal' in education has become a complex and multi-factorial process in which several issues remain unresolved. The lockdown period has left pending education tasks on top of those already pre-existing. In Mexico, the two-year period has shown a diverse spectrum of situations in the health field and social, political, and behavioral realms [4]. The dismantling of the entire national, institutional, familial, and personal aspects of education has caused a poor and less agile return than the initial establishment of the system. In this context, it is regrettable that the lessons learned and sustained by the health emergency are not being assimilated if they are only being dismantled to return to the old practices and the same pre-pandemic scenario [7]. It could be said that this critical stage has not been worth experiencing and has not taught us anything. It is not yet possible to measure the social changes that the educational disruption of the pandemic has left us globally, nationally, and personally in the long term.

This work sought a comprehensive understanding of students' behavior in a computer science course at a Mexican university and learning physics at a higher education institution throughout the COVID-19 lockdown. The period studied spanned the pre-pandemic period to the 'New Normal'. Performances were compared in several sections of each course for several cohorts transiting the confinement period. In addition, an academic categorization for the newest cohort was performed. It transitioned from the COVID-19 confinement with only online courses to the 'New Normal' stage with only face-to-face courses. In addition, the transition from high school to university was undertaken entirely under pandemic conditions. The second section presents the context and the related literature preceding this experience. The third section describes the research questions and objectives, the methods utilized, and the data gathering. The outcomes are presented and compared in the fourth section, corresponding to the specific research objectives. The fifth section discusses the outcomes interpreted in light of the teacher experience. Conclusions, opportunities, and future work are presented in the final section.

2. Theoretical Background: Context, Previous Studies, and Possible Success Factors

The COVID-19 lockdown began in Mexico on 16 March 2020. Two years later, education, in general, has not returned to the face-to-face level it previously had, particularly for basic education (primary and secondary) and for a few higher education centers. For the rest of the students, the first half of 2022 has barely established the massive return to the classrooms. During the confinement, many students transitioned into middle, high school, and college education from their previous educational levels, mainly through online-based education [4]. Many of them continued under the same educational scheme after the transition. In 2022, they fully reintegrated into the classrooms, showing the corrective needs in their education, particularly in the hidden curriculum developed previously in the face-to-face teaching modality (this refers to the students' pre-existing technological skills). The transition to higher education established a set of changes in the hidden curriculum that was critical to acquiring in a limited time [8]. Together, an inevitable induction is due, which possibly was skipped, leading to a series of recommendations for higher education schools [9]. They are usually based on social learning because there are no courses intentionally developing them. In a complementary trend, previous studies have shown that several success factors could be important for students, including their learning styles, personality, inclusivity, and hidden curricula regarding the ability to exploit relevant technology. Rarely were these factors put on the discussion table when emergent educative plans were formulated. In Mexico, several higher education institutions collaborated to establish quality teaching programs to maintain academic continuity [10].

This paper analyzes several contextual dimensions of the COVID-19 period in higher education physics teaching. Previous studies sought to establish, in a general framework, some elements that had a marked influence on the learning process [11]. Here, we seek to contextualize the analysis during the COVID-19 confinement. Some elements were evident during the transition to the 'New Normal' and will be present in students' future education [12]. These must not be forgotten and generate learning for educators, as has happened with every critical stage of human history. We are a species that considers education as a moral value and an intangible good, so it is essential to pay attention, more than ever, to the changes that this transcendental activity may have for us [13]. We have developed much more educational technology in this period than in any other in human history. The technological competencies of students and teachers have gone through a process of development and standardization never seen before. Technology has been with us, but our students adopted it more than ever during this period. In addition, teachers have been exposed to associated learning theories more than ever during the COVID-19 pandemic; thus, learning as collateral social factors affect Education [14].

2.1. Teaching Physics during the COVID-19 Pandemic

The teaching of physics has been diverse throughout human history. The discipline is crucial in any scientific or engineering program in the contemporary era. It commonly involves at least a core theoretical part and an experimental practice. In the COVID-19 confinement, the teaching of this discipline had to overcome the limitations imposed by the circumstances [15], such as limited social learning, absent or limited experimental teaching, and limited contact between students and teachers. All limited and compromised the future competencies of an entire generation in some not-yet-quantified way. At the same time, however, such limitations should be overcome to a lesser or greater extent so new learning experiences can emerge. This work explores these two aspects: the possible losses in face-to-face attendance that online education has left and the opportunities and lessons of this confinement period, which had not existed before this era.

In addition to the overall technology used to forecast and manage online courses, many applications have been deployed to share, deliver, and receive educative materials, integrating services not always included in a unique service. More critical, concrete applications were used to supersede the absence of experimental practices, including simulators and smartphone applications that integrated sensors for straightforward physical measurements to set up experiments [7,16]. Despite the limitations, the effective use of such technologies produced changes in each student, who acquired new competencies to approach the learning of physics concepts. The transition to the 'New Normal' has brought a sudden return to the pre-pandemic conditions, putting each student on foreign ground where specific competencies could be missing [17].

Thus, differentiated performance could denote changes in each cohort passing through the several stages of the COVID-19 pandemic (pre-pandemic, confinement, and 'New Normal'). In each course, different grade components refer to theoretical or experimental aspects whose evolution could be analyzed separately to determine behavioral patterns. Comparisons should be relatively trustworthy if the main activity items are the same or comparable through the periods [15]. Other complementary analyses could be performed based on demographic information about the composition of the cohorts, particularly ones that refer to learning styles, personality, and others. Those aspects are discussed below.

2.2. Physics for Computer Science and Programming Related Programs

For students in programs related to computer science or computing technologies, the teaching of university physics is compulsory, but its training should be guided. For this reason, our university has created an educational model for engineering with broad avenues allowing adapting the curriculum to the needs of each program. The necessary student competencies related to computer science and technology have been identified [18], so their education in physics involves computing simulation more than experimental elements, as typical in other programs. Under such a scheme, our institution outlined an online teaching model during the pandemic to take care of several aspects of each teaching delivery [19].

Each physics course is taught by three teachers covering the subject contents in the course (the main section), a second teacher instructs math, and a third one teaches computing. These latter two sections support and accompany the physics contents. The computing teacher guides the development of an associated simulation project as a challenge-based learning (CBL) activity. The activity is denominated as the challenge. In this report, we analyzed the complete course information in the three sections, but we focused on the teaching experience just considering physics, the traditional course [15,20]. Thus, during the pandemic, the experimental practice that included the simulations could be easily maintained, despite the accompaniment given to the student; otherwise, the collaboration among students could be reduced [21].

In other practical components, teaching was enriched by including electronic notes using an iPad combined with an i-Pencil and Notability. Publishing electronic notes in each class was a didactic practice supporting students. In addition, using a scientific calculator on a smartphone shared on the screen and some other elements easing visualization (such as Mathematica, Matlab, and Desmos) promoted an enriched learning experience (traditionally absent in the pre-pandemic approach, but now inherited in the 'New Normal' practice). The complementary series of teaching videos solving additional physics problems was published on the Learning Management System (LMS), commonly used by the institution in the form of a virtual classroom (which is now included in the new face-to-face course version in the 'New Normal' period) [7,15]. We wanted to analyze student transitions through the different stages of the COVID-19 pandemic and consider the teacher learning inherited from the online teaching experience. We were interested in the experimental or applied section in those courses because it involves the core component for the future education of those students.

2.3. Changes, Losses, and Gains in Learning Due to the COVID-19 Confinement

Social learning is one of the main aspects that can be affected. The ability of human beings to meet, share, and rely on the transmission of knowledge was naturally diminished, at least during the early stages of the pandemic [21]. Causal factors conditioning learning performance were diverse. For teachers, an analysis of teachers in Spanish-speaking countries revealed that the stress generated by transitioning to online education led to a diminished capacity to successfully exhibit their digital competencies [22], mainly if they were digital immigrants (born after 1980). A similar analysis of Italian teachers at all educative levels showed the same phenomenon [23]. Cultural and behavioral aspects causing differentiated stress based on internal and external factors have also been noted [24]. In addition, a closer analysis of teachers in the Latin American and Caribbean region revealed another critical factor: the level of digitalization, technology, and innovation in the environment [25]. Regarding the previous reports, such factors are two-fold, internal and external factors involving the country and institutional environment and the previous self-development of educative technologies. Thus, a similar behavior could be expected from students worried about the future, education continuity, resources, self-discipline, and others. Still, geographical and economic regions had different responses and strategies to provide academic continuity to their students. The students also experienced stress in maintaining their education, particularly those in higher education, who, normally more independent, could afford such transition by their means, still had to address diverse family, economic, and curriculum factors and environments [26]. In any case, the situation for public and private schools generally lived differently [27].

The cooperation among the natural student study groups was diminished by the sudden change in the learning dynamics. However, many applications to maintain closer contact were a novelty among students and teachers, despite their existence before the pandemic [15]. Thus, the initial perception of this issue would be corrected with the mastery and proper exploitation of technology to bring the students closer. Similarly, collaboration among teachers occurred very early in some cases, when the institutions they belonged to promoted interaction and collaboration by several channels [7]. These support groups increased throughout the lockdown to share and standardize recommendations on technological applications and teaching techniques during online learning.

The differences in the pre-pandemic, confinement, and 'New Normal' stages for social learning should be analyzed because online education could diminish such significant interactions. In addition, teachers improved practice to include technologies and spaces in their teaching designs when confinement was extended. The lessons learned using technology (when they became definitively integrated into the teaching profile) have enriched the face-to-face approach during the 'New Normal', closing the distance with improved blended learning, thus bridging the online gap existing before the COVID-19 pandemic [28]. Those losses and gains generated by the COVID-19 era have significantly changed the educative scenario. Thus, as a duty, each teacher should evaluate their own experience to enrich their current practice during the 'New Normal', correcting those weak academic aspects detected in their students.

Nevertheless, such recovery could not reach all students evenly. Learning styles [29], personality [30,31], and the diversity of teaching approaches and methodologies of the university [32], played essential roles in the differentiated successes of the students before and during the COVID-19 confinement. In addition, during such confinement, students' digital competencies were crucial to follow online education with proper discipline [33]. Compared with the school practices and profile, those parameters could define an affinity index impacting each student's academic success [34]. In this sense, a cross-referenced analysis of the pandemic performance based on such students' categorization using learning styles, personality traits, technological competencies, and perceptions about school inclusivity is in order.

2.4. Teaching and Learning through the COVID-19 Pandemic to the 'New Normal' Era

Returning to the face-to-face scenario after two years of confinement and online education, many students opted for engineering programs after high school without having had a due process of transition [9]. They invariably transition to the face-to-face scheme again, including higher courses in physics and mathematics (typically differential and integral calculus). Whether they do it for the first time after their high school education or in continuity with a previous semester still in partial or optional confinement, there are still several aspects to highlight in this transition. First, there was not adequate follow-up in these courses' inherent abstract reasoning and mathematical writing [35,36]. The ability to solve problems may be diminished [37]. In addition, experimental ability and skills to relate theory and practice, as well as the ability to assemble an experimental setup, the skills needed to gather measurements and analyze data may be absent or superficial [38]. Finally, the ability for social learning and collaboration in physics may be limited [39].

As indicated before, physics teaching brings together several ingredients that must be integrated into each course. For the students involved in the present study, those elements also included the associated computing learning dictated by the institutional model [20]. The ability to understand physical phenomena requires a minimal relationship with the experimental field to achieve the appropriation of physical concepts; this aspect could be tangibly diminished during online education, at least if the space for them was not considered and created. In addition, identifying problems and their quantitative solutions are aspects where mathematical ability, the algebraic handling of physical laws, and the ability to diagram problems and translate them into mathematical and quantitative language concur. Another component is the following in computing, which contributes to the simulation-based learning performed in the form of a challenge inside the entire physics course. Thus, the course in this current report involved four different sections: physics properly, math and computing as scaffolding, and finally, the challenge section to guide the development of the simulation project in the course as the experimental and applied component for Computer Sciences and Programming students [15].

Personalized follow-up may not have been open and available to every student under confinement conditions. It depended on the type of accompaniment and activities sought during online education. Additionally, and as already emphasized, social learning usually plays a supporting role in many students who prefer to learn in pairs than under the assistance of the teacher, so the limitation of forming effective study groups among students under online education must have been limited in contrast to the natural spaces in face-to-face education [3]. All those aspects have a behavioral component previously settled in each student.

2.5. Learning Styles, Personality, School Teaching Strategies, and Previous Technology Competencies as Success Learning Factors in Adapting to the COVID-19 Transitions

Higher education success has been analyzed in terms of several student traits to identify a possible profile for students with positive outcomes in the university. Those traits refer to students' learning styles, personalities, and previous technological competencies. In another issue, aspects related to school inclusivity expressed as diversity in teaching strategies or teaching styles are also important [40]. Figure 1 summarizes the contextual development of the current research report. While the students' history has shaped those academic traits, the university profile deliberately scaffolds (or not) for each student. In one sense, the horizontal grey arrows of Figure 1 represent Affinity and Adaptation. They are mutual elements established between each student and the university, even though they are offered (or not) by each institution. Then, in such a scenario, the COVID-19 pandemic introduced new elements affecting academic success through its different stages. In addition, specific requirements were demanded for appropriate education in physics for its student profile.

The COVID-19 pandemic has been a period when education practitioners have attended to some pending issues about knowledge of Education theory regarding the impact on academic success. To a great extent, teachers have become updated in educative technologies, theories, and research reports about online education. Regarding academic success, cognitive learning theory (CGLT) states that learning practices should be designed as a function of the learner's thinking style [41]. Constructivist learning theory (CNLT) assumes that knowledge is constructed by steps departing from previous knowledge and recent additional experiences [42]. In a more psychological approach, behavioural learning theory

(BLT) suggests that learners usually act based on their interactions with their environment and community necessities [43]. From a modern point of view, connective learning theory (CCLT) states that learners are moved into action to learn by the overall connections in their lives: the past, their needs, people, and duties, for example [44]. Then, this diverse theoretical scenario should be attended to state some causal factors for academic success in terms of affinity and adaptation, for the crucial connections shown in Figure 1.

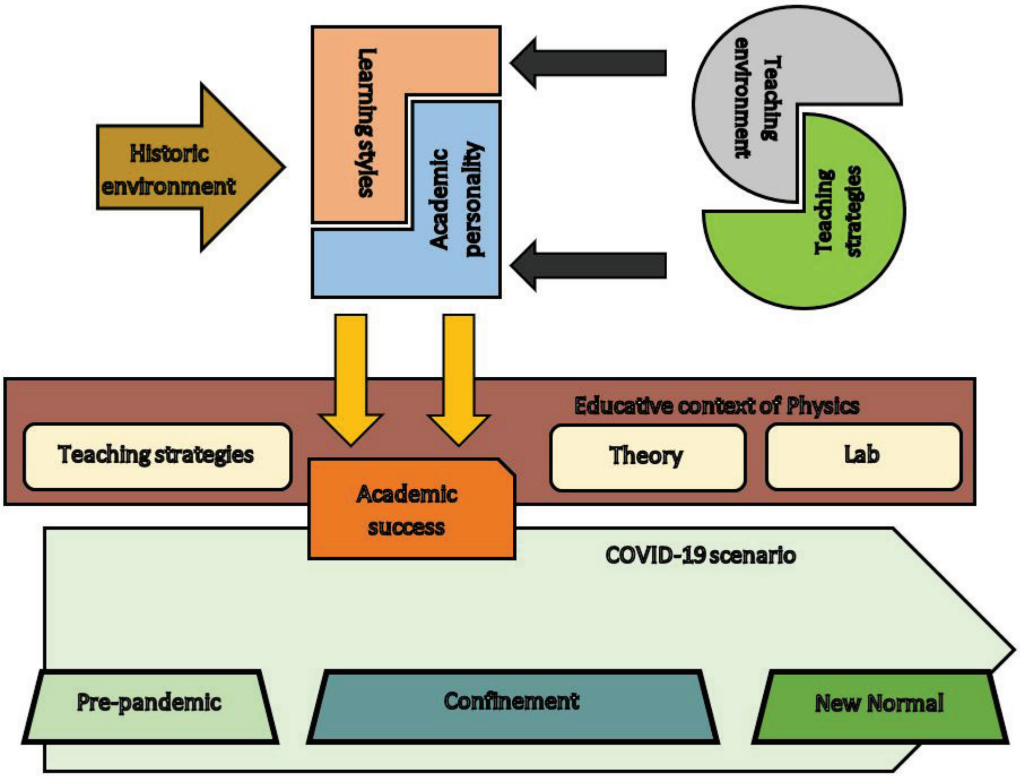


Figure 1. Diagram illustrating the context of the current research report. While some individual student traits relevant to academic life are considered (here, student learning styles and academic personality have been shaped by their histories), the university structure scaffolds their potential academic success. In such an environment, online education during the COVID-19 stages was sustained. For physics courses, a minimum of specific didactic elements must be supported and developed.

2.5.1. Learning and Teaching Styles Categorization in Higher Education

Learning styles theory is an intended categorization in the approach to retaining information on several scales and channels during the learning process. A series of scales corresponds to a specific learning style model. While learning different concepts, students take several differentiated approaches to shaping the outcomes of their academic performance.

First introduced by Felder [45] in a lean classification, it has been modified diversely to include more concrete approaches to information processing in learning [46]. Classification introduced by Fleming and Mills [29], includes four categories: external/internal (Concrete/Abstract), visual/auditory, sequential/global, and active/reflexive. Sometimes, a fifth dimension could be added, Deductive/Inductive [46]. Thirty-two possible learning style combinations could then comprise each category. Despite this, many are commonly underrepresented in the university population [29].

In our analysis, a learning style assessment was used to examine possible relationships between the learning styles of each student and their performance in physics courses, mainly concerning the cohort transitioning to the 'New Normal'. Those learning styles could also be identified as teaching styles for the faculty: the ways stated by teachers to deliver the knowledge.

2.5.2. Personality as Academic Traits Identified in Higher Education

Personality traits are symbolic qualities supposedly related to the potential of creating a brand personality which is helpful for competitive differentiation [31]. Drawing on a series of qualitative and quantitative studies based on psychometric scales, those traits, confirmed by statistical correlation, provide particular suggestions about success in higher education [47]. Most common personality types use the Myers–Briggs type indicator (MBTI) to identify the learning preferences of these personality types: external/internal, sensitive/intuitive, thinking/reflexive, or judgement/perception [32]. Again, as for learning styles, many of those personality traits combinations were underrepresented in a university population. Despite this, those personality traits could be remarkable in the adaptive context to learning changes imposed by the COVID-19 era.

2.5.3. Technology Dominion in Hidden Curriculum and Its Impact on the Higher Education Success

COVID-19 has brought fast changes in the learning and teaching formats in higher education. At the same time that teachers tried to adapt themselves to existing and emergent technology, students did the same, thus transitioning first to a completely online model to then slowly returning to combined face-to-face models, possibly retaining several online components [48].

During the COVID-19 pandemic, several education systems worldwide moved to an online format, assuming that users (both teachers and students) had specific technological competencies. Analyses performed on previously acquired technological competencies aimed to examine the relationship of such mastery to the success of online teaching during the crisis [49].

Thus, the COVID-19 pandemic significantly shifted education from a traditional face-to-face to an online format, completely emergent for teachers and students. We were interested in how the success rate of such learning transition was due to skills mastery [50]. Such research could be performed with a mastery scale by typed of technology. For instance, the Digital Competency Framework (EDCF) for Citizens states proficiency levels for a previous technology classification [51]. Such a framework can be applied to teachers and students.

2.5.4. Diversity in Teaching Strategies as a Measure of Inclusivity in Higher Education

The diversity in teaching approaches inside a university implies learning possibilities that match each student's different abilities. In that sense, such diversity sets a possible measure of inclusivity covering the diversity of learning styles and personalities inside the student population [52].

Inclusivity could be correlated with each student's actual or perceived performance to set interesting possibilities for each educative system to succeed in its learning task. During the COVID-19 pandemic, identifying the fundamental causes and barriers in learning adaptation became relevant to improving educative systems and revealing the learning impact of individual differences (learning styles, personality, teaching strategies) [53].

2.5.5. Some Considerations on the Reliability of Learning styles and Personality Traits on the MBTI Scale

Despite that Learning Styles theory still has relatively good acceptance from its initial proposal, through time, it has had a natural declination in some black spots where particular weaknesses have been observed. As an interpretative behavioral science, academic psychology defines reliability as the property of obtaining the same outcomes in repeated tests performed under identical conditions. Of course, it is almost impossible, although one can reach a sufficiently good approximation to that ideal under certain conditions. Otherwise, as in social sciences, theories could exhibit temporal validity trends in the newest studies and professional considerations in each field.

Thus, learning styles have been commonly used in teacher training to characterize some didactic methodologies in students' preferred approaches. Despite not being universally accepted and sometimes considered inaccurate [54], they should be carefully interpreted as ways of interaction between learners, teachers, and content, instead of definitive ways to learn [55]. In the words of Felder [56], they are not strict and invariant student behaviors; instead, they are guides to strengthen the teacher's practice for certain groups of students and topics. Our primary interest was to include such a concept as a possible causal acting on their academic performance because some of our institution's initiatives have been based on methodologies and approaches to deliver content intending to emphasize these methodologies. In face-to-face practice, learning activities promote stimuli variation. Despite this, such practice could have diminished under the online learning approach during the confinement. Thus, learning styles still provide a valuable basis to set particular affinity between learners' and teachers' actions. The affinity could alter when the teaching media changed in each COVID-19 transition.

Similarly, in the study of personality typology, the MBTI scale suggests how people perceive the world and make decisions. Nevertheless, it has been considered an indicator of the preference for some activities and professional abilities. This last interpretation has developed many detractors criticizing the MBTI scale's reliability and validity. Based on a previous Carl Jung scale related to psychological types, the MBTI scale is still valuable to track some behavioral traits barely characterizing certain academic conduct (mainly related to the decisions made when we learn) [57]. Such traits are not definitive or universal to each person; instead, they are adaptable for each learning experience (student and content). Despite this, a student can repeatedly show each trait for specific topics (for instance, physics).

So, the current analysis considers the MBTI scale valuable because some personality traits as conditioners of effective learning became notable during teaching. Under controlled and limited conditions, those traits could have an observable correlation [58]. The correlation is mainly observed in groups of concurrent traits, as in the current analysis [57]. Our final interest was establishing a specific characterization of the student population based on observable behavioral categories of particular tendencies affording learning activity. The MBTI scale became more reliable for academic purposes [59].

3. Research Questions and Objectives

The interest of the current research was to analyze how the different stages of the COVID-19 pandemic impacted the teaching of physics under the university's contemporary educative model, which was implemented in August 2019 [20]. This model intends that each physics course should be accompanied by a couple of teachers in math and computing to scaffold the course basics and the development of the challenge. The beginning generation (class year in the study) was the first cohort under an entirely face-to-face approach before Covid19. Its students completed two courses (Kinematics–Dynamics and Conservation Laws) in Fall 2019. Then, a couple of cohorts followed, the first in the fall of 2020 (AD, August–December) and spring of 2021 (FJ, February–June). The second one occurred in the fall of 2021 and Spring of 2022. Both cohorts completed four courses (Kinematics–Dynamics, Conservation Laws, Electricity, and Electromagnetism). While the first cohort became educated entirely under the face-to-face model, the second and third transitioned into the hybrid and face-to-face approaches in the 'New Normal'.

Research Questions and Objectives

The current research analyzed how several behavioral, environmental, and academic factors conditioned the educational transitions toward confinement and the physics courses and how the differentiated performance, by course sections and activities, evolved in each cohort during the pandemic's different periods.

Of particular interest was how the transition from confinement to the 'New Normal' was evaluated considering the characterization of the students in each stage. We intended to analyze the relative aspects of each group and then deduce some possible success and failure factors. Thus, for the current report, we established the specific research objectives as follows:

(1) To analyze the computer science students' outcomes and performances in the physics courses through the several stages of the COVID-19 pandemic.
(2) To compare the student performance in those courses in the several sections and among the cohorts studying the courses to make sense of changes produced by the Covid-19 confinement and online education.
(3) To analyze the students' perception of the transition for the most recent cohort crossing the confinement period to the 'New Normal' period.
(4) To characterize the behavior during the educative transition in terms of several possible academic traits reported in the literature.

4. Materials, Methods, and Data Collection

Table 1 depicts some demographic or temporal issues of each cohort included in the analysis and each course type. It shows the corresponding semester of the program course and the sub-period in which it was taught. For instance, AD2019-1 refers to the first part of the Fall 2019 semester (August to December) because two sequenced courses of physics were offered to each cohort in each period.

Table 1. Groups of students considered in the research from 2019 to 2022. Three cohorts were studied as they transitioned through the pre-pandemic, confinement, and 'New Normal' stages. The courses, semester, number of students, and labels are in the table.

Cohort Course	Cohort 1: Sub-Period	Fall 2019 Semester	Studs	Cohort 2: Sub-Period	Fall 2020 Semester	Studs	Cohort 3: Sub-Period	Fall 2021 Semester	Studs
Kinematics–Dynamics	AD2019-1	1	51	AD2020-1	1	56	AD2021-1	1	62
Conservation laws	AD2019-2	1	49	AD2020-2	1	63	AD2021-2	1	54
Electricity	-	-	-	FJ2021-1	2	59	FJ2022-1	2	57
Electromagnetism	-	-	-	FJ2021-2	2	58	-	-	-

4.1. Groups of Analysis, Materials and Methods

The study corresponds to all students in the computer science programs (Robotics and Digital Systems Engineering, Computer Technologies Engineering, and Business Digital Transformation Engineering), starting with the cohort entering 2019. All students enrolled in the introductory physics courses taught in the first year of the university (from fall 2019 to spring 2022) were included, despite some periods missed not taught by the author. They are summarized in Table 1; nevertheless, three existent cohorts were included in most of the physics courses with activities following a similar methodology.

In general, the physics courses in which those students were enrolled corresponded to four blocks in the topics of Kinematics–Dynamics, Conservation Laws, Electricity, and Electromagnetism. The last cohort transitioned to the face-to-face model again one semester after entering the university. Those students completed one semester (Fall 2021) for the courses of Kinematics–Dynamics, and Conservation Laws under online education and their second semester (Spring 2022) for Electricity and Electromagnetism courses under a fully face-to-face model. In addition, detailed performance information was available for all cohorts. The design of activities was broadly similar, although there were slight adaptations in the online model, some of which continued in the new face-to-face version. Each course or block consisted of three sections taught by three teachers: physics (primary), math, and computing. Physics, the most extensive, comprised one-half of the teaching time. It was the physics course itself, while the other two (mathematics and computing) scaffolded the teaching of physics concepts through a computer simulation project (the challenge) associated with each of the three blocks. This expanded the mathematical vision and applicability of the course to related courses studied simultaneously, such as Differential and Integral Calculus (one and several variables) and Programming [15].

To cover the last two objectives in the last cohort, we applied a combined instrument to this group. This demographic survey was developed by combining several documented instruments (see Appendix A). This instrument (questionnaire) combined in independent sections the data collection on learning styles [45,46] (section A) and personality [32,60] (Section B) of each participant. pre-existing technological skills in each student were compiled as a 'hidden curriculum' [50,51,61], and the students' perception of the average skills of their teachers, their educational institution, and its characteristic teaching strategies (section C). In addition, it measured each student's perception of the institution's preponderant approach to diversifying teaching, comparing the learning styles advanced by the university to theirs [32] (section D). A specific question sought the self-perception of each student about the relevance of their current education in their period of studies to their career (section E).

Those factors had to be assessed to understand student perception during the pandemic and the return to the 'New Normal' in education. Sections F and G gathered this information. The correlations were contrasted with the observed performance in the physics courses in the different cohorts and the cohorts in transition under this additional study. Thus, because at least two cohorts went through the same treatment in physics courses, the last one, in transition to the 'New Normal' in face-to-face courses, allowing for additional comparisons.

In brief, the instrument evaluated the learning styles on the Fleming and Mills [29] scale and the personality [32] using the MBTI. This instrument included the students' perception of those dimensions and their assessment in the same sense of the learning styles in their school environment. The instrument also included the self-perception of their mastery of various computing technologies per the EDCF [51] and their teachers' mastery in the school environment. At the same time, the students assessed the diversity of activities implemented in the institution to vary the teaching strategies. Finally, the second part of the instrument measured the perception of success, adaptation, and preference or quality, first for online education during confinement and then during the return to face-to-face educational activities under the 'New Normal'.

4.2. Data Collection and Analysis

Data for the first two objectives were obtained from the detailed grades in a weblog. Grades of each activity were gathered but grouped into only two kinds of activities: exams and global grades for each section: physics, math, and computing. For the challenge, we compared it with the global grade for the overall course because there was not a proper examination. Grades were maintained separately for each student to obtain statistical central or dispersion for each sub-period in Table 1 (AD2019-1, 2019-2, etc.). Exams were applied face-to-face during AD2019-1, AD2019-2, and FJ2022-1. In other sub-periods, exams were presented online from a large question bank on each course topic. For the transitional cohort into 'New Normal' (that entered AD2021-1 and transitioned to FJ2022-1 entirely to face-to-face teaching), the previously depicted instrument (see Appendix A) was applied to the entire population. Forty-nine of the 57 students answered it (86 %), thus giving overall confidence). Notably, despite the number of students through cohort 3 varying slightly in each course, 53 students common to the three courses were reported. Of them, 48 students responded to the survey (98 % from the fixed population studying the three courses and experiencing the transition to the 'New Normal'). The survey reported in Appendix A contains, in parentheses, the codification to gather the answers (Co, Ab, . . .) in sections A and B of the questionnaire. For answers in Section C, a combination of a word (ID, CC, . . .) and a number denoting the dominion (1, 2, . . .) were obtained. Section D accounted for each Teaching strategy, summing activities for each one. Answers for section E were open. Finally, for sections F and G, a level in the ordered (but not parametric) scale was obtained from each student (questions Q32 to Q38, except for question Q35, which was open). Responses were analyzed by crossing them with another data series to compare with the next section. Appendix B reports the raw data obtained from the application and the final grade for the physics course during the FJ2022-1 period for cohort 3. In some cases, statistical tests were performed to infer certain observed behaviors. Such analysis is in the Discussion section.

5. Raw Outcomes, Relevant Comparisons, and Factor Analysis

This section reports the synthesized outcomes partially processed from the raw data. We comment only on the evident conclusions derived from the presentation. A deeper discussion involving the outstanding facts is presented in the next section in light of author interpretations and other contextual considerations.

5.1. Comparative Analysis of Performance through Several Stages around COVID-19 Pandemic

First, we analyzed the differentiated grades obtained in each course section (physics, math, computing, and the challenge). Because each section included an exam and other graded learning activities, we differentiated both components. The challenge did not involve an exam, so we paired it with the final grade for the entire course. Thus, Figure 2a–i report for each sub-period the grades by section (computing, physics, math, and the challenge) and on each axis, comparing the exams (horizontal) and the global one (vertical). For each section and type of grade, the comparison between those grades includes horizontal and vertical bars to mark the standard deviation of each group of grades. They are colored in a different gray tone, as indicated in the legends for each section. Nine plots are reported, referring to each sub-period as they were listed in Table 1. Sub-periods are marked in the red labels. They correspond to the following cohorts: First cohort (a,b), Second cohort (c–f), and Third cohort (g–i).

Comparing the plots, we advise that for cohort 1, the exam grades were the lowest in the entire sub-periods and among the cohorts, particularly for the sub-period AD2019-2. This was more dramatic in the computing section than math and slightly different in physics. Nevertheless, the challenge grade was almost maintained in the same range (80–90) as most sub-periods. It impacted the global grades of each section and the final course grade. Despite this, the phenomenon was not uniform among all students, noticeable from the wide dispersion in the grades, indicating that only some students had lower grades in each group of students. We highlight that cohort 1 corresponds to the pre-pandemic face-to-face version of the course, the first version of the institution's educative model [20]. The challenge grade was uniform for the whole of the students.

For the remaining cohorts, courses, and sub-periods, the grades were almost in the same range, except the exam grades, which were performed online, increased except notably for the last sub-period FJ2022-1. Despite this, the dispersion was significant for the AD2020-2 sub-period in the Conservation Laws course, the corresponding one with AD2019-2, the most variable course in the plot. Such course still exhibited a slight lowering in the grades. Nevertheless, it was not the same for the corresponding course AD2021-1. Another notable aspect was the flattening in the differences in grades for each course after cohort 1. Nevertheless, we note the sudden recurrent dispersion for computing in some sub-periods (AD2020-2, FJ2021-2, and AD2021-1). Such behavior appears to impact the global evaluation for its section. As a rule, grades in the exams were commonly in increasing order for computing, math, and physics. In addition, after cohort 1, we note that Global/Course grades were almost in the same range.

In another view of the outcomes, Figure 3 shows the evolution of grades for each section: (a) challenge versus final grade for the Course; and Exams versus Section grade for (b) math section, (c) physics section, and (d) computing section. Colored dots indicate the outcome for each sub-period in agreement with the color-bar scale (going from the blue dots to the red ones). The ending arrow marks the transition order from the pre-pandemic into 'New Normal', going through the different cohorts. Figure 3a–c again highlights the odd behavior of cohort 1 (initial dots in blue).

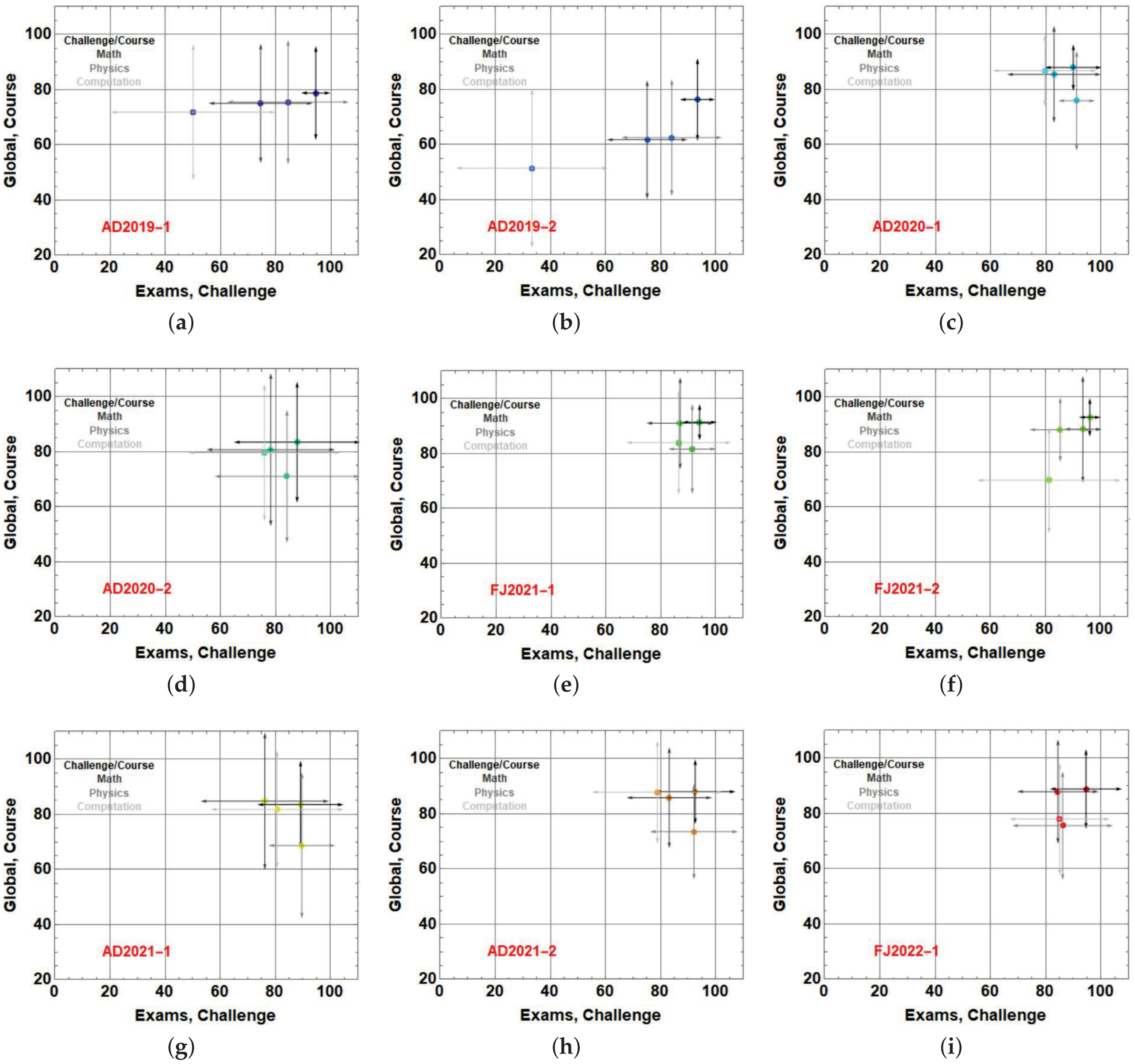


Figure 2. Average grades though time for challenge/course, math, physics, and computing as sections of the physics course (each indicated per the different gray levels for the one-standard deviation arrows in each case, showing the dispersion). Horizontal/Vertical coordinates refer to Exams/Global grades and show their corresponding dispersion arrows. The subperiods correspond to: Pre-pandemic period: (**a**) AD2019-1, (**b**) AD2019-2. Pandemic: (**c**) AD2020-1, (**d**) AD2020-2, (**e**) FJ2021-1, (**f**) FJ2021-2. 'New Normal': (**g**) AD2021-1, (**h**) AD2021-2 (those under a hybrid model with optional online orientation by decision of each student), (**i**) FJ2022-1.

First, we note the more significant changes in the exams' grades for the computing section, more stable among cohorts 2 and 3. Modest, similar behavior is observed in the math section. The final grade for each section exhibits similar ranging through the sub-periods. The average grades for the course and each section were maintained in similar ranges throughout the sections (despite the differences in the dispersion noticed for cohort 1 in Figure 2). Interestingly, the exam grades varied only mildly for cohorts 2 and 3. Remarkably, the changes did not revert to the pre-pandemic situation for cohort 3 when it moved to the 'New Normal'.

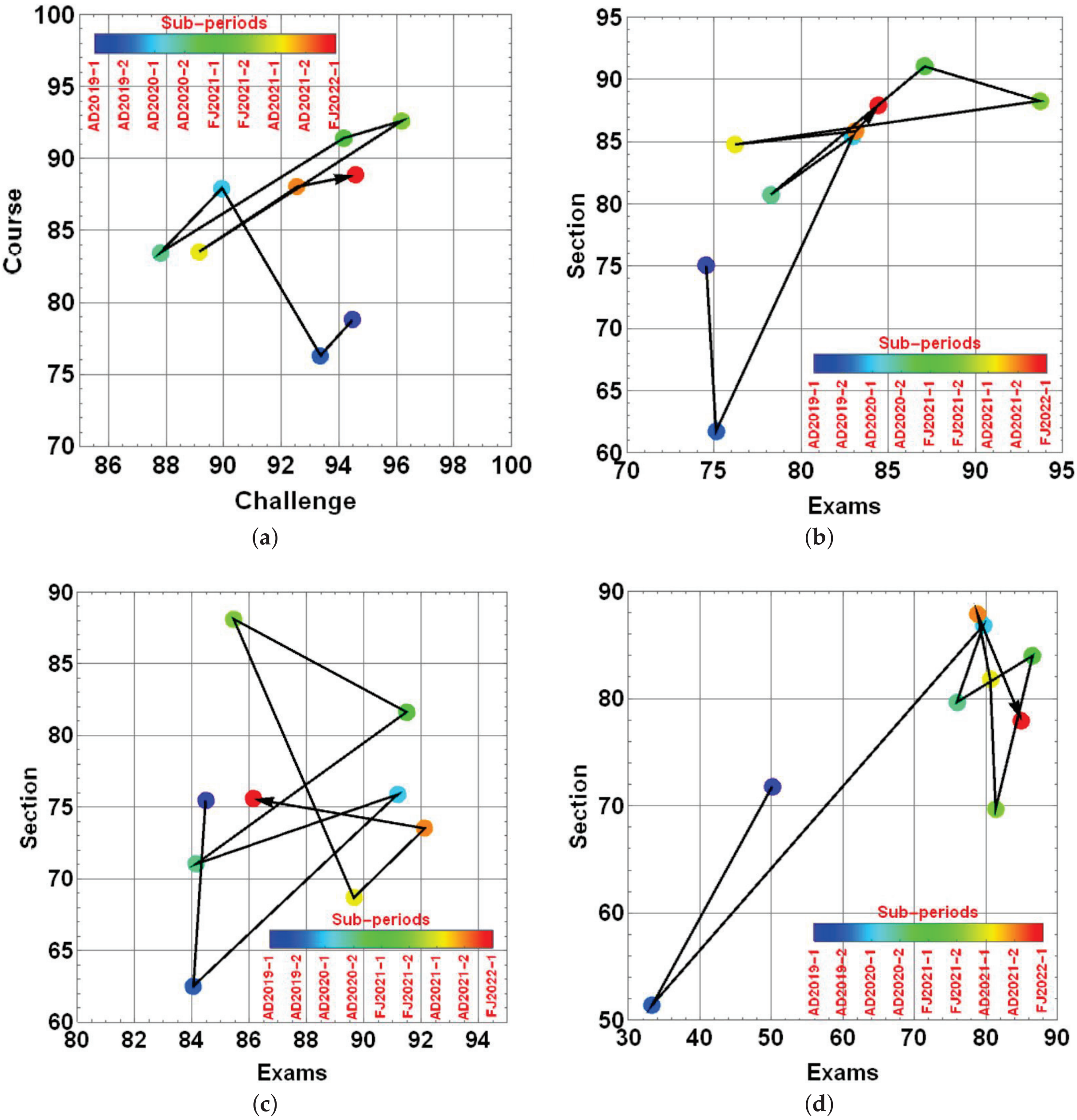


Figure 3. Average grades evolution through each sub-period (indicated with colored points in agreement with the color scale). Each grade section is reported comparing (**a**) challenge grade/Course grade, (**b**) math section: Exams/Section, (**c**) physics section: Exams/Section, and (**d**) Computation section: Exams/Section. The colors in Figure 3 correspond to each sub-period.

These facts suggest that the lower exam grades for cohort 1 are proper for this population, but there is no apparent evidence that face-to-face exams give a different range of grades compared with online exams. At least, there is a different treatment for those face-to-face exams for cohort 3. Against popular belief, another possible explanation could be an improved ability of students to prepare themselves for the exams, inherited from confinement as a positive aspect, gaining this discipline because of the crisis. We will try to find specific evidence on this issue in subsequent analyses. In the next section, we analyze cohort 3 in detail, trying to detect possible facts related to the transition to the 'New Normal'.

5.2. Demographic Analysis of the Transitional Cohort Based on Learning Styles, Personality, the Hidden Curriculum, and perception of Teaching Strategies

Transitional cohort 3 had high school studies under an online model to a great extent. They arrived in higher education under the same online model in several aspects, with similar flexibility rules, possibly relaxed discipline, and teaching limitations. How did the students in this cohort address the changes required for their academic growth? Which factors produced different academic paths for each student? In the current section, we report the cohort's behavior in learning styles, personality, technology-hidden curriculum, and perception of their university and academic life. With 86% of the cohort 3 population represented and 98% of the sample taking the three physics courses reported, we gathered an authentic representation of the entire cohort. Then, with their additional self-assessment of the pandemic stage, we intended to identify possible paths and traits for academic success.

5.2.1. Analysis of Learning Styles in the Transitional Cohort

Learning styles are analyzed in five dimensions based on the classification introduced by Fleming and Mills [29]: External/Internal (Concrete/Abstract), Visual/Auditory, Active/Reflexive, Sequential/Global, and adding Deductive/Inductive. The instrument included in Appendix A and partially based on the instrument used by [46] gathered the students' self-perception and perception of the equivalent average teaching orientation in the university. The raw outcomes were first analyzed by crossing their opinions about their own learning style versus the learning style of the environment. Figure 4 shows the comparisons by dimension. Each quadrant crosses the student learning style versus the perceived orientation of the university (the dispersion of dots in each quadrant is non-meaningful; they only represent the size of the conglomerate.) Percentages in the center of each plot correspond to the part of the sample in each quadrant.

For External/Internal (Concrete/Abstract), most of the students considered themselves Concrete, but the perception of learning orientation was split to a great extent on Abstract (Figure 4a). The same situation holds for Visual/Auditory, with student predominance in Visual (Figure 4b). However, for Deductive/Inductive, the population was divided into both categories, despite most students perceiving predominantly a Deductive orientation for learning in the university (Figure 4c). For Active/Reflexive, most students considered themselves active, despite the university orientation being perceived as equally divided (Figure 4d). Finally, for Sequential/Global, most students perceived themselves as Sequential, and the predominant perception was that the learning style orientation in the university fit them, a common outcome in Engineering programs.

Another view of the global composition of cohort 3 is presented in Figure 5a, representing the frequency of learning style classes effectively as a radar plot. Notably, two classes are predominant: CoViDeAcSe and CoViInAcSe (the short names given in the instrument), with only one dimension split, Deductive/Inductive. More than one-half of the sample fell in those classes. Interestingly, regarding the learning style orientation in the university, the perception was disperse (Figure 5b). Notably, the real student classes in cohort 3 were not the most perceived among the learning styles promoted in the university; they were just moderately represented. Instead, classes CoAuDeReSe, AbViDeAcSe, AbViDeReSe, and AbAuDeAcSe became the most perceived. There, the Abstract, Deductive, and Sequential styles predominated. By comparison, the two first probably disrupted the main learning styles of the students. An Affinity index could be constructed by considering the matching fraction of coincident learning styles of each student with their opinion about the university orientation. We discuss the Affinity index below in the context of academic performance.

5.2.2. Academic Personality Traits for the Transitional Cohort

Certain personality traits have been identified as meaningful in higher education success. MBTI considers the learning preferences of students: external/internal, sensitive/intuitive, thinking/reflexive, or judgement/perception. Using an adaptation of

MBTI [32], we included Section B in the instrument of Appendix A to gather the students' self-perception of those personality traits.

Thus, Figure 5c shows the frequency of personality classes in those dimensions in cohort 3. The main class, InItThJu (using the short names in the instrument of Appendix A), was followed by ExSeThPe, InItThPe, InSeThJu, ExItThJu, and ExSeThJu, comprising more than two-thirds of the sample. Note that predominant traits in cohort 3 were Thinking and Judgement. Below, we report the correlation of each class and trait with academic performance, discussing Figure 5d.

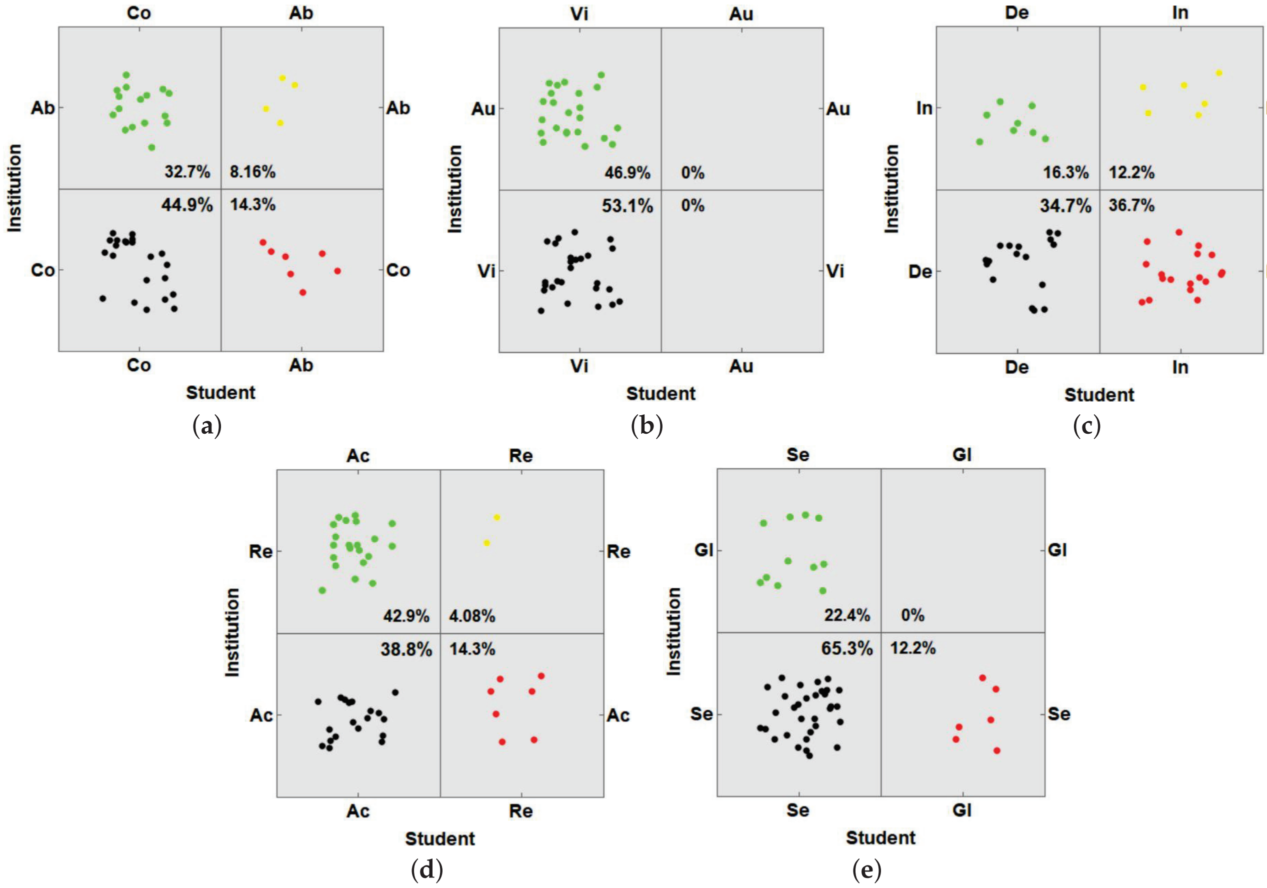


Figure 4. Students' learning styles versus Learning styles of the school as perceived by students. (**a**) Concrete/Abstract, (**b**) Visual/Verbal, (**c**) Deductive/Inductive, (**d**) Active/Reflexive, and (**e**) Sequential/Global.

5.2.3. Technology Hidden Curriculum for the Transitional Cohort

A hidden curriculum for each student commonly contains diverse lifelong learning that is practical to scaffold academic performance. It is crucial in higher education, where students prepare for a professional life where success cannot only depend on academic knowledge. Technology is part of that hidden curriculum on several levels in science and engineering. The EDCF classifies technology in five spheres: Search for information and data (ID), Communication and collaboration (CC), Creation of digital content (CD), Computer security (CS), and Troubleshooting (TS). The instrument used in this work gathered in Section C the mastery of each student in five levels (1–5, with 5 the highest) based on self-evaluation. The mastery means are reported in Figure 6a for each of the last technology spheres (solid blue line in the middle), including bands marking minus/plus one standard deviation (red/green or inner/outer dashed lines) to show the dispersion among students. The average evaluation is around 3, denoting an expected value for a student in the Freshman level (Search for information and data the lowest and Computer security the highest, but with the highest dispersion). In fact, technological command was not a concerning issue throughout the confinement, mainly due to the university orientation.

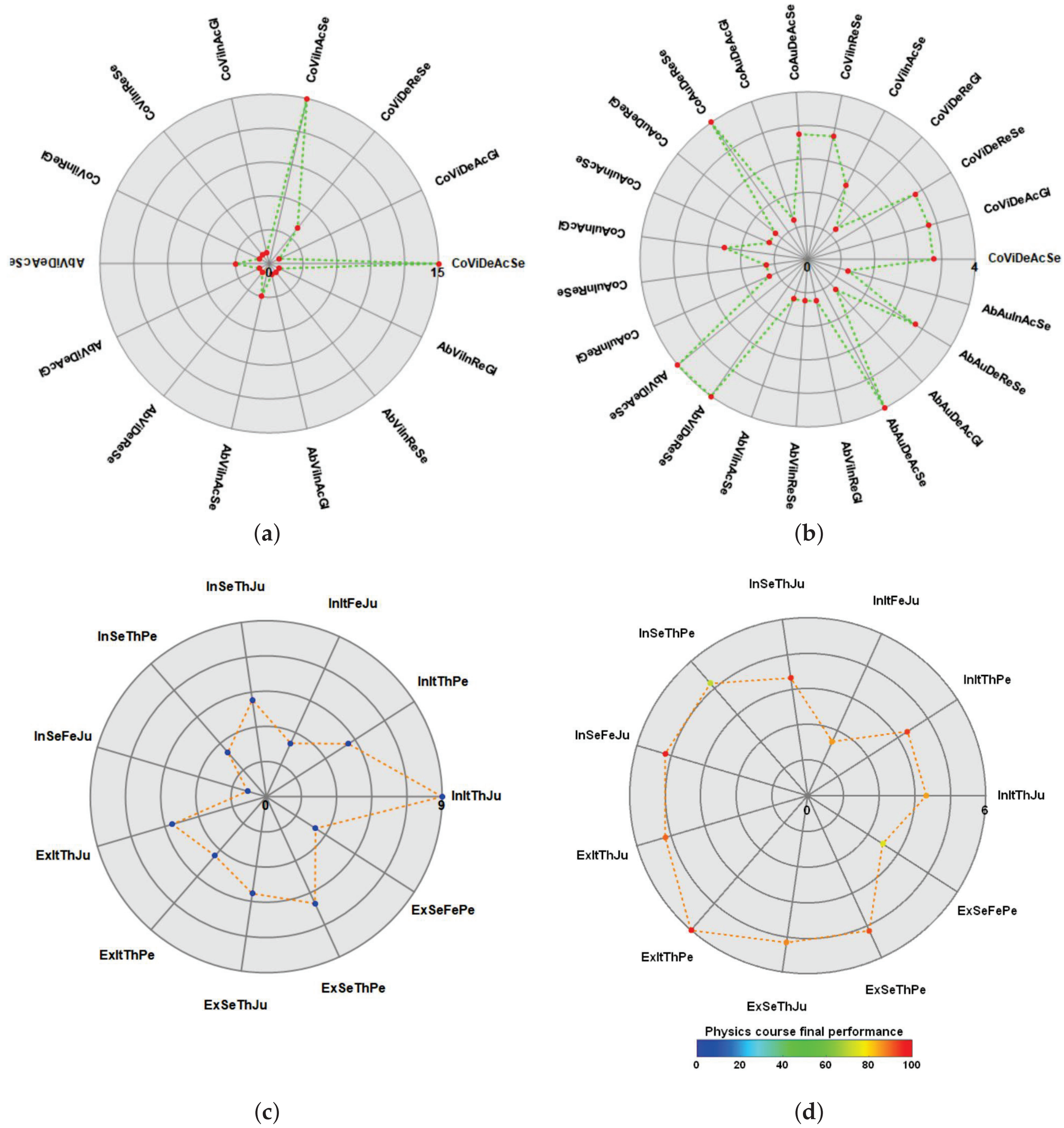


Figure 5. (**a**) Distribution of main learning styles in the group surveyed, (**b**) Distribution of the primary school learning styles as perceived by students, (**c**) Distribution of primary personality traits (Extroversion/Introversion, Sensitive/Intuitive, Thinking/Feeling, Judgement/Perception), self-perceived by each student, and (**d**) Online performance declared (radial) and physics course performance (color) by personality traits.

In the same trend, students were asked about their perception of their teachers' mastery in the identical technology spheres. The outcomes are shown in Figure 6b with the same features as Figure 6a. There is evident similitude, but the teachers' computer security rating is lower than the students'. This aspect generally reflects that students consider themselves at the same level or higher in technological abilities as their teachers. At this level of mastery, the students surely have sufficient ability to develop online learning.

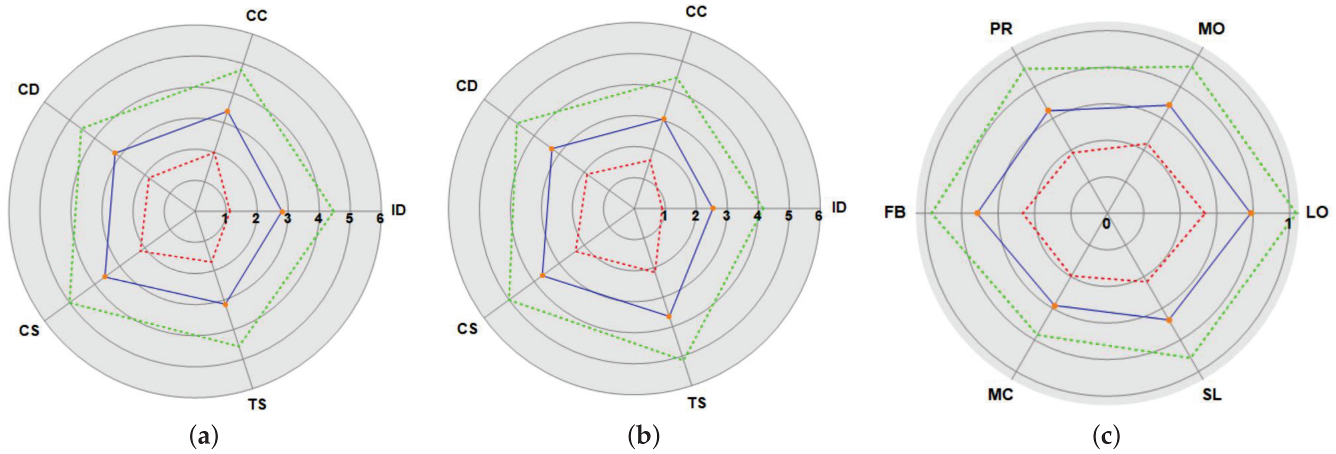


Figure 6. (**a**) Technological competencies (Search for information and data-ID, Communication and Collaboration-CC, Creation of digital content-CD, Computer security-CS, and TroubleshootingTS) self-perceived by each student on a scale of 1–6 (less to more), (**b**) Technological competencies being perceived by students on their teachers on the same scale, and (**c**) Main teaching strategies in the school as perceived by students (Learning organization-LO, Motivation-MO, Practice-PR, Feedback-FB, Metacognition-MC, and Social learning-SL).

5.2.4. Variability in Teaching Strategies Perceived by the Transitional Cohort

Diversity in teaching strategies widens the opportunities for diverse learning styles, adapting to the learning trend. It means certain inclusivity in academic life. In the instrument applied, we included in Section D the gathering of perceived practices for several teaching strategies classified as Learning organization (LO), Motivation (MO), Practice or skills development (PR), Effective feedback (FB), Reflection or metacognition (MC), and Social learning (SL) [52]. Practices present in each class add points to an increasing score. Then, average student outcomes are presented in Figure 6c on a scale of 0 to 1 (solid blue line in the middle), with 1 being the highest. The figure also displays bands marking minus/plus one standard deviation (red/green or inner/outer dashed lines) to show the dispersion among students. Such an average is defined as the Inclusivity Index. Learning organization is the highest strategy recognized (≈0.8), possibly due to using an institutional learning management system (LMS). Other teaching strategies are average evaluated on half of the scale (≈0.6). A uniform evaluation of the teaching strategies suggests a considerable Inclusivity index for cohort 3. Both terms will be considered equivalent in further analysis.

5.3. Performance Analysed by Academic, Curriculum, and Personality Factors

In this section, several analyses were performed correlating learning styles, personality traits, and teaching strategies (sometimes shown as Affinity or Inclusivity indices) versus Online or Face-to-face learning performances and the physics course final grade in the most recent face-to-face course (FJ2022-1). The instrument's answers in Sections F and G were used for analysis.

The affinity index is defined as the matching fraction between each student's learning style against the corresponding perceived orientation of learning style in the university (0–1 scale). It indicates the fraction of coincidences between those two indicators. The inclusivity index is first measured by assigning a normalized score for each teaching strategy by adding the selections in Q25-Q30 and then averaging the scores of the six types. In addition, we used the ordered 1–3 scale in Q34 to measure the teaching quality in online instruction (3 is the best quality). The ordered 1–3 scale in Q38 was used to measure the preference for face-to-face learning over online (3 is the higher preference). Adaptation (for online and face-to-face models) is also measured in its own ordered 1–4 scale in Q33 and Q37, respectively (4 represents the highest adaptation).

Online and face-to-face perceived performances (Q32 and Q36, respectively) were measured in the ordered scales 1–6 and 1–5, respectively (6 and 5 representing the highest performances). Finally, the physics course grade was measured on its own 0–100 scale as given to the student.

5.3.1. Minimum Online Performance and Physics Course Final Grade versus Personality Traits

When Online performances (Q32 and Q36) are classified by Personality trait (Figure 5c), they sometimes become statistically multi-modal by trait. Thus, Figure 5d comprises the minimum mode (the worst performance) of each trait in declared Online performance (radial) versus their average physics course performance (final grade, in color agreement with the color-bar below). The final grades had values above 80 except for the ExSeThPe (70.3) and InSeThPe (70.7) traits. Interestingly, the most frequent traits in cohort 3 indicated higher performance in online learning, matching the course performance. Online performance was lower for a few traits, coinciding with a lower performance in the face-to-face physics course during FJ2022-1 (despite no clear pattern of individual traits). Note that the most frequent trait belongs to this last group (but not to the lowest online learning performance).

5.3.2. Affinity and Inclusivity versus Physics Course Final Grade

In Figure 7, each student in the sample was characterized by Affinity and Inclusivity indices. Slightly horizontal displacements are non-meaningful; they were introduced to differentiate each respondent. Each dot was colored in agreement with the student quartile of the final grade for the entire physics course, indicated in the color-bar below. The dashed line graphically splits the cases with higher Affinity and Inclusivity indices from those with lower ones. Figure 7a shows that the reddest dots with the best performance are mainly located above the line, with middle and lower performances below (green to blue).

Notably, students in the highest quartile usually have both indices high. The opposite is true for some students in the lowest quartile and the lowest indices. Some students in the highest quartile correspond to a higher Affinity index without a clear dependence on the Inclusivity index. It suggests that Inclusivity provides more support to those students who are academically weaker.

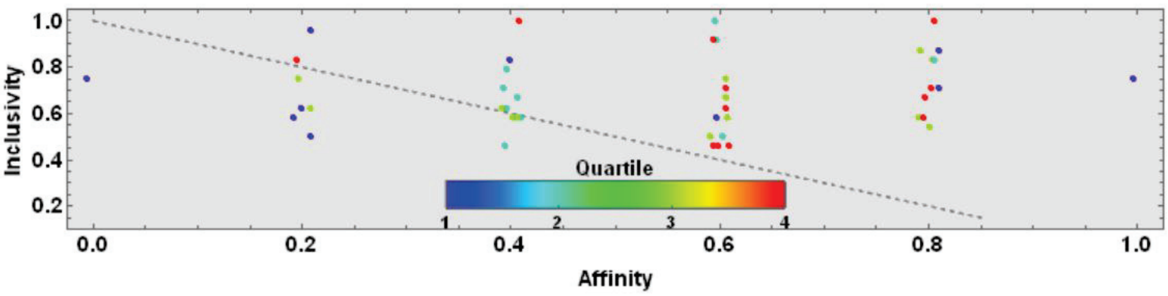
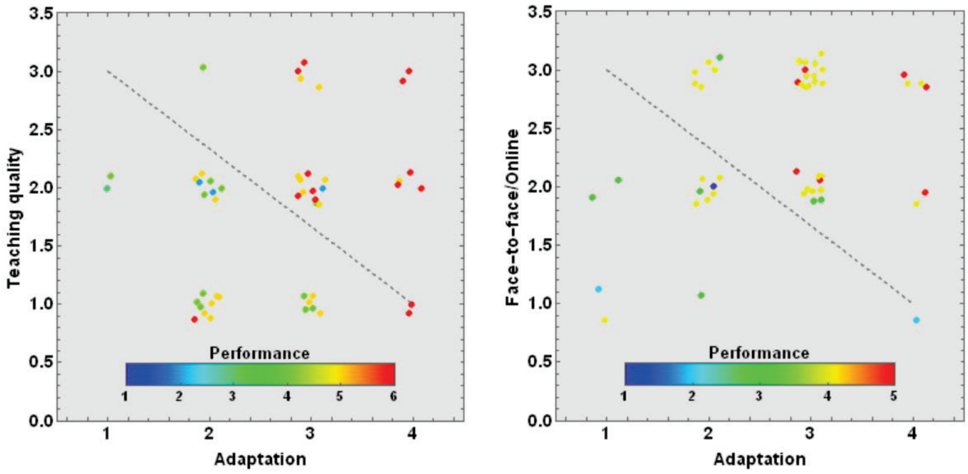


Figure 7. The incremental affinity between students and school versus the degree of inclusivity is measured as cumulative perceptions of teaching strategies. Each student is additionally characterized by their final grade quartile of the current physics course.

5.3.3. Adaptation and Teaching Quality Perceived versus Online Teaching Performance

We first analyzed the online teaching plot thoroughly. Adaptation to online learning during the COVID-19 period within cohort 3 is represented in Figure 8a. It compares Adaptation versus Teaching quality perception during the online learning period under confinement. Each dot represents each student in the sample, colored in agreement with their declared online learning performance (see the color bar below). Slight displacements are non-meaningful again, just distinguishing the conglomerate of students individually. The dashed line divides the highest Adaptation/Teaching quality from the lowest. The highest declared performance corresponds to the highest adaptation and teaching quality.

Note that better Adaptation does not necessarily correspond with the recognition of better Teaching quality.



(**a**) (**b**)

Figure 8. (**a**) Degree of adaptation to the online teaching model during the COVID-19 confinement versus self-perceived online teaching quality, with students characterized by their self-perceived performance in the online teaching model; and (**b**) Degree of adaptation to the face-to-face teaching model during the 'New Normal' versus preference of face-to-face over online teaching, with students again characterized by self-perceived performance in the face-to-face teaching model.

Figure 8b compares Adaptation to face-to-face learning (coming to the 'New Normal') versus preference for face-to-face learning over online learning. The color is again assigned in agreement with the face-to-face learning performance declared under the 'New Normal'. Higher performances correspond with the preference for face-to-face instruction than Adaptation. Again, lower performances correspond with poor Adaptation and preference for the face-to-face model. In general, the performances declared are lower in face-to-face learning than online.

5.3.4. Preference of Instruction and Physics Course Final Grade versus Online and Face-to-Face Performance

Finally, we analyzed the comparison between declared performances in online instruction versus face-to-face instruction. The reader should remember that the scales for each declared performance were different: 1–6 for online performance (to include a terrible performance hardly present in the short period of the face-to-face transition during the 'New Normal'), and 1–5 for the face-to-face one. Thus, Figure 9a includes in color the preference for the face-to-face model over the online one. The dashed line splits the lower and upper-performance regions. Note that the reddest points (greater preference for face-to-face over the online approach) are located above that line (both best performances). Performance in face-to-face instruction depends intensely on the preference for such a learning model but still not affecting the performance during online instruction. A few students with lower performances in both models preferred online instruction. Students with indistinct preferences still exhibited a better performance in the face-to-face model.

A similar comparison was performed in Figure 9b but is now considering the final grade of the first physics course during the 'New Normal' period (in color). Again, the reddest points corresponding to the higher grades are located above the line, corresponding to the best-declared performances in both models. The grades are patently high and not surprisingly correlated with higher performances in both models. The same previous behavior is noticed; a few students had generally lower performance, not depending on the learning model.

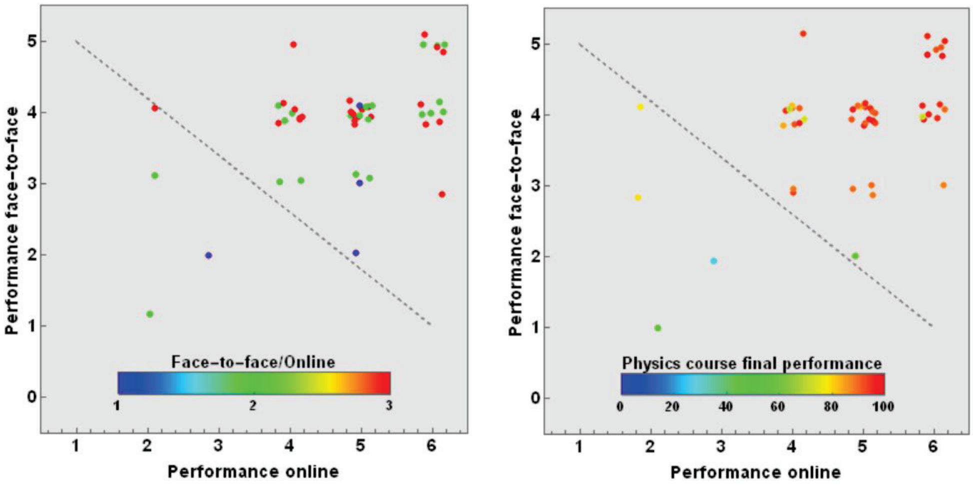


Figure 9. Comparison of self-perceived performance between the online and face-to-face teaching models, showing in color (**a**) the preference for face-to-face over online teaching and (**b**) the final grade on the last face-to-face physics course.

6. Discussion in Context and Outstanding Findings

To fulfill the research objectives, at this point, we analyzed the performance behavior through the pandemic stages, cohorts, sections, and sub-periods. We also introduce the Affinity and Adaptation indices to measure specific interactions between the students and the university that possibly supported their academic performance. We still needed to study the meaningfulness of certain notable relations stating possible variations through the pandemic periods. Beyond grade variations observed for cohort 1 and those related to math and computing in some sub-periods, we were particularly interested in the effectiveness of online education in the transition to face-to-face education under the 'New Normal'.

Thus, finding critical differences through Affinity and Inclusivity indices precisely identified their meaningfulness. Other factors such as Learning styles and Personality should still be bounded. In this section, we discuss findings and outstanding aspects unveiled by the raw results in the previous section or their comparative analysis, particularly those related to the research objectives. Each of the following aspects derived from the raw data, and the immediate comparisons emerged from them:

(1) Meaningful differences in the performances based on sub-periods and course sections.
(2) Meaningful differences in performance as a function of personality traits and learning styles.
(3) Meaningful differences in performance through the online and face-to-face learning periods.
(4) Education preference conditioned the success in online education during COVID-19 confinement.
(5) Academic traits and preferences conditioned the success of the return to face-to-face learning during the 'New Normal'.

We reanalyze these noteworthy aspects in the following sub-section, discussing their soundness. The discussion is guided by solid data and formal analysis, which is made more profound by the contextual facts of the teachers' considerations.

6.1. Meaningful Differences in Performances in Course Sections through Sub-Periods

The Figure 2 clearly shows low performance by the first cohort during AD2019-1,2 sub-periods. This time corresponded to a period before the pandemic. In addition, it was the first class entering under the university's new educative model [20] changing the traditional approach for a physics course. In this new model, called Tec21, the physics course is delivered in two short courses in sub-periods of five weeks each, with content managed independently compared to the traditional course during the entire semester. In addition, the course is delivered by three teachers, two supporting the physics contents. The author remembers this generation's poor performances in the physics and computing section exams and requiring extended tutoring sessions. Notably, students were not afforded the short time to prepare for examinations, a rare practice in traditional education models having semesters with spaced examinations. It is additionally noteworthy that, cohort 3 students in FJ2022-1, during the 'New Normal' already, had face-to-face exams with much better outcomes than their peers in cohort 1 two years before. Still, they came from an online model and transitioned to the 'New Normal' (this cohort had its first semester optionally face-to-face, but less than 10% of students attended.) The facts show good adaptation by this third cohort and a different performance level. Thus, the cohort 1 behavior appears to be an outlier behavior rather than an issue related to the educative model or relaxation in grading during the pandemic.

Regarding the sections, there were no notable differences in performances by activity type, apart from the behavior already commented for cohort 1, where the computing section produced the lowest performances, notably in the exams. Exams and activities had an even composition in the global grade of each section (see the vertical scales in the Figure 2 plots), where no notable differences were observed except in cohort 1. There was no unusual behavior in performance differences by sections, except more recurrent computing sections exhibited lower performances. It was not necessarily in exams but in other activities, as observed in the global grades of each section (already noticed in an initial partial study at the beginning of the pandemic [15]). The latter is seen in the variations in Figure 3b. The final grades for the course (reported vertically in the darkest arrows of each plot against the performance for the challenge shown horizontally in those arrows) sometimes were higher than the sections because they included a qualitative evaluation of engineering competencies added or complementary to the section grades.

Another interesting issue is the dispersion of the courses, especially all in cohort 1, an effect of its student composition. Other courses with notably higher dispersion were those in the AD2020-2 and AD2021-1 sub-periods, both delivered online during the COVID-19 pandemic. The AD2020-2 sub-period for cohort 2 contained the Conservation Laws course, which exhibited the lowest performance outcomes and largest dispersion by cohort 1. The AD2021-1 sub-period contained the Kinematics Dynamics course for cohort 3, again the entry point to the Tec21 model but with a mild impact on this cohort. There was still a smooth behavior of the average final grade for each section in the period (see Figure 3a). Initial variations in the observed period could be explained by the adaptation to the complementary sections in math and computing in the physics course, which promoted deep and applied learning (commonly not present in the traditional approach before the Tec21 model). Still, regarding the outcomes, it is difficult to recognize the effect of the pandemic on the performances because the evaluation and examination conditions were changed. This comment also considers the performance observed in the FJ2022-1 sub-period when the conditions practically returned to those similar to AD2019-1,2.

To establish the significant factor differences in the course performances in the sections and sub-periods, we performed a two-way ANOVA test [62,63] considering two different treatments: Course section (challenge, math, physics, computing) and Sub-period (each of the nine sub-periods from the pre-pandemic to 'New Normal'). The exam grades were used to compare performance in this test, as they introduced the individual performance. The outcome is shown in Table 2. Considering the p-values and the significance used, $\alpha = 0.05$, both are $p \leq \alpha$, denoting the meaningful differences in the performance markedly through the sections and the sub-periods. The outcome shows that differences observed in the graphical analysis had a real substrate far from the natural variability.

Regarding the teachers, the sub-period differences were not due to the COVID-19 crisis but instead to the composition and abilities of students in each cohort, especially cohort 1 with the lowest abilities. Similarly, for the course sections, the differences were due to developing and evaluating different types of competencies, more applied in computing and the challenge, much more theoretical in math, and more complex and sustained in physics. Still, not all students had consistent performance in each section, so the deviation observed in cohort 1 was generated by a biased accumulation of low-performance students.

Table 2. Two-way ANOVA for exam grades by course section (challenge, Math, Physics, and Computing) and pandemic sub-period.

	D. F.	Sum of Squares	Mean Sq	*F*-Ratio	*p*-Value
Section	3	101,215.0	33,738.2	90.0129	1.1371×10^{-54}
Pandemic sub-period	8	64,844.4	8105.54	21.6255	7.9197×10^{-32}
Error	2020	757,126.0	374.815		
Total	2031	923,185.0			

In addition, to track meaningful differences in the previous performances by groups, pairwise $T-$tests [62] with a significance of 0.05 were performed between the groups of each involved factor. By course section, all pairs exhibited meaningful differences with p-values lower than $8.345 \times 10^{-7} < 0.05$ (the sections exhibiting the highest differences were the challenge with math and computing and physics with computing). The analysis by pandemic sub-period exhibited two meaningful differences. The first was among sub-periods 1 and 2 with any other sub-period (with exception between them) due to the outlier outcomes of cohort 1. For this case, all $p-$values are below of 0.023. The second, among sub-period 4 with sub-periods 5 and 6 (same cohort 2, but changing from the Conservation Laws block to the Electricity and Electromagnetism blocks). In addition, between sub-period 5 and sub-period 7 (cohort 2 for Electricity block and cohort 3 for Kinematics–Dynamics block). All the corresponding $p-$values were below of 1×10^{-4} in those cases.

6.2. Adaptive Success during COVID-19 Confinement and 'New Normal'

Interesting initial aspects of the composition of the student population for cohort 3 were analyzed through the survey. First, very few combinations of Learning Styles were present (Figure 5). The university orientation was not always focused on such styles (Figure 2), particularly the Internal, Reflexive, and Global styles. This aspect leads to the relatively extended patterns for the Affinity indices in Figure 7. Regarding personality, Figure 5c shows more represented combination traits, and the predominant trait, InItThJu. The variation of learning stimulus through diverse teaching strategies (Figure 6c) mitigated such differences extending the defined Inclusivity index. Our university has a permanent teacher training program on teaching methodologies, educative technologies, and student welfare. Thus, most students exhibit acceptable values in both indices, indicating that the best performance outcomes in the course were located in that region (Figure 7).

Figure 5d exhibits an interesting aspect of the student composition. The traits on the right side of the plot indicate markedly poor online performances during the COVID-19 pandemic (the Introversion trait was the commonest among them). Still, for the most represented trait InItThJu, (although the face-to-face performance in the physics course appears to have recovered but still not to the best performance level), we have insight into the effect of Personality traits on educative performances.

Interestingly, Figure 7 shows the impact on the face-to-face performance of the students in the physics course with low values for both the Affinity and Inclusivity indices (below the dashed line). From the teachers' observations, students with the lowest grades in the course were characterized by (a) shy behavior, always with some difficulties expressed in previous abilities in physics and/or math, and (b) a bad attitude toward learning physics and/or math (low attention, distraction by other academic activities or interests, a possible belief that class is not necessary because they already understand—incorrectly—the physics contents). These aspects fit with traits such as Introversion, Intuition, and Judgement, commonly present in the engineering profiles, but we note that they are concomitant with other attitudes or previous weak academic achievements. A causal relation is out of the scope of this study; it means traits contribute to other factors generating low performances, or the low performances are directly observed consequences of the traits.

To assess these aspects, we analyzed the significance of Adaptation for cohort 3 (as evaluated from the questionnaire) as a function of Learning styles and Personality traits, each crossed with the Pandemic Stage (Online and Face-to-Face). Note that cohort 3 better represents the average students in the course because it did not have the outliers like cohort 1. Thus, we considered the students' declared performance in each academic stage (Q33 and Q37) classified by Learning style and Personality trait, one at a time. Then, considering them as treatments, we again performed a respective two-way ANOVA test to check the significant dependence. Outcomes are reported in Tables 3 and 4.

Table 3. Two-way ANOVA for Adaptation by Learning style and Pandemic stage.

	D. F.	Sum of Squares	Mean Sq	*F*-Ratio	*p*-Value
Learning style	13	0.9215	0.0709	1.9749	0.0331
Pandemic stage	1	0.0006	0.0006	0.0178	0.8943
Error	83	2.9791	0.0359		
Total	97	3.9011			

Table 4. Two-way ANOVA for Adaptation by Personality trait and Pandemic stage.

	D. F.	Sum of Squares	Mean Sq	*F*-Ratio	*p*-Value
Personality trait	10	0.5923	0.0593	1.5397	0.1393
Pandemic stage	1	0.0006	0.0006	0.0166	0.8978
Error	86	3.3082	0.0385		
Total	97	3.9011			

In Table 3, the treatments based on Learning styles denote a meaningful impact on the declared Adaptation ($p = 0.0331 < 0.5 = \alpha$). Otherwise, that is not true for the transition from the Online to Face-to-face period ($p = 0.8943 > 0.5 = \alpha$). Similarly, Table 4 does not show a meaningful impact on Adaptation from the Personality trait or the Pandemic Stage (Online or Face-to-face), giving p values above the test significance, α. Such outcomes finally reflect that some students' learning styles could impact the perceived level of Adaptation of each one, while Personality does not appear meaningful. This implies the necessity to align the university teaching practices to the students' profile in this dimension. Figure 7 depicts that students with lower Affinity and lower Inclusivity denoted the lowest performances. Interestingly, Adaptation to the academic approach through the pandemic periods appeared not to be important, at least in the group of students belonging to cohort 3.

6.3. Differences Perceived in Online and Face-to-Face Performances

We analyzed deeper the performance differences during two different periods of instruction, online during confinement and face-to-face during 'New Normal'. We had feedback regarding cohort 1 before the pandemic. First, Figure 8a,b, compare each with useful indicators involved in each period. In Figure 8a, students declared higher performances during the online instruction, apparently due to teaching quality and their Adaptation, as understood in this work. Still, few students declared lower performances in general, despite lower values for Adaptation and online quality of teaching. Whatever was the causal in the appreciation, there is a notable distinction between two regions with higher and lower indicators. Few students assessed themselves with extreme performances (highest or lowest) for face-to-face instruction during the 'New Normal' but most expressed higher/lower middle performances. Nevertheless, the analysis still discriminates that students assessed themselves with better performances when they identified a higher preference for the face-to-face model. Despite being few, lower-performing students still preferred the lower-quality online model. Both responses were not suggested to be correlated during the survey; such students did not have good academic outcomes during the confinement. We come back to this point in the next section. In the teachers' opinion, some of those students could be identified in the face-to-face class as students with lower grades commonly trying to return to the online approach, particularly during examinations (our institution opened such a possibility if any student declared himself a possible COVID-19 contaminant).

Figure 9a,b, exhibit a comparison of the differentiated performances. Figure 9a compares both performances in the function of preference for the face-to-face model. In any case, students with the highest performances preferred the face-to-face model. Students preferring the online model exhibited better performance in the online scheme. Those outcomes probably result from the corresponding model's final course outcomes. When exam grades in the physics course were mapped on both performances, most students had higher performances in both models. Students with lower performance in the physics class show had the lowest outcomes in the online model, thus suggesting that the face-to-face model was more effective. In the daily teaching practice, the teacher did not identify a definite preference for the online model, apart from the declaration at the end of the previous paragraph (the declared COVID-19 spread during the examinations increased more than 300% than previous weeks before the examinations).

Otherwise, in the previous section, we found that Learning style had a meaningful impact on the declared Adaptation, but what was the impact of the students' traits on their declared performance? Again, we analyzed Performance due to student traits through the pandemic periods. Using a two-way ANOVA test again to establish the statistical significance of Learning styles and Personality traits (one at a time) on the declared performance through the pandemic periods (Q32 and Q36), we got the outcomes shown in Tables 5 and 6. There, both declared performances were previously normalized on a 0–1 scale to be comparable by the test.

In this case, unlike the Adaptation case, only Personality traits appeared to have a meaningful impact on declared performance ($p = 0.0096 < 0.5 = \alpha$). Interestingly, Learning styles had different levels of Adaptation in the academic context, but Personality traits appeared significant for students' academic success. As observed in the classroom, the learning styles different from those preferred by students resulted in some students feeling excluded and little interested, but they were not conditional aspects of having bad performance in the course; instead, they produced some discomfort in students. Nevertheless, aspects mainly depicted by Personality traits do impact whether those students become integrated or not in learning the course.

Table 5. Two-way ANOVA on the normalized performance by Learning style and Pandemic stage.

	D. F.	Sum of Squares	Mean Sq	*F*-Ratio	*p*-Value
Learning style	13	0.4473	0.0344	1.0240	0.4368
Pandemic stage	1	0.0200	0.0200	0.5953	0.4426
Error	83	2.7886	0.0336		
Total	97	3.2558			

Table 6. Two-way ANOVA for the normalized performance by Personality trait and Pandemic stage.

	D. F.	Sum of Squares	Mean Sq	*F*-Ratio	*p*-Value
Personality trait	10	0.7397	0.0740	2.5487	0.0096
Pandemic stage	1	0.0200	0.0200	0.6891	0.4088
Error	86	2.4961	0.0290		
Total	97	3.2558			

6.4. Analysing Multifactorial Success of Online Education

The behavioral responses of students were probed during the pandemic. Although some contents could have been lightened during the COVID-19 period, new competencies were developed. Possibly for the first time, educative theories were put on the table for most educators during the pandemic. Educators modified, tried, experienced, and assessed new approaches for their educative practices.

In the current work, we learned some causal factors such as learning styles or academic personalities that possibly supported the students during the COVID-19 pandemic, the period of online education, and the return to face-to-face courses in the 'New Normal'. In our case, learning styles were sufficiently identified in the academic practice, thus being addressed. Adaptation was measured by matching students' learning styles and the corresponding teaching orientation offered by the engineering faculty. Despite a clear tendency to declare the face-to-face approach as preferred by the students, most perceived a solid effort to adapt, particularly within the physics courses. Outstandingly, some performance outcomes in physics of cohort 1 before the pandemic were widely superseded by the following cohorts taking physics during the pandemic and excellently adapting to the face-to-face return during the 'New Normal'.

6.5. Transition to 'New Normal' Period: Characterizing the Students and Their Response

Transitioning to the Tec21 model was difficult for teachers and students, partially changing the focus on learning goals and teaching approaches. During the first cohort period, still in the pre-pandemic stage, dispersed outcomes in several aspects of grades were disturbing. Thus, one year later, the online approach for the same courses became worrisome due to the conditions and limitations, despite one semester of experience already accumulated, shared, and matured among the cloisters' teachers [7]. Other previous experiences during the first confinement semester had demonstrated a decreased social learning during the first period of the confinement [21], worsening the learning expectation.

Despite the last scenario and context, teaching physics to students in cohort 2 was a pleasant experience, probably because they were students with computer science orientation. The mandatory simulation activities engaged them, thus producing outstanding outcomes [15]. Thus, experimental practice is not necessarily associated with the courses involved (other experimental courses in physics exist) but with the computer simulation challenge. Together, despite online, outcomes in examinations were better than their face-to-face version exhibited in the previous cohort. In their examinations, a large test bank based on the same textbook and class problems was used. Thus, each student examination could be different but have shared questions. Although multiple choice questions were used, students could upload their procedures and argumentation for the entire test. A preliminary thought was that online examinations offered a more user-friendly environment than face-to-face versions. Still, with the same limited development time, the procedures of cohorts 2 and 3 looked much better executed than those of cohort 1. Electronic preparation of the examination report also pressured the students, so the user-friendly context could pale for the students and sometimes was assumed by teachers.

In any case, cohort 3 demonstrated no significant loss in abilities on writing examinations under the face-to-face scheme of the 'New Normal'. Thus, for the teacher, cohort 1 exhibited a lower profile in physics than cohorts 2 and 3. The teacher's appreciation is about an excellent level of adaptation in those groups of students for the online approach, which was rich in learning support and resources [15]. Nevertheless, when we analyzed the individual, detailed behavior, we found groups of students who were isolated from academic accompaniment, despite teachers supporting them with additional tools and follow-up actions. In the groups with lower Adaptation or Inclusivity, the teachers identified only a few students during the analysis; not all were evident during the course time. Their previous categorization could have helped identify potential course droppings or failures.

In the survey, students were asked about the Online teaching quality (Q34) and Face-to-face education preference (Q38). We note that if both questions are well evaluated (either poor online education compared to face-to-face preference or rich online education with poor face-to-face preference), they do not indicate their real preference for the face-to-face learning model. Instead, when they are oppositely concordant, it implies a double check in preference for one of the models, face-to-face or online. Thus, to perform such a comparison, we crossed and counted the outcomes of Teaching online quality (Q34) and Face-to-face education preference (Q38). They are represented in Figure 10 (counts are on the vertical axis). In addition, the relative average of declared online performance is reported for each cluster on the top of each bar.

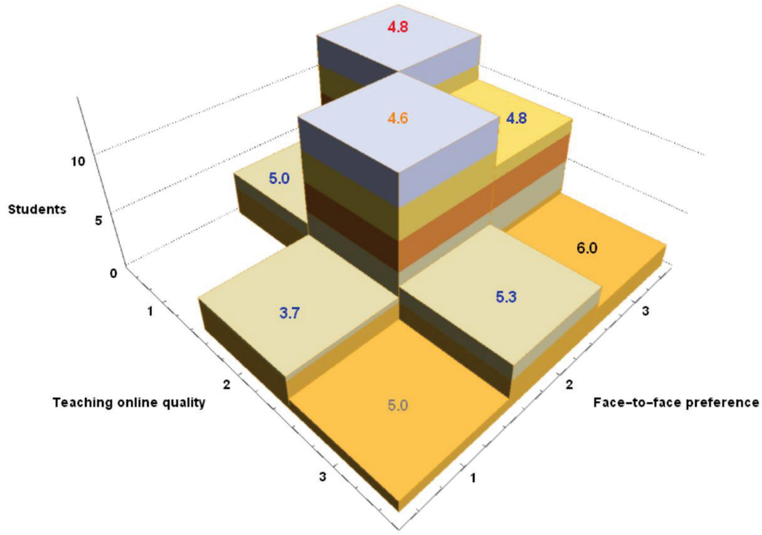


Figure 10. Frequency comparison of Teaching online quality (Q34) and Face-to-face education preference (Q38), including the Online performance average on the top for students of cohort 3.

Outstandingly, in cohort 3, no students were evaluating lower models at the time, which in the teacher's opinion, denoted well-oriented students in the academic terrain. Most students were divided, with a comparable online performance above the average (scale 1–6). The first group with an Online average performance of 4.8 (red) were the students who preferred the Face-to-face model, despite being well-adapted to the online model. The second one, with an Online average performance of 4.6 (orange), comprised students well adapted to any model (online or face-to-face). A third dominating group (4.8 in Online average performance in blue) preferred the face-to-face model but became well-adapted to the online one. A minority group of students preferred the online model; possibly, they had good outcomes in such a model (gray). Such facts reflect the preference for the face-to-face model but also show a healthy level of Adaptation to the online model.

6.6. Teaching Physics for Computer Science Students through the COVID-19 Stages: A Summary

In practice, teaching physics is a multi-factor experience for complete success. It depends on the previous technical skills and interests of students. During the pandemic stages, with the implementation of the new educative model, teacher adaptation required a swift response during the first months of the confinement in terms of strategies, tools, technology, and accompaniment schemes. As mentioned, for computer science students, with differentiated learning programs and plans, the orientation to computer physics simulations as a challenge helped the online learning approach. Computer simulation alternative to the experimental practice engaged the students outstandingly during the period, boosting the social learning above the previous experiences reported in other courses [21], despite being oriented to simulation.

In a more traditional trend, the theoretical approach to physics was sustained using prepared computer simulations, smartphones as measurement devices, automatic electronic notes, multimedia materials, and a friendly design on the LMS in the form of a virtual classroom. However, still, such a traditional main component of the course became more meaningful due to its quick application in the applied simulations. Those simulations involved a volcano, a roller coaster, and the earth's magnetic field, making the physics course valuable and visual.

Several practices were adopted during the 'New Normal' from the pandemic and online period. These included using Matlab and Mathematica software to address project simulations (not standard in physics despite being adopted due to Tec21 and mainly due to the pandemic) and the use of public electronic notes using an iPad, i-Pencil, and Notability (currently, Blackboard is no longer used in the class). Notably, although students were encouraged to take notes, they found the teacher's notes helpful as references. During the 'New Normal', around 30% of students used iPad to take notes in class. It is an interestingly positive phenomenon because such technology has promoted the practice of taking notes again; before the two years of the pandemic, students used to take pictures of the blackboard. In addition, applications such as Verbe, Socrative, and Desmos, to promote social learning in class activities, and smartphones as measurement devices, have definitively changed the face-to-face approach [7].

The current analysis shows that some student traits, not just learning styles that comprise a common approach but also academic personality and the school's characterization of teaching strategies, naturally boost students' engagement and possible performance improvement. Besides the overall analysis and learning about strategies and outcomes in teaching physics during the COVID-19 pandemic, another outstanding observation is the teachers' self-analysis of their entire teaching practice throughout the time. The self-assessment allowed the understanding of other elements present in teaching together and possible performance improvement strategies.

7. Conclusions

Physics education is typical in the core of engineering programs. This discipline gave a two-fold value to the students involved in the current research. For students to be oriented to robotics, this discipline was the basis for other technical courses related to mechanical engineering or electronics. Physics is a learning lab to integrate math and computing through precise rules to practice programming related to computer simulations, data science, or computer interfaces for students mainly oriented to Computer Sciences. Still, not all students can comprehend that the scope of those courses is relevant to their academic engineering program. Considering question Q31, only 18.3% of students felt this course was an essential part of their program (considering it represents almost one-half of their course time). The orientation of the Tec21 model promotes in those courses this deliberated approach. The current analysis mainly centered on the effective integration of face-to-face education in the 'New Normal' and online education's positive or negative impact during the extended two-year period of the COVID-19 pandemic. We intended to analyze the behavioral transition based on psychological issues such as Learning styles and Academic personality recognized in Education literature as causal factors in the success of university studies. In addition, the hidden curriculum, particularly that related to technological mastery, helped understand the scope of this educative period widely dominated by technology but invisibly related to personality. Our analysis centered on the academic performance declared and observed during the physics course as an entry point of engineering programs. In addition, Adaptation was considered a crucial factor in success and transition. Finally, the recognition of online teaching quality and the preference for each type of educative approach were at the core of the analysis for different groups crossing the initial period in the university, but also directly associated with our primary interest: physics learning and teaching.

Clearly, additional limitations for the current analysis regard university orientation as essential support in terms of facilities and teacher training. In addition, engineering and science students and teachers are commonly more technology-oriented to enable the transition to online education. Still, experiences throughout the country are generally diverse because each government and institution set different strategies in the regional scenario to overcome the educative crisis [26,27].

7.1. Lessons through the Pandemic: Losses, Gains, and Challenges

Through three cohorts, we compared several sub-periods of a university physics course that passed through the several stages of the COVID-19 pandemic: pre-pandemic period, confinement, and the beginning of the 'New Normal'. Analyzing almost the entire student population, we observed different variations, possibly due to the students' group composition and type of education (online or face-to-face). All courses were delivered with practically the same activities and structure, making them widely comparable.

Due to outlier behavior in the first cohort of students, we did not find significant differences in performance for online education during the pandemic; instead, those students exhibited a higher level of adaptation. Dispersion and averages observed in the direct performances on the course grades could be more associated with the group composition than other causal factors. For the transition cohort (cohort 3) in 'New Normal', significant deviations in performance were not detected per the type of education received (online or face-to-face).

In cohort 3 (where all students were enrolled at the university during the confinement, question Q35), we detected a few Learning styles and Personality traits possibly representative of engineering students related to Computer Science. Course performance for several Personality traits appeared below the others, particularly those corresponding to introverted students. Among them, personality traits appeared to be a significant factor in deciding performance. In another trend, Learning style exhibited a more meaningful correlation with declared Adaptation (lower for online education).

The hidden curriculum of prior technology mastery is acceptable and uniform for students in the first year of university, possibly aligned with the university profile where the faculty is perceived technologically competent by students. Thus, it was not a critical causal factor of failure in the online education introduced. Notably, students declaring a higher level of affinity and inclusivity with the university had higher performance in the physics courses during the confinement period. In addition, there was a correlation between adaptability and the declared performance in the confinement period and the 'New Normal' one. Students declaring good performance commonly had a high opinion about the teaching quality received online; nevertheless, it was not their preferred way of instruction.

Students declaring good performance commonly showed higher levels of adaptation, performance, and recognition of teaching quality (both online and face-to-face). On the other hand, students declaring low performance or physics course grades tended to have a lower assessment of the university's efforts during the confinement education and the 'New Normal'. Other performance differences were meaningfully associated with the graded section (physics, math, computing, or challenge). Such differences among sections significantly influenced the physics course (exams) performance through the different sub-periods.

Although a statistically significant preference for the face-to-face approach was found, we identified high adaptation among the students and part of declared performance through the direct grades analysis of the analyzed cohorts. The main clusters formed were split between: (a) a strong preference for face-to-face education or (b) recognition of the value of both models. The students in the research almost comprised 100% of the students in the target population, namely, the students in computer science and computing-related programs. Their level of adaptation completely masked possible differences in the performance induced by the changes in the educational context. The generation of children and adolescents crossing such a period has been called a Lost Generation [64] regarding health, well-being, and education. It could be an exaggerated label for the group of students considered in the current research. What must be considered is the broader care promoted by the institution, years of previous teacher training in educational technology, and educative methodologies. This past and ongoing investment by the university could have resulted in reasonable outcomes in the unexpected COVID-19 pandemic. The author believes it is not the unique explanation; in the end, the human spirit of most students effectively responded and was contextually supported by the establishment. Unfortunately, not all students worldwide had this advantage [65]; the global experience was negative.

7.2. Recommendations for the Practice

As teachers, the COVID-19 pandemic should show us that teacher training is essential for the success of Education. Otherwise, educative technologies arrive in our lives, remain, develop, and effectively become included in our teaching practices. Hybrid learning should be more common as a valuable model to diversify the educative channels in our lives, mainly because it is the recommended channel to be used for training in future professional life [66].

The attention paid and knowledge acquired by teachers during the COVID-19 pandemic about theories and methodologies of education, particularly in higher education where it is not a common practice, has changed how teachers perceive and practice their profession. The necessity for a self or institutional assessment is another inherited aspect that should be remarked on for effective changes and impact on learning. Thus, teachers must follow this practice to improve their teaching and comprehend each student's educative phenomenon.

7.3. Future Work ad Final Remarks

Despite us possibly (and hopefully) not having another period to prove the advantages of online education and its improvement on a large scale, we must recognize that this period improved teacher training in educative technologies and active methodologies to make a difference in the sustainability and continuity of education. Another significant silent difference is the personal assessment each teacher should perform at the end of each course to improve it, which naturally became a common practice through the pandemic stages.

Thus, it is required that teacher training be boosted, together with institutional and governmental promotion and recognition pursued worldwide. Exciting and valuable future work would account for how extended this practice was, mainly because of the perceived success of education through this crisis. In other additional and more sophisticated trends, the previous analysis and categorization of our students in terms of their learning styles and academic personalities could become helpful in providing closer support to the entire student population. That practice and research should be future work, not requiring a crisis, but rather for more advanced knowledge about the success factors in higher education.

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Data Availability Statement: Data sets were obtained about sensitive individual grades of students from institutional and author records, then processed, losing their individual character for the statistical report. They are partially available upon request to the authors.

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Abbreviations

The following abbreviations are used in this manuscript:

BLT	Behavioural Learning Theory
CBL	Challenge-Based Learning
CCLT	Connective Learning Theory
CGLT	Cognitive Learning Theory
CNLT	Constructivist Learning Theory
EDCF	European Digital Competence Framework
LMS	Learning Management System
MBTI	Myers–Briggs Type Indicator

Appendix A. Higher Education Transition into 'New Normal'

The textual representation of the questionnaire was applied online to students to gather facts about learning styles, personality, school perception, technological competencies, and personal challenges from the COVID-19 pandemic and the 'New Normal' in Education. Each question was labeled with a reference code in the form Qx, x being the data entry number. Scale numbers included in each response item are used in the text to show the outcomes. Symbol +0.5 implies adding 0.5 to the score of each option selected in questions from Q25 through Q30. These Code labels for questions and Scale numbers are used to report the raw outcomes in Table A1.

HIGHER EDUCATION TRANSITION INTO 'New Normal'

The objective of this questionnaire is to analyze the impact of COVID-19 confinement on higher education. The first part consists of 5 sections categorizing each student. The second part contains questions evaluating the confinement period and the return to face-to-face teaching during the 'New Normal'.

Next, we ask you to answer the best option in a series of categorizations defining your most common way of approaching learning.

(A) Teaching and learning styles

- (A.1) Categorization of your learning style
  It is believed that each person learns differently through certain stimuli, privileging particular approaches. None are good or bad; they are just how we like to do it.
  - (Q1) What kind of information do you preferentially perceive when learning?
    - 1 External (Co): visions, sounds, physical sensations
    - 2 Internal (Ab): possibilities, hunches, intuitions
  - (Q2) Through what sensory channel do you commonly perceive external information during learning?
    - 1 Visual (Vi): photographs, diagrams, graphs, experimental demonstrations
    - 2 Auditory (Au): words, sounds
  - (Q3) When learning, what kind of information organization makes you feel most comfortable?
    - 1 Deductive (De): principles given, to deduce consequences and applications
    - 2 Inductive (In): facts and observations given, to infer principles
  - (Q4) How do you prefer to process the information?
    - 1 Actively (Ac): by including in a physical activity or discussion
    - 2 Reflexive (Re): through introspection and abstraction
  - (Q5) How do you progress towards the understanding a learning topic?

1 Sequentially (Se): in small continuous and structured steps
2 Globally (Gl): in leaps and bounds, suddenly towards the whole

(A.2) Categorization of the teaching environment
Higher education and academic disciplines can privilege certain teaching styles that fit your learning experience to a lesser or greater degree.

(Q6) In your current education, what kind of information is mainly emphasized by your teachers?

1 Concrete (Co): based on facts
2 Abstract (Ab): based on concepts or theories

(Q7) What type of presentation of information is most common in your classes?

1 Visual (Vi): photographs, diagrams, films, experimental demonstrations
2 Verbal (Au): presentations, readings, discussions

(Q8) How is the information organized in most of your classes?

1 Inductively (In): phenomena guide learned principles
2 Deductively (De): principles guide the learned phenomena

(Q9) What kind of participation is promoted in most of your classes?

1 Active (Ac): students talk, participate, and reflect
2 Passive (Re): students see and hear

(Q10) What kind of perspective is primarily provided by the information presented?

1 Sequential (Se): step by step as a methodological procedure
2 Global (Gl): the global context and its relevance are initially given

(B) Personality

(B.1) Categorization of your personality
It is believed that certain personality traits can facilitate insertion and success in university life. The following statements are generic; they are how you approach certain aspects of your life in different situations.

(Q11) What is your fanciful world?

1 Extroversion (Ex): you focus on your external world
2 Introversion (In): you focus on your inner world

(Q12) What information do you privilege?

1 Sensitive (Se): the basic information that comes from the outside
2 Intuitive (It): the meanings and interpretation you generate of the information

(Q13) How do you usually make decisions?

1 Thinking (Th): based on logic and consistency
2 Feeling (Fe): based on people's opinion or special circumstances

(Q14) When dealing with the outside world, how do you prefer to act?

1 Judgment (Ju): based on consistent and final decisions
2 Perception (Pe): being willing to change based on new information and choices

(C) Technological competences
Different digital and computing technologies are classified. Read the statement to understand each one, and then evaluate your proficiency level in the following questions as accurately as possible.

(i) Search for information and data (ID)

It uses browsers and information search engines through keywords, information discrimination, and source validation. Likewise, to obtain specific data from public sources.
Software examples: browsers, consultation of information bases and their download, precise search for specific information in viable sources.

(ii) Communication and collaboration (CC)
It refers to using applications to work and collaborate in groups creating solutions, content, or learning.
Software examples: Word, Excel, Power Point, Canvas, Social networks, Zoom, Google docs.

(iii) Creation of digital content (CD)
It concerns the creation of web pages or associated materials published in an open or restricted form through servers, drives, and databases. These materials establish curated documents that have a communication or learning purpose.
Software examples: Weebly, Word Press, Google Drive, Dropbox, and Applications to generate interactive activities.

(iv) Computer security (CS)
It refers to the operational mastery of computer security in terms of comprehensive password and privacy management, discrimination of information, and insecure access, management, and use of antivirus.
Software examples: Antivirus, Multi-factor security in public applications, Privacy management.

(v) Troubleshooting (TS)
It concerns using specific software to handle information, processing it, and obtaining useful and analyzed information to solve technical problems.
Software examples: Programming languages, specialized packaging (Matlab, Mathematica, PSpice, Catia, CAD, Programming languages.

(C.1) Inventory of your level of proficiency in computer technologies
Then, the following domain levels are established for each dominion from lowest to highest.

1 I identify concepts and strategies that would allow me to include this type of technology in classes
2 I have the skills that would allow me to include these technologies in class.
3 I can advise my classmates on the use of these technologies in class
4 I am normally motivated to use this group of technologies in my class
5 I think this type of technology is very significant in class, and I commonly use it

Select for each one just the domain level (mastery) you consider you have in each group.

Domain & Level	(Q15) ID	(Q16) DC	(Q17) CC	(Q18) CS	(Q19) TS
1	◯	◯	◯	◯	◯
2	◯	◯	◯	◯	◯
3	◯	◯	◯	◯	◯
4	◯	◯	◯	◯	◯
5	◯	◯	◯	◯	◯

(C.2) Inventory on the technological domain of your professors and institution

Based on your general perception, evaluate the previous competencies for the institutional knowledge and your teachers in the same dominion levels used for you.

Domain & Level	(Q20) ID	(Q21) DC	(Q22) CC	(Q23) CS	(Q24) TS
1	◯	◯	◯	◯	◯
2	◯	◯	◯	◯	◯
3	◯	◯	◯	◯	◯
4	◯	◯	◯	◯	◯
5	◯	◯	◯	◯	◯

(D) Teaching strategies

An institution should promote strategies to diversify learning regarding organization, motivation, skills development, effective feedback, and reflection. It is crucial in the development of each student. Indicate which of the following practices are common and present in your institution. Select all those that apply.

(Q25) Learning organization	Selection
+0.5 A public study program is established	☐
+0.5 Study notes are provided	☐
(Q26) Motivation	Selection
+0.5 Discussion is promoted and reinforced about the value of learning	☐
+0.5 Examples of procedural contents are developed	☐
(Q27) Practice	Selection
+0.5 Tests are applied feed-backing to the student	☐
+0.5 Student is motivated to attend counseling individually	☐
+0.5 Procedural practice is promoted in small groups through some didactic technique	☐
+0.5 An applied project is included to be developed from the contents, but it includes other related learning or already dominated by the student	☐
(Q28) Feedback	Selection
+0.5 Homework feedback to students	☐
+0.5 Students receive recommendations in their participation or presentations	☐
(Q29) Metacognition	Selection
+0.5 Spaces for reflection are established in class	☐
+0.5 Self-assessment is promoted	☐
(Q30) Social learning	Selection
+0.5 Promotes social learning between activities with peers	☐
+0.5 Graded team activities are established	☐

(E) Question about personal academic location

(Q31) Currently, do you consider yourself already in the main line of learning about your career development?

1 Yes, I am already studying subjects related to my career
2 No, most of them are still basic and support courses corresponding to the common core

(F) Academic stage during the COVID-19 confinement

(Q32) Performance in the online teaching model: Which of the following phrases best describes your academic self-assessment during the lockdown period?

1 I failed more than three courses due to poor performance
2 I failed at least one course due to poor performance
3 I dropped out at least one course due to poor performance in the same course
4 I passed all my courses, but I estimate that I was below the average performance of my classmates
5 I passed all my courses and I estimate that I was above the average performance of my classmates without being from the group with the best dominion of the contents

6 I passed all my courses, and I consider that I was in the top 25% of the students with the highest performance in most of them

(Q33) Adaptation to online teaching model: Which of the following phrases best describes your adaptation self-assessment during the lockdown period?

1 I was never able to adapt to online courses and had difficulty tracking activities and content proficiency
2 I adapted to online courses, but I always felt lagging the performance I observed in my peers.
3 I adapted well to online courses and felt as competent as most of my peers
4 I adapted well to online courses and was normally from the most competent group of students in my courses

(Q34) Teaching quality of online courses. During the period of confinement, which of the following phrases best describes your assessment of the teaching received?

1 Most of the online classes were monotonous and without no variation of stimulus from one to the other.
2 I had several outstanding online classes that varied the activities carried out, with what I think I could learn better.
3 Most of my online classes had varied stimuli, making them attractive and allowing me to learn better.

(Q35) I made the transition from high school to university during the period of confinement

1 Yes
2 No

(G) Face-to-face academic stage after confinement

(Q36) During the back-to-school period, which of the following phrases best describes your academic self-assessment?

1 I have already dropped out of at least one course due to poor performance
2 I failed at least one course due to poor performance
3 I have passed all my courses so far, but I estimate that I have been below the average performance of my classmates.
4 I have passed all my courses so far, and I estimate that I have been above the average performance of my classmates without being from the group with the best dominion of the contents
5 I passed all my courses and I consider that I in the top 25% of the students with the highest performance in most of them

(Q37) During the back-to-school period, which of the following phrases best describes your adaptation self-assessment?

1 I have not been able to adapt to the face-to-face courses and I had difficulty monitoring activities and content mastery
2 I adapted to the face-to-face courses, but I always felt lagging in relation to the performance I observed in my classmates
3 I adapted well to the face-to-face courses and felt as competent as most of my peers
4 I adapted well to face-to-face courses and was normally from the most competent group of students in my courses.

(Q38) Comparing your online classes with your face-to-face classes, which of the following phrases best describes your assessment of the teaching received?

1 Online classes have more advantages over the classes I receive in person to facilitate my learning
2 Both classes, although of a different nature, have elements that facilitate my learning.

3 Face-to-face classes have more advantages over classes I received online to facilitate my learning

The questionnaire is over. We appreciate your participation in enriching the knowledge about higher education's effectiveness.

Appendix B. Raw Data Obtained in the Questionnaire Application Together with Physics Course Grades

This section includes the raw data gathered for the current analysis in the questionnaire using the Code labels and Scale numbers reported in Appendix A. Column ID is a non-meaningful number identifying each student. The column labeled Grade reports the final grade in the physics course FJ2022-1 for cohort 3 being surveyed.

Table A1. Raw data obtained from each student in the questionnaire in terms of Code labels of each question and Scale numbers. The last column reports the final grade for the physics course during FJ2022-1 for cohort 3.

ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Grade
1	2	1	1	1	2	1	1	2	2	1	2	1	1	1	5	3	4	3	3	5	5	5	5	5	1	1	0.75	1	1	1	2	2	3	2	1	4	3	3	78
2	2	1	1	1	1	2	1	1	2	1	1	2	1	2	1	4	1	5	4	1	5	1	5	2	1	0.5	0.5	1	0.5	0.5	2	5	3	2	1	4	3	3	98
3	1	1	2	1	1	2	2	1	2	1	1	2	2	1	1	3	4	5	2	1	3	2	4	5	1	0.5	1	1	0.5	1	2	5	2	2	1	4	3	2	98
4	1	1	2	1	1	2	1	2	1	1	2	1	1	2	1	2	3	4	5	1	2	3	4	5	1	1	1	1	1	1	1	6	4	3	1	4	3	2	98
5	1	1	1	1	1	2	1	1	2	1	1	1	1	2	2	5	4	3	1	1	2	5	4	3	0.5	0.5	0.25	0.5	0.5	0.5	2	6	2	1	1	4	2	3	99
6	1	1	1	1	1	1	1	1	1	2	1	1	1	1	4	4	5	5	4	5	5	5	5	5	1	1	0.75	1	0.5	1	1	5	3	1	1	4	3	3	81
7	2	1	2	2	1	2	1	1	1	1	2	1	1	1	3	5	2	1	4	4	3	2	1	5	1	1	1	1	1	1	2	5	2	1	1	3	1	2	90
8	1	1	2	1	1	1	2	1	2	1	2	2	1	2	1	3	5	4	2	1	3	2	5	4	1	0.5	0.5	0.5	0.5	0.5	2	5	4	2	1	3	2	1	90
9	1	1	2	1	1	1	1	1	2	1	2	1	1	2	1	4	5	2	3	1	5	2	4	3	0.5	0.5	0.75	1	0.5	0.5	2	6	3	3	1	5	3	2	99
10	1	1	2	1	1	1	1	1	2	1	1	2	1	1	1	2	3	5	4	4	3	2	5	1	1	0.5	0.75	1	0.5	0.5	2	5	2	1	1	4	3	3	98
11	1	1	2	1	1	1	1	1	1	2	2	2	1	1	4	5	3	1	2	2	1	3	5	4	1	0.5	0.5	0.5	1	0.5	2	5	3	3	1	4	2	2	94
12	1	1	2	1	1	1	1	1	1	1	1	1	1	2	2	5	1	4	3	3	5	4	1	2	1	0.5	0.25	0.5	0.5	0.5	2	4	2	3	1	4	2	2	92
13	1	1	2	1	1	1	2	2	2	2	1	1	1	2	2	3	4	5	1	1	3	5	4	2	1	0.5	0.5	0.5	0.5	0.5	2	5	2	1	1	3	3	2	89
14	2	1	1	1	1	1	2	2	1	2	1	1	1	2	1	2	4	3	5	4	3	5	1	2	0.5	1	1	0.5	0.5	1	2	4	2	1	1	4	3	3	96
15	1	1	1	1	1	1	2	1	2	1	1	2	1	1	1	2	3	4	5	3	2	1	4	5	0.5	0.5	0.5	0.5	0.5	0.5	2	4	3	2	1	4	3	2	91
16	1	1	2	1	1	1	1	2	2	1	2	2	1	2	1	2	3	5	4	1	3	5	2	4	1	1	0.5	1	0.5	1	2	5	2	2	1	4	2	3	95
17	1	1	1	1	1	2	1	2	2	1	2	2	1	2	1	5	2	4	3	5	2	3	4	1	1	1	1	1	1	1	2	5	2	2	1	4	2	3	98
18	1	1	1	2	1	1	2	1	1	1	1	1	1	2	1	4	5	3	2	4	2	5	1	3	0.5	0.5	0.5	0.5	0.5	0.5	2	4	3	1	1	3	2	2	94
19	1	1	2	1	1	2	2	1	1	2	1	2	1	2	2	3	4	1	5	1	2	3	4	5	0.5	0.5	1	0.5	0.5	0.5	2	2	2	2	1	1	2	2	56
20	1	1	1	1	1	2	2	2	1	1	1	1	2	1	2	5	2	5	3	5	5	5	5	5	1	1	0.75	0.5	0.5	1	2	4	2	2	1	4	2	3	89
21	1	1	1	1	1	2	1	1	1	1	2	1	1	2	1	4	5	3	2	1	4	2	3	5	1	0.5	0.75	1	0.5	0.5	2	6	3	2	1	5	3	3	97
22	2	1	2	1	1	1	1	1	1	1	2	2	1	2	5	3	2	1	4	1	3	2	4	5	1	1	0.5	1	0.5	0.5	2	6	3	2	1	5	4	3	92
23	2	1	2	1	1	1	2	1	2	1	1	1	1	1	3	2	1	3	1	1	2	1	3	3	0.5	0.5	0.75	0.5	0.5	1	2	4	2	1	1	4	3	3	82
24	1	1	2	1	2	2	1	1	1	1	2	2	2	2	1	2	3	4	5	1	2	3	4	5	0.5	0.5	0.25	0.5	0.5	0.5	2	6	4	3	1	5	4	3	97
25	2	1	2	1	2	1	2	2	1	1	1	1	1	1	4	3	2	5	1	4	2	5	3	1	1	1	0.25	1	0.5	0.5	1	6	3	3	1	4	4	3	90
26	1	1	1	1	1	1	2	2	2	1	1	1	1	1	3	5	2	1	4	2	5	1	5	4	0.5	0.5	0.5	1	0.5	0.5	2	4	2	2	1	4	2	2	73
27	1	1	1	1	1	1	1	2	1	1	2	1	1	1	1	4	2	5	3	4	2	1	5	3	0.5	0.5	0.5	0.5	1	0.5	2	6	4	1	1	4	4	3	96
28	2	1	2	2	2	2	2	1	1	1	1	1	1	1	5	5	3	4	5	4	5	4	4	4	1	0.5	0.25	1	0.5	0.5	2	6	4	1	2	5	4	2	92
29	1	1	2	1	1	2	1	1	2	1	2	2	1	2	5	5	4	4	5	5	5	4	4	5	0.5	1	0.5	0.5	0.5	0.5	1	6	3	2	1	3	2	3	88
30	1	1	1	1	1	2	1	1	1	1	2	1	1	1	3	1	5	4	2	2	3	5	4	1	1	1	0.75	1	0.5	1	2	6	4	2	1	4	2	2	96
31	1	1	1	1	1	1	1	1	2	2	2	1	1	1	5	4	1	3	2	1	3	2	5	4	1	0.5	0.5	0.5	0.5	0.5	2	5	3	1	1	4	3	3	92
32	1	1	1	1	1	1	2	1	2	1	1	2	1	1	5	5	5	5	5	3	5	5	3	5	0.5	0.5	0.25	0.5	0.5	0.5	2	6	3	2	1	4	4	2	97
33	1	1	1	1	1	1	1	2	1	1	2	1	1	2	5	5	5	5	5	5	5	5	5	5	0.5	0.5	0.5	0.5	0.5	1	2	5	3	2	1	4	3	2	98
34	1	1	2	1	1	2	1	1	2	1	2	2	1	2	5	5	5	5	5	5	5	5	5	5	0.5	0.5	1	0.5	0.5	0.5	2	5	3	2	1	4	3	2	92

Table A1. *Cont.*

ID	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16	Q17	Q18	Q19	Q20	Q21	Q22	Q23	Q24	Q25	Q26	Q27	Q28	Q29	Q30	Q31	Q32	Q33	Q34	Q35	Q36	Q37	Q38	Grade
35	1	1	1	1	1	2	2	1	2	1	1	2	1	1	1	3	2	5	4	5	2	4	3	1	0.5	0.5	0.75	0.5	1	0.5	2	4	2	2	1	3	3	2	89
36	1	1	2	2	1	1	2	1	2	2	2	2	1	1	5	5	4	2	5	5	5	5	5	5	1	1	1	0.5	0.5	1	2	6	4	2	1	4	3	2	72
37	1	1	2	1	1	1	2	1	1	1	2	2	1	1	3	2	4	5	1	2	3	4	5	1	0.5	0.5	1	0.5	0.5	0.5	1	4	1	2	1	4	2	3	84
38	1	1	2	2	2	2	2	1	1	1	1	1	1	1	5	1	2	3	4	1	2	4	5	3	1	1	0.5	0.5	0.5	1	2	4	3	1	1	4	3	3	70
39	1	1	1	1	1	2	2	1	2	1	2	2	1	1	3	1	2	5	4	1	2	3	4	5	0.5	0.5	0.25	0.5	0.5	0.5	2	5	3	3	2	4	1	1	90
40	1	1	1	1	1	1	1	1	1	1	1	1	2	1	3	3	3	3	3	1	2	3	4	5	1	1	1	0.5	0.5	0.5	1	2	2	2	1	3	1	2	79
41	2	1	1	2	1	1	1	1	2	1	1	1	2	1	1	3	2	5	4	1	3	2	5	4	1	0.5	1	1	1	0.5	2	5	3	1	1	4	3	3	88
42	1	1	1	2	1	1	2	1	1	2	1	1	1	1	3	5	1	4	2	1	2	4	3	5	1	0.5	0.5	0.5	0.5	0.5	2	4	2	1	1	5	3	3	95
43	2	1	1	1	1	1	1	1	1	2	1	1	1	1	3	5	4	1	2	1	5	4	2	3	1	1	1	1	0.5	1	2	5	2	1	1	4	3	3	91
44	1	1	1	2	1	1	2	2	1	2	1	2	1	2	5	1	4	1	2	2	2	1	1	2	0.5	0.5	0.5	0.5	0.5	0.5	2	5	3	2	2	2	1	1	57
45	1	1	1	1	2	2	2	1	1	1	2	2	1	1	5	4	2	3	1	2	1	3	4	5	0.5	1	0.75	0.5	0.5	0.5	1	5	2	1	1	4	3	3	96
46	1	1	2	1	1	1	1	2	2	1	2	2	2	2	5	1	4	3	2	4	2	3	1	5	0.5	0.5	0.75	1	0.5	1	2	3	1	2	2	2	4	1	27
47	2	1	2	1	1	2	1	2	2	2	2	2	2	2	1	4	4	5	1	1	1	3	3	3	0.5	0.5	0.25	0.5	0.5	0.5	1	4	3	1	1	4	3	3	97
48	1	1	1	2	1	1	2	1	1	1	1	2	1	1	1	1	5	5	1	1	1	2	3	1	1	1	1	1	0.5	1	2	6	4	2	1	5	3	2	100
49	1	1	2	1	1	2	2	1	1	1	1	1	1	1	5	3	1	2	4	4	1	3	2	5	1	0.5	0.5	1	0.5	0.5	1	5	3	2	1	4	2	2	91

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education sciences

Article

Reshaping Sustainable University Education in Post-Pandemic World: Lessons Learned from an Empirical Study

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Abstract: The outbreak of COVID-19 has affected people all around the world. Governments had no choice but to put people in self-isolation to stop the spread of the virus. As a result, all companies and educational institutions switched to working or studying from home. The purpose of the study is to investigate the impact of COVID-19 on student teaching and learning in the context of Malmö university. Furthermore, the study proposes recommendations for sustainable post-pandemic education at Malmö University. The study includes ten semi-structured interviews with students followed by a workshop with ten senior lecturers teaching bachelor's and master's courses. The study uses snowball sampling to select students for the interviews and senior lecturers for the workshop. A qualitative data analysis technique, thematic analysis, is used for data analysis on the data collected from interviews with students and the workshop with senior lecturers. The results from the study suggested that online education leads to several benefits for students, such as better time management, higher lecture attendance, flexibility, and discipline in their studies. However, the shift to online education has caused a communication deterioration between students and teachers. Less social interaction with other students leads to depression, anxiety, and stress. The recommendations for post-pandemic education include the unified selection of digital learning tools across courses, a designated budget for digital learning tools, training support, and hybrid learning methods. In conclusion, the study proposes blended and hybrid learning to improve higher education at the university, requiring digital tools to minimize students' communication barriers.

Keywords: COVID-19; digital education; teaching and learning; sustainable education

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1. Introduction

Coronavirus disease, also known as COVID-19, is a highly contagious disease caused by the SARS-CoV-2 virus. COVID-19 was first discovered in late 2019, and the World Health Organization (WHO) declared a pandemic on 21 March 2020 [1]. The effect of COVID-19 was significant across all sectors, and the Education sector was no different [2]. Governments worldwide have restricted people from working or studying in quarantine to stop the spread of Coronavirus as it became an existential crisis for humanity [3]. Education institutions worldwide decided to move from on-campus education to distance education temporarily [4,5]. According to UNESCO, 10,481,082 learners worldwide have been affected by education institutional closures [6]. Based on the public health authority in Sweden, the Swedish Government also announced on the 18 March 2020 that higher education institutions such as high schools and universities should provide distance education [7]. This shift from on-campus to distance learning occurred instantly, which led to significant changes for teachers and students in teaching and learning methods [8,9]. More recently, governments around the world have started easing off COVID-19 restrictions. The Swedish health authority has announced the end of COVID-19 restrictions from the 9 February 2022 [10]. Consequently, the universities in Sweden have gradually resumed on-campus teaching and learning activities. The scope of this study is limited to Malmö university and there are two main objectives of this study which are as follows.

- Investigate the impact of COVID-19 on teaching and learning due to the forced transition from on-campus to digital education at Malmö University.
- Propose recommendations for sustainable post-pandemic university education.

To address the objectives, the paper is structured in the following sections. Section 2 explains the related work, and Section 3 highlights the research questions, research methodology, and data collection methods used in the study. Furthermore, Section 4 presents the results and analysis followed by Section 6, which presents the conclusion of the study.

2. Related Work

Educational programs where teachers and students are not present at the same place are referred to as distance learning or distance education [11,12]. The idea of distance learning is not new in itself as the roots of distance learning can be traced back to the 1800s [13]. However, the adoption of distance learning accelerated in the 20th century significantly with the much-improved communication technologies [14]. Many researchers are cautious in comparing the current shift to digital education due to COVID-19 with the traditional digital education [15]. The difference can be highlighted in the speed of this forced transition with little planning, technological infrastructure, content copyright and learning outcomes.

Loton et al. [16] investigated student success and satisfaction during the pandemic and discovered that there was a dip in student satisfaction with minor improvements in the grades during digital education. Debose et al. [17] conducted a study at Midwestern university France to investigate the impact of COVID-19 on student learning during the pandemic. The findings revealed that 84.2% of beginner level students did not feel prepared for the transition to online education, and 58% of higher-level students, such as post graduate students, responded that they were reasonably prepared because they had the prior experience of taking online courses. In addition, Boggiano et al. [18] conducted a study in several English universities to reveal that the quality of education has declined in online learning due to the pandemic. However, all those institutions with stronger digital learning tools and training support for both staff and students encountered a smoother transition. Nambiar et al. [19] surveyed students' perception and experiences with digital education in colleges and universities. The results showed that students experienced a lack of interest (59.3%), lack of motivation (60%), and inability to concentrate (62%). Several other studies conducted have found a similar pattern with self-discipline also highlighted as a common problem for students during digital education [20–22].

One of the most severe consequences of a pandemic for students is self-isolation which contributes to mental health issues [23,24]. These mental health issues include anxiety, insomnia, depression, and social dysfunction in the daily life of 73% of students [23]. Unger et al. [24] conducted a study with undergraduate students in Wingate University and showed that 76% of students expressed anxiety over finishing the online semester quickly. However, the same survey was repeated after three weeks, and 53% felt less anxious. Bergdahl et al. [15] conducted a study with 153 teachers in several cities of Sweden and found out that the majority of the teachers have struggled to engage students in digital learning.

In contrast, several studies reported that digital transformation for students has been successful [21,25] despite the sudden forced online learning transition, half of the students prefer to continue online learning in the future. The key reasons attributed to this opinion are well planned semester schedules and course activities [25]. However, students who struggled with technical difficulties did not want to continue online learning. Hassan et al. [21] performed a survey, and results showed that 67% of participants strongly agreed that it is more convenient to take online classes as opposed to physical classes. The debate around how to make post-pandemic higher education has already started among researchers and university policymakers. Therefore, this study attempts to investigate the impact of COVID-19 on student learning and provide strategies for sustainable post-pandemic higher education.

3. Research Methodology

This section explains the research questions, research design, data collection method, and data analysis method. The study design steps can be seen in Figure 1. The study has followed the guidelines for designing the semi structured interview and workshop from Runeson et al. [26]. This study included twenty participants, ten students, and ten senior lectures adhering to existing literature suggestions on sample size in qualitative studies.

Figure 1. Research stages including thematic analysis.

3.1. Research Questions

We have formulated the following research question based on the objectives of the study mentioned in the introduction (see Section 1).

> *RQ1: What is the impact of switching from face-to-face to digital learning on student learning at Malmö University due to COVID-19?*
>
> *RQ2: What recommendations can be proposed for the sustainable post post-pandemic education at the university?*

3.2. Semi-Structured Interviews

The study included ten student interviews from bachelor's in the system development program at Malmö university. The recruitment of interviewees was performed using the snowball sampling method. Initially, two students were selected to be included in the sample, which in turn referred to additional participants to be included in the interviews. All interviews were performed online using zoom. Furthermore, all students involved in the interviews were given a unique ID (I1 to I10) to keep the interviewees anonymous, and their unique IDs were used to reference them in the analysis (see Table 1). All the interviewees are third-year students who experienced the transition from on-campus education to digital education during the pandemic. The semi-structured interview guidelines from Runeson et al. [26]. were used to develop the questionnaire and divided into the following parts:

- Demographics;
- Digital education experience ;
- Pandemic impact on students and university education;
- Future of university education and recommendations for improvement;
- Concluding remarks.

We performed two pilot interviews based on the initial set of semi-structured questions derived from the related work studies and further refined the questionnaire after pilot interviews. The aim was to identify the student's perception of shifting from on-campus to digital education at the university and propose improvement suggestions for post-pandemic university education. The semi-structured interview guide to conduct interviews can be found in Appendix A.1.

Table 1. List of interviewees.

Interviewee_ID	Discipline	Level
I1	System Development	Bachelors
I2	System Development	Bachelors
I3	System Development	Bachelors
I4	System Development	Bachelors
I5	System Development	Bachelors
I6	System Development	Bachelors
I7	System Development	Bachelors
I8	System Development	Bachelors
I9	System Development	Bachelors
I10	System Development	Bachelors

3.3. Workshop Design

The study included an open-ended workshop design followed by student interviews. The workshop was primarily geared towards recommendations and finding the best practices of higher education teaching in post-pandemic education to improve student learning. Ten senior lecturers from the computer science department participated in the workshop discussion held on zoom. These senior lecturers are responsible for teaching courses at the bachelor's and master's levels in the department. The workshop lasted for one hour and thirty minutes, and the author was responsible for moderating the zoom session. These senior lecturers teach a wide range of bachelor's and master's courses, including programming software engineering, research methods, and game development. All workshop participants were presented with an open-ended question about the best possible teaching practices that could be adopted going forward in post-pandemic education in the context of their experience and student learning. All participants were informed that participation is voluntary, and they could withdraw from the workshop at any given time. All participants were kept anonymous, and their data was kept confidential in the research process. The workshop guide to facilitate the discussion can be seen in Appendix A.2.

3.4. Qualitative Data Analysis Using Thematic Analysis

All interviews were recorded and transcribed as mentioned in Table 1. Afterward, thematic analysis was performed on the qualitative data obtained from the interview transcriptions [27,28]. The process for performing thematic analysis entails the following steps:

1. Familiarization with the qualitative data from interviews and workshop;
2. Coding of the qualitative data;
3. Define the initial set of themes based on the qualitative data;
4. Reviewing themes;
5. Defining and naming themes;
6. Finalize the distinct themes to answer the research questions.

The qualitative data analysis tool NVivo was used to perform the thematic analysis in the study. The first step involved transcribing the audio, reading through the text, taking initial notes, and looking through the data to get familiar with it. The second step contains coming up with the short labels or codes based on the statements from the qualitative data. The third step entails combining several codes into one theme. The fourth step included defining and reviewing each theme distinctly to make it more understandable. Finally, the analysis identified distinct themes in the qualitative data, as shown in Figure 2.

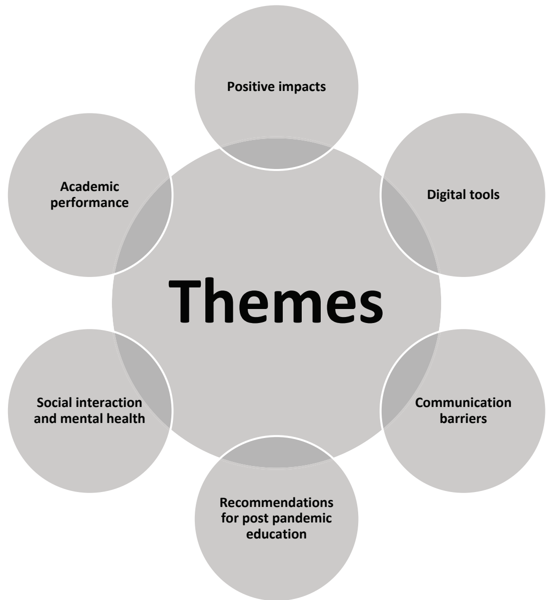

Figure 2. Distinct themes from thematic analysis.

4. Results and Discussion

This section presents results and discussion from thematic analysis performed on the qualitative data collected from the interviews and workshop. We have found seven distinct themes and reflected upon each theme in the sub-sections below.

4.1. Digital Tools

This theme refers to the digital tools used by the universities to switch from on-campus to digital teaching. Furthermore, the theme highlights the experiences of teachers and students using these digital tools for teaching and learning. Several digital tools are used for digital teaching and learning, including Zoom, Google Meet, Google Classroom, Microsoft Teams, Google Drive [15,19,22,24,29–33]. However, many tools were missing some key feature of recording introductions and instructions for students to watch lectures later [15]. Students and teachers have emphasized tools that could facilitate asynchronous and synchronous communication. Modern digital tools must allow the interaction between students, between students and teachers, and one-to-one with teachers. Several studies have reported that digital tools play an important role in convenience and good quality digital education [22,32,33]. However, these tools require some technical learning curves to work with them. Therefore, there should be a support process to handle the technical issues arising from using them in digital education. Technical difficulties have been highlighted as the most common challenge in the existing studies [15,19,22,25,29,31,33,34]. Figure 3 shows the use of digital tools used during online learning. Most of the interviewees in this study are familiar with the digital tools used at MAU. However, some interviewees struggled with technical issues. Below are a few examples of quotes related to the technical issues.

> *My mic does not work whenever there is an update, and I could not figure out why—(I5).*
>
> *Once I had a presentation during the course, but I couldn't connect and needed to install some client to make it work, which caught me by surprise just before the presentation.—(I8)*
>
> *Sometimes, students have trouble joining break-out rooms created by the teachers.—(I2)*

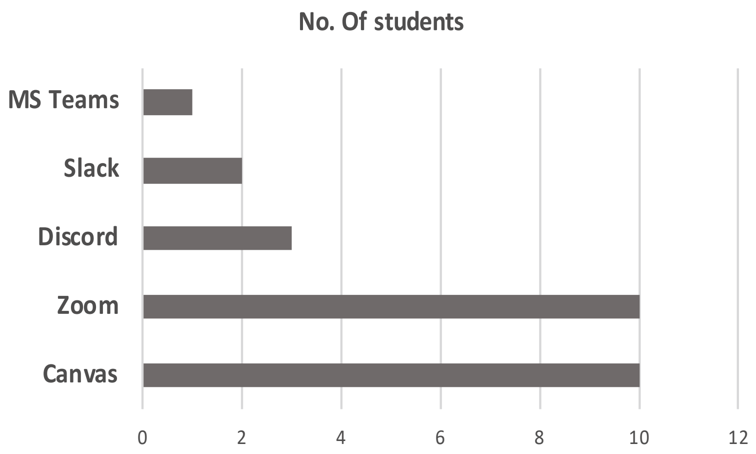

Figure 3. Students' reported use of tools for digital learning.

4.2. Positive Impacts

This theme refers to the positive impacts of distance learning because of the pandemic for students. The literature review identifies several studies reporting the positive effects on students [19–21,30,35]. First, the time-saving factor turns out to be the most important factor highlighted in the studies as the students manage to reduce the commute time to the university and utilize that time for their studies [19–21]. To further substantiate the literature evidence, most of the students mentioned in their interviews that online education saves time and is thus perceived to be more convenient. Convenience was mentioned by most students who live far away from the university, but it was not uncommon among students living nearby. Below are examples of some quotes from the interviews.

My lecture at the university starts at 8 AM and it takes me about 40 min to reach the campus. Now when the classes start at 8 AM during a pandemic, I can just wake up 10 min before, switch on my PC, and I am ready to attend my class—(I1).

It saves a lot of time for me because I live in a different city, and it takes me 70–80 min back and forth, so it saved me like an hour every time. However, even if you live in the same city, it saves you some time—(I5).

I have more time to study and free time. Taking the bus and train takes time, and it adds up, so I feel like I have more time now—(I2).

Furthermore, the time-saving factor has contributed to a healthier lifestyle as the students found more time outside the university.

I have more time for other things like working out, which positively affects me. So, I would say my health is better.—(I6)

Second, digital education led to economic benefits as well (S2). Third, shifting to online education led to flexibility for students in terms of better time management. This allowed the students to attend classes anywhere and whenever they wanted to learn more effectively at their own pace (S2, S7, S14).

There are occasions when I would skip a lecture in the middle of the day because it would require me to travel three hours back and forth. So, it is much more flexible to attend since it is online.—(I7)

Fourth, the online classes have given students complete autonomy over their learning, which contributed to enhancing the quality of the learning. Students can absorb information better and perform better than they would otherwise [20]. The explanation for that is that the student can read quickly through the course they are comfortable with and take more time for the parts they find difficult to understand. Finally, digital learning is often more student-centered, which puts more pressure on students to develop a more disciplined study schedule [21]. Students have developed more disciplined self-study habits as the pandemic forced contact deterioration between classmates and teachers in physical campus settings [21,30]. Students also feel that online education has positively affected their attendance rate due to the convenience aspect of online education.

> *I think I am more likely to go to the lectures when it's online because it's way easier for me. I think my attendance rate in lectures has improved to online lectures".—(I1)*
>
> *I feel like my attendance has improved because I attend my lectures on my phone or the computer. So, I would say it has affected my learning more positively because it is more convenient now".—(I5)*

4.3. Communication Barriers

This theme addresses the communication barriers in teaching and learning because of switching from campus to digital education during the pandemic. The majority of studies have reported that the students believe that communication between students and teachers has deteriorated [17–19,33–36]. Eight out of ten interviewees think they have lost some or all interaction with other classmates and would much rather have more face-to-face interaction. Below are a few examples from quotes from the interviews.

> *It was easier to talk to classmates I did not know in a physical classroom environment since we were sitting close to each other, but now with the online situation, I only speak to classmates I know well.—(I1)*
>
> *Yes, of course. Now we only communicate when we have assignments or similar things that you feel is important to ask".—(I2)*
>
> *Most definitely, I have lost contact with many classmates, and it makes sense to have less communication because you do not see them very often now.—(I9)*

Similarly, the interviewees mentioned the communication challenges between teachers and students as well. Five out of ten interviewees felt no significant communication difference between teachers. Two students believed that online education made it easier to communicate because they are shy and find it challenging to raise a hand to ask a question during a physical learning environment. However, three interviewees believed that pandemic has made communication between teachers and students more difficult. Below are a few quotes from the interviews.

> *It was relatively easy to ask questions during or after the lecture, but now we are forced to use emails. So, it takes longer to get an answer.—(I1)*
>
> *I am less likely to ask questions in an online environment because I feel like I am interrupting the lecturer. It was easier to ask questions in physical classrooms because it didn't feel like you were interrupting the lecturer.—(I4)*
>
> *One of the biggest changes must be the communication part of online education. It is difficult to communicate whether it's a classmate or lectures"—(I10)*

4.4. Social Interaction and Mental Health

This theme addresses the social and mental health aspects of transition from physical to online education due to COVID-19. The majority of the interviewees believed that online education is less engaging as opposed to the on-campus education. The interviewees empathized that sharing a computer screen does not have the same value as attending the lecture on campus. Moreover, several studies have reported the impact of online education on student mental health [17,18,23,24]. Governments all over the world have imposed self-isolation to stop the spread of COVID-19. However, these self-isolation guidelines came at the expense of psychological health such as anxiety [23,24], depression [23] and stress [17,18] effects on university students. Below are a few quotes from the interviewees.

> *It feels like university is not a big part of my life anymore. I use to spent a lot of time at the university even when I am waiting for classes in between lectures and hanging out with my classmates. Now that everything is online it takes away the university student feeling—(I1).*

Although the lectures run smooth on zoom, but it does not present the same feeling of attending a lecture. I feel more like a passive listener rather than an active participant—(I7)

Socially, I do not feel very involved which makes school less fun and motivating—(I10)

4.5. Academic Performance

This theme refers to the impact of online learning on students' academic performance. Several studies have reported positive [16,20,30,37] and negative effects [33,38,39] of online learning on the academic performance of the students. The students have reported having a hard time grasping course contents online as opposed to on campus classes [21,29–31,40]. There are several reasons mentioned for not understanding the concepts in the course such as environmental distractions at home [15,17,18,22], lack of self-discipline [22,30,32,40], lacking hands on experience with the labs in the course and limited online help from teachers. The majority of interviewees believed that it is more difficult to perform during online education due to lost communication with the classmates and slower response time from teachers on emails. Therefore, this affected the academic performance of the students negatively. Below are a few quotes from interviewees expressing the negative effect on their academic performance.

School is not going as very well anymore because I do not have the same communication as it was before. It is very difficult to meet new people on zoom and I do not know who I shall talk to seek help from—(I3)

It is difficult during group assignments to engage all group members because you do not see them all and cannot force anyone to turn on their camera. It is a challenge to have an engaged group and make everyone talk. In contrast, it was easier to communicate and hold someone responsible for their work during face-to-face meetings—(I6).

I think the switch to online education has a bad impact on my performance. I use to talk to my classmates and hear new things about a course assignments and exams which made me better prepared for the exams. This information has been lost and you just never know what will happen next. You just wait for a new announcement on Canvas. It is also awkward to send my classmate a message and ask for help—(I9)

The communication with the teachers has become worse as we do not get assignment reminders as they used to be in face-2-face lectures."—(I10)

I have a big problem in getting the feedback from the teacher on labs. Before pandemic, I could usually ask the teacher during a lectures or lab and get instant feedback. But now you just send an email and hope to get a response before the deadlines."—(I7)

Some interviewees also highlighted that online learning has made it easier to go back to lecture recordings if they need a clarification regarding the lecture contents. Furthermore, online learning has also made it easier to focus on exams and perform better.

I feel it is less stressful and easier for me to do exams at home—(I2)

Lectures are recorded by teachers, and you could watch the lecture later as well if you missed something in it. I liked that very much—(I5)

Finally, neither students nor teachers were prepared for this transition from on-campus to digital education, and therefore, everyone struggled with this forced transition in the short space of time [15,34,36]. There was no strategy in place from the university for teachers regarding how to approach digital education. Therefore, everyone adopted strategies that suited them instead of a one common strategy from the university.

4.6. Recommendations for Sustainable Post-Pandemic Education

This theme explains the possible recommendations to improve the post-pandemic teaching and learning experience at the university.

4.6.1. Unified Selection of Digital Tools

This theme highlights the need for a uniform selection of tools in teaching and learning. It includes both communication and collaboration tools. Interviewees and workshop participants agreed on the lack of university guidelines or support for choosing the same communication and collaborative tools. From a teacher's perspective, there are too many communication tools used in several courses, making it difficult to monitor all the communication channels and respond to student queries in a timely manner. Therefore, it is essential to limit the solutions geared toward catering to the needs of individual students and adopt a more unified approach to the selection of communication tools. It is also important to highlight that Canvas is a well-accepted tool for course content collaboration [41]. However, this problem is more evident in choosing communication tools such as Discord, slack, Miro, etc. Another critical dimension related to using non-approved tools from the university may result in GDPR infringement as it involves student data [42,43]. The data collected from the workshop with teachers suggest a lack of clear understanding regarding data privacy and the use of the non-approved communication tools. Most of the students and teachers agreed that universities need to have a clearer strategy regarding using communication and collaboration tools. This also makes it possible to co-develop courses in collaboration with other universities using the same set of digital tools.

4.6.2. Blended and Hybrid Learning

This proposal of having blended and hybrid learning is gaining traction to improve the teaching and learning experience [44]. Blended learning deals with the combination of online and offline instructions in which students interact with teachers, classmates, and the course material through physical classrooms and online learning platforms [45]. Hybrid learning is a form of education where some students attend the class virtually while others attend the class on campus [46]. Both students and teachers have expressed their interest in adopting blended learning. Teaching activities such as lectures, labs, and seminars could be in person, while student supervision meetings can be online. It allows students to make physical interaction with other students in the class. However, hybrid learning has mixed views among teachers due to its challenges. Table 2 shows the challenges along with the possible solution to address the challenges in blended and hybrid learning.

Table 2. Possible solution to challenges in blended and hybrid learning.

Challenge(s)	Solution Recommendation(s)
Technical difficulties with the digital equipment	IT support for students and teachers
Cost of acquiring equipment	Support from university to acquire digital equipment at a lower cost
Communication barriers	Integration of communication tools with Canvas to improve teaching and learning experience
The geographical distance between teachers and students	On-campus and online streaming of lectures
Student learning	Availability of online recorded lectures
Learning curve in the transition to hybrid and blended learning	Training courses for teachers

These challenges include installing equipment (e.g., camera, microphone) to have the possibility to stream lectures online and on-campus simultaneously. Many interviewees emphasized that technical equipment required for online education is expensive, and a structural change is needed from the university to lower the cost of acquiring equipment for the students, which is in line with the findings from existing studies [32,47]. Furthermore, it requires more training regarding the use of streaming equipment and support for technical challenges that arise at the run time. These tools shall also be integrated with digital communication tools such as Canvas to improve the teaching and learning experience. As it stands, this integration of digital tools with Canvas needs improvement. From students' perspective, hybrid learning seems promising since it allows students to attend lectures from anywhere, as many students were stuck in their home countries due to the pandemic. It is also important to highlight that teachers believe that students at the beginning of their programs need more on-campus activities in relation to those students who are further in their study years.

Teachers have also struggled to cope with online education transition, and therefore, it is important for the teachers to go through training for online teaching and learning such as the adoption of new tools [21]. One possible suggestion for teachers is to opt for blended learning where online classes are combined with physical classes to improve student learning [22,40]. Furthermore, teachers can provide more flexible deadlines for assignments to allow students to have more time to complete their courses [17]. Interviewees suggested that teachers can be more motivated and should continue recording lectures and have them available on student platforms to facilitate online learning for students. Interviewees also felt the need for additional lab assistance to address their queries and rapid feedback. Below are the quotes from interviewees regarding future perspectives on university education.

> *I am attending a course right now, and the teacher is not willing to set up a discord server where students can feel more connected and share their thoughts regarding the course contents. It is quite possible that the teacher is not familiar with Discord and is unwilling to set up the server for the class to share their experiences and thoughts regarding the assignments and labs.—(I3)*

> *It is nice to have the recorded lectures available if you missed a course, you could still catch up with the rest of the class.—(I7)*

> *It is essential to set up more time for questions or help. For example, the teachers can set up designated zoom sessions for labs assistance. (I1)*

> *It will improve student learning if the teachers plan a few activities in the course on campus.—(I8)*

4.6.3. Designated Budget for Digital Tools

The use of digital tools to shift from on-campus to digital education came to the rescue for all educational institutions during the pandemic. However, the selection of these tools was dependent on individual preferences. This led to the purchase of a subscription of tools for selective courses requested by the teachers. It is quite expensive to buy the tools subscription to deal with the individual requests. Therefore, it is important to have a designated budget to buy a collective subscription of thesis digital tools for teachers to improve the teaching and learning experience [48].

4.6.4. Continuation of Recorded Lectures

One of the most appreciated learning activities of online teaching and learning was the availability of the recorded lectures online from the teachers [49,50]. Therefore, most students in the interviews expressed their desire for the continuation of recorded lectures and making them available online as it facilitates asynchronous learning. Moreover, it allows teachers to reduce their course budgets as well.

5. Limitations of the Study

The scope of the study is limited to Malmö University since the participants included in the study for interviews and workshops are a subset of the population from the computer science department. The students from the computer science department are considered more familiar with digital tools. They may find it easier to adopt digital tools than other disciplines in the university. This study laid the foundation for identifying challenges experienced by students and teachers and potential solutions for sustainable higher education going forward.

Furthermore, the study was designed based on the recommendations of ethical review guidelines involving human test subjects. Therefore, the interviews and workshop do not collect sensitive data (e.g., age, gender, etc.) related to participants in the study. A voluntary informed consent was taken from all participants before conducting the interviews and workshop.

6. Conclusions

This study focuses on investigating the impact of COVID-19 on student learning at Malmö University. We performed a case study using semi-structured interviews with students. The study contributes to existing knowledge on the impact of the pandemic on the teaching and learning of students. The study uses a thematic analysis technique to identify seven distinct themes from the interview transcriptions to answer the research question. These themes include digital tools, positive impacts, challenges, communication barriers, social interaction and mental health, academic performance, and recommendations for future education. The most used tools in this transition from on-campus to digital education include Zoom and Canvas. The majority of the interviewees did not experience many technical difficulties using the digital learning tools, with a few exceptions. One possible explanation for it could be that all interviewees were from the department of computer science with reasonably good prior digital skills. Many students welcomed the switch to digital education as it helped them increase the lecture attendance rate due to the convenience of attending digital lectures. The recorded lectures gave students the flexibility to go through the contents of the lectures at their convenience. However, students struggled to grasp the course contents in digital learning. Major reasons include lack of self-discipline in students, procrastination, lack of motivation, long feedback time from teachers, and less communication with classmates. The lack of self-discipline, motivation, and procrastination are reported by previous studies as well [20–22]. Furthermore, this study confirms the findings of previous studies that many students experience anxiety and stress due to self-isolation during the pandemic [23,23,24,51]. Students also believed that teachers were not prepared for this shift, and therefore, all teachers opted for teaching strategies that suited them better. Students suggested that teachers focus more on motivating and engaging students in digital education. Finally, students gave recommendations for future teaching and learning at the university. These suggestions include a blended learning method in which students would have some activities such as labs at the university to interact with classmates and teachers. The right balance between on-campus and digital education is the most desirable outcome.

As for future work, there is another survey study in progress. The findings of this study served as an important input in designing the survey. The survey will be distributed across many universities worldwide to address the limitations of this study related to the limited sample size. Consequently, the study will improve the generalization of results and implications of digital learning for teachers and students in post-pandemic higher education.

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Informed Consent Statement: All participants in the study were volunteers and informed consent was taken prior to interviews and workshops.

Data Availability Statement: The data collected in the study cannot be shared publicly due to the privacy of the participants. The data is handled under the Data Protection Act (2018:218).

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Appendix A

Appendix A.1. Semi-Structured Interview Questionnaire

All interviewees were informed that participation is voluntary, and the interviewees' data will be kept anonymous and confidential in the research process. The data collected during the research process will only be used for research purposes.

- What program are you studying?
- Which year are you in?
- Do you have prior experience with online education?
- How has the shift in education affected your attendance rate?
- What digital learning tools are you familiar with in digital education?
- What digital learning resources are you using for distance education, and how do you find them helpful in your education?
- What challenges do you experience with digital tools used in the university?
- How does the switch to online education affect your health? Could you elaborate on how and why?
- How has the online education due to COVID affected your motivation to learn in a new learning environment?
- What is the impact of online education on you and your classmates (e.g., performance, communication, etc.)?
- What difference have you noticed in lectures before and after the online transition, and how does it impact you?
- What was the most significant change you noticed after transitioning to online learning?
- Could you explain what went well with the transition to online education?
- Could you explain what did not work with the transition to online education?
- What challenges did you face in digital education from the pandemic?
- What did you do specifically to overcome or adapt to these challenges?
- What improvements or recommendations can you give to students to improve digital education?
- What recommendations would you give to teachers to improve the online learning experience?
- Concluding Remarks: Is there anything you would like to add more to what I have discussed?

Appendix A.2. Workshop Guidelines

The moderator of the workshop has presented the following discussion points. However, these points were provided to facilitate the discussion. The participants were allowed to express their experiences and recommendations for university education in a post-pandemic world.

- Digital tools;
- Budgeting for the tools;
- Choosing the best of the two worlds (Online vs. on-campus learning);
- Existing Challenges faced by teachers ;
- Possible solutions to the challenges ;
- Recommendations for the university;
- Concluding remarks.

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education sciences

Article

The Professional Identity of Academic Lecturers in Higher Education Post-COVID-19 in Israel

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Abstract: Professional identity development in higher education and its implications is a growing interest in the literature. Research indicates that the professional identity of academic lecturers has been unstable and influenced by a variety of personal and contextual factors. With a lack of a clear definition of professional identity in literature, we composed The Professional Identity COVID Scale (PI-COVID) specifically designed to measure lecturers' professional identity in dealing with the COVID-19 pandemic. The items focused on three components: occupational security, academic skills, and combining teaching and research. The purpose of the present study was to examine the associations between lecturers' age, years of seniority, academic rank, and work permanence on the professional identity of academic lecturers post-COVID-19 in Israel. Participants were 95 academic lecturers teaching in universities and colleges. Using self-report questionnaires, participants filled the PI-COVID scale. Results showed that age is negatively and significantly associated with PI-COVID. Moreover, seniority years, academic rank, and work permanence are associated with more COVID-19 challenges. Findings showed that lecturers without work permanence and with lower academic rank reported higher occupational insecurity during the pandemic, which emphasizes the vulnerability of younger lecturers and their need for confidence and stability, especially during a crisis event. Thus, our study contributes to the existing literature by better understanding the post-COVID-19 professional identity of academic lecturers. Implications and limitations for future research are discussed.

Keywords: professional identity; academic lecturers; higher education; COVID-19; seniority; academic rank; work performance; occupational security

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1. Introduction

Professional identity development in higher education and its implications is a growing interest in literature [1–3]. More specifically, research indicates that the professional identity of academic lecturers has been unstable and influenced by a variety of personal and contextual factors [4]. It is mainly driven by two contrasting forces affecting their identity: students' demands and academic demands (i.e., research and administration duties). The challenge for lecturers is to navigate between the two [5]. Studies showed that professional identity is a continuous process in which individuals develop their professional identity throughout their lives, especially in light of the new era and pedagogical innovation [6,7]. However, with the sudden outbreak of the COVID-19 pandemic, academic institutions around the world were forced to switch to online learning, using alternative teaching methods [8,9]. Researchers consider this phenomenon as emergency remote teaching, which refers to a temporary change of instruction as a result of a crisis situation [10–12]. Thus, this sudden shift created new problems for lecturers to deal with. They have become another communication channel, competing for students' attention, and as with all other communication channels now available, the students tend to multi-task and distract themselves with other activities [13]. Moreover, a recent study conducted on academic staff in the

UK indicated that academic staff members have expressed significant concerns regarding virtual learning and its ability to achieve deep learning among students. It also referred to lecturers' concern that the publication of their class recordings will harm their intellectual property, which in turn may affect their sense of job security [14]. Hence, the goal of the present study is to explore the professional identity of lecturers in academia post-COVID-19 in Israel. By using a new scale specifically designed to measure lecturers' professional identity in dealing with the COVID-19 pandemic, the study aims to understand how lecturers perceive their job demands, academic skills, the challenge of combining teaching and research, their sense of occupational security post-COVID-19, and how those perceptions may vary by age, seniority, academic rank, and work permanence. Our results may add to the theoretical knowledge on academic lecturers' PI specifically during a crisis event and provide practical recommendations for academic institutions and policymakers.

1.1. Professional Identity (PI)

The concept of professional identity in literature is complex and composed of conflicting definitions [4]. Beijaard et al. [15] clarify that the term identity is a relational phenomenon, which refers to a variety of characteristics. Moreover, they point out that "identity development occurs in an intersubjective field and can be best characterized as an ongoing process, a process of interpreting oneself as a certain kind of person and being recognized as such in a given context" [15] (p.108). Adams et al. [6] further assert that PI is a continuous process in which individuals develop their professional identity throughout their lives. A study on teachers' professional identity indicated that, in most studies reviewed, the concept of professional identity was either defined differently or not defined at all [15]. Barbarà-i-Molinero et al., [1] point out that previous definitions of PI were mainly associated with a profession and the workplace thus suggesting that PI only develops in the working environment. However, recent studies focus on the understanding that identity is composed of a variety of factors and characterized by a changing and dynamic nature influenced by life experiences such as social experience, educational context, demographic characteristics, professional image, and experience [1,4,16]. Following the literature suggesting a lack of a clear definition and taking a wider view regarding the components of PI, the current research refers to a variety of factors influencing academic lecturers' professional identity. In particular, we examined lectures' sense of occupational security, academic skills, and the challenge of combining teaching and research as components of professional identity.

1.2. Professional Identity Post-COVID-19

The coronavirus pandemic abruptly transformed and influenced our lives. Efforts to reduce the spread of the virus have fostered countries to decide on lockdowns and home quarantine affecting individuals' psychological and physical health and causing financial problems in many households [17]. In addition, another drastic change was the transition to home working and learning online. Without much notice, the educational system was expected to adapt to the new situation and shift to online learning and teaching [18,19]. Results of qualitative research showed that emergency remote teaching has numerous technological, pedagogical, and social challenges [10]. Teachers and lecturers needed to deal with technical difficulties (e.g., unstable internet connections, challenges in utilizing ZOOM or TEAMS applications) while rebuilding their entire teaching materials and altering them to online learning [20,21]. Lecturers also struggled for students' attention as with all other communication channels now available (e.g., WhatsApp, Instagram, Facebook) the students tend to multi-task and distract themselves with other activities while learning [13]. Moreover, Kınıkoğlu and Can [22] point out that the COVID-19 pandemic has intensified uncertainties and concerns about the future of the academic labor market and working conditions. Hence, as demonstrated in the literature above, professional identity is an ongoing process that is influenced by life experiences [16]. Therefore, we suggest that the COVID-19 crisis profoundly impacted the professional identity of lecturers in academia, in particular, it influenced their sense of occupational security, challenged their academic skills, and caused difficulties in combining teaching and research.

1.3. Lecturers' Age

One of the components that may influence lecturers' professional identity is their age. Younger lecturers may be more prone to feelings of insecurity and doubt than older lecturers. A study on faculty perception toward online education during COVID-19 demonstrated that there was a significant difference in faculty's perception in terms of age, educational attainment, years of teaching, and academic rank, such that older faculty members were in favor of online education more than younger faculty [23]. Another study on teachers' challenges regarding digital literacy after COVID-19 showed that the more experienced the teacher, the higher their level of competence [24]. Along the same lines, Owan et al. [25] examined the preparedness of academic staff in African Universities to adopt internet tools for research sharing based on gender and age differences. Results showed that older lecturers reported a higher rate of preparedness than their younger colleagues to adopt internet tools for research sharing during the COVID-19 pandemic. Hence, following the literature, we suggest that younger lecturers will face more difficulties and challenges during and after post-COVID-19, which accordingly may affect their PI. Thus, we hypothesized that younger participants will be associated with more COVID-19 challenges.

H1a. *Age is associated with more COVID-19 challenges, such that younger participants will report higher on the PI-COVID scale.*

1.4. Lecturers' Seniority, Academic Rank, and Work Permanence

Professional identity may also be affected by lecturers' years of seniority, their academic rank, and work permanence. These components may have a profound influence on lecturers, especially at an early stage of their career. A study conducted before the coronavirus in Chinese academic institutions found that the tenure-track system increases academic pressure on young academics. Participants reported negative emotions regarding their career such as insecurity, uncertainty, and anxiety mainly due to the high expectations regarding publications [26]. Moreover, a study on the relationships between student evaluations of lecturers and faculty members' perceptions showed that lecturers who are at the beginning of their academic life and those who are in lower ranks address the negative aspects of the surveys more than others [27]. Miller, Taylor, and Bedeian [28] point out that tenure-track faculty feel significantly more pressure than their tenured colleagues to publish in peer-reviewed journals. These findings corroborate with other studies referring to the high pressure and insecurity young academics experience [26,29].

Furthermore, a recent study conducted in Israeli academia found a positive influence of academic seniority on scholarly productivity, and that the most productive scholars are mid-career life scientists, pointing out the beneficial factors of seniority years and rank on lecturers' experience and performance [30]. Hence, as the literature demonstrated the association between lecturers' years of seniority, academic rank, and work permanence with higher confidence and accomplishments, it is suggested that the uncertainties of dealing with a life-threatening pandemic such as COVID-19 may increase young lecturers' difficulties and thus affecting their sense of professional identity. Therefore, we hypothesized that participants with fewer years of seniority, lower academic rank, and without work permanence will report more COVID-19 challenges.

H1b. *Seniority years are associated with more COVID-19 challenges, such that participants with fewer years of seniority will report higher on the PI-COVID scale.*

H1c. *Academic rank is associated with more COVID-19 challenges, such that participants with lower academic rank will report higher on the PI-COVID scale.*

H1d. *Work permanence is associated with more COVID-19 challenges, such that participants without work permanence will report higher on the PI-COVID scale.*

1.5. Occupational Security

Having a sense of occupational security is greatly significant for employees in the workforce [31]. The research defines job security as employees' perceptions regarding the stability and permanence of their job [32]. Studies demonstrated a positive correlation between negative workplace outcomes and job insecurity such as low job satisfaction, low psycho-social wellbeing, and organizational withdrawal [33]. These outcomes have recently increased due to the COVID-19 global crisis, resulting in diverse economic pressures, instability, and occupational insecurity both for organizations and employees [34].

Studies refer to different aspects of security in academia. Bothma and Rossouw [35] explain that professional security in higher education consists of three main factors: The first is environmental security, influenced by a general sense of job security, institutional and collegial support, and possessing applicable resources. The second is psychological security, affected by lecturers' feelings of respect and recognition, and the prospects for personal and professional growth. The third is having a sense of legal security, protection, and fairness in administrative matters.

Nir and Zilberstein-Levy [36] point out the implications of role stress derived from occupational insecurity as influencing the professional choices of pre-tenured faculty. Moreover, they clarify that the sense of security of having work permanence is an essential aspect of academia, and acts as an incentive for faculty members' motivation and academic development. A recent review examining the causes of occupational stress among Australian and New Zealand academics suggest that job insecurity and an unstable work environment are part of the environmental factors that can cause occupational stress [37]. Similarly, Miller, Rutherford, and Kolodinsky [38] point out that concern for employment security (among other factors) is associated with high levels of stress in teaching in higher education.

Another component that may influence academics' occupational security is rank. A study on the impact of rank on organizational commitment of faculty members showed that overall organizational commitment increases progressively with rank, and that rank does not have a positive influence on affective, continuance, and normative commitment. These findings indicate that the faculty in higher positions are generally more committed to their organization than their lower-ranking colleagues [39]. Hence, we hypothesized that participants without work permanence and lower academic ranks will report higher occupational insecurity.

H2a. *Participants without work permanence will report higher occupational insecurity.*

H2b. *Participants with lower academic ranks will report more occupational insecurity than those with higher academic ranks.*

In summary, the purpose of the present study was to examine the association between lecturers' age, years of seniority, academic rank, and work permanence on the professional identity of academic lecturers post-COVID-19 in Israel.

2. Materials and Methods

2.1. Participants

The study hypotheses were tested on 95 subjects using self-report questionnaires. Subjects were Israeli academic lecturers teaching in universities and colleges. The primary difference between a university and a college in Israel is that only a university can grant doctorate degrees, and therefore tend to be more research-oriented than the more teaching-oriented colleges, however, both institutions are recognized and academically supervised by the Council for Higher Education in Israel. The sample consisted of 33 men (34.7%) and 62 women (65.3%). Participants ranged in age from 37 to 84 years with a mean age of 52.36% (SD = 9.9). Seniority ranged from 3 to 45 years in academia, and 49 lecturers (54.4%) reported having a work permanence. A total of 62 lecturers (72.1%) had a senior rank (doctors or professors) and 47 (49.5%) taught only in universities compared with 39 (41.1%) who taught only in colleges.

2.2. Measures

The Professional Identity COVID Scale (PI-COVID) is composed of 10 items ranging from 1 “strongly disagree” to 5 “strongly agree”, reflecting the degree to which an individual evaluates his/her professional identity post-COVID-19. The scale was specifically designed to measure lecturers’ professional identity in relation to dealing with the COVID-19 pandemic. As such, the items focused on three components: occupational security, academic skills, and combining teaching and research. An item for example is: “The Corona period made me feel occupational insecurity” (see Appendix A). A pretest conducted among 27 lecturers yielded a coefficient alpha of 0.75 for the whole scale. In addition, the occupational insecurity component (4 items) was supported as the pretest reliability was 0.86.

2.3. Procedure

IRB approval was obtained, and all ethical procedures were observed by the Ethics Committee of the University. Participants signed a consent form before completing the questionnaires and were informed that their responses would remain anonymous and that participation was voluntary. The study was promoted among lecturers teaching in universities and colleges on email and social media (WhatsApp groups) using a snowball approach. The online data were collected using Google Forms between May and July 2021 after the end of the third wave of the COVID-19 pandemic in Israel. At this point, the government removed most of the restrictions and opened the educational system, workplaces, and shopping centers.

2.4. Analyses

Data were analyzed quantitatively using IBM SPSS statistics 26. Cronbach’s reliability of the PI-COVID scale was 0.75, and the occupational security component’s reliability was 0.76. Given the number of items and the complexity of the concept, these reliabilities are considered adequate. Since the independent factors were inserted as free text, a qualitative analysis was performed to classify the information into the measured variables. As such, the variable seniority years was classified into three categories representing low seniority (3–11 years), medium seniority (12–19 years), and high seniority (20 years and above). In addition, the variable academic rank was classified into two categories representing low rank (lecturers with M.A. degree or equivalent, as well as doctoral students) and high rank (lecturers with Ph.D. degrees and above). Harman’s single-factor test for examining common method bias was applied to the item scales in the study. It was clear that one factor explained only a small amount of common variance (33%).

3. Results

The means, standard deviations, coefficient alphas, and zero-order correlations among study variables are presented in Table 1, and the differences in PI-COVID by seniority years, work permanence, and academic rank are shown in Table 2.

Table 1. Means, standard deviations, coefficient alphas, and zero-order correlations among study variables.

		Mean	SD	N	1	2	3	4	5	6
1.	PI-COVID	2.08	0.66	95	(0.75)					
2.	Occupational insecurity	1.91	0.94	95	0.83 **	(0.76)				
3.	Age	52.36	9.9	87	−0.31 **	−0.25 *	-			

Table 1. *Cont.*

		Mean	SD	N	1	2	3	4	5	6
4.	Seniority years	-	-	93	−0.18	−0.15	−0.66 **	-		
5.	Work permanence	-	-	90	−0.34 **	−0.47 **	0.28 **	0.33 **	-	
6.	Academic rank	-	-	86	−0.32 **	−0.27 *	0.21	0.28 **	0.28 *	-

Note. Coefficient alphas in brackets.* $p < 0.05$, ** $p < 0.01$.

Table 2. One-way analyses of PI-COVID differences by seniority years, work permanence, and academic rank.

	Level	N (Valid%)	PI-COVID Mean (SD)	*F*	*Sig.*
Seniority years	low medium high	32 (34.4%) 30 (32.3%) 31 (33.3%)	2.33 (0.72) 1.87 (0.52) 2.04 (0.64)	$F_{(2.90)} = 4.16$	$p = 0.019$
Academic rank	low high	24 (27.9%) 62 (72.1%)	2.40 (0.70) 1.95 (0.59)	$F_{(1,84)} = 9.49$	$p = 0.003$
Work permanence	no yes	41 (45.6%) 49 (54.4%)	2.33 (0.75) 1.88 (0.50)	$F_{(1,88)} = 11.49$	$p = 0.001$

Hypothesis H1a stipulates that age is associated with more COVID-19 challenges, such that younger participants will report higher on the PI-COVID scale. A Pearson correlation analysis shows that age is negatively and significantly associated with PI-COVID ($r = -0.31$, N= 87, $p < 0.01$), indicating that younger lectures experience more challenges associated with COVID-19 compared with their older colleagues (see Table 1). As such, hypothesis H1a is supported.

Hypothesis H1b argues that seniority years are associated with more COVID-19 challenges, such that participants with fewer years of seniority will report higher on the PI-COVID scale. Findings show a significant effect of seniority years on PI-COVID scores ($F_{(2,90)} = 4.16$, $p < 0.05$) (see Table 2). Post hoc comparisons using Tukey's HSD test indicate that the PI-COVID mean score of the least senior group (M = 2.33, SD = 0.72) is significantly higher than the mean score of the medium seniority group (M = 1.87, SD = 0.52). However, the PI-COVID mean score of the high seniority group (M = 2.04, SD = 0.64) does not differ significantly from either of the other two groups. Thus, hypothesis H1B is partially supported.

The third hypothesis (H1c) contends that academic rank is associated with more COVID-19 challenges, such that participants with lower academic rank will report higher on the PI-COVID scale. One-way ANOVA analysis reveals a significant effect for academic rank ($F_{(1,84)} = 9.49$, $p < 0.01$) such that the PI-COVID mean score for low rank lecturers (M = 2.40, SD = 0.70) is greater from that of the higher rank lecturers (M = 1.94, SD = 0.59) (see Table 2). Thus, hypothesis H1c is also supported.

Hypothesis H1d argues that work permanence is associated with more COVID-19 challenges, such that participants without work permanence will report higher on the PI-COVID scale. Findings show a significant effect for work permanence ($F_{(1,88)} = 11.49$, $p = 0.001$) such that lecturers without work permanence score higher on the PI-COVID scale (M = 2.33, SD = 0.75) compared to lecturers with work permanence (M = 1.88, SD = 0.50), supporting hypothesis H1d (see Table 2).

As for hypotheses H2a and H2b concerning the effect of work permanence and academic rank on the PI-COVID component of occupational insecurity, findings show a significant effect for work permanence on occupational insecurity ($F_{(1,88)} = 24.43$, $p < 0.001$) such that lecturers without work permanence reported higher occupational insecurity (M = 2.41, SD = 1.07) compared to lecturers with work permanence (M = 1.52, SD = 0.61). In addition, a significant effect was found for academic rank ($F_{(1,84)} = 6.83$, $p < 0.05$) such that lecturers with lower academic rank reported higher occupational insecurity (M = 2.28, SD = 0.95) compared to lecturers with higher academic rank (M = 1.72, SD = 0.88) (see Table 3). Therefore, hypotheses H2a and H2b were both supported.

Table 3. One-way analyses of differences in occupational insecurity by work permanence and academic rank.

	Description	N (Valid%)	Occupational Insecurity Mean (SD)	*F*	*Sig.*
Work permanence	no yes	41 (45.6%) 49 (54.4%)	2.41 (1.07) 1.52 (0.61)	$F_{(1,88)} = 24.43$	$p = 0.000$
Academic rank	low high	24 (27.9%) 62 (72.1%)	2.28 (0.95) 1.72 (0.88)	$F_{(1,84)} = 6.83$	$p = 0.011$

4. Discussion

The purpose of the current study was to explore the associations between lecturers' age, years of seniority, academic rank, and work permanence on the professional identity of academic lecturers post-COVID-19. As hypothesized, the findings presented here showed that age is negatively and significantly associated with PI-COVID, thus indicating that younger lectures experienced more challenges associated with COVID-19 compared with their older colleagues. This finding is consistent with other studies showing that younger teachers report more stress due to career change, familial status, and overall workload [40].

More findings revealed that seniority years are associated with more COVID-19 challenges, such that participants with fewer years of seniority reported higher on the PI-COVID scale compared with the medium seniority group. In addition, although not statistically significant, the direction of results indicated that the PI-COVID mean score of the high seniority group is somewhat higher than the mean score of the medium seniority group but lower than the mean score of the least senior group. These findings suggest that the medium seniority group might be more open to experiences, and thus feel more confident to face challenges. In contrast, lecturers with fewer years of seniority might feel insecure and therefore experience difficulties when dealing with a crisis [25]. Likewise, the high seniority group might struggle with changes as they are relatively less tech-savvy and tend to be more fixated on traditional methods and habits [41].

Results also showed that academic rank and work permanence are associated with more COVID-19 challenges, such that participants with lower academic rank and without work permanence reported higher on the PI-COVID scale. Our findings support recent literature pointing to the beneficial factors of rank on lecturers' experience and performance [27,30]. In addition, our results corroborate with other studies referring to the high pressure and insecurity that young academics, without work permanence experience in academia [26,28,29].

Further results showed that lecturers without work permanence reported higher occupational insecurity compared to lecturers with work permanence. In addition, lecturers with lower academic rank reported higher occupational insecurity compared to lecturers with higher academic rank. These findings demonstrate the vulnerability of younger lecturers who do not possess work permeance or higher ranks and their need for confidence. Kinman and Court's [42] study claimed that to experience security in their working environment, lecturers need support, encouragement, and respect, especially from university management and their peers. They assert that such actions may enhance levels of psychological wellbeing, commitment to job performance, and job satisfaction.

Limitations

This research has several limitations that should be noted. The first is the study's measures which were limited to lecturers' self-report questionnaires. We suggest that to enhance the reliability of the study mixed-method research that combines quantitative and qualitative components such as semi-structured interviews with academic lectures may provide broader and more accurate results. It should also be noted that the study was conducted in Israeli academic institutions which provides a specific point of view and therefore it is recommended to conduct it in other countries as well to receive a wider understanding of lecturers' PI. Moreover, data were collected in May 2021 after the end of the third wave of the COVID-19 pandemic, in which the government removed most of the restrictions and opened the educational system and workplaces. As such, perhaps we would have received different results if given at a different time. Thus, for further research, it is recommended to do a longitudinal study to examine the professional identity of lecturers at several time points. Another suggestion for further research may include other variables such as psychological components of wellbeing and mental health as predictors of lecturers' professional identity post-COVID-19.

5. Conclusions

As countries around the world are still dealing with long-COVID effects and different variants, our results emphasize that academic institutions, educational administration, and policymakers should take into consideration the implications of emergency remote teaching during the pandemic, in which younger lecturers with lower academic ranks may be more vulnerable to crises and experience obstacles and feelings of occupational insecurity thus leading to dropout. Therefore, to enhance lecturers' professional identity in higher education it is recommended that academic institutions provide lecturers and especially those with lower academic ranks, with support groups and workshops of technological and emotional guidance to better cope with events of crises.

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Appendix A

The Professional Identity COVID Scale (PI-COVID)
Occupational security

1. The Corona period made me rethink my professional future
2. The Corona period made me feel occupational insecurity
3. The Corona period made me feel insecure about my work as a lecturer
4. I feel confident regarding my occupational future in academia

Academic skills

5. I often doubt whether I fit the academic work

6. I know what to do and how to do my academic work
7. I think I have the required skills to be a good academician

Combining teaching and research

8. The Corona period caused me difficulties in finding the time to combine teaching and research
9. The Corona period allowed me to dedicate valuable time to doing research
10. I feel satisfied with my ability to combine the academic requirements of research, publication, and teaching

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education sciences

Article

COVID-19 Pandemic: The Impact of the Social Media Technology on Higher Education

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Abstract: The COVID-19 pandemic led universities to transform the traditional teaching methodologies into distance education. Therefore, social media has become progressively prominent as teaching and learning resources in universities. Several studies have been conducted for the development of social media as a learning tool. However, there is limited empirical evidence supporting this claim. The present study bridges the gap in the literature concerning the value of the use of social media in higher education. This research seeks to examine the impact of the use of social media in (a) enhancing teaching and learning in universities, (b) motivating and supporting students and (c) developing community connection. A qualitative methodology was adopted. Specifically, in-depth interviews were conducted to assess the effectiveness of social media on students learning in higher education. The results showed that the use of social media by higher educational institutions positively impacts the educational process by (a) promoting teaching and learning, (b) motivating students to be active participants, and (c) establishing connections in the university community. Some obstacles in the teaching and learning process were also identified. Future areas of research are proposed.

Keywords: COVID-19; higher education; social media; technology

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1. Introduction

It is generally accepted that there has been an extraordinary growth of social media and other Web 2.0 technologies [1–4]. However, the worldwide COVID-19 pandemic underlined its value and turned it into a necessity [5]. The environment of personal and professional relationships has been transformed by social media technology. Today, in the middle of a global health crisis, social networking sites are almost a vital part of most users' private lives with the use of technology. Social media consists of several activities such as interacting with friends, posting images and videos, engaging in conversation on public topics, watching the news, playing games, introducing real-time web chat instant messages, elements that allow networking, communication, and collaboration [6]. Defining social media is a challenging task since it is an area that is continuously changed. According to Joosten [7], the term "social media" is generally used to describe any number of technological systems connected to cooperation and community. More specifically, as Kietzmann et al. [8] quoted, social media "employs mobile and web-based technologies to create highly interactive platforms via which individuals and communities share, co-create, discuss, and modify user-generated content". Likely, Dulek and Saydan [9] defined social media as "social platforms where users share their information, manners, interests through the internet or mobile systems" and big data applications [10–12]. Additionally, Grosse et al. [13] underlined that social media is a way of sharing online information among people in a virtual community and creating material. From our perspective, social media can be more easily defined and understood through some vital examples. Some of the most popular examples of social media are (a) Content Communities such as Youtube, (b) Blogs like WordPress, (c) Collaborative Projects such as Wikipedia, (d) Social Networking Sites like Facebook, Instagram, Twitter, and Linkedln and (e) Social Messaging Applications such as Viber, Skype and WhatsApp [14–20].

According to Jiao et al. [21], social media is used to create social relationships and educational purposes. In several contexts, social media has attracted the interest of academics. One of these issues, limited but growing research, was using social media as a learning tool in higher education [22,23] or as mobile learning in higher education [24,25]. To the best of our knowledge, limited studies have been conducted on social media and its impact on education in Cyprus. The issue has increased in importance in light of the recent global changes because of COVID-19. The pandemic has changed teaching and learning from the conventional approach to a fully online way [26]. The present article is devoted to investigating the potential role of social media as a facilitator of learning in higher education in Cyprus, especially during a health crisis. It assesses the extent to which social media can be used in academic education as a learning and teaching tool. Which are the advantages and disadvantages of using social media in universities? Does social media enhance learning and knowledge and promote community connection? Is it a plague or a blessing? The potential obstacles that may emerge around adopting social media as communication for teaching and learning purposes are identified. It also adds to the existing literature as a forum for academic purposes on the use of social media.

Social media is used by millions of people all over the world. Young learners, teenagers, high school students, university students and elderly people use social media for communication, entertainment, work, sales, shopping, information sharing, travelling information sharing, sharing experiences, news, announcements, and so forth. Facebook, Twitter, Instagram, Wiki, Google, YouTube, and so forth are the most common social media. University departments are used Facebook to advertise their departments. Department of Biostatistics at Columbia University, Department of Biostatistics at the Harvard, Department of Political Sciences at the University of Oregon, Department of Psychology at Columbia University, Department of Biochemistry at University of Oxford, Department of Informatics at University of Western Macedonia, Department of Music, University of Sheffield, Department of Art at Miami University and many many other books on Facebook with the view to supporting educational developments. The majority of them are considering social media both as learning as well as instruction means passing through a precise platform [27]. Social media networking platform permits skills enhancement as well as communication skills [28], facilitates collaboration among peers from different university departments, different universities and different countries with different cultural and learning opportunities, different modules and enables both teacher and student to be active users in order to have the chance to learn in a collaborative environment by sharing information and various learning activities [29,30] has a serious impact on social media users, enables alliance, cooperation and dynamic interaction between students and teachers, and enhances innovativeness and imagination as well as enhancing student participation in learning activities [31,32], increases self-esteem, helps the development of a foreign language reading and writing and oral communications skills, increases students' awareness and finally enhances academic performance. In addition social media networking permits students to be informed continually, dissemination information is abundant and the information is shared rapidly and is effortlessness and widespread, social network takes each part of a person's life time and is a social platform for users to make contacts and start friendships, read news, spread information and a huge amount of data, to generate influence as well as influence teaching, learning processes and educational processes, and knowledge successfully [33], work independently, individually, and autonomously according to their appropriate working hours seeking the exact information they need in order to expand their own horizons [34]. What is of major importance is the fact that the use of network platforms for education purposes can contribute to individuals' personal commination capabilities not only for educational targets but mostly for carrier purposes and job opportunities [28]. In addition it was stated [35] that social media networking not only offers opportunities related to interaction, communication, information sharing, video sharing and learning material sharing but also offers the opportunity for emotional intelligence sharing. Consequently from the previous analysis regarding the benefits of social media use in favor of academic achievement, the contribution of the present study to the scientific community and especially to the tertiary educational community is made obvious.

2. Literature Review

Social media is used in a variety of different sectors by different people. Social media is used for informal social networking or improving social capital and for online engagement and marketing, establishing customer relationships, problem-solving, and grievance resolution [36–39]. Performance in the industry is due to the successful use of information and communication technologies in today's digital economy. Higher education institutions are not excluded from these continually advancing changes in technology. They should, therefore, not afford to fall behind these innovations since they can not only provide the academic community with useful insights but potentially enhance learning.

A multitude of studies that explore its role in higher education have contributed to the overwhelming popularity of social media. These involve the study of the association between the use of social media by higher education researchers for professional and teaching purposes [40]; use of social media for learning concerning the learning styles of students [41]; online social networks' effect on the academic success [42]; learner-generated knowledge and its impact on student achievement and satisfaction [43,44] and success indicators of social media usage [45] and mature critical thinking [46] and trade [47,48]. Selwyn [49] stated that even though there are controversies on social media usage for education and information creation, educators are continuously encouraged to figure out ways to use social media in higher education environments effectively.

According to Hamid et al. [50], social networking can be used for content creation, sharing, engagement, and collective socialization in higher education. Social networking can be enabled to provide instructional materials, educational data, update and promote contact and collaboration. In the same vein, various researchers argued that social media could encourage communication among faculty members and students, support students, strengthen self-confidence and develop a strong partnership and community [51–59]. Specifically, McCarroll and Curran [55] stated that the use of social media is "beneficial to students on a number of levels, facilitating knowledge exchange, alleviating apprehension, enabling socialization and building- community". Moreover, findings of previous studies [46–48] showed that social media has a great potential to improve the learning experience via active communication and cooperation.

Indeed, there is a rigorous movement in using social media by universities. According to Blackhow et al. [59,60], an excellent distance education plan can help remote learning appear not so remote. Some universities create their channels to encourage students to watch videos, cultivate concerted efforts by students and teachers, improve the learning process, and enable students to provide real-time feedback [61–63]. Other institutions of higher education use Learning Management Systems, which are computer systems for the management and administration of teaching material and instructional and e-learning program evaluation [64]. The advantage of using these systems is that all learning information is stored and organized in a virtual learning area (such as Moodle). Similarly, other universities use Blended Learning, which positively impacts the teaching process [65–67]. According to various researchers, blended learning is adopted to reinforce conventional teaching methods with online sessions, which leads the students to respond easier and faster rate of learning [68–70].

The use of social media in higher education continues to increase and change as supporters discuss its merits and demerits. According to the literature, the use of social media also has some drawbacks. The first disadvantage while using social media is the difficulty to ensure personal privacy. It is easy to keep track of people's online activities through advanced technology, whose security and privacy may be threatened [71–73]. Moran et al.'s [74] study supported that faculty members had great concerns about keeping their personal lives and profiles safe. In the same vein, students can be discriminated against because of social media usage [75], being negatively or positively biased by their teachers [76], or facing bullying by their peers who are not friendly [77]. At the same time, the complexity of online communication makes misinterpretations possible and may lead to conflicts. Moreover, some advocated that social media leads to antisocial behavior because all the actions occur in a virtual student world, which is sometimes very different from the real one [78].

Another disadvantage is the difficulty in controlling and monitoring the quality of learning and teaching [79–81]. Since various external open social media sources are available, it is difficult for academics to monitor each tool to guarantee that the students use them appropriately. Moreover, according to Phillips [82], social media can interfere with studying time. In other words, the student's attention may be diverted so that valuable study time is left behind. Lastly, there is a possibility of either no Internet access at home or constraints on data downloading from mobile devices [83], a fact that would make the educational process very difficult. Similarly, ref. [84] illustrated the mobility weaknesses of Learning Management Systems since some of them are only available for selected mobile devices.

For several years, universities in Cyprus have promoted distance learning. It is a country that has got a robust infrastructure, strong communication technology, and good structural electronic strategies to communicate with students. For example, some universities use Blackboard while some others use Moodle and Microsoft Teams. However, it is the first time that Universities in Cyprus have been called upon to respond to a global health crisis and cope exclusively with distance education. Despite the fact that there is a variety of research on the use of social media in higher education, there are limited studies in the Greek context. At the same time, it is important to say that distance education used to be a choice. However, the covid pandemic transformed the choice into necessity. All conventional courses had to be converted to distance courses because of covid regulations and protocols. Thus, on the one hand the students of the conventional courses were obliged to conduct the lessons online, while on the other hand all universities had to develop a distance education program. This turn of events has been a challenge for all universities, especially those that have never had distance education before. Moreover, the academics used to use social media in order to enrich their lessons with supplementary materials, however during the pandemic they are called to use media as a means to conduct the lessons. As Hajli and Lin [85] argued, social media can play a significant role in supporting distance education in the area of education. Therefore, the present study is devoted to reinforcing or rejecting the view mentioned earlier, considering the Cypriot higher educational context. Additionally, the present study can be used as a guideline for institutions, all around the world, that have recently commenced teaching online due to the pandemic.

Other than social media, this research deals with three other important aspects that should be exemplified: teaching and learning, student motivation and support, and community connection. It is important to present the way that the terms mentioned earlier are used in this research. Learning is about a change: developing a new skill, changing a thought, or understanding a theory [86]. When the students attend a course in higher education they set out to learn. In the present study the students received distance education. Distance education is correlated with e-learning, in other words learning via electronic means. It includes the enhancement of knowledge and skills, using electronic devices and internet. Nevertheless, before the evolution of the internet, the distance lessons still existed. For example, in 1840s Isaac Pitman guided his students by correspondence, in 1954 Harvard

University introduced a teaching machine to give instructions to the students, in the 1960s the first computer-based program PLATO was invented and in the late 1970s e-learning became more popular via mail [87]. However, with the introduction of the internet and the technological advancements in the 20th and 21st centuries, e-learning has been improved and well-used worldwide. According to Mohammed et al. (2017: p. 221) [87] "e-learning is a platform that provides institutions with means of improving teaching and learning activities, enhances students-teacher relationship and provide students with means of interactions". In this study the aforementioned means is the social media. Social media gives the opportunity to develop student personalized learning environments and enhance learning experiences via customization and personalization [88].

Academics are responsible for supporting the process of learning by teaching. The role of the teacher is important in providing material, guiding, consolidating, interpreting, and giving feedback to the students to optimize learning [89]. Social media can be used to send course-related information to students; to provide a space where students' academic successes and failures can be shared and discussed; to improve interactions between teachers and students and provide a forum where the teacher can answer any educational question, providing an open-ended way of consulting that may produce interesting or unexpected points of view [90]. Academics can also make content available for future reflection and review through the use of social media, enabling students to revisit and revise their artefacts, enriching the learning experience. The ability to comment on students' creative work, as well as the fact that blogs can be commented on, provide opportunities for input, which helps a learner in his or her search for constructing knowledge [91].

Moreover, the learning process is facilitated by motivating and supporting students. According to Ryan and Deci [92], motivation refers to doing something interesting or enjoyable. Considering student motivation, they argued that motivation happens when a student is attracted to undertake an assignment for its good, the learning it gains, and the feelings he/she may have. Motivation is related to students' support. Support can take many forms, including mental, physical, financial, academic, and spiritual, and it is one of the most important factors in student success in education. The instructor must do everything possible to help the student achieve a higher degree of need satisfaction so that he or she can concentrate on learning [93]. Motivation and student dispositions, can affect students' desire to participate in immersive learning [94]. According to the existing research, students want to be encouraged to be less distracted during lectures [95]. It is important to understand the various behaviors, motives, and approaches to learning by this new generation in adult classes in order to improve learning for all students [96]. Researchers identified that social media plays an important role in student motivation, improving the student-learning environment with creative forms of education, and changing the essence of learning boundaries, resulting in student learning growth [97].

Additionally, when it comes to an educational institute, we must also have in mind the community connections, in other words, the relationship among the students and the faculty members. As Honig et al. [98] stated, community connections give more opportunities to teach and learn. We believe that social practice theory is an adequate theoretical framework for this situation [99,100]. In addition to the psychological and cognitive aspects of change, this theory considers the social and affective dimensions of change. In other words, it contends that the most important aspects of change processes in teaching, learning, and evaluation are social interactions at the workgroup level. In brief, they participate in the social construction of reality, at least in the places where they share common interests. They create a shared language, a distinct approach to using the resources at their disposal, and a situationally awareness of the project's various aspects. Social media may bring together small virtual groups of people who are interested in building awareness around a shared subject in a community of practice while also helping one another. Data sharing is allowed by personal or community blogs, and experts and novices alike may make their work accessible to the rest of the online world. As a result, learners not only engage in an activity and gain skills, but also achieve mutual results and contribute to the group's intellectual capital. Thus, it is also essential to understand whether social media helps in the connected community.

Below new relevant research on the benefits of social networks in the learning processes of Higher Education students is added. The access to knowledge is fundamental [101]. According to Lifelong Learning Agenda (CEC, 2000) information skills as well as motivation and knowledge are of major importance in order to improve and enhance competitiveness and increase employability. Nowadays there is an ongoing argument among academicians as well as in the academic literature that the use of social media and social networking sites would enable collaborative learning and scholarship [102]. Use of social media, social networking sites and smart phones have advantages as well as unique challenges regarding retrieving course material and course subjects, video, applications and so forth. Social networking and social media for collaborative learning have an enormous impact on student academic achievements [103]. Collaborative learning syndicates can improve knowledge and teaching in many educational domains and lead to advanced learning outcomes [104]. In addition, Facebook and Youtube channels use similarly enlarged learning capabilities and understandings of outcomes [105]. Authors in their study [106] argued that ease of internet use can develop cognitive competences through social media availability. In their study, the authors of [102] found that the use of social network and platforms for collaborative learning drives communication and collaboration with peers, and instructors touch academic achievement in a positive manner. The authors of [107] argued that the social media practice shows an enormous positive impact regarding students' achievements and academic performance due to the fact that networking sites enhance interaction, collaboration, inspiration and creativity as well as facilitate their learning outcomes. Facebook, Youtube, Twitter and Instagram have revealed new forms of communication patterns with enormous possibilities for information and communication channels [108]. In [109] the authors argued that the use of social media platforms and virtual reality in tertiary education produces a sustainable and worthwhile procedure of technology heightened instruction. The authors of [110] stated that learning management systems simplifies instruction in an online situation. In the current situation of the pandemic the need for online instruction with the application of more sophisticated communication technology and digital interaction in real time by sharing teaching information is more necessary than ever before and the use of the internet for e-learning procedures is favored [111]. Moreover, in [112], the authors have stated that aside from entertainment reasons and societal commitments, social media has increased in the instruction area.

So far, we have presented the social media advantages, and now we are presenting some negative aspects of the digitalization of education, to make the analysis more complete, reflective and realistic. During the pandemic of COVID-19, distance education replaced in person education. There are many benefits of using social media in education and especially those that have to do with limiting the spread of the COVID-19 pandemic. We put emphasis on the strengths of the use of social media in education, but it is good to highlight some weaknesses and shortcomings, such as: (a) the huge amount of information, including fake news, which makes it difficult for students to sift through the true information; (b) the long time that students stay in front of computers and laptops; (c) the reduction or even lack of social connections and contacts, which affects the mental health of young people; (d) various health problems resulting from the prolonged use of computers; (e) the additional social divisions resulting from digitalization.

Without a doubt, the huge amount of information, including fake news, makes it difficult for students to sift through the true information. Anyone can post any information on social media. Facebook, Instagram, Youtube and Twitter are examples of such social media. Posts on these platforms transmit information very quickly, and it is not easy to determine its validity [113]. They are formulated in such a way as to attract the attention of online friends and constitute an appropriate framework for the dissemination of false news [114]. They point out that social media allows too much fake news that is likely to mislead, defame, manipulate, undermine, satirize people, situations or events, from friendly, family, social, and political environments [115,116]. It is extremely difficult not only for pupils and students but also for adults to recognize the false from the true news. Knowledge and critical thinking are needed so that people do not become the target of manipulation through social networks. Excessive reliance on Internet sources can lead to misinformation and consequent deception [117].

The COVID-19 pandemic has imposed digital platforms as the only means for people to maintain socio–emotional connection [118]. The COVID-19 pandemic came with severe restrictions on social contacts and mandatory lockdowns. As a result, the use of digital devices has multiplied around the world. Consequently, people are being pushed to rely on digital platforms. Education, social contact, education and work, as well as socialization, can only occur online with incredible implications for mental health and user balance. While careful use of digital devices is associated with well-being, excessive screen time is reported to be closely associated with a number of negative mental health outcomes, low emotional stability, isolation, depression and anxiety [119].

It is not strange that the reduction or even lack of social connections and contacts affects the mental health of younger people as well as older people. On a daily basis and around the world people of all ages connect to social networking platforms such as Facebook, Instagram, Youtube and Twitter to communicate with their friends and connect with new online friends. Online friends often do not know each other through their social and professional life. Their connection is through the internet and is not identical to real social life. Social contact brings people closer, they share contact, people can hug each other in joy or sorrow, take a walk together, travel, have a meal, and so forth. In the case of the internet, where the question is communication, people feel indeed alone. Feelings of loneliness, anxiety and stress are not removed. Studies show that social media raises feelings of inadequacy for your life or appearance, fear of loss (FOMO), isolation, depression and anxiety, cyberbullying, self-absorption, and so forth. Learning or tele-learning with the help of Zoom, Teams, Webex, Google meetings and so forth causes great stress; stress about the conversation, about the appearance, the crisis, the communication and so forth, which affects mental health, especially of young people [120]. In [121], the authors report that very young people have realized the negative dimensions and negative effects of social media. Young people think that they are addicted to social media and resort to it because they are hunting something that was true, especially during the lockdown period in the COVID-19 pandemic. In addition, they report that the lessons and online meetings through Zoom, Teams and Webex were compulsory and long and exhausting.

In regard to the various health problems resulting from prolonged use of computers, studies have shown the effects that long hours have on children's health. More specifically, studies have shown that the longer children stay in front of a computer screen, the more they become overweight and have greater sleep disorders and vision disorders and loss of attention and stress [122,123]. There is also an augmented danger related to musculoskeletal problems, vision problems, stress disorders problems, headaches, sleeping problems, hearing problems from the headphones, fear of technology, internet addiction, and so forth [124–126].

In [127], the authors tried to explain the digital divide by focusing on four types of access. The first refers to the lack of any form of digital experience due to both the lack of interest in digital resources and the fear of digital resources, the second refers to the lack of digital resources and internet connection, the third focuses on the lack of digital skills due to absence or insufficient appropriate training and the fourth and last refers to the opportunities for accessibility and use of digital media. Social and class inequalities are a shaping and differentiating factor of digital inequalities. Factors related to access to the internet, hardware (computers and printers), access to tablets, smart phones, and so forth are differentiated and there is essentially unequal access to digital resources [128,129]. Access to distance education due to the lack of availability of digital resources is almost impossible or completely impossible for vulnerable students. Children from low income families do not have access to digital media, computers, mobile phones and internet access [130–134]. The cost of internet access can be a deterrent to low-income families [135]. The low economic level of parents corresponds to very low digital skills for themselves and consequently the aggregated parents are unable to support their children and help them in their lessons and to support e-learning in general [136,137].

Although each of Cyprus's eight universities addressed the COVID-19 pandemic autonomously and individually during the Spring 2020 semester, a concerted and coordinated method was developed at the national level in order to develop a national framework within which all universities would operate. Various stakeholders participated in this collaboration, including: (i) the Ministry of Education, Culture, Sports, and Youth; (ii) the Cyprus Rectors' Conference; (iii) the Cyprus Agency for Quality Assurance and Accreditation in Higher Education; and (iv) the Pancyprian Federation of Student Unions. In the following there are some examples to demonstrate the significance of the numerous talks that took place. Pancyprian Federation of Student Unions The Pancyprian Federation of Student Unions provided feedback to the universities (POFEN). Following, there is a sample of POFEN's feedback:

(a) POFEN letter to the Ministers of (i) Education, Culture, Sports, and Youth, (ii) Health, (iii) Foreign Affairs, (iv) Finance, and (v) Transport, Communications, and Works. The letter was also send to the Chair and Members of the Educational Committee of the House of Representatives, and Universities.
(b) POFEN arranged Video Conference with the Minister of Education, Culture, Sports and Youth.

2.1. Cyprus Rectors' Conference

The Cyprus Rectors' Conference (CRC), comprised of the Rectors of all universities in Cyprus, collaborated amicably to build a unified framework for Cyprus universities' response to the pandemic. CRC has taken the following actions, which are listed below:

(a) On 19 March 2020, the CRC convened via videoconference to discuss the impact of COVID-19 on higher education in Cyprus and to agree on a shared set of actions and a framework for their joint response to the situation. The CRC unanimously passed a Resolution [138], which was then forwarded to the Cyprus Agency for Quality Assurance and Accreditation in Higher Education and the Ministry of Education, Culture, Sports, and Youth. The Resolution emphasized the following:
    1. "The Rectors' Conference welcomes the full compliance of the Higher Education Institutions with all emergency measures decided upon and stipulated by the Republic of Cyprus in order to address the dangers posed by the coronavirus pandemic to society and the economy.
    2. It is the unwavering intention of the Universities to complete, without delay, the current spring semester 2020, in accordance with each University's academic calendar 2019–2020, as announced to students at the beginning of the academic year. The Universities, through the Rectors' Conference, reassure their students once more, that their academic path and professional trajectory, along with ensuring their health and safety, are their highest priority.
    3. At the same time, the Universities have responded to the need to continue reliably providing high quality undergraduate and postgraduate Higher Education, by adopting and implementing the distance learning mode of delivery for each Programme of Study, utilizing online and digital tools and techniques. The high quality of education offered by universities in Cyprus continues to be assured, with the active support and constructive contribution of the Cyprus Agency of Quality Assurance and Accreditation in Higher Education (CYQAA)."
(b) On 30 March 2020, the CRC held a videoconference meeting with the Chair of the Cyprus Agency for Quality Assurance and Accreditation in Higher Education to inform the Agency about the universities' efforts to combat the pandemic, as well as conversations at the CRC and at the universities about the completion of the Spring

2020 semester and the use of alternative assessment methods. The Chair expressed the Agency's complete support and pledged to provide a quality assurance framework for alternative assessment methodologies.

(c) There was a videoconference between CRC and the Minister of Education, Culture, Sports, and Youth on 13 April 2020, to discuss related issues and seek the Minister's cooperation.

(d) On 5 May 2020, the CRC held a videoconference meeting with the Board of the Cyprus Agency for Quality Assurance and Accreditation in Higher Education and the Chair of the Parliamentary Committee on Education and Culture to discuss connected concerns and seek Parliamentary support.

2.2. Cyprus Agency of Quality Assurance and Accreditation in Higher Education

The Cyprus Agency for Quality Assurance and Accreditation in Higher Education has backed universities in their attempts to combat the pandemic. The Agency has taken the following initiatives in this regard:

(a) Helped universities transition from face-to-face to online learning [139].
(b) Recommended tools for online learning [140].
(c) Alternative techniques of midterm assessments are suggested [141].
(d) Created a quality standard and instructions for different methods of final evaluation [142].

As understood from the above discussion, all the Cypriot Universities used online learning delivery during the COVID-19 pandemic. This is of course based on the policies and measures taken at a national level basis.

As the Ministry of Education, Culture, Sports, and Youth mentioned, the online learning delivery offered by Cypriot Universities was successful. It is important to mention that the Cyprus Agency for Quality Assurance and Accreditation in Higher Education (CYQAA) monitored the situation caused by the COVID-19 epidemic, as well as the impact on higher education institutions and higher education in general. CYQAA has taken action within the context of its competencies to assist higher education institutions, students, and academic employees during this period of crisis in order to ensure the quality of online teaching delivery in all Cypriot universities. We believe that further research is needed in order to identify the success of the online learning delivery method. It is crucial that all Cypriot universities must carry out a SWOT analysis of their online learning delivery.

3. Methodology

3.1. Sample

This research is a case study. It was conducted using academic members and students of a higher education institute located on the island of Cyprus. The participants were selected from five different school faculties: Economics-Administration and Computer Science, Architecture and Engineering, Health Sciences, Social Sciences, and Law. Specifically, the sample of the research was randomly selected; two academics and four students from each faculty, thus the sample of the research consists of two groups: (a) 10 faculty members and (b) 20 students.

Written e-mailed consent forms were sought, from the academics and students, before conducting the interviews. The form was used to provide information and introduce the participants to the research, highlighting its purpose as well as the confidentiality of the data generated. To provide trust and openness, participants were also told of their rights to ensure that their privacy and personal data were confidential. Consequently, for confidentiality reasons, the authors will refer to the participants as Student 1–20 and Academic 1–10.

3.2. Qualitative Research Method

A qualitative research method approach was used to achieve the purpose of this research. The collection of data was accomplished by using interviews because the authors aim to capture the "insider perspective" [143] of students' and academics' perceptions of social media as a tool for learning and teaching within faculty. In-depth interviews were implemented to assess the potential for effective use of social media in three areas and possible obstacles in the teaching and learning process.

3.3. Research Questions

According to Lan et al. [144], social media is a digital learning platform with high interaction between faculty and students. The authors believe that social media in distance education can have a significant contribution to higher education (see Figure 1). Specifically, the present study investigated the following research question: What is the impact of the use of social media in (a) enhancing teaching and learning in higher education, (b) motivating and supporting students, and (c) developing community connection?

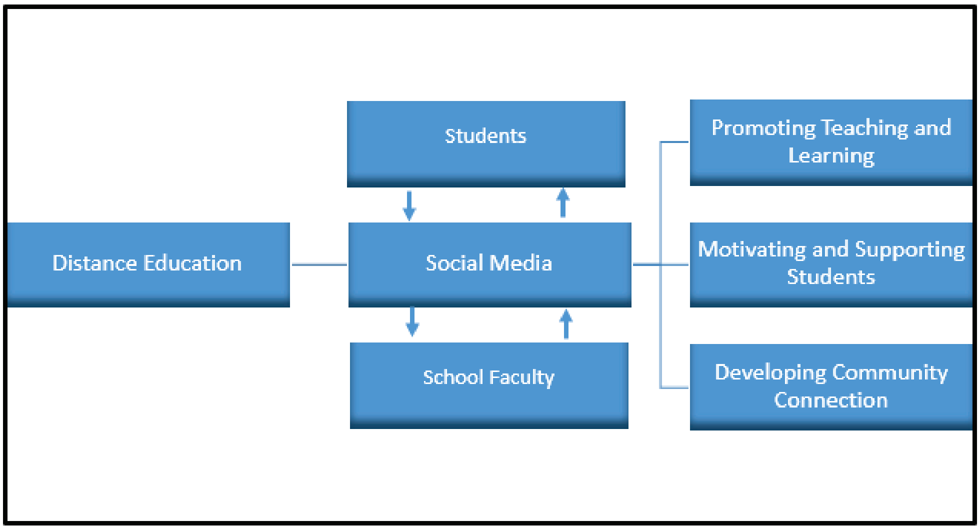

Figure 1. Theoretical Model Adapted from Lan et al. (2001).

3.4. Research Tool

The interviews were undertaken in two phases. During the first phase, academics were interviewed to examine how distance education works and how social media is used in the university under study. Students were interviewed in the second stage to cross-validate the data (gathered from the first stage) and discuss the effectiveness of learning with social media in more detail. The interviews took place online, through Skype, during the COVID-19 crisis in November of 2020. All the interviews were recorded (after approval by the participants). As already mentioned, overall, the researcher conducted 30 in-depth interviews, 10 from academics and 20 from students.

3.5. Data Analysis

The data were evaluated manually using content analysis. In the present study the authors adopted both manifest and latent analysis. In the first case we described what the informants actually said, staying very close to the text, while in the second case we went to an interpretive stage, where we looked for the text's underlying meaning [145–147]. To increase the validity of the research, we performed the analysis separately and afterwards we discussed the results in order to come to an agreement [148]. We followed the following main stages of content analysis: the decontextualization, the recontextualization, the categorisation, and the compilation. At the decontextualization stage we familiarized ourselves with data by reading through the transcribed text to get a sense of the whole. Afterwards, we broke down in smaller meaning units sets of sentences or paragraphs containing similar aspects that addressed the goal [149]. In other words, we used the "open coding method" technique [145]. At the recontextualization stage, we checked to see if all aspects of the material were covered in relation to the target. Along with the final list of value units, the initial text was read again in order to discard non-essential knowledge ("dross") that did not pertain to the study's goal. In the categorization process, themes and categories were identified. The authors used the following key constructs in order to code (a) Teaching and Learning; (b) Motivation and Support; (c) Community connection. Teaching was coded under the subheadings: (a) providing material; (b) guiding; and (c) giving feedback, and learning was coded under the subheadings: (a) developing new skills; (b) understanding theories; and (c) improving critical thinking. Additionally, motivation related to whether the students were attracted to undertaking an assignment and support to any form of support including mental, academic, and spiritual. Lastly, community connection was coded under the subheading (a) connect with academics and (b) connect with other peers. At the compilation stage, the review and writing up process started.

3.6. Interview Structure

The questions of the interviews were clustered around six areas. Both academics and students were asked the same questions for the following reasons: firstly, to avoid bias responses [150] and secondly, to confirm and enrich the understanding from the two sources. The first part of the interview was devoted to the demographic characteristics (gender, age, years of studying/position, and distance teaching experience) and information relating to their internet reliability and speed in their respective universities and home.

The second part was related to the context of usage of social media, considering which social media were used, how much, when, and why. The third part was about the experience in an academic setting with the use of social media. Specifically, they were asked whether they had experience in using social media interactions, which platforms were often used, and how they were fully informed of the use of social media. In the fourth part of the interview, the perceived effects on learning and teaching experiences were assessed. Both academics and students were asked how useful they considered social media in learning, if they felt more interested in the educational process due to social media, and if social media had enhanced their learning/teaching experience and in which ways.

The fifth part was about student support. Academics were asked about the motivation and support that they provide to their students and its possible effectiveness. In contrast, the students were asked if they feel more encouraged to engage in the discussions, class planning, and completion of assignments via the use of social media. The final part was devoted to the barriers or difficulties that an academic or student faced using social media in an online university course. Respondents were also asked to add any comment or suggestion about the use of social media for academic purposes in higher educational institutions.

4. Results, Analysis, and Discussion

4.1. Demographic Analysis

The interviews gave a deep insight into student online activities in higher education, allowing a broader image to be created. At this stage, it is valuable to present the demographic data (see Table 1) and the engagement of the participants with social media. Regarding the gender, two (20%) of the academics were women while eight (80%) were men, while eight (40%) of the students were female and 12 (60%) were male. Turning now to their year of study, six (30%) were first-year students, five (25%) were second-year students, one (5%) was a third-year student, and eight (40%) were final-year students. Considering the distance learning, the experience of the academics was pointed out as follows; one (10%) academic had 1-year experience, three (30%) academics had 3 years experience, three (30%) academics had 4 years experience, two (20%) academics had 6 years experience and one (10%) academic had 10 years experience. The vast majority of the academics (seven (70%)) were between 41 and 60 years old, while the other three (30%) were between 30 and 40 years old.

Table 1. The profile of respondents.

		Academics	Students
Gender	Male	8 (80%)	12 (60%)
	Female	2 (20%)	8 (40%)
Age	<30	-	
	30–40	3 (30%)	
	41–60	7 (70%)	
	>60	-	
Year of Study	1st Year		6 (30%)
	2nd Year		5 (25%)
	3rd Year		1 (5%)
	4th Year		8 (40%)
Years of Distance Academic Experience	1–3	4 (40%)	
	4–6	5 (50%)	
	7–9	-	
	>9	1 (10%)	
Faculty	Economics-Administration and Computer Science	2 (20%)	4 (20%)
	Architecture and Engineering	2 (20%)	4 (20%)
	Health Sciences	2 (20%)	4 (20%)
	Social Sciences	2 (20%)	4 (20%)
	Law	2 (20%)	4 (20%)
Devices Used to Connect in Social Media	Smart Phone	10 (100%)	20 (100%)
	IPad	4 (40%)	10 (50%)
	Laptop	5 (50%)	10 (50%)
	Desktop	8 (80%)	2 (10%)
Social Media Used	Facebook	8 (80%)	18 (90%)
	YouTube	10 (100%)	19 (95%)
	Forums	10 (100%)	10 (50%)
	Viber	5 (50%)	17 (85%)
	Twitter	-	11 (55%)
	WhatsApp	-	3 (15%)
The purpose of Using Social Media	Connecting with friends	10 (100%)	20 (100%)
	Connecting with family	9 (90%)	17 (85%)
	Connecting with other colleagues and students	10 (100%)	-
	Connecting with other fellows and academics	-	16 (80%)
	For academic and learning Purposes	10 (100%)	20 (100%)
	Updating with the local and global news	10 (100%)	16 (80%)
	Demonstrating points of opinion	8 (80%)	7 (35%)
	Doing market research	2 (20%)	19 (95%)

Importantly, all the participants (academics and students) stated that they use social media and have excellent Internet access and connectivity. Both scholars and students were involved in social media regularly. All interviewees referred to their smartphones as being active on social media. Except for the smartphones (100%), the participants also mentioned some other devices for connecting online such as iPads (four (40%) teachers, 10 (50%) students), laptops (five (50%) teachers, 10 (50%) students), and desktops eight (80%) teachers, two (10%) students). It is shown that the participants had easy access via various devices to social media.

Regarding the types of social media used, the data varied among the two group samples. The first group (academics) indicated that eight (80%) used Facebook, 10 (100%) used YouTube, 10 (100%) used Forums and five (50%) used Viber. In contrast, from the second group (students), 18 (90%) referred to the use of Facebook, 19 (95%) to the use of YouTube, 10 (50%) to the use of Forums, 17 (85%) to the use of Viber, 11 (55%) to the use of Twitter and three (15%) to the use of WhatsApp. It can be seen that both academics and students use several social media. The highest social media used in both groups was YouTube. Academics, however, also had a preference for the Forums (100%), the fact that it is opposite to the community of students, as only 50% had indicated that they used it. Moreover, Facebook was the second-highest used site by both groups. The use of Viber was at the top of the student preferences, which was not in the academic community, as it was used by just half of them. Students also used other social media that were not mentioned by academics, such as Twitter and WhatsApp.

Given the prioritization of the participants' social media interests, it is important to examine the reasons for using them. While respondents used social media for more than one reason, according to them, the key motivation for using social media was communication. All academics and students used social media for connecting with friends. Similarly, 90% (9) of scholars and 85% (17) of students contacted family and relatives. Additionally, 100% (10) of academics stated that they used social media for connecting with other colleagues and students while 80% (16) of students with other fellow students and, of course, academics. Lastly, the interviewees also mentioned some other reasons for using social media such as keeping updated with the local or global news (10 (100%) Academics and 16 (80%) Students), demonstrating points of opinion (8 (80%) Academics and 7 (35%) Students) and doing market research (2 Academics (20%) and 19 (95%) Students).

4.2. Social Media as a Teaching and Learning Tool

Now, turning to the use of social media for academic and learning purposes, the data revealed that social media played a significant role. Starting with the academic community, the COVID-19 pandemic tends to lead them to the full use of social media to support their lectures. One hundred percent of academics referred to both YouTube videos and extra links for enriching their lectures and the Forums for enhancing communication and support to the students regarding their assignments. At the same time, as academic 1 stated, "Moodle is a fantastic instrument in the hand of any academic, and all we have to do is to take advantage of it". Similarly, academic 5 mentioned that "social media always enlightens in many ways my lessons". Moreover, Facebook was used by several academics (seven) for online lectures and seminars among colleagues and contact with colleagues from other universities (eight).

Shifting to the students group, the data showed that the students use social media for learning purposes. All of the students who took part in the research (100%) said they use social media to learn and complete their university courses. Some indicative answers are the following: "Of course I use social media for learning purposes" (Student 3); laughing … "I cannot imagine myself without learning from social media… you can find everything on YouTube" (Student 14); "… most of my courses use social media… " (Student 8). YouTube and Viber are used by most students, while Forum is used by half of the students (50%). From the responses, it is an interesting fact that students were using more Viber and WhatsApp for dealing with group course assignments in contrast with the academics who used the Forums the entire time. As student 4 mentioned, "Most of us frequently use Forums with our tutors to discuss the lesson and our activities. We use Viber or WhatsApp between us (students) to discuss any group work or solve course questions". Also, student 12 stated that "Viber is easier for us because we can also conduct group call sessions and discuss everything for our course tasks". This evidence may also explain the high rate of use of Viber relative to that of Forums in student groups, as they often use Viber for study purposes.

According to the academics, the university started to use full distance education courses in March 2020 because of COVID-19. As a result, Spring Semester 2020 courses were completed by distance education, using Moodle and Microsoft Teams. The in person university classes started again in September 2020, while at that time, the university adopted the Blended Theory Model. However, this did not last for long since the university switched back to completely online education by the end of October 2020. The interviews of the present study took place during the period that the courses were conducted via the use of Moodle and Microsoft Teams.

It is essential to state that the data gathered from the third part of the interviews showed that a series of online training courses and lectures about using social media as a teaching and learning tool were embraced by academics and students. In particular, to increase understanding of how to use them effectively, a series of seminars took place to introduce and explain the Moodle platform and Microsoft Teams. They were educated in all of the educational options embraced by these sites. They were kindly asked to use them appropriately to facilitate the efficient running of the university courses since the pandemic still exists, as Academic 6 and Student 17 mentioned. Blackboard was also assisted by the university by launching and upholding a mobile service application package that provides a mobile service to students (Students 3, 16, 19 & 20). This move is in line with the study proposal by [151] for Blackboard support. Overall, the interview data supported awareness by both students and academics of how to use social media for teaching and learning purposes.

4.3. Discussion

The results of the content analysis showed that the participants' answers support the view that media impacts positively on student learning in higher education (see Figure 2). This article presents, discusses, and analyses the value of social media in three thematic areas: (a) enhancing teaching and learning in higher education, (b) motivating and supporting students, and (c) developing community connection.

4.4. Social Media Enhancing Teaching and Learning

These research results showed that the constructed and sustainable partnership between academics and students in learning and content sharing is the latest creation of social media. During the interviews, all participants (100% of both groups) answered that social media enhanced the teaching and learning process, which can support Grodeka and Wild's [152] study. Therefore, they were asked to explain in which ways the use of social media helps these processes.

Expanding on this, the authors first present the academics' views. Academics underlined the importance of social media as an economical way to transfer details to students (Academics 2, 3, 7 & 8). Moreover, the majority of them found the use of social media great for posting useful information and links to the students, for further studying and understanding of the lesson (Academic 9), and publishing of the lecture sections for examples power points, videos, guidelines, and so forth (Academic 10). As Academic 7 mentioned, "social media has increased my resource access". Of course, it helps to quote updates on assignments (Academic 2, 3 and 4) and changes on the course timetable (Academics 1, 5, 7 and 10). All academics also mentioned that it is an easy way to post students' accomplishments or educational achievements.

Additionally, academics underlined the importance of social media in guiding the students to learn. The presence of Forums for their subjects helps to "quickly explain students' questions about the lesson" (Academic 4), to "have a conversation about lesson strategies and material with students" (Academic 6), and to "facilitate class discussion, project work or assignments" (Academic 9). The majority of academics identify the use of social media in interpreting and developing the concepts and theories of the lesson. For example, academic 6 pointed out, "I guided my students to have a more deep insight in lesson's theories by using game simulation and online case studies". He also added that he organized theory debates in Forums, where each student had to consolidate the lesson's theory and give examples. Similarly, academics (5, 7, 9) argued that they used hypothetical scenarios based on course material and asked students to reflect critically on them as a group. Academic 7 characteristically reported, "it was amazing how students reflect on the scenarios. I have been watching their conversations and I was giving guidelines where it was necessary". In the same vein, Academic 3 stated, "I let my students contact more research and investigate in depth lesson theories to optimize learning". Social media allowed the students to reflect on the provided material, do more research, and develop lesson theories. These findings are in agreement with the Moran et al. [153] study, which reported that the faculty members supported that social media sites are valuable tools for teaching and learning. Moreover, it supports Liburd and Christensen [154], who claimed that "social media supports a more reflecting approach to learning and offers the opportunity to make teaching more practical and application-oriented".

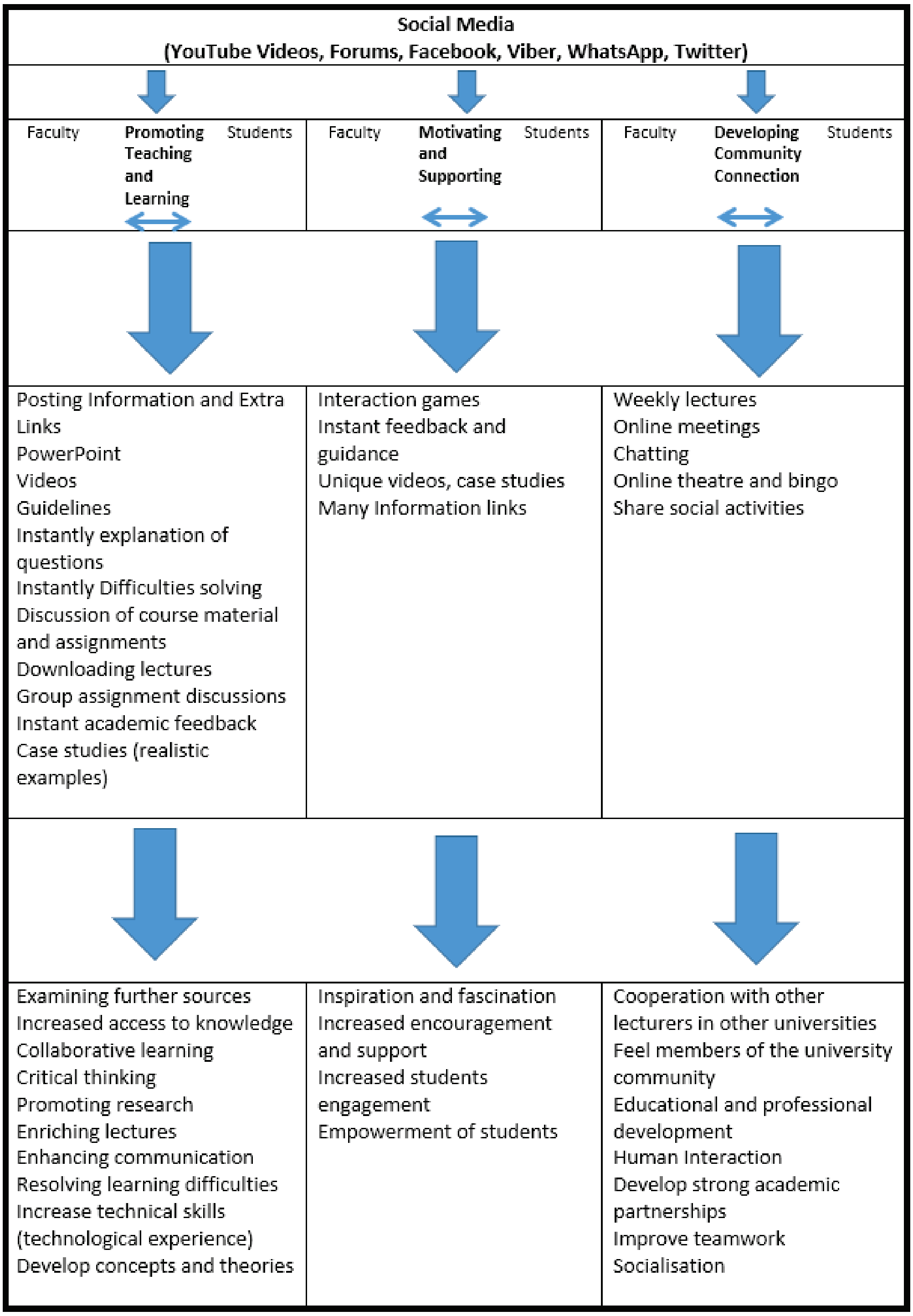

Figure 2. Results—The Value of Using Social Media in Higher Education.

In the same vein, students' group answers gave evidence about the positive value of social media on learning. All students referred to the advantage of direct access to their courses. They mentioned that it was easy to receive any course official statement (Student 18), to check course assignments (Student 19), and marks (Student 20). Similarly, all students said that it helped them to download lectures and any information posted by their academics to enhance their learning. For example, Student 1 claimed that he watched some of the lectures again to clarify some points, while Student 7 called the downloaded lectures and videos his "learning weapons".

Moreover, social media proved to be supportive in helping them discover new sources (Students 1, 7, 16 and 20) and providing the courses with a background context (Students 3, 6, 15, 18 and 20). Specifically via social media, academics provide examples or explain theories, by which, as it was noted, the reading was further facilitated (Student 20). Social media was lauded for getting students out of the theoretical bubble by bringing them into an external sense of only reading all these books, presenting examples of realistic applications of theories (Students 2, 4, 13, 15 and 20). At the same time, "students' doubts were easily explained by providing a discussion in the Forum based on our topic... our tutor was always there to answer any question or resolve any learning difficulty" (Student 14).

Additionally, the data showed that social media helped students access current events and examine further sources based on opinions (Students 5 and 3). For example, Student 9 said, "I have improved experience to different viewpoints". Increased access to knowledge via social media was also shown to help expand their resource base. Besides, Student 1 said, "I have the opportunity to share the concepts/ideas I have learned in other lessons".

Moreover, it is important to mention that the majority of the students (16, (80%)) referred to the weekly group assignments as a way of improving their critical thinking. For instance, student 7 mentioned that he had to interact critically with his fellow students to complete the assignment. There is a connection between social media and visual and active learning in terms of improving students' thinking skills. When using social media, students used videos, photographs, and short stories to view vast quantities of information (Students 4, 6 and 9). This verbal and visual knowledge aided students in making connections, comprehending the relationships between concepts, remembering relevant details, and expressing their thoughts through writing. Students' imaginations were piqued and their ingenuity was enhanced as they learned from social media.

Furthermore, student 9 said, "We had to reflect on all lessons theories and discuss in detail in order to have a good result". In the same vein, student 12 reported that they had opportunities for intercommunication and feedback, collaboration, and access to resources and interaction that are not limited by geography, a reality that enhances active learning by "involving them in the development of content". These are findings that agreed with Dyson et al. [155] study, which supported that social media offered self-study course material and promoted critical thinking. The findings are also in line with Liburd and Christensen's [156] study, which stated that social media encourage learners through engagement and collaboration to engage and build in-depth learning. At the same time, it follows Kele's [157] study, which stated that social media is one of the key means of collaborative learning.

Lastly, it would be an oversight not to mention that both groups of participants supported that the use of social media contributed to the increased technological experience. Here are some characteristic statements of the participants. "I realized that using more technology to support my lessons helped me enhance my technical experience" (Academic 10). "The fact that I had to teach all by distance to my students led me to look for more realistic rather than theoretical information, a fact that makes me an expert in using social media to search and implement new class materials" (Academic 5). "I already have technical skills, but I liked to learn more... I'm particularly excited about the use of Moodle and how Teams works" (Student 19). According to Kathuria [158], students can learn new technology and develop computer acquaintance by using social media.

4.5. Social Media Motivating and Supporting Students

Let us turn now to the second thematic area, the value of social media in student motivation and support. The majority 80% (eight) of academics believed that the presence of social media made the lessons more attractive for the students. For instance, Academics 7 and 5 said that it would be very hard to have an interesting lesson for the students without social media. Academics 2 and 3 also mentioned that social media-inspired some students to engage more in debates and discussions. Academic 10 exemplifies that he enjoyed having discussions on Forums with the students, especially when he was about to give feedback and support. It is important to say that four out of eight academics referred to increased encouragement and support due to the full-distance education led by COVID-19. They explained that the whole situation led them to want to be closer to and more supportive of the students. The only way, therefore, was with the use of online social media (Academics 3, 5, 7). Characteristically, Academic 9 said, "In order to attract the students and feel content with my course, I always try to use unique videos, case studies and examples", while Academic 3 said, "I want to have happy students, full of energy and ready to learn... so I include many interaction games in my lessons". These come in line with Nicol and McFarlane-Dick's [159] view that social media is a way to empower the students. It also supports the research of Ernst et al. [160], which stated that students use social media because of the pleasant experience they got from using it.

Similarly, the majority 85% (17) of students felt that social media played an important role in being motivated and supported. Social media knowledge was found to have improved incentives for students to engage in discussions. For example, it is mentioned that the existence of "impressive videos" (Student 11), "awesome interactive games" (Student 7), and "presentations rich in information links" (Student 20) made the lesson more fascinating to attend and take part in the activities. In addition, Student 4 quoted that "social media has served as a motivation for more reading because I am more interested in it". At the same time, Student 9 said that he was often inspired to do more in-depth research on the subject discussed at the lecture.

Moreover, it is of great importance that the student group also referred to COVID-19. A vast amount of 65% (13) of students mentioned insecurity and anxiety because of COVID-19 regulations. "It's frustrating to have a dissertation to do, but you can't physically visit your tutor or go to libraries" (Student 3). Nevertheless, the same student argued that through the Forums, Microsoft Teams, and Viber, he had full support from his tutor and characteristically stated, "the guidance of my tutor is more than appreciated". At the same time, four (66.6%) of the first-year students reported that social media use helped them navigate the registration process, attend seminars for staggered financial assistance, and get virtual orientation for the university and services. These data are similar to the findings of Wodzicki et al. [161] research. Despite the results of the research, it is not certain that the Coronavirus will last forever. Thus the faculty must provide more motivation to the students in order to keep their rigorous participation in discussion on social media. One way to do this is to ask students to participate as part of their course evaluations once a week or a given number of times per semester. Unless there is some reward, such as marks for evaluation, students lack the desire to interact online [162]. Additionally, as Bowers-Campbell [163] quoted, a system of virtual gifts can be used as a rewarding method for recognizing students' efforts in participating online.

4.6. Social Media Developing Community Connection

Last but not least is the third thematic area dealing with the impact of social media on the community connection. The data of the research showed that social media has a positive impact on the relationships inside and among groups. All academics and students spoke with positive comments towards the effects of social media on their relationships. First of all, academics developed strong partnerships with their colleagues since they have to face the same ambiguities because of the full distance learning and use of technology. Thus as they reported, they had on a regular basis online meetings (Academics 2, 5, 8 and

10), a Forum where they discuss any educational or administrative matter (Academics 1, 2, 6 and 9), a group on Viber for other than academic purposes (Academics 2, 3, 5 and 8) and weekly lectures via Facebook for educational or professional development (Academics 4, 6, 7, 9 and 10). Moreover, some of them mentioned that they arrange cooperation with lecturers in other countries (Academics 3 and 10). Simultaneously, the use of Forums and Teams gives a glimpse of human interaction among students and academics. It is a more student-oriented method that gives the opportunity to "break the ice" (Academic 6) between students and academics.

These research results strengthen the Lan et al. [164] study, which claimed that social media is an emerging digital learning platform in higher education and has a unique advantage in connectivity and interaction between students and faculty in the virtual community. Similarly, the results come in line with Ukwishaka and Aghaee's [165] research, which supported that social media promotes peer-to-peer and student-teacher interactions.

At the same time, the majority, 85% (17) of the students, stated that they found the use of social media an excellent way to connect with their academics. All students agreed that the use of social media helped them to feel like members of the University community and be connected, since they could not meet physically because of COVID-19 regulations. Ninety percent (18) of the students reported that they had live conversations and talks with their peers, which mostly allowed them to feel like they were students who belonged to the university. In particular, social media facilitated student's involvement and participation in online activities such as theatre and bingo (Students 4 and 7), improved their communication skills (Students 1, 6 and 10), and developed their ability to work on team projects (Students 2, 3, 8 and 9). As Student 9 said, "If it wasn't for Viber, how could we ever manage to do our assignment and meet my fellows after all?". He also added: "We have a Viber group to discuss football and the latest news". Likewise, Student 2 said that she made a friend, and they speak about fashion and design.

Moreover, 70% (14) of the students indicated that they were encouraged to share their social activities and make arrangements to join together after COVID-19. Overall, this study supports Ellison et al.'s [166] argument that indeed students are further integrated into university life by using social media. It is also in accordance with Gray et al.'s [167] study which claimed that social media could empower the connections in the university community and with Sanchez et al.'s [168] vision that social media promotes high levels of team working and cooperation.

4.7. Main Barriers/Recommendations for the Use of Social Media

Academics and students argued that using social media as a teaching and learning tool is of great significance; they were asked about the main obstacles to their limited use (see Table 2). It is interesting the fact that 60% of the academics have admitted that, in the beginning, they were concerned about their privacy. Fortunately, as the same academics said, the university faculty placed strict rules on privacy that would risk grades if the students omitted them. Indeed, no incident has ever been reported. Moreover, one of the key difficulties, identified by administrative academics, was the vast workload (2 and 10), as they had to verify the adequacy of the study guides and module materials before being distributed to the students.

Nevertheless, this is a big advantage of the university itself, because according to Mason and Rennie [169], there is a necessity to evaluate and recognize the work of the teachers as acceptable forms of academic work. The management and monitoring of information and student activities was another difficulty. The majority of academics (75%) said that it was very difficult to monitor the vast amount of students' activities on different social media. As Academic 8 said, "it was a very time consuming and exhausting procedure". In this case, the university can consider the Bubas et al. [170] study, which proposes a more integrated environment that incorporates a Moodle system with a Wiki tool built-in and an e-portfolio system such as Mahara's College. The authors pointed out that the separate topics generated by the various tools were handled more effectively [171]. The authors argued that there is the potential to create a more personalized learning experience for students by combining these existing learning channels with Web 2.0 features.

In conclusion, 85% of the students reported as their main difficulty the controlling of the vast amount of information gathered from all the courses in social media. As Student 13 quoted, "It was very difficult for me to have constant daily contact with the social media in order to be up to date and take part in the courses". Likewise, Student 17 stated that he spent too much time on social media in order to be consistent on the scheduled assignments. This falls in line with the academics' references to the difficulty in managing information and the large workload. Perhaps the above obstacle can be resolved by setting a stricter program in each course with assignment specifications, word count limit comments, and posting hours. In this way, the information will be less and more precise, a fact that would help to reduce the workload. In addition, the fixed posting hours would enhance, for both faculty and students, better time management.

Table 2. Barriers and Recommendations.

Barriers	Recommendations
Large workload Time consuming	- Setting a strict program - Word count limit comments - Posting hours
Difficulties in monitoring the vast information Time consuming	- Incorporate a Moodle system with a Wiki tool and an e-portfolio system

5. Conclusions

Education employs digital technology as a new or enhanced method for better teaching and learning [172]. Social data has developed as a technology of highly useful personal contact. Still, can the incorporation of social media in higher education institutions positively impact the education process? Or as Rehow et al. [173] questioned, does social media serve as educational tools?

In a bid to improve academic success through a number of other methods, social media assists students socially. Social media builds partnerships that would never exist in the real world, putting together a wider variety of people and addressing the regional, class and ethnic barriers. In the educational process, the adoption of social media used by both students and educators has been shown to be more than beneficial through the current study. Nowadays, technology investment and social media incorporation, as future creative tools, have become important for the new generation.

Social media platforms, like a cooperative standard, enable students the opportunity to elucidate innovative educational projects and share data. Students claim to be satisfied regarding the use of Facebook, Instagram information with the team students and discuss details, information and relative issues considering every element [174]. Facebook offers chances to students to develop self-confidence to participate within teams and build trust between peers. The authors of [174] pointed out that social media networking is considered by students as a way to permit communication in real time. More especially according to students social media networking is a means of communication not only without time but without space restrictions. They also claimed that social media networking is a means for in depth discussions and immediate dynamic feedback. The author of [175] endorses the utility of social media in tertiary education, due to the fact that it produces a worthwhile type of knowledge enhanced teaching and learning. In addition, ref. [175] argued that social media networking benefits academic society from the point of view of dynamic collaboration, flexibility and interaction in order to maximize didactical methodology to provide the appropriate education needed in this specific high tech era and to offer both new learning prospects as well as new didactical challenges. Teaching by social media platforms and universities LMSs could and should provide on effective online instruction virtual environment appropriate for the new pedagogical demands.

Hajli and Lin [176] rightly argued that social media could significantly support online learning in education. This research seeks to fill a gap in the literature by providing evidence that the use of social media by higher educational institutions impacts positively on the educational process by promoting teaching and learning, motivating students to be active participants, and establishing connections in the university community. This provides further insight into the controversies surrounding the incorporation of social media in higher education and demonstrates how students and academics have reacted within a university with an already large social media existence.

Additionally, the results of this research indicate that every university should, as a priority in today's higher education, develop a strategy of incorporating information technology, including the use of social media. Nevertheless, the current study is a case study, so additional field studies should be conducted to generalize the findings. Moreover, future research should be devoted in every research question separately, in order to have a more in-depth investigation and more detailed results to be used by the universities. The authors are committed to continuing to explore and expand on all of the topics covered in this study in the future. Therefore, it can be easily adopted as a guide for future and further research. Specifically, future research could investigate the changing pedagogical strategies of educators through their use of social media, eliciting creative good practice models by using mixed methodology. Universities, backed by adequate policy tools and realistic guidance, should encourage social media as a means of teaching. Since we live in the big data and cloud computing era, there will be a growing interest in the field and its effects on education, in general [177–181]. Practice recommendations encourage scholars to investigate and acknowledge social media tools, not as an 'attach' technology, but as a detailed plan for successful teaching that facilitates the pedagogical transition to the use of social media technologies. Overall, the results of this research showed that social media has a positive effect on higher education. Social media enhances teaching and learning in higher education, motivating and supporting students and developing community connections. These results support the significant role of the use of social media in higher education. The authors recommend that university faculties should incorporate social media into the teaching and learning process.

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Article

Student Grade Evaluation, Survey Feedback, and Lessons Learned during the COVID-19 Pandemic: A Comparative Study of Virtual vs. In-Person Offering of a Freshman-Level General Chemistry II Course in Summer at Xavier University of Louisiana

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Abstract: A primary motivation for this study was to compare student perceptions and performance within a virtual learning environment to the traditional in-person learning experience for the General Chemistry II course taught during a 5-week summer session at Xavier University of Louisiana, a minority serving institution. The authors present quantitative and qualitative analyses including the comparison of student performance on exams during the COVID-19 remote learning experience with exam performance over a 3-year period of conventional in-person instruction. In this article, student grades, survey feedback, and learning outcomes are outlined. This study was performed to assist the faculty in improving and enriching the course content and its delivery, as they coped with the transition to a virtual learning environment imposed by the COVID-19 pandemic.

Keywords: history/mission; internet/virtual learning; first-year undergraduates; second-year undergraduates; general chemistry; survey; assessment

1. Background

Xavier University of Louisiana (Xavier) is the only historically Black and Catholic institution of higher education in the United States. Saint Katharine Drexel and the Sisters of the Blessed Sacrament (SBS) sought to create educational institutions from kindergarten through college that serve the African American and America Indian communities. The SBS established elementary schools, a high school, and a normal school, which evolved into Xavier University of Louisiana [1]. In 1925, Xavier University was established in this context to promote stewardship, leadership, and service. Xavier's mission—"The ultimate purpose of the University is to contribute to the promotion of a more just and humane society by preparing its students to assume roles of leadership and service in a global society"—continues to reflect the institution's founding purpose [2]. Xavier is the only Black and Catholic university in the United States. The university continues to produce well-educated graduates positioned to become leaders in the community and to promote Xavier's social justice mission through education, research, and community service. Xavier offers preparation in more than 50 majors on the undergraduate, graduate, and professional degree levels. The university's Fall 2021 enrollment was 3604 (approximately 76.9% African American/Black, 5.0% Asian, 5.7% White, 4.6% Hispanic/Latino, and 7.8% others; approximately 76.0% female, 23.9% male, 0.1% not reported). Of the 2749 undergraduate students, 77.3% majored in Biomedical and Physical Sciences.

According to the U.S. Department of Education, during the past decade, Xavier has ranked first nationally in the number of African American students earning undergraduate degrees in Biology, Chemistry, Physics, and the Physical Sciences [1]. Xavier also has a national reputation for producing health professionals. In 2012, according to the Association of American Medical Colleges, the university was named the number one undergraduate source of African Americans who complete their medical degrees [1]. In September 2015, the *New York Times Magazine* chronicled the unmatched success of Xavier's premedical program [1]. The iniversity is first in the nation in the number of Black graduates who go on to earn doctorates in the Life Sciences, and fifth in the nation in producing African American students who earn Ph.D.s in Science and Engineering [1]. The College of Pharmacy has also consistently been among the nation's leaders (top 4) in awarding Doctor of Pharmacy degrees to African Americans [1]. The number of students graduating with Chemistry degrees from Xavier is one of the highest in Louisiana. Xavier has been ranked by the American Chemical Society (ACS) as one of the top 25 universities in the nation in awarding bachelor's degrees in Chemistry and has consistently ranked first in the U.S. in producing African American Chemistry graduates [2,3].

2. Need for the Study

Noting the magnitude of the COVID-19 pandemic, almost all the academic institutions in the United States and in most other countries shut down their physical campuses to the students, forcing a majority of faculty instructors to urgently adjust to a new virtual learning environment [4–7]. To do so, they have relied on remote teaching delivery platforms provided by Adobe Connect, Google Classroom, Zoom, etc., to reach and serve their students [8–10]. While various institutions have selected different tools, many have focused on addressing and overcoming similar challenges as they had to adapt to emergency remote learning over the more conventional online learning [11–18].

Similar to many small liberal arts colleges, Xavier, a predominantly undergraduate institution (PUI), provides a conducive learning environment that is based on extensive faculty–student interactions and small class sizes. Xavier students have ample access to a host of resources, such as free tutoring, a campus-wide open-door policy for faculty and staff, and peer mentoring. It is important to note that Xavier University did not offer any virtual course offerings in Chemistry before COVID-19.

During the campus shutdown, Xavier was swift in trans-mediating academic resources to a virtual environment. All classes, tutoring, advising, and office hours were conducted synchronously via Zoom from March to August 2020. Since the Fall 2020 semester, following social distancing and other CDC (Centers for Disease Control and Prevention) COVID-19 guidelines, the university has slowly and methodically transitioned some services, including the majority of classes, back to campus. However, because of their large enrollment, General Chemistry I and II courses continued to be taught virtually until Fall 2021 semester.

Many studies have been performed and published on the various approaches taken in higher education to deal with the pandemic-related limitations and their outcomes. Gamage et al. [17] reported new delivery methods and practices for teaching lecture and laboratory courses. Pilkington and Hanif reported how they used technology by providing pre-recorded lecture videos to the students rather than live streaming of lectures [18]. Studies comparing student learning in in-person vs. virtual or hybrid modalities have suggested that there are no significant differences between the different modes of course content delivery. Rather, student performance primarily depends on the pedagogical approaches used to deliver course content [19,20]. Since the beginning of the pandemic, the change from in-person to virtual instruction has been rapid and unprecedented, and many students have found it challenging to adapt. Socioeconomic inequities such as lack of reliable Internet connectivity and access to adequate computer equipment added more uncertainty for a large number of students. Xavier University used a student survey to identify such problems and addressed them to some extent with a laptop loan program and parking lot Wi-Fi zones where the students could connect to the Internet in their cars. Additionally, in both Xavier students and college students around the globe, the

COVID-19 pandemic has induced a variety of negative emotions, including frustration, anxiety, and isolation [21–23]. According to an institutional survey administered soon after the end of the Spring 2020 semester, first-time freshmen overwhelmingly preferred a return to in-person classes for the Fall 2020 semester, while continuing students indicated mixed preferences for virtual and in-person or a combination of the two. As the academic world transitioned to a predominantly virtual space, the authors developed this study to analyze the perceptions of students in the General Chemistry II course and to address the following questions:

1 How easy or challenging was it for the students to adapt to virtual learning?
2 What indicators are important for understanding student adaptation to virtual learning?
3 How can we improve student achievement of learning outcomes in a virtual environment?

3. Study Details and Results

The impetus for the study described in this paper was the precipitous decline in student performance in the General Chemistry II course (CHEM 1020) at Xavier. This study specifically focused on student performance in CHEM 1020 within the accelerated summer session course. For the summer session course, this study showed the impact of the COVID-19 pandemic on CHEM 1020 students' grades compared to the previous 3 years of CHEM 1020 instruction. The authors sought to identify the factors that might be responsible for the observed differences and investigate whether they could be countered. The data used in the study were collected at Xavier from 2017 to 2020 for the 5-week summer session course. The traditional General Chemistry courses at Xavier consist of three distinct components: (1) classroom instruction; (2) formative assessment and group learning activities; and (3) summative assessment using multiple-choice exams. In addition, student learning is supported through easy access to peer tutors, open-door office hours, and regularly scheduled review sessions. During the in-person lectures, students are introduced to new concepts through a variety of pedagogical strategies (i.e., traditional lectures, group/collaborative learning, just-in-time teaching, etc.). Formative assessments and group learning activities are accomplished during an instructional period called *drill*. Students are required to enroll in the CHEM 1020 lecture and drill concurrently. The drill sessions begin with short quizzes on pertinent topics and concepts discussed in lecture. Students receive immediate feedback on these quizzes and have a chance to earn a portion of the points lost by working with their peers on drill problems similar to those missed during the quiz. The drill period, a primary source of student engagement and formative assessment during traditional in-person instruction, has traditionally been a cornerstone of Xavier's success in producing graduates in the Physical and Life Sciences [24]. Finally, exams consisting of multiple-choice questions are used for summative assessments. Points earned in lecture and drill components are combined and, based on these, the final course grades in CHEM 1020 are assigned.

Throughout the 5-week summer session, there are 10 formative assessments (drill quizzes) and 4 exams (3 semester exams and a comprehensive final exam). Drill sessions are scheduled 3–4 times per week, for a period of 2 hours each. During this study, the summer class sizes varied from 32 to 48 students. To increase instructor–student interaction opportunities, the lecture students were divided into two drill sections. The abovementioned details are summarized in Table 1.

Table 1. Representation of course curriculum.

Course Components	Length
Traditional Classroom Instruction: Lecture	5 Days/Week (each session ~85 min) for 5 weeks
Formative Assessment and Group Learning Activities: Drill	Problem-Solving Session and Drill Quizzes (60–90 min/3–4 times per week)
Summative Assessment: Exams	3—Exams (50 min each) 1—Final Exam (120 min)

Prior to the COVID-19 pandemic, the Chemistry Department faculty were not enthusiastic about offering virtual Chemistry courses and had no such plans to do so for the foreseeable future; the mandatory transition to remote learning was the impetus to adapt the CHEM 1020 curriculum classroom instruction and the drill period to the virtual environment. As previously mentioned, student engagement and formative assessment during the traditional in-person drill sessions have played important roles in the success of Xavier graduates, and thus, a change to virtual instruction represented a true dilemma [24]. It was decided to conduct classes synchronously on the Zoom platform, which enabled interaction between the instructor and students, and use a document camera to solve problems and PowerPoint slides to convey information. All the lectures were recorded using Zoom's recording feature and made available to students through Xavier's learning management system (LMS), Brightspace. Formative drill quizzes were administered through the "Quizzes" tool in Brightspace and proctored in real time using Zoom's video conferencing feature. Zoom's "Breakout Rooms" feature was used to encourage peer-to-peer interactions during group learning activities after the drill quizzes. Summative assessments (three semester exams and a comprehensive final exam) were also administered through Brightspace. A key difference between in-person iterations of the course and the synchronous virtual offering during the Summer 2020 session was that the instructors were unable to provide meaningful immediate feedback on drill quizzes administered online. Specifically, online drill quizzes could only be graded as correct or incorrect, whereas in-person instructor feedback normally included analysis of the student's approach to solving each question.

Students enrolled in the Summer 2020 session were asked to complete a voluntary survey designed by course instructors. The survey was administered using Qualtrics software (www.qualtrics.com and accessed on 12 January 2022). A total of 27 out of 47 students, who were at freshmen level (2nd semester), volunteered to participate in the survey, which included the six questions listed in Table 2. The class consisted of 85% female students, which is typical for the institution. The survey responses were anonymous, with no identifying information. The survey was submitted to the Institutional Review Board (IRB) for approval; however, because of time constraints, it was not reviewed prior to administration. The survey was later reviewed by the IRB with no concerns/inquiries.

Table 2. Course survey items.

Question Number	Question
Q1	*Have you ever taken a full semester of General Chemistry I or General Chemistry II lecture and drill at Xavier?* *Yes/No*
Q2	*Is this the first time you have taken a full semester of General Chemistry lecture and drill online?* *Yes/No*
Q3	*How would you compare your learning outcomes between online classes and in-person classes?* *(a) No difference* *(b) Nothing to compare* *(c) Online is better* *(d) In-person is better*
Q4	*How do you feel your performance would have differed if you had an in-person lecture/drill course this semester?* *(a) No difference* *(b) Grade would have been better* *(c) Grade would have been worse*
Q5	*Not being at Xavier, what is the most important part of the in-person lecture/drill system that you miss? (Choose all that apply)* *(a) Reinforcement quiz group discussion* *(b) Tutoring center* *(c) One-to-one teacher-student interactions* *(d) Other (please explain)*
Q6	*Is there anything else you would like to share about your experiences in General Chemistry this semester? (optional)*

The data from the previous three summer sessions (2017–2019) of in-person instruction were compared to that of the virtual Summer 2020 session (Table 3).

Table 3. Average grades for summative assessments (three semester exams and final).

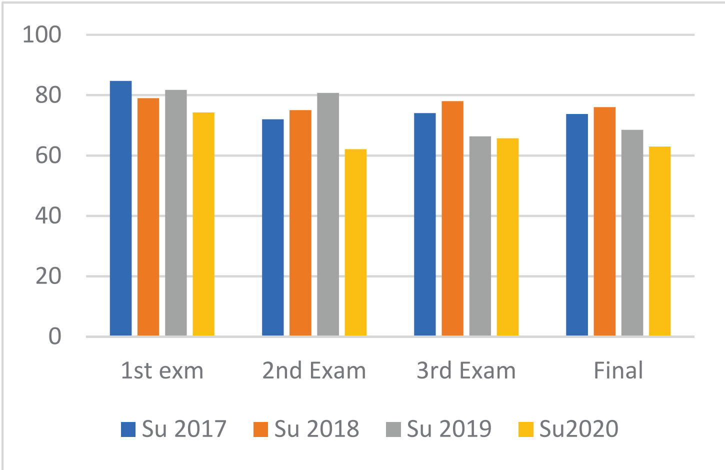
	Summer 2017	Summer 2018	Summer 2019	Average (2017–2019)	Summer 2020
Exam 1	84.7%	79.0%	81.7%	81.8%	74.2%
Exam 2	72.0%	75.0%	80.7%	75.9%	62.1%
Exam 3	74.0%	78.0%	66.3%	72.8%	65.7%
Final Exam	73.7%	76.0%	68.5%	72.3%	62.9%

Upon comparing the data from the semester exams, final exams, and final GPAs earned in the course, a significant decline was observed from the previous years (2017–2019) to Summer 2020 (Figure 1). Averages of 81.8, 75.9, and 72.3% were observed for semester exams 1, 2, and 3, respectively, for summer sessions in 2017–2019 of in-person instruction, versus 74.3, 62.0, and 65.6% for those in the Summer 2020 session. For the final exam, an average of 72.3% was observed for summer sessions in 2017–2019 vs. 62.9% in 2020, a significant decline of 10 percentage points. These significant drops in the grades earned during the exams impacted the overall course average, leading to a course GPA of 2.03, which was the lowest when compared with the previous 3 years of summer course offerings (Table 3 and Figure 1). The GPA was determined based on final course grades assigned in CHEM 1020, on a "10-point" scale—that is, 90% = A, 80% = B, 70% = C, and 60% = D. It is important to note that the same instructors taught the courses compared in this study, and the difficulty levels and question types used in the exams were also kept the same. As described previously, the General Chemistry course at Xavier relies heavily on faculty–student and peer-to-peer interactions, as well as remediation and collaborative/group learning activities during the drill period. Based on the significant diminishment in student performance on summative assessment, it was speculated that the emotional impact and isolation that were direct results of the COVID-19 pandemic contributed significantly to the reduction in student performance throughout the Summer 2020 virtual CHEM 1020 course. A similar study by Mahdy [25] noted a similar phenomenon in veterinary medical students who voluntarily reported that virtual learning during the COVID-19 pandemic had a negative impact on their performance. Interestingly, Gonzalez et al. [26] noted in their study that the isolation and confinement resulting from the pandemic improved student performance. Recently, another publication reaffirmed that social interaction plays an important role in student engagement and feeling of belonging, particularly for underrepresented minority groups [27].

The survey results provided some key information:

- Of the students completing the survey, 100% had taken a General Chemistry course at Xavier prior to this class (Q1). Because this is the second in the General Chemistry course sequence at Xavier, these results confirmed that all respondents were continuing Xavier students.
- A total of 81% of the students responded that they had taken an online General Chemistry lecture/drill before, while 19% had not (Q2). Since General Chemistry at Xavier was not offered online prior to the COVID-19 pandemic, these students were enrolled in General Chemistry during the Spring 2020 semester, when all courses were urgently moved online mid-semester.
- A total of 92% of the students stated that they had better learning outcomes when taking in-person courses, while 4% found online instruction better, and the other 4% did not see a difference (Q3, Figure 2).
- In total, 88% of students felt that their grades would have been better if they had been enrolled in the course in person, which was in line with the responses to question 3 (Q4, Figure 2).

- A total of 41% of the students stated that they most missed the one-to-one student–instructor interactions; 32% indicated that they most missed the availability of the in-person tutoring center; 14% most missed the reinforcement quiz discussions with their peers; and the rest chose “other” (Q5, Figure 2). The survey results from Q5 showed that students in General Chemistry at Xavier place significant value on in-person interactions.



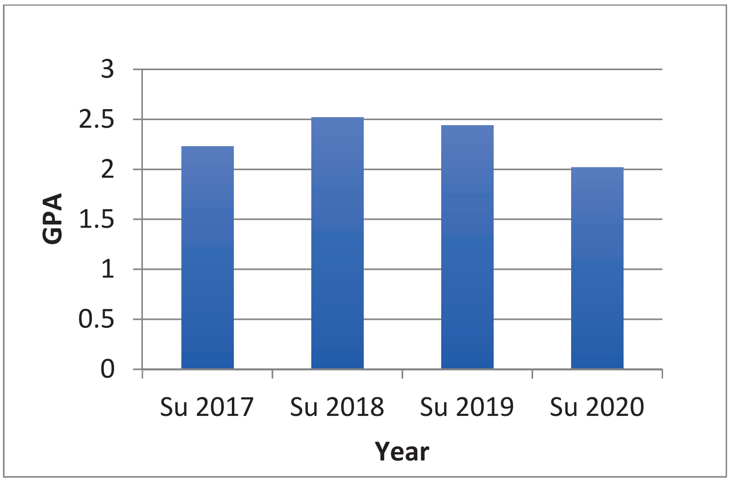


Figure 1. Comparison of exam grades and course GPAs from 2017 to 2020.

This information supported the conclusion that the isolation and reduced person-to-person interaction had a negative effect on student performance on summative assessments in the virtual learning environment during the Summer 2020 accelerated session. However, it is also important to note that, prior to the Summer 2020 session, virtual and online instruction for STEM courses at Xavier were taught only in emergency situations such as the shutdown at the beginning of the COVID-19 pandemic during the Spring 2020 semester that immediately preceded the Summer 2020 session. The university responded to this emergency remote learning situation by providing professional development and training opportunities to improve faculty preparedness in online learning. This training was offered during Summer 2020, concurrently with the academic summer sessions. While a lack of faculty preparedness and training in online and virtual instruction may have also contributed to the reduced student performance, the perception of Xavier students in the Summer 2020 General Chemistry II cohort supported the conclusion that the lack of in-person interaction was a significant factor in their performance.

The challenges faced by students in experiencing the lecture/drill in a virtual synchronous (remote) format in the Summer 2020 session were evident from the comments received in the survey in response to questions 5 and 6. Only a few students responded to question number 6. The comments below appear as they were written by the students (nothing was corrected, added, or removed).

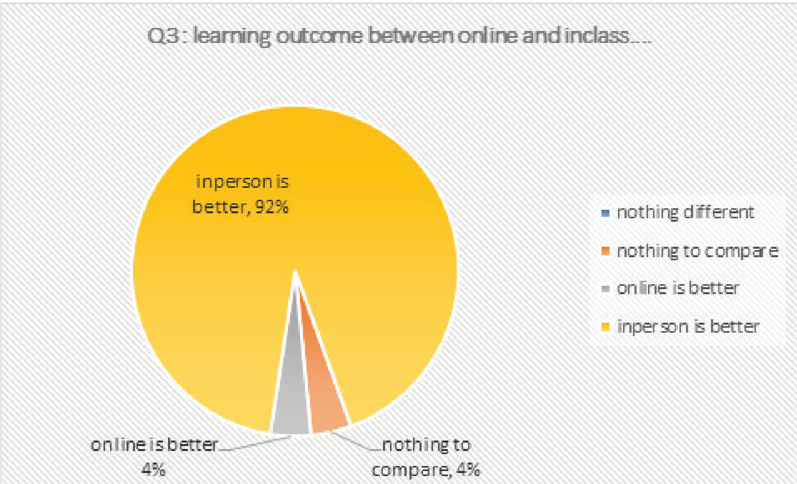
> *"It was a lot harder since it was shorter and online."*

> *"The course moved EXTREMELY too fast. This course compared to my general chem I course is completely different from each other. It should be no way why the exams covering three modules where one week apart from each other when the in-person course didn't even do this. If the course mirrored the in-person course as we're used to, I as well as the others taking the course grades would have been better."*

> *"I feel like the professors did a good job on teaching the material and helping us out when needed. The course is just fast paced, and it can be hard to remember the recently taught last module while trying to focus on the new one at the same time. Maybe more review sessions would help."*

> *"Taking the class online has been extremely difficult. In addition to dealing with the stress of the pandemic, taking a science course online has been extremely stressful. I would never take such an important class online ever again if it was my choice."*

> *"I struggle very much with chemistry and I started off doing very well with my drills and exams. But, the last two exams I didn't do well on and I think if I would have had extra help from the tutoring center and study groups at school I would have excelled more."*



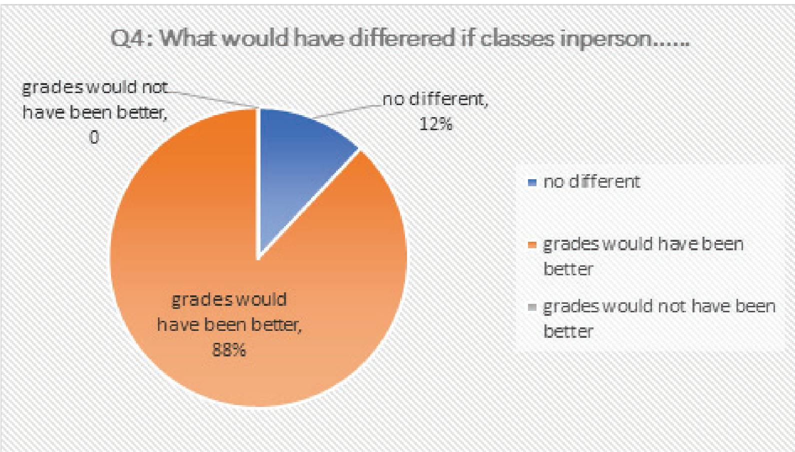


Figure 2. *Cont.*

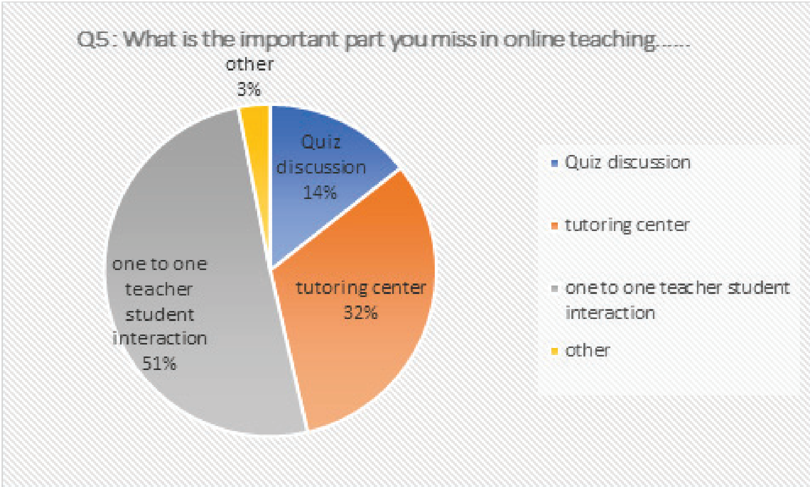


Figure 2. Distribution of responses for survey questions 3, 4, and 5.

4. Conclusions

The courses included in this study were all taught during the short 5-week summer sessions, and thus were fast paced. The entire CHEM 1020 course was taught virtually for the first time during the 5-week Summer 2020 session. In general, at Xavier, students are advised against taking science courses during these short sessions; however, many use the summer to catch up with their studies. Since the class meets every weekday, keeping up with the material requires discipline and consistency in studying.

Survey data and observations led to the conclusion that students performed below the average in the virtual General Chemistry II course, comparied with grades from the same course when offered in-person during the previous three summers. Multiple factors seemed to play a role:

- Xavier students are not accustomed to taking science courses virtually and had difficulty adapting to that learning environment. This was also reflected in a university-wide survey that indicated that the majority of Xavier undergraduates prefer in-person instruction.
- Despite their heavy use during the in-person fall and spring semesters, there was a general lack of student attendance in the free tutoring (group and individual peer-tutoring) and review sessions offered by the Chemistry Resource Center through Zoom. This was further verified in a conversation with the Center's Director, who stated that very few students took advantage of the virtual services offered.
- Students' use of faculty office hours also declined in comparison to in-person sessions. Only a few students attended the Zoom virtual office hours throughout the Summer 2020 session.
- Decreased peer-to-peer interactions in class as well as in study groups affected overall student performance as observed from the survey responses.
- Although synchronous remote instruction using the Zoom platform made virtual teaching more interactive, it was not comparable to the in-person instructor–student interactions, leading to decreased student engagement during class.
- Also as expected, students were dealing with emotional, social, and economic stresses due to the COVID-19 pandemic, which could have affected their academic performance.

It is important to note that in the Summer 2020 session, the university required all faculty to complete intensive training for virtual instruction. The term "virtual" encompasses four different types of instruction at Xavier: (1) Online; (2) Remote; (3) Hybrid; and (4) Mixed Mode. "Online" indicates courses that are taught asynchronously. Students do not have specific virtual class meeting times and may complete work at their own pace within the confines of assignment deadlines. "Remote" refers to courses that are taught synchronously. In these courses, students have defined times during which they must meet in virtual classrooms to receive instruction. "Hybrid" refers to courses where part of the instruction is in-person and part is virtual. The combination of these two modes of instruction can vary from one course to another, and the virtual portion may be synchronous or asynchronous. "Mixed Mode" denotes courses that are taught in-person (the instructor is physically present in the classroom), but the courses are designed to allow students to attend in-person or virtually and have the same instructional experience no matter how they choose to attend.

Even though most universities shared similar problems, there is also literature available indicating how to introduce distance learning [28]. Research has demonstrated that training to deliver virtual instruction helps instructors improve the quality of the virtual courses they teach and translates into an enhanced overall learning experience for the students enrolled in those courses [29].

Consequently, there arose a need to prepare Xavier's faculty to effectively deliver instruction in any of the virtual modes offered by the university. Training was developed that consisted of three distinct but related parts. The first part, called XULA-Flex, was a 5-week training that was designed to teach the mechanics of Xavier's learning management system (LMS), Brightspace. This training included topics such as creating a gradebook, creating content, and designing and deploying assessments. Once faculty completed XULA-Flex, they were enrolled in a self-paced course called #LearnEverywhereXULA (#LEX). The course was developed based on the eight Quality Matters Course Design Rubric Standards and was designed to demonstrate and model the pedagogical practices and standards that facilitate effective virtual instruction [30]. After completing both XULA-Flex and #LEX, for the third part of their training faculty were required to submit the material developed for a course scheduled to be taught in the Fall 2020 semester for review. The courses were reviewed to observe evidence that the principles and practices demonstrated in XULA-Flex and #LEX were incorporated into the faculty's virtual courses.

In the absence of circumstances such as the current pandemic, the Chemistry Department at Xavier plans to continue offering all Chemistry courses in the in-person format. The faculty firmly believe that the discipline is best taught and learned when students are physically present in the classroom, receive the most personal attention from their instructors, and have opportunities for peer-to-peer interactions. However, if circumstances dictate that Chemistry courses continue to be offered in a virtual format, steps must be taken to address the obstacles identified by students in the Summer 2020 session's virtual CHEM 1020 course. Three trends or themes arose from analysis of the 2017–2020 data. The first trend/theme observed was that students did not use the services of the Chemistry Resource Center or instructor office hours during virtual instruction at the level they did during in-person instruction. The coordinators and instructors of the CHEM 1020 course should incorporate use of the Chemistry Resource Center into the curriculum, such that it would be required for accomplishing certain tasks within the course. Also, instructors should encourage students to visit their virtual office hours by requiring at least one visit each week, even if students do not have specific course-related questions. The single experience of interacting one-to-one with their instructors during virtual office hours may enhance the likelihood of additional visits to seek assistance. The second trend/theme revealed by analysis of the 2017–2020 data was that students missed the peer–peer interactions that helped them to learn course content and prepare for exams. Lack of a sense of community has also been reported in the literature as a weakness in virtual learning [31]. Cox et al. reported a similar result where they showed the significance of the "sense of belongingness" in a large enrollment group in General and Organic Chemistry [32]. It was previously indicated that the Peer-Led Team Learning (PLTL) model plays an important role in enhancing the conceptual understanding of students by reducing their anxiety [33]. To encourage more of this peer–peer interaction in the virtual environment, course instructors and coordinators should facilitate formation of groups where students can work together during and outside of virtual class times to support each other in mastering the course material. Because there are always students who prefer to and work better on their own, this peer–peer interaction should be strongly encouraged but not required. The third theme/trend observed from this analysis was that teaching CHEM 1020 in a shortened 5-week period exacerbated the pressure experienced by students. While course instructors and coordinators can put a variety of interventions in place as noted above, in order to create a virtual environment that more resembles the in-person environment where students thrive, very little can be done to mitigate the stress induced by a shortened course period in summer sessions. The Chemistry Department will continue discouraging students from taking Chemistry courses in the 5-week summer sessions when possible. However, as some students need to catch up with their studies and progress toward timely graduation, these courses will continue to be offered. In future we will implement new assessment tools (polls, Kahoot, formal surveys, etc.) to evaluate the success and learning outcomes of our students to be disseminated to the education and teaching community [34–36].

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Institutional Review Board Statement: The above named study was presented as a proposal for approval to the Xavier University IRB in the summer of 2020 but was not able to be reviewed until after the data had already been collected. The Xavier University IRB cannot grant retroactive approval to a study. However, this study consists of a simple five-item questionnaire asking students for feedback on a classroom activity. The questions are innocuous and it is made clear to the students that choosing to answer the questions is voluntary. Had this study been reviewed before data collection, it would have been approved as written.

Informed Consent Statement: The survey was accompanied by the following statement: The purpose of this short assessment is to gain insight into your experience of taking online and in-person General Chemistry drill and lecture. Your feedback is extremely useful. Completion of this assessment should take no more than five minutes, is anonymous (that is, you do not have to provide any identifying information), and voluntary. You will have the option to leave comments if you wish. Letter is also attached from IRB.

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Article

Impacts on Students' Academic Performance Due to Emergency Transition to Remote Teaching during the COVID-19 Pandemic: A Financial Engineering Course Case Study

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Abstract: The COVID-19 pandemic has enforced higher education institutions to adopt emergency remote teaching (ERT) as the substitution for traditional face-to-face (F2F) classes. A lot of concerns have been raised among education institutions, faculty, and students regarding the effectiveness of this sudden shift to online learning. This study aims to statistically investigate the impacts of such a transition on the academic performance of undergraduate students enrolled in the Financial Engineering course. A novel rank percentage measure is proposed and employed to compare the academic performance of around 500 students who attended the course during the four semesters, including the transitional disrupted semester by the pandemic, two consecutive online semesters, and the traditional face-to-face classroom. Our analysis emphasizes the significance of the differences between specific subgroups of the students. In particular, academically average to good students with cumulative GPAs greater than 2.90 have been negatively impacted by the transition to online learning, whereas the results for students with cumulative GPAs less than 2.90 are not very conclusive. Realizing the effects of such closures on the academic performance of students is considered important, since the results might have some merits for other courses and instructors. The template model can be transferred to other courses, and employed by the university administrators, specifically for developing policies in emergency circumstances that are not limited to pandemics.

Keywords: COVID-19; emergency remote teaching; face-to-face classes; academic performance

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1. Introduction

The novel coronavirus disease (COVID-19) has spread globally and has affected various aspects of daily human life routines. To control the transmission of the infection, and flatten the curves, strategies such as staying at home and lockdowns have been employed. On 11 March 2020, and after the World Health Organization (WHO, Geneva, Switzerland) declaration of the pandemic [1], higher education institutions in the United States began to close in-person classes. State-wide stay-at-home orders were also designed to slow the spread of the virus. The education system, as one of the most crucial parts of society, has seen considerable disruption by the outbreak [2,3]. According to the United Nations Educational Scientific and Cultural Organization (UNESCO, Paris, France) statement, over 6 billion learners across more than 190 countries were seriously affected, in terms of education, during the peak of the crisis [4]. In addition, it highlighted that 24 million students are at risk of dropping out. In the United States, at least 14 million students have been affected by the closure of more than a thousand colleges and universities by 26 March 2020 [5].

In these circumstances, the transition to online platforms and distance learning seems to be the only feasible and attractive alternative. Therefore, higher education institutions have been enforced to employ e-learning as the substitution for traditional face-to-face

(F2F) classes [6,7]. Despite investments in learning technologies and online learning management systems, universities suffered from the loss of contingency plans appropriate to the emergency transition caused by the pandemic. Faculties and students worldwide were pushed to swiftly adopt remote education using synchronous and/or asynchronous online classes. The transition to remote teaching was stressful, since neither faculty nor students were completely prepared for this quick change, and the shift heavily relied on the ability to access or use online learning and teaching tools. Besides, some institutions lacked faculty with online teaching experience [8].

Online learning is defined by a majority of researchers as access to learning experiences using some sort of technology [9]. It is a learning process that provides learners agency, responsibility, flexibility, and choice, and to develop an effective learning ecology, careful planning, designing, and determination of goals are required [10]. However, educational experts have argued that the transition to digital settings resulting from the COVID-19 pandemic cannot be considered as "online learning". Therefore, a new concept of "emergency remote teaching" (ERT) has been defined [11,12], which is a temporary solution to an immediate problem. Such distinction plays an important role in the prosperity of distance education in a post-COVID world [10].

Synchronous and asynchronous are two types of online instruction modes when considering synchrony [13]. Blended learning (BL), on the other hand, refers to combining onsite and online learning to provide flexibility to learners, instructors, and educational institutions [11].

The impact of different teaching modalities, including face-to-face (F2F), blended (BL), and online learning, on students' academic performance has received considerable attention in educational research for decades. The literature shows that the results depend on the type of analysis, study samples such as single or multiple courses, and graduate or undergraduate level of courses [13–22]. For example, Ladyshewsky's findings and Cavanaugh et al.'s analysis over 9 and 5000 courses, respectively, confirm that by increasing the number of analyzed courses, students achieved better grades in online learning compared to those in F2F classes [21,22]. In addition, Skylar investigated the impact of synchronous and asynchronous environments on student achievement and satisfaction. The results suggest that both types of instructions are effective; however, the majority of students would prefer synchronous lectures instead of asynchronous ones [23].

During the ERT caused by the COVID-19, Chaka conducted a study to review how selected higher education institutions in the U.S. and South Africa switched to online learning, and which online tools and resources they used [24]. The findings revealed that mainly two types of online tools and resources have been employed by a majority of institutions: video conferencing platforms and learning management systems (LMS). Zoom, Canvas, Blackboard (Collaborate), Panopto, and Microsoft Teams were considered the most used online tools by U.S. universities. In addition, Blackboard (Collaborate), institutional LMSes, WhatsApp, Zoom, and Moodle were the most embraced online tools employed by South African universities [24].

In the review of emergency remote teaching due to the COVID-19 pandemic, Mishra et al. critically analyzed the publications using a range of scientometric techniques. They reported that quantitative methods were the most popular research methodology used by the researchers (43.6%), followed by qualitative (13.33%), and mixed methods (9.09%). However, the research methodology was not indicated by a large proportion of publications (33%) [25]. Khansal et al. conducted a scoping review on organizational adaptation during the early stages of the pandemic [26]. The study highlights that due to maintaining educational activities during the pandemic, instructors actively employed various methods and strategies. A survey conducted by Dios and Charlo regarding students' perceptions and opinions of F2F and e-learning caused by COVID-19 reveals that students prefer to continue with F2F learning instructions rather than online teaching or BL [27]. Aristovnik et al. presented a large-scale study on the impacts of the first wave of COVID-19 pandemic on the life of a sample of 30,383 students from 62 countries using an online questionnaire [28].

The study reveals students' satisfaction and perception of various aspects/elements of their lives during the pandemic, such as their opinions on the immediate and distant future [28].

Regarding the impact of emergency remote teaching due to the COVID-19 pandemic on students' academic performance, it seems there is no conclusive agreement in the literature. Engelhardt et al. compared the performance of students in the disrupted semester by COVID-19 to that of three previous unaffected semesters [29]. They concluded that there were no significant differences in students' performance throughout the semesters. They identified not only no measurable impact for the low-income, first-generation, and minority students, but also women overperformed in the disrupted semester compared to previous terms. Alam and Asimiran conducted an evidence-based study to compare academic and job-readiness of graduates using an empirical survey with a sample of 240 people (before and during COVID-19) [30–32]. The findings reveal that better academic scores were achieved by during-pandemic students compared to pre-pandemic ones, whereas pre-pandemic counterparts performed better in terms of job-readiness [30]. Moreover, a study conducted by Iglesias-Pradas et al. shows an increase in students' academic performance in ERT [33]. The analysis supports the idea that successful ERT implementation may be contributed to the organizational factors.

In this research study, we investigate the impact of the pandemic mid-semester disruption on the academic performance of students attending a Financial Engineering course. The Financial Engineering course (IE201) at the University of Illinois at Chicago is one of the important undergraduate courses in the College of Engineering, which is taken by four different majors, including Industrial Engineering, Mechanical Engineering, Civil Engineering, and Engineering Management. A sample data set of around 500 students is employed to conduct the analysis. The students attended the course in a transitional disrupted semester by the pandemic, two consecutive online semesters, and a traditional face-to-face semester. The course was taught by the same instructor in all semesters. This study does not represent a generic model to compare all teaching modalities for all courses. Moreover, we do not aim to develop a general approach for comparing in-person, blended, and online instructional modalities. The purpose of this study is to report insightful analysis, results, and conclusions of a case study as a guidance for future design. We aim to answer the following research questions:

RQ1: Did the emergency remote teaching affect the academic performance of the IE201 course students?

RQ2: Are there any differences in students' academic performance between those who attended IE201 in a traditional F2F classroom, those who had a disrupted semester by the pandemic (BL), and asynchronous and synchronous online teaching modes?

RQ3: In an emergency transition, which group/s of IE201 students will be more affected in terms of academic performance, and which teaching modalities would be selected for each subgroup of students?

To answer these research questions, the study investigates the potential impact of different instruction modes (BL, asynchronous (Async.), and synchronous (Sync.) online teaching) resulting from the pandemic on the academic performance of undergraduate students enrolled in the IE201 course. The results are also compared with the traditional F2F classroom.

Realizing the effects of such closures on the academic performance of IE201 students is considered important for university-level planning and decision-making. The results might have some merits for other courses and instructors. The template model can be transferred to other courses, and employed by the university administrators, specifically for developing policies in emergency circumstances that are not limited to pandemics. The remainder of the paper is organized as follows: Section 2 details the materials and methods used in the analysis. The presentation of the data analysis and results are described in Section 3. Section 4 discusses the main research findings and limitations of the study, followed by conclusions in Section 5.

2. Materials and Methods

2.1. Research Methodology

As Alam and Parvin mentioned in their study, the effectiveness of an active learning process is often measured by its contribution to graduates' development [32]. Consequently, for primary and secondary education, academic performance is considered as the main parameter or key performance indicator (KPI) [32]. In addition to academic performance, the other key indicators for measuring the efficacy of an active learning process of higher education are also job-ready graduates, and the production of knowledge [30,34,35].

The aim of this project is to investigate how the emergency transition (from traditional F2F classrooms to online teaching modes) affected the academic performance of undergraduate students in the Financial Engineering course. Students are categorized into four cohorts based on the type of teaching modalities they attended. One cohort comprises pre-COVID-19 students that attended the IE201 course in the traditional face-to-face classroom. The second cohort consists of the students who attended the course in the transitional semester disrupted by the COVID-19 pandemic. The other two cohorts comprise during-COVID-19 cohorts. One of them is the students who attended the course in an asynchronous online teaching mode, and the other is those who attended the course in a synchronous online teaching mode.

We use students' IE201 course grades as the measure of academic performance, and transform it to a new relative metric called "Rank Percentage". The rank percentage is less sensitive to the absolute values of students' grades. We will discuss this evaluation metric in Section 2.2.

Given the data that we have, and the research time framework, the job-ready graduates and production of knowledge comparisons before and during the COVID-19 pandemic are not feasible. The reason is that they require standard questionnaires and longer time series data. It is worth mentioning that our comparison method is not an ideal one. Moreover, obtaining the information is challenging, and we are not trying to find the impact of the transition on every single student. Therefore, we indirectly address the problem by incorporating students' cumulative GPA (before the course started), and investigate the academic performance for the same sub-groups of students based on cumulative GPA bins. Four different cumulative GPA bins/subgroups are defined, based on letter grades of A, B, C, and D/F. We will discuss it in Section 2.4.

This research compares the rank percentage (a transformed version of the course grade) achieved by four cohorts of students in one domain, namely academic performance. Given the nature of the data, this study uses both descriptive analysis and statistical hypothesis tests to draw a more conclusive result. Therefore, based on Creswell's schema [36], herein, the research methodology is a mix of qualitative and quantitative, and the research model/design is a case study.

2.2. Rank Percentage Concept

In this study, we aim to investigate the effectiveness of different teaching modalities of the IE201 course before and during the COVID-19 pandemic. Educational researchers usually utilize course grades to evaluate students' academic performance [37–40]. The course grade has been considered as the performance measure of an individual student (absolute measure), and it is not comparable with other cohorts' grades. The delivery mode and education atmosphere were completely different for all four cohorts of students. So, under such circumstances, we propose a new metric called "Rank Percentage", and compare students' course rank percentage instead of students' course grades.

A rank is an ordinal number assigned to each student based on their performance in the class. In other words, after the final exam, students are sorted based on their final grades, and the rank will be assigned to each of them. Lesser rank means better performance and vice versa. Besides, since the course presented in each semester may differ in size, and to make comparison possible, the rank percentage is calculated using each student's rank divided by the total number of students in the class.

The rank percentage can capture students' academic performance compared to other students in the class. In addition, the rank percentage is not sensitive to the delivery mode and difficulty level of the course, and is always comparable for all students in the class. Moreover, in an emergency circumstance, such as the ERT resulting from the pandemic, considering students' grades as the evaluation metric to compare the effectiveness of different instructional modalities seems to be unreasonable.

2.3. Course Data

The study uses sample data from an undergraduate course called Financial Engineering (IE201), presented by the Mechanical and Industrial Engineering Department at the University of Illinois at Chicago. This is a theoretical and sophomore course taken by four different majors of Industrial, Mechanical, Civil Engineering, and Engineering Management, and needs intermediate calculus as the prerequisite. The data source contains course-level aggregated grades of students during the three affected semesters by the COVID-19 pandemic (Spring 2020, Fall 2020, and Spring 2021), and one previous unaffected semester (Spring 2019). They are the four cohorts of students previously introduced in Section 2.1. The general characteristics of the course are described in Table 1.

Table 1. IE201 general characteristics of four different instruction modes.

Mode/Contribution to Final Grade [1]	Semester	Sample Size	#Exam [2]	#Homework [3]	Project	EXPO	COVID Affected?
F2F	Spring 2019	134	5 20% each	11 5%	√ 10%	√ 5%	No
BL	Spring 2020	102	5 20% each	11 10%	√ 10%	-	Yes
Online (Async.)	Fall 2020	144	9 70%	11 20%	√ 10%	-	Yes
Online (Sync.)	Spring 2021	123	5 68%	11 32%	-	-	Yes

[1] In all four semesters (student cohorts), the lowest exam grade and the lowest homework grade for each student were dropped. [2] Number of exams. [3] Number of homework.

Spring 2019 (pre-COVID19 cohort) is considered as the traditional F2F instruction mode in which all classes were held in-person, whereas Spring 2020 (during COVID-19 cohort) is the transitional semester disrupted by the pandemic. So, almost half of the course was held in-person, and the remaining sessions were taught remotely using Blackboard and Zoom platforms. On the other hand, Fall 2020 and Spring 2021 were both completely online (during-COVID19 cohorts). The former was asynchronous using Blackboard Collaborate, and the latter was synchronous using the Zoom platform and Blackboard. In addition, since the IE201 withdrawal rate is very low, students who withdrew from the course are not included in our analysis. Furthermore, the course was taught by the same instructor in all semesters.

2.4. Student Data

Cumulative grade point average (GPA) is considered an important indicator of the academic history of students. So, we incorporate students' cumulative GPA (before the IE201 course started) to find out the academic history of students in each cohort. Figure 1 illustrates the distribution of cumulative GPAs achieved by students enrolled in the IE201 course (before the course started) in all four semesters.

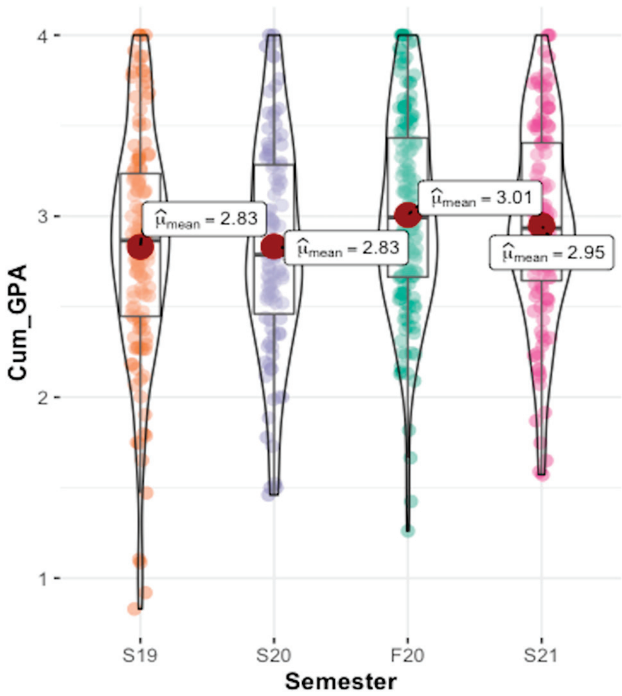

Figure 1. Differences in the distribution of cumulative GPA in the semesters.

As the graphs present, if we disregard a few outliers, the dispersion of the cumulative GPAs is almost the same for all cohorts. So, all cohorts of students come from almost similar academic history.

Figure 2 represents the scatterplots of cumulative GPA versus rank percentage for all four cohorts. We employ the "Locally Estimated Scatterplot Smoothing" (LOESS) method for fitting a smooth curve between two variables of cumulative GPA and rank percentage. A span value of 0.35 is also utilized to control the degree of smoothness. As the graph suggests, in all instruction modalities, the rank percentage values decrease as the cumulative GPAs are increasing, i.e., it can be observed that there exists a potential inverse relationship between the cumulative GPA and rank percentage.

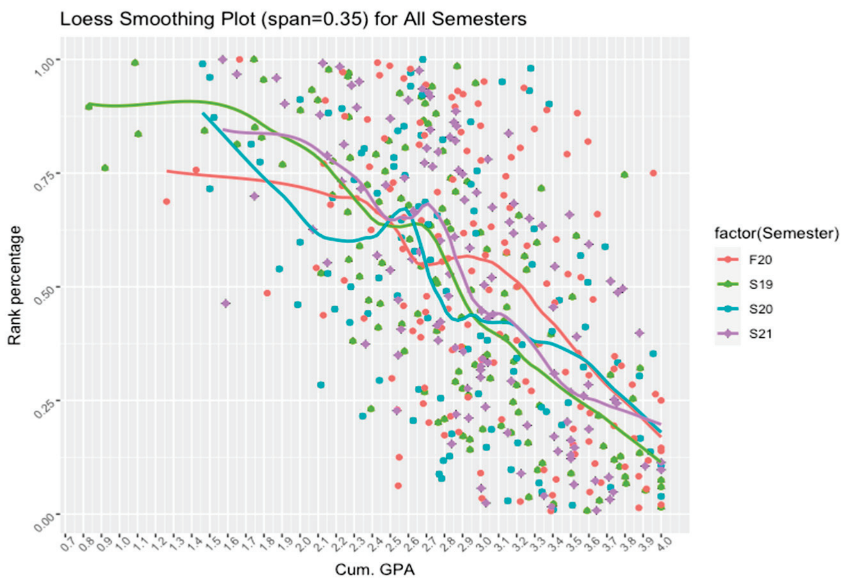

Figure 2. Cumulative GPA vs. rank percentage in four instruction modes.

On the other hand, comparing the curves seems to be not conclusive regarding the students' academic performance. This means, depending on the cumulative GPA spectrum, the relative rank percentage of the curves is changing with respect to each other. Moreover, decisions based on the 0.00 to 4.00 cumulative GPA boundary could be controversial. In other words, there might be some hidden trends that can be detected if we divide each cohort of students into certain subgroups based on a specific criterion, such as cumulative GPA.

Therefore, to measure the potential impacts of the ERT on students' academic performance in IE201, we consider cumulative GPA bins. To define cumulative GPA bins or subgroups, we employ the norm that the majority of the engineering faculty used to determine letter grades. The subgroups include G1 = (3.40, 4.00), G2 = (2.90, 3.40), G3 = (2.40, 2.90), and G4 = (0, 2.40) which stand for A, B, C, and D/F letter grades, respectively. Therefore, we compare the academic performance of each subgroup (rank percentage) between different cohorts. It seems that there could be a considerable difference between students' rank percentage in each semester when the cumulative GPA subgroups changed.

2.5. Statistical Hypothesis Tests

As we described, the rank percentage is considered to evaluate students' academic performance in each cohort, and we divided each cohort of students based on their cumulative GPAs into four different subgroups. The goal is to compare students' rank percentage in each cumulative GPA subgroup between the four various cohorts (teaching modalities) to test if there exist any significant differences.

To analyze the data and present them in the findings, firstly, we use descriptive analysis using some graphs (violin plots) and simple statistical parameters such as mean. Secondly, statistical methods are also used to draw more conclusive results. The tests include the Kruskal–Wallis test for differences in academic performance across all four cohorts, and Mann–Whitney U tests to test for differences in rank percentage between each pair of the cohorts. In Mann–Whitney and Kruskal–Wallis tests, the test statistic only depends on the ranks of the observations, and no assumption about the distribution of the population is made. The former is used for two samples, whereas the latter is used when there are two or more samples. These non-parametric tests are employed because our observations do not follow the normality assumption. Statistical tests are also performed using R software (version 4.0.3) and the R package "ggstatsplot", with the most common analysis options combined with a graphical output [41].

3. Results

We investigate the potential impact of different teaching modalities caused by the ERT on the academic performance of IE201 students. Specifically, we implement the following three scenarios to study which teaching modalities would be more effective for each subgroup of IE201 students in an emergency transition to online modes:

Scenario 1: Comparing students' rank percentage over the four cohorts of students who attended different instructional modalities, including F2F, BL, Async., and Sync.

Scenario 2: Comparing students' rank percentage between F2F mode (the pre-COVID-19 cohort) and all three semesters affected by the COVID-19 pandemic (BL, Async., and Sync., or during-COVID-19 cohorts).

Scenario 3: Comparing students' rank percentage between F2F mode and online modes (Async. and Sync.).

Further, to clarify the differences between instructional modalities that we consider in this study; we again describe them here:

F2F (S19): Traditional face-to-face classroom, and not affected by the pandemic (pre-COVID-19 cohort).

BL (S20): Transitional semester disrupted by the COVID-19.

Async. (F20): Asynchronous online instruction mode.

Sync. (S21): Synchronous online instruction mode.

It is worth mentioning that the last three teaching modes were affected by the COVID-19 pandemic.

3.1. Scenario 1: Comparing F2F, BL, Async., and Sync.

Figure 3 depicts the distribution of students' rank percentage for each of the cumulative GPA subgroups in all four cohorts of students (i.e., different teaching modes). The graphs suggest that there are some differences between the teaching modes' effectiveness in some subgroups, such as subgroup G1 (top left graph) and G4 (bottom right graph). So, we investigate them using the Kruskal–Wallis test.

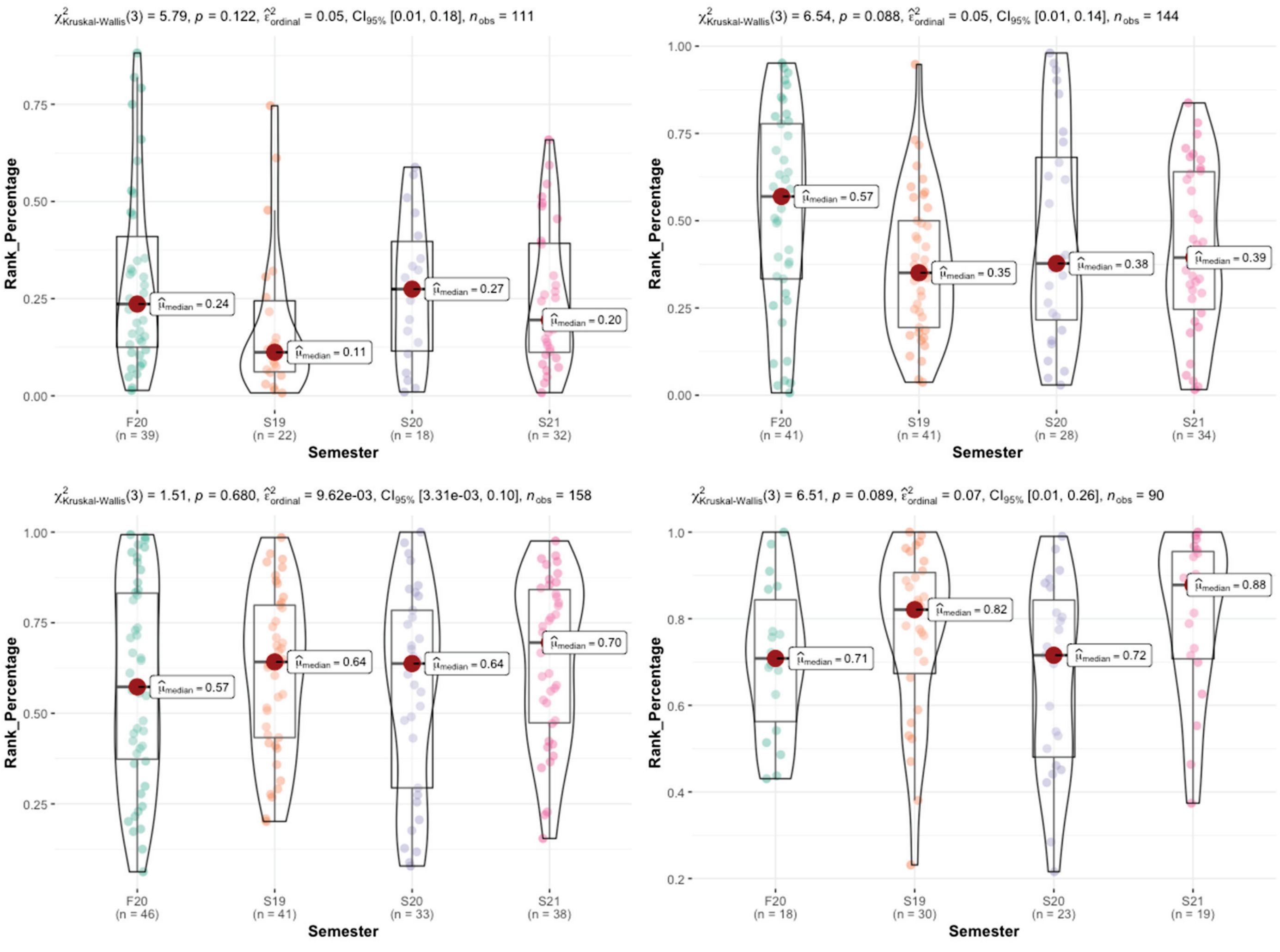

Figure 3. Differences in the distribution of rank percentage between four various instruction modes in cumulative GPA subgroup G1 (**top left**), subgroup G2 (**top right**), subgroup G3 (**bottom left**), and subgroup G4 (**bottom right**).

In Table 2, we represent the result of statistical tests to check the differences in students' rank percentage throughout all four instructional modalities.

Table 2. *P*-value of Kruskal–Wallis test comparing all modes.

Terms/Cum. GPA Subgroups	G1	G2	G3	G4
S19, S20, F20, S21	1.223×10^{-1}	8.801×10^{-2}	6.797×10^{-1}	8.926×10^{-2}

As the results show, there are no significant differences between all modes, i.e., at the significant level of 5 percent, and when we compare all teaching modes together (the academic performance of four cohorts of students in each cumulative GPA subgroup), none of them are significant. So, none of the teaching modes are more effective than the others. On the other hand, when we compare the output of the graphical tests illustrated in Figure 3, it seems that for some cohorts, the statistical test results can be different if we employ pairwise comparisons (Mann–Whitney U test).

Table 3 summarizes pairwise comparison test results between different instructional modalities in IE201. Some of the differences are statistically significant. In these cases, we also employ the one-tailed hypothesis to investigate in which modes (cohorts) students performed better. In cumulative GPA subgroup G1, there is a significant difference between F2F and Async. modes. As the one-tailed test result shows in subgroup G1, the academic performance of students in the asynchronous online mode is worse than those in traditional F2F class. This difference is even more significant when we compare F2F and Async. modes in subgroup G2. This suggests that the transition from face-to-face to an asynchronous online mode affected academically average-to-good students more. Moreover, in subgroup G1, students' academic performance in the F2F mode is better than the online synchronous mode (one-tailed p-value = 0.0369).

Table 3. p-value of Mann–Whitney tests comparing all modes.

Terms/Cum. GPA Sub.	G1 (2-Tailed)	G1 (1-Tailed)	G2 (2-Tailed)	G2 (1-Tailed)	G3 (2-Tailed)	G3 (1-Tailed)	G4 (2-Tailed)	G4 (1-Tailed)
S19, S20	1.255×10^{-1}	-	4.19×10^{-1}	-	5.962×10^{-1}	-	7.7×10^{-2}	3.85×10^{-2} * H1:S19 > S20
S19, F20	2.029×10^{-2} *	1.014×10^{-2} * H1:F20 > S19	9.037×10^{-3} **	4.519×10^{-3} ** H1:F20 > S19	6.326×10^{-1}	-	1.729×10^{-1}	-
S19, S21	7.379×10^{-2}	3.69×10^{-2} * H1:S21 > S19	3.763×10^{-1}	-	5.036×10^{-1}	-	5.114×10^{-1}	-
S20, F20	8.502×10^{-1}	-	3.275×10^{-1}	-	9.208×10^{-1}	-	7.651×10^{-1}	-
S20, S21	7.564×10^{-1}	-	7.734×10^{-1}	-	3.042×10^{-1}	-	3.495×10^{-2} *	1.748×10^{-2} * H1:S21 > S20
F20, S21	4.868×10^{-1}	-	9902×10^{-2}	4.951×10^{-2} * H1:F20 > S21	3.229×10^{-1}	-	8.88×10^{-1}	4.44×10^{-2} * H1:S21 > F20

Note: * indicates statistical significance at the 5% level. ** indicates statistical significance at the 1% level.

In addition, in subgroup G4, or students with cumulative GPAs below 2.40, there are some significant differences between F2F and BL, BL and Sync., and Async. and Sync. modes. The results suggest that this subgroup of students performed better in the blended transitional semester disrupted by the pandemic in comparison with face-to-face and online synchronous modes.

On the other hand, in subgroup G3, high p-values indicate that the evidence is not strong enough to suggest an effect in the population. In other words, the equality assumption of the medians of students' rank percentage in all instruction modes cannot be rejected. So, we can assume that the ERT has no considerable effect on the performance of this group of students.

3.2. Scenario 2: F2F vs. BL-Async.-Sync. (Pre-COVID-19 vs. during-COVID-19 Cohorts)

Table 4 concludes the results of comparing the academic performance between F2F mode and all three COVID-19-affected semesters to investigate the potential impacts of ERT. In subgroups G1 and G2, at the level of 5 percent, the differences are significant. As the one-tailed hypothesis suggests, students with cumulative GPAs greater than 2.90 have been more affected by the emergency transition remote teaching, and their academic performance has been negatively impacted. In other words, in subgroups G1 and G2, the pre-COVID-19 cohort achieved better academic grades compared to during-COVID-19 counterparts.

Table 4. *p*-value of Mann–Whitney tests comparing F2F vs. BL-online modes.

Terms/Cum. GPA Sub.	G1 (2-Tailed)	G1 (1-Tailed)	G2 (2-Tailed)	G2 (1-Tailed)	G3 (2-Tailed)	G3 (1-Tailed)	G4 (2-Tailed)	G4 (1-Tailed)
S19 vs. S20-F20-S21	2.476×10^{-2} *	1.238×10^{-2} * H1:S20-F20-S21 > S19	5.47×10^{-2}	2.735×10^{-2} * H1:S20-F20-S21 > S19	7.631×10^{-1}	-	3.292×10^{-1}	-

Note: * indicates statistical significance at the 5% level.

3.3. Scenario 3: F2F vs. Online

Combining asynchronous and synchronous online modes to compare them with the traditional F2F class is considered in this scenario. Table 5 confirms the same, yet more significant, results compared to the second scenario. It suggests that students with A and B letters' cumulative GPA grades performed better in terms of academic scores in the traditional F2F class compared to online teaching.

Table 5. *p*-value of Mann–Whitney tests comparing F2F vs. online modes.

Terms/Cum. GPA Sub.	G1 (2-Tailed)	G1 (1-Tailed)	G2 (2-Tailed)	G2 (1-Tailed)	G3 (2-Tailed)	G3 (1-Tailed)	G4 (2-Tailed)	G4 (1-Tailed)
S19 vs. F20-S21	1.992×10^{-2} *	9.959×10^{-3} ** H1:F20-S21 > S19	2.618×10^{-2} *	1.309×10^{-2} * H1:F20-S21 > S19	9.685×10^{-1}	-	6.59×10^{-1}	-

Note: * indicates statistical significance at the 5% level. ** indicates statistical significance at the 1% level.

4. Discussion

This section describes responses to the research questions that we raised in the introduction section. The first question is about the impact of the ERT on the IE201 course students in terms of academic performance. Generally speaking, the analysis reveals that there is no significant difference between students' academic performance when we compare all four cohorts of students. However, pairwise comparisons reveal that specific subgroups of students have been affected by the emergency transition to remote teaching. It is worth keeping in mind that the analysis of the transitional semester disrupted by the COVID-19 pandemic (Spring 2020: BL) is considered as a report, and we cannot draw any strong conclusion based on its results.

Regarding the second research question (i.e., differences in students' academic performance), three different comparisons can be considered: (1) F2F vs. Asynchronous: The results suggest that differences are significant in cumulative GPA subgroups G1 and G2. In other words, students with cumulative GPAs greater than 2.90, who are considered academically average-to-good students, have performed worse in asynchronous online teaching compared to the traditional face-to-face classroom. It seems that the academic performance of students in other cumulative GPA subgroups (G3 and G4) was not statistically different. (2) F2F vs. Synchronous: The analysis supports that students with cumulative GPAs above 3.40 (subgroup G1) performed better in the face-to-face class in comparison with synchronous online instruction. It is also observed that there are not any statistically significant differences in other subgroups. It seems that the majority of students had a reasonable academic performance with the synchronous instruction mode. (3) Synchronous vs. Asynchronous: The differences are considered significant in two cumulative GPA subgroups: subgroups G2 and G4. The results reveal that subgroup G2 students performed better in the synchronous online instruction compared to the asynchronous one, whereas the academic performance of students with cumulative GPAs below 2.40 was better in the asynchronous online mode compared to the synchronous one. The results also suggest that the difference between asynchronous and synchronous online instruction modes is not very conclusive.

The third question concerns the effectiveness of different teaching modalities in an emergency transition. The analysis, particularly the results of second and third scenarios, would support that among all subgroups of students in different cohorts, the academic performance of students with cumulative GPAs above 2.90 (subgroups G1 and G2) have been negatively impacted by the transition to online education. In other words, in subgroups G1 and G2, the pre-COVID-19 cohort achieved better academic grades in comparison with the during-COVID-19 cohorts. It seems that these subgroups of students are more dependent on the face-to-face classroom. So, for further decisions regarding the instructional modality design, this consideration could be taken into account. For instance, non-mandatory small-sized classes could be implemented for these groups of students. On the other hand, it seems that students with cumulative GPAs below 2.90 have been not significantly affected by the transition to online modes. They could be more flexible in terms of instructional modality design.

It is worth noting that Russell's book lists 355 sources dating back as early as 1928 to discuss compelling arguments, and settle the debate of online learning and its effectiveness, specifically in comparison to face-to-face learning [42]. The general conclusion of the evidence renders is that there is no significant difference to be almost indisputable. Russell notes that just because the research suggests that there is no difference in student performance, this does not mean that distance learning is necessarily better than other methods of learning, just that it can be as effective. However, there are also some criticisms about Russell's work, such as that it failed to control for extraneous variables or use valid tools to measure outcome [18,43]. In the current research, Russell's conclusion is supported if we compare all four cohorts (four different teaching modalities), i.e., no significant difference exists. However, when we split the cohorts to the subgroups based on criteria (cumulative GPA here), there are some significant differences. This also might be related to the fact that there are some extraneous variables, and the cumulative GPA could be considered as one of them.

The results of this study represent that the COVID-19 pandemic has affected the academic performance of undergraduate students who attended the Financial Engineering course. Although previous studies mainly focus on students' course grades as an academic performance evaluation metric, we define the rank percentage measure to test our hypothesis, which is unique to the literature. We do not claim that the rank percentage is the best metric. Since the delivery mode and education atmosphere were completely different for all cohorts, there is not an ideal metric to compare the effectiveness of different teaching modes. However, the rank percentage allows us to make the academic scores more comparable. There is a wide range of factors that might affect students' academic performance, such as classroom population, academic history of the instructor, level of the class, major, university entrance score, etc. [37]. Some of these factors are controlled in our analysis. For instance, since the same instructor taught the course for all of the cohorts, the impact of the academic history of the instructor is controlled. The difficulty level of the classes is also controlled by introducing the rank percentage metric. Moreover, the academic level of students attended in the class is reflected in the cumulative GPAs, which has been used to define more academically homogenous subgroups for our comparison purposes.

Moreover, in this study, we only consider one research domain, namely academic performance. Given the data and research time frame, multidimensional analysis is not considered. We attempt to reveal that although the differences between all cohorts are not significant, certain subgroups of students have been impacted by the transition. We investigate this assumption by splitting each cohort of students into subgroups based on specific criterion, such as cumulative GPA. For instance, in our study, academically average-to-good students with cumulative GPAs greater than 2.90 have been negatively impacted. This impact is not detectable without dividing the cohorts into specific subgroups. Defining meaningful subgroups and splitting criteria can be the subjects for future research. The reason for choosing cumulative GPA (splitting criterion) is to create subgroups that have at least one similar interpretable attribute.

This study has certain limitations. Firstly, it is considered a case study in the Financial Engineering course, and the results are specific to one course taught by a single instructor in one higher education institution. In addition, the choice of the course was made by convenience and availability of data. So, we do not claim the universal validity of our findings, and for organizational-level decisions, more studies need to be done. Moreover, there are some insignificant differences (in subgroup G3, for instance) that might represent some hidden patterns, and cannot be detected with this research design.

Secondly, some individual aspects, such as students' digital skills, the accessibility and ownership of digital technologies, and self-regulation, are not considered in this study, and can be used to develop a questionnaire for a future study.

Thirdly, there is enough evidence that during the pandemic, students have experienced a lot of stress [44]. The stress caused by the pandemic lockdowns is closely related to anxiety, loneliness, and depression [45]. Therefore, it could have a potential impact on students' academic performance decrease. Since the attitudes and behavior of students have been not considered in this study, the potential negative effects of such variables are not evaluated. This limitation also includes other COVID-19-related issues, such as medical and financial problems.

Finally, transparency, reliability, and security issues of online evaluation and examination have always been controversial [46]. So, the potential effect of cheating behavior cannot be discarded. We could not assess dishonest behavior in our analysis.

Considering the sample sizes, this study does not represent a general comparison model for the teaching modalities. We suggest that our findings invite the research community to seek or investigate the effectiveness of different teaching modes in terms of academic performance on subgroups of students when comparing populations with different teaching modes. Though our work has its limitations, it certainly encourages the readers to navigate this line of research, and focus their studies on certain subgroups of interest.

5. Conclusions

The unprecedented global health crisis has prompted emergency adaptations to a distance teaching-learning system called "emergency remote teaching" (ERT). There are a lot of concerns about the effectiveness of the shift to online learning among students, faculty, and higher education administrators. This study is an effort to investigate the potential impacts of such a transition on the academic performance of students enrolled in the Financial Engineering course. We have employed a novel rank percentage measure to compare students' academic performance in a transitional disrupted semester by the pandemic, two consecutive online semesters, and a traditional face-to-face classroom. Our analysis reveals that the differences are significant between specific subgroups of students. The findings suggest that the academic performance of students with cumulative GPAs greater than 2.90, specifically higher than 3.40, has been negatively impacted by the transition, whereas the impact on students with cumulative GPAs below 2.90 are not very conclusive.

The COVID-19 pandemic should be considered as an opportunity to enhance digital preparedness, capacity development, and innovations in higher education institutions. This study aims to assist university administrators to make decisions about short or long-term closures, re-opening face-to-face classes, and online learning continuance in extreme situations, disruptions, and emergency circumstances.

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Institutional Review Board Statement: This study was approved by University of Illinois at Chicago Internal Review Board. Permission from University of Illinois at Chicago Privacy Board and Internal Review Board were required to access the data used in this study. All the experiment protocols involving human data were in accordance with the University of Illinois at Chicago Privacy Board and Internal Review Board guidelines.

Informed Consent Statement: Our research was provided a waiver of informed consent, parental permission and assent from the University of Illinois at Chicago IRB granted under 45 CFR 46.116(f).

Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy concerns.

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Conflicts of Interest: The authors declare no conflict of interest.

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education sciences

Article

"Growing as a Stronger Clinician in Adverse Conditions"—A Snapshot of Clinical Training during COVID-19

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Abstract: Transformative learning theory has been recommended as a pedagogy of uncertainty for accommodating new beliefs that enable humans to thrive amid the challenges and complexity of our world. As higher education institutions embrace new roles and responsibilities, few studies have focused on how the disruptions caused by COVID-19 may facilitate formative learning experiences. This study explored how registrars responded to the challenges facing clinical training during the first wave of COVID-19, and how the impact of these disruptions prompted personal and professional development. Registrars completed an online qualitative SWOT (strengths, weaknesses, opportunities, and threats) analysis of their training experiences during the COVID-19 pandemic. Data were thematically analysed. Four hundred and five responses were received from 54 registrars. Themes related to challenges included mental distress, resource constraints, and compromised and inadequate training. Themes related to strengths and opportunities included new learning experiences, resilience, coping strategies, and enhanced graduate competencies related to leadership, collaboration, communication, and health advocacy. The disruptive and disorienting elements of COVID-19, although situated in chaos, aggravating the constraints of training in under-resourced settings, also provided unexpected learning opportunities. These findings highlight the transformative potential of disrupted learning contexts and the need for responsive curricular to enhance graduate competencies, adaptability, and resilience.

Keywords: COVID-19; disruptive learning contexts; transformational learning; graduate competencies; postgraduate medical education; registrars

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1. Introduction

Pandemics can usher significant disruptive societal changes, requiring us to imagine society in new ways. As society changes, transformation becomes a primary medium through which adaptations to the changing environment may be viewed. For frontline health care workers (HCW), including registrars, who have been at the forefront of the changes ushered in by COVID-19, the need to adapt to the ever-changing demands of a rapidly evolving viral disease has been most acute [1,2]. COVID-19 has disrupted most learning contexts, with medical trainees responding to the crisis instead of focusing on academics [3]. Emergency departments in the COVID-19 responses became the new learning context in the absence of traditional academic learning contexts.

The literature on the pandemic has mainly focused on the impact, concerns, and challenges of COVID-19 [4–6], and on adapting medical education programmes [3,7–9]. The solutions to such problems have rested on the innovative power of online learning platforms and the ability of such innovations to overcome the challenge of disrupted learning [3,10]. Hence, for the most part, the medical education literature has focused on the institutional resources needed to respond to the challenges facing medical education during COVID-19 without paying sufficient attention to the transformations that students themselves need to make to meet the COVID-19-related challenges.

This study explores registrars' experiences of clinical training during the COVID-19 crisis. Registrars are qualified doctors who undertake postgraduate specialist training in different medical disciplines [11]. Registrar roles are often perceived to be one of the most challenging in hospitals, as they constantly juggle training and service needs, especially in resource-constrained environments [5]. The importance of creating effective ways to foster the development of fully competent registrars [11] who are entering unpredictable medical environments [6] has highlighted the need for congruence between registrars' training environments and learning requirements. However, COVID-19 disruptions have prevented registrars from working in ways that are in tandem with their training needs due to the refocus of resources towards dealing with a highly complex global pandemic. Al-Benna [12] has highlighted how surgical registrars deployed to areas outside of their scope of practice because of the COVID-19 response may need assistance to orient themselves to unfamiliar settings and the performance of competency-related tasks.

Further, while studies have charted the ensuing disruption of the COVID-19 pandemic, few have explored how these disruptions may facilitate formative learning experiences and the development of competencies and other attributes. In this study, we aimed to explore how registrars responded to the challenges of COVID-19 by conducting a SWOT (strengths, weaknesses, opportunities, and threats) analysis of registrars' clinical training in the first wave of the crisis. We also sought to understand how the impact of the disruptions of the COVID-19 crisis could potentially trigger transformational learning opportunities, prompting new learning perspectives for the registrars.

Transformative learning is based on a notion of change where learners are challenged to "critically question and assess the integrity of their deeply held assumptions about how they relate to the world around them" [12]. In transformative learning, a need for personal change is stimulated by identifying a disorienting dilemma, which poses a challenge to the learner's ability to continue learning as before. During the COVID-19 pandemic, clinical trainees had to respond to challenges that included unfamiliar learning experiences and learning outside the typical learning environment [13]. At the heart of the critical questioning central to transformative learning are questions of self-perspective, meaning systems, identities, roles, and abilities, all of which are objects of transformation in transformative learning.

Transformative learning theory is recommended as a pedagogy of uncertainty for health professions education in the 21st century to accommodate new beliefs that enable humans to thrive amid the challenges and complexity of our world [13]. Van Schalkwyk et al. described the conditions that "trigger" transformative learning to be an unfamiliar or atypical learning experience that may be "an intense, authentic learning experience or event that usually create a disorienting dilemma" that "may produce feelings of fear, discomfort, uncertainty, and vulnerability" [13]. Hence, in this paper, we further argue that the disruptions of the COVID-19 crisis created a context that could have triggered transformative learning opportunities for registrars despite the challenges posed by the COVID-19 crisis.

2. Materials and Methods

We conducted a SWOT (strengths, weaknesses, opportunities, and threats) analysis using an online qualitative survey. Qualitative surveys overcome resource and time constraints for researchers and participants and offer "a wide-angle lens," equipping researchers with the ability to capture a diversity of experiences for an area of interest [14]. The SWOT framework is an effective situation analysis technique and planning tool that is used to inform the strategies and resource capabilities of a system or situation [15].

2.1. Setting

Successful registrar training in South Africa (SA) certifies medical practitioners for independent specialty practice in the country. Registrar training occurs over a four-year salaried period, during which registrars register for a Master of Medicine (MMed) programme at an academic institution. The work-based MMed programme includes clinical training, a research methodology course, and a research project via publication or a dissertation. Registrars work in the frontlines of specialised public sector referral (regional) hospitals governed by the SA Department of Health. The registrars in this study work and train in the public healthcare hospitals across the largest cities and towns of Kwa-Zulu Natal (KZN). KZN is one of nine provinces in SA. Public hospitals in SA serve non-fee-paying patients from the lower-income sector.

2.2. Data Collection

Since registrars working in the frontline of the COVID-19 responses may have limited time to participate in traditional interviews, data were collected via a self-administered online survey created using SurveyMonkey® [16]. The survey included a biographical section and eight open-ended questions. The questions focused on the personal and professional strengths, weaknesses, opportunities, and threats related to clinical training during the COVID-19 pandemic (e.g., list any personal strengths related to training to clinical training during the COVID-19 pandemic; list any profession-related strengths to clinical training during the COVID-19 pandemic). The survey was piloted with three registrars for face validity before the online hyperlink was shared via the WhatsApp® social media platform. Repeated reminders were sent to encourage volunteers to participate in the study.

2.3. Sample

We tried to sample registrars across the medical and surgical disciplines using snowball sampling. Snowball sampling was adopted for use in this study due to the constraints of COVID-19, which restricted access to the respondents. Representatives based at the different hospitals in KZN and in different medical and surgical disciplines were contacted by the primary investigator, who asked them to participate in the study and share the survey link with other registrars. Hence, registrars were invited to participate via their university representatives (discipline-nominated senior registrars) during the first wave of the COVID-19 pandemic (June–September 2020) in SA. The survey was kept open for over a month and closed after no new responses were received.

2.4. Data Analysis

We used thematic analysis to analyse the data. Thematic analysis is a qualitative method used for organising and analysing human experiences [17,18], and it has been used in healthcare settings such as psychology [17] and nursing [19,20]. We relied on descriptive codes and in vivo codes to generate the themes [17] that would form the object of our analysis. To minimise bias and enhance the credibility of the data analysis, both the authors (V.S.S. and D.S.) and a trained research assistant analysed the data independently.

We began by formatting the data into separate Microsoft Word tables (from an Excel spreadsheet) to show all the text per SWOT theme. This allowed us to focus on each swot category more closely and to analyse individual responses. We analysed the data sets for the categories within the SWOT themes, starting with a thorough reading of the data and then drawing some concept maps. Through this process, we manually assigned "descriptive codes" [21] to the various issues that cropped up repeatedly within participants' responses. These codes (short phrases/single words) were then organised into categories (combining similar codes) according to our interpretation of what was being communicated by the participants, and their views on how their clinical learning was affected by the onset of the COVID-19 pandemic. This process also served to "condense and summarise the data rather than simply reduce them" [17,21]. The constant comparative method was used throughout the data analysis where the codes used to develop themes were constantly compared to other coded responses in the data set for similarities and differences [22].

Discrepancies between data analysts were discussed until a consensus was reached to increase the trustworthiness of the data analysis, as we recognise that coders are influenced by their beliefs, perceptions, and prior knowledge [22]. The categorising was also informed by the current literature, which consisted of opinion pieces and empirical studies of how clinical learning had been affected by the COVID pandemic and previous outbreaks of infectious diseases elsewhere. Since the questionnaires were collected anonymously, the respondents were unknown to the researchers.

This study received approval from the University of KwaZulu-Natal ethics committee (HSSREC/00001306/2020). All participants consented to take part.

3. Results

Fifty-four registrars from 16 clinical disciplines consented to participate in the study (Figure 1). The majority of the participants were women (74%), married (68%), and without children (57%). Figure 1 provides an overview of the participants' disciplines. Four hundred and five responses were received across the SWOT domains. The majority of the responses related to weaknesses, closely followed by strengths, threats, and opportunities.

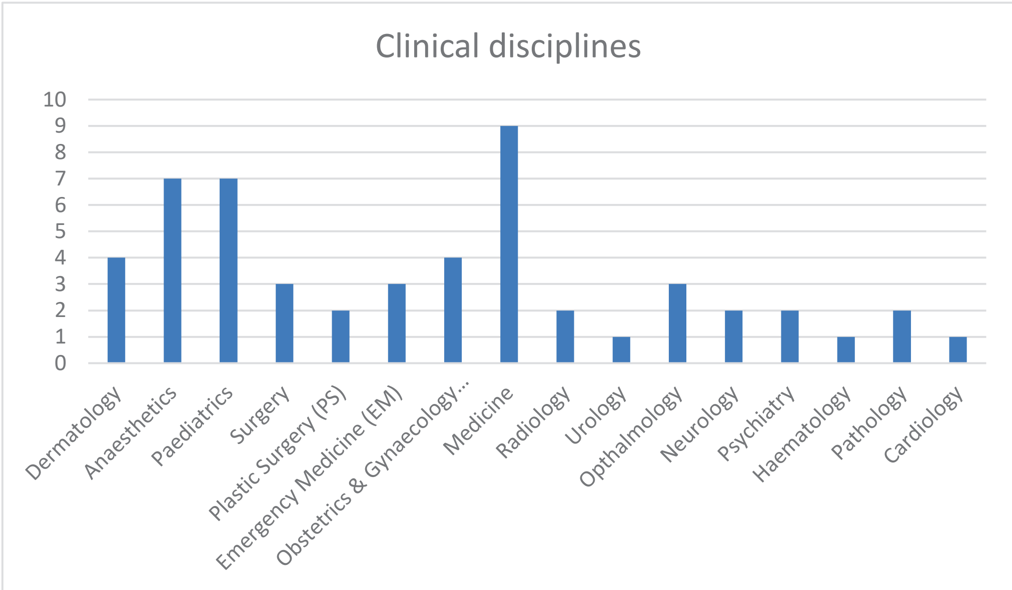

Figure 1. Number of registrar participants in the survey by clinical discipline.

The major themes and subthemes are illustrated in Table 1. The themes emerging from weaknesses and threats were collectively described as challenges.

Table 1. Major themes and subthemes.

Challenges	Strengths and Opportunities
Mental distress Resource constraints/system deficiencies Compromised and inadequate training	Resilience and coping strategies Development of competencies - Leadership - Health advocacy, collaboration, and communication New learning opportunities

3.1. Challenges

3.1.1. Mental Distress

COVID-19 was described as a fear-provoking experience that was coupled with feelings of anxiety and uncertainty. Fear ranged from fear about the self ("*COVID might kill me*" (Anaesthetics-P18)) to family members (including a "*constant fear of making our loved* *ones ill"* (Paediatrics-P13) and "*fear of hospital-acquired infection reaching elderly parents . . . and child"* (Anaesthetics-P37)).

Registrars, especially those who had young children, described anxieties and uncertainty around the personal and professional sphere of their lives, which were exacerbated by the COVID-19 lockdown restrictions in South Africa, such as the closure of childcare facilities and travel restrictions:

> *" . . . very few childcare options . . .* [and] *kids are only at school intermittently . . . this means anything currently "optional" on a work-front is NOT getting done in my off time e.g., studying and MMED".* (Medicine-P32)

Other challenges reported by registrars related to the impact of isolation and lockdown measures occasioned by COVID-19:

> *"Being isolated from colleagues due to social distancing has had an impact on mental health"* (Psychiatry-P43)

> *"Inability to see family has affected my psychological wellbeing so much, I'm not as productive as before"*. (O&G-P41)

3.1.2. Resource Constraints and Systemic Deficiencies

Coupled with the pandemonium or chaos encountered during the COVID-19 crisis, registrars in already resource-constrained hospitals experienced even higher levels of stress and strain.

Registrars raised issues regarding the working conditions in their hospital settings as part of the weaknesses and threats experienced during clinical training:

> *"there are no resources or infrastructure"* (Surgery-P28);

> *"extreme staff and resource shortages—gloves, masks"* (EM-P14)

Inadequate human resources were also intensified, adding further strain on the existing skeleton staff "*due to people contracting COVID*" (Surgery-P9), with "*inadequate nursing staff due to illness*" (Ophthalmology-P27), and "*sub-optimal consultant support on calls*" (Medicine-P24). "*Time constraints* [and] *Overload*" (EM-P12) during a time when registrars found the "*calibre of patients more demanding, requir[ing] more time to treat each patient*" (Medicine-P24). Further, the "*lack of protocols to deal with short-staffing, lack of testing following work exposure led to registrars [feeling like they] are the sacrificial lambs*" (O&G-P30). Some registrars who were unable to identify or engage with any emergent learning opportunities were those who reported a lack of infrastructural and leadership support due to a "*lack of support and empathy from seniors*" (O&G-P15).

Registrars felt that not enough attention was given to the toll that the overwhelming COVID-19 pandemic would have on them, particularly by the leadership in these disciplines and institutions. They requested "*better leadership and planning from the Department of Health*" (Anaesthetics-P18) and felt that "*COVID-19 has thrown every health care system into chaos, and the leaders at the top had time to plan but failed to do so adequately*" (EM-P12).

3.1.3. Compromised and Inadequate Training

Clinical bedside teaching came to a halt during COVID-19. Further disaster management regulations and social distancing measures around learning in higher educational institutions meant that registrars could no longer attend academic and training sessions the way they used to, as "*the pandemic ended ALL* [sic] *academic activities*, and *there is simply no time or capacity for anyone to attend any form of academic activity*" (Medicine-P32). A registrar who reported "poor health" (Surgery-P28), both as a personal weakness and a personal threat, was unable to identify any learning opportunities that emerged during clinical training, indicating that perhaps their personal health concerns and fears may have hindered their learning opportunities.

Curtailed academic activity and training sessions led to registrars feeling anxious about missing contact time during training due to "*limited ward rounds and teaching sessions* *around patients*" (Neurology-P32). Due to COVID-19 demands, registrar training was redirected to deal with the COVID-19 crisis. Hence, registrars reported that "*due to the pandemic I do not have gynae operating time*" (O&G-P30). They also reported that they had "*no elective surgical experience*" (Surgery-P27) and "*a lack of cases to practice clinical skills*" (O&G-P41).

The lack of institutional communication regarding the completion of the training programmes were also described as challenges: "*There is a lack of communication regarding where we as registrars stand in terms of continuation of training*" (Surgery-P28). Due to the novelty of the COVID-19 crisis, registrars also highlighted their knowledge gaps and lack of training, as there was "*minimal formal training on-site regarding updated protocols*" (EM-P14)

3.2. Strengths and Opportunities

Resilience and Coping Strategies

Although three registrars were unable to identify any strengths and 14 were unable to identify any opportunities, others identified improvements in their "*adaptive*" (EM-P12) strengths, such as "*courage and resilience*" (O&G-P15), and found that they had the "*opportunity to learn new coping mechanisms*" (Pathology-P42).

In other cases, registrars recognised a psychological shift in themselves through "*improved introspection*" and "*increased mindfulness of self and others during crisis*" (Anaesthetics-P37). Registrars also began to appreciate the importance of self-care: "*the fact that we are forced to do only urgent surgery has led to us being more rested, with stronger immune systems and more time to read*" (Plastic Surgery-P10).

Further, help-seeking behaviours and self-awareness emerged amid the disruptions as registrars requested "more mental health support in [their] hospitals. Rather than just emails, look at sitting down with each registrar to assess mental health. We are all on the same journey, just taking different paths with different obstacles... all equally important" (O&G-P30).

3.3. Development of Graduate Competencies

3.3.1. Leadership

Though registrars felt overwhelmed with work, they also recognised the opportunities derived from "*working out of* [their] *comfort zone*" (EM-P12) and the opportunity to develop leadership competencies, such as "*adaptability*" and "*flexibility*" (Opthamology-P49). For example, one registrar reported that she saw an "*opportunity to think outside of the box, i.e., devising systems to handle stable outpatients in order to avoid unnecessary influx of patients in the hospital environment*" (Paediatrics-P33). In this instance, the registrar solved the problem of high patient influx by devising strategies that allowed them to overcome the problem of increased patient volumes. A registrar from Medicine (P32) reported "*learning to triage patients with reference to who can I help and who can't I help*" to cope with the overload of patients. Registrars also "*practice[d] 'making a plan' in severely sub-optimal conditions*" (Medicine-P32) and reported "*staying focused amidst all the uncertainty and fear* whilst recognising the opportunity to be a *"health advocate and leader*" (Paediatrics-P13).

3.3.2. Health Advocacy, Collaboration, and Communication

Collaboration and communication were registered as positives alongside health advocacy during this crisis. Many Registrars reported that training during the COVID-19 crisis created opportunities for becoming "*communicators and collaborators*" (Anaesthetics-P4) and helped them "*grow as a health advocate*" (Anaesthetics-P18) as they were "*able to be an advocate for patients and other colleagues*" (Paediatrics-P50). Others also reported that in the COVID-19 crisis, "*there has definitely been a need for more collaboration*" (Psychiatry-P43) and an "*opportunity to learn about other methods of communication*" (O&G-P41). In the absence of formal counselling, another registrar reported the "*counselling of nurses and appreciation for the ancillary staff*" (Neurology-P34) as opportunities that arose during the pandemic. Registrars' adoption of health advocacy could be linked to their criticism of the leadership responses described in the challenges reported in this analysis. Registrars took the lead in advocating responsively to gaps that they felt undermined their wellbeing and the wellbeing of others around them.

3.4. New Learning and Training Opportunities

Registrars found that the "*increased availability and awareness of online learning opportunities*" led to "*increased academic activities due to online access platforms*" (Ophthalmology-P27). Registrars also appreciated the new sharing and access to information created globally during the pandemic, reporting that "*most courses are online*" (Anaesthetics-P18). There was also an "*improved attendance of clinical meetings with use of virtual platforms such as Zoom*" (Paediatrics-P33), and "*a sponsorship to attend virtual international conference*" (Psychiatry-P43). Hence, registrars embraced the new learning and training opportunities, which also enhanced their self-directed, life-long learning skills: "*I'm able to use evidence-based medicine*" (Paediatrics-P50).

4. Discussion

In tandem with studies that have found fear amongst HCWs at the forefront of the COVID-19 response [23,24], our study also registered feelings of fear, anxiety, and despair amongst most registrars. However, registrars also recognised opportunities and developed strategies to help them allay these fears by utilising their personal and professional strengths. The registrars' recognition of strengths and their ability to act on emerging opportunities in ways that transformed their personal and professional lives may be viewed as occurring within a learning context that, although characterised by disruption and disorientation, held great transformative learning potential [8,9]. However, this study also found that some registrars were unable to respond and engage "with the unfamiliar learning experiences" [25]; hence, transformative learning may not have occurred [13]. Registrars who were unable to identify any transformative shifts in the form of opportunities or abilities to act on emerging opportunities were those who reported a lack of leadership, infrastructural, and staff support, and poor health conditions. Registrars who reported negatively on personal or professional strengths in opposition to those who reported positive personal attributes, such as resilience, courage, or personal leadership skills, also did not list any opportunities. Research has demonstrated that learners have different transformative learning capacities and that not all learners may resolve disorienting dilemmas simultaneously [25]. These differences highlight individual, structural, and social factors that could hinder their transformative learning potential.

This study highlighted how the pandemic aggravated the constraints of under-resourced work-based healthcare training sectors, such as in SA, where there is one specialist doctor per 11,000 people in the public sector (as opposed to 1: <500 in the private sector) [26]. Similar to other countries [27], the registrars in this study also expressed concerns regarding the lack of resources and shortage of PPE. Given the double dilemma of having their worlds shifted and not having enough basic materials to keep themselves safe, registrars devised practical strategies to help them manage, such as the effective triaging of patients and thinking carefully about which patients to prioritise to reduce high patient loads under very demanding circumstances. Registrars spoke about developing a sense of mindfulness, which has been reported elsewhere, and which they found to be helpful [28,29]. We see, developing in connection to this mindfulness, themes around health advocacy, with registrars initiating solutions and changes in response to their patients' and colleagues' needs, developing skills outside of their usual scope of practice.

These developments included, for example, the registrars themselves taking up roles whereby they provided informal counselling to their peers and some of their patients in the absence of formal channels of psychological support. It has been found that frontline workers are usually psychologically the most impacted upon during frontline responses [30]. Although the provision of informal psychological and therapeutic support by healthcare workers to other healthcare workers has not yet been fully explored, Polizzi, Lynn, and

Perry have commented on it in terms of trauma responses to other events, such as the September 9/11 attacks in the US [24]. They reported that, during the aftermath of the attacks, "many experienced a sense of control, self-esteem, and belonging by providing emotional and practical support to family, friends, and the larger community and interpreted their actions in a positive manner" [24]. By taking responsibility for providing psychological support to colleagues, registrars were able to allay fears and provide continuity for the settings they were in. As a development out of the crisis, we would recommend that the role of informal psychological techniques be investigated further.

The registrars highlighted an important facet of crisis response. As with other crises inflected by discourses of disorientation, the grand narrative directing the COVID-19 response rested on global as well as national experts, remaining focused only on the pandemic response without considering other less directly COVID-19-related aspects of communication to registrars. For example, the registrars lamented the lack of clarity around continuing their training from their academic institutions, something they would have found reassurance in, while responding to COVID-19. The registrars' lamentation highlighted that no unit of communication is ever too small to reassure those affected by the crisis in such situations. Out of this realisation arose their criticism of some of the decisions taken at the broader national institutional level.

Further increased service loads brought on by the pandemic have exacerbated the constant conflict between service and training in registrar training [31]. This area warrants further attention post-pandemic, and extended training contracts should be considered to make up for the loss of clinical and operative experience due to the specialist training schedules being interrupted and replaced by COVID-19 rotations. The extended training contracts would ease the anxieties and concerns about not having time to acquire the necessary specialist-specific competencies.

Almost overnight, a significant transformation to have emerged from the COVID-19 pandemic in medical education is the move to online learning platforms [32] to deal with disruptions in education and training. Unlike other findings that have reported significant problems in HCWs' ability to adapt to online platforms [33,34], we found that the registrars adapted with much ease and appreciation for online platforms. Registrars harnessed these online learning sessions, which seemed to encourage greater attendance and the development of life-long learning skills.

We also found that the COVID-19 crisis changed the registrars' perspectives related to wellbeing and self-care. It highlighted, for them, the importance of investing in their physical and mental wellbeing. Registrars must continue to be encouraged and empowered to engage in self-care and improve their working lives during and after the pandemic [8].

An interesting finding of this study relates to instances where registrars had taken up leadership roles in ways that they felt would best suit the circumstances in which they found themselves. Registrars also embraced opportunities to develop other core competencies, such as collaboration, communication, and health advocacy, facets of learning that have been described as integral to developing competent clinicians [35,36]. These findings strengthen the call for organisations to "support these unsung heroes" by including formal leadership programmes to enhance registrar training [37] and graduate competencies. We argue that the COVID-19 crisis provided a space in which the registrars could take up these roles and add to their competencies in ways that may not have been immediately possible outside of the disorientating dilemmas created by COVID-19.

This study has highlighted how the disruptions of the pandemic could be viewed as transformational learning opportunities in a crisis, which could lead to new perspectives relating to personal coping strategies and enhanced graduate competencies in postgraduate clinical training. Registrars recognised and embraced the new learning experiences linked to their clinical knowledge and skills development, while also reflecting on their leadership, collaboration, health advocacy, and professionalism competencies. Our study also adds to the growing body of evidence highlighting the importance of the human factors of medicine's hidden curriculum that are critical for healthcare today [5].

In conclusion, postgraduate medical training during the COVID-19 pandemic not only posed challenges for the registrars, but also contributed to them "*growing as stronger clinician*[s] *in adverse conditions*" (Anaesthetics-P45).

5. Limitations and Concluding Remarks

A limited sample size may limit the generalisability of the findings in this study due to bias, and because resources and infrastructure may differ between regions. However, this study aimed to provide a snapshot of work-based clinical training to facilitate and inform future interventions during the pandemic.

This study did not focus on sex and discipline differences between the registrars. Since the majority of respondents were women, there is a possibility of bias by way of the survey reflecting feelings and attitudes that may be sex specific. Further, the data were collectively analysed without considering discipline-specific nuances due to the small number of registrar responses within the different disciplines. Hence, gender and differences between disciplines warrant further investigation.

Survey-based studies may limit an in-depth analysis. Future studies should include interviews with the work-based trainers to provide a much more in-depth, inclusionary account of the formative experiences of clinical training during a pandemic.

Psychological stress has been identified as one of the major impacts on HCWs during the COVID-19 pandemic. The continued use of online platforms to implement wellbeing interventions, such as mindfulness training [38], and virtual training for registrars to provide a sense of continuity with the possibility of alleviating the negative impact of disruptions [2,3] are recommended. Such strategies should also be implemented in routine training to help registrars adapt and adjust to unpredictable learning environments. Recent research has looked towards the theoretical underpinnings of self-directed learning (SDL), where learners take the initiative to address their learning needs with or without the support of others in disrupted learning environments [39]. SDL was recommended as a core competency and as an essential component of responsive curricula that empowers trainees to identify and implement relevant learning strategies to optimise disrupted clinical training [39].

Our reflexivity statement in this study centres on issues of positionality and paradigmatic worldviews that may have impinged on our interpretation of the data. V.S.S. being a medical educationalist with interest in understanding the challenges and opportunities of constrained training contexts, especially during the pandemic, and positioned academically in a transformative learning theory paradigm, meant that there was a constant risk of confirmation bias in terms of transformative learning. D.S. being a postdoctoral researcher in medical education with a critical health psychology paradigmatic orientation, which is critical (and often suspicious) of institutional practices, there was the ever-present risk of this critical position impinging negatively on the researcher's interpretation of participants challenges. To reduce both these potential biases, the data analysis process was kept transparent through constant consultations between V.S.S. and D.S. as we tried to read and interpret the data objectively.

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Data Availability Statement: The data that support the findings of this study are available from the corresponding author, upon reasonable request. The data are not publicly available for reasons pertaining to authors' participant anonymity considerations.

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education sciences

Article

Emergency Digital Teaching during the COVID-19 Lockdown: Students' Perspectives

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Abstract: This paper presents a qualitative study of the experience of students of the shift from face-to-face learning to online learning during the COVID-19 lockdown in Norway. Detailed inputs were collected from 200 university students enrolled in a bachelor's degree in information technology in Norway through an online survey. Their responses were categorized into three main themes: the teacher's role, the life of a student, and digital learning. We found that, surprisingly, the students felt that the shift to digital learning had positive effects on their lives, such as the availability of more time for study, study flexibility through recorded lectures which could be reviewed repeatedly and anytime, and more time to pose questions. However, some students also pointed out negative effects such as more distractions, lack of structure, and a perceived invasion of privacy when required to turn on their cameras. The students valued the use of high-quality technical equipment as well as student engagement during online lectures, but also freedom of choice to participate.

Keywords: digital learning; COVID-19; higher education; student perspective

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1. Introduction

In March 2019, Norway, along with large parts of the world, was shut down due to the coronavirus disease 2019 (COVID-19). As a result of the pandemic and subsequent shutdowns, the landscape of higher education institutions underwent major changes [1]. In a matter of days or weeks, educational institutions had to transition to online teaching and choose which digital tools their lecturers would use to continue offering education to their students. This necessitated new types of technology infrastructure as well as support and guidance for educational staff who had neither used digital tools to deliver lectures nor taught online before. Indeed, this was a significant transition for teachers, who not only suddenly had to use digital tools but also to change their teaching plans. However, students also experienced significant changes. From sitting side by side with classmates and having physical interaction with the lecturer, student assistants, and peers, students have had to sit for long hours at home watching lectures on their screens and working in isolation.

The sudden transition from classroom education to digital education has been labelled emergency remote teaching (ERT) [2,3]. The term was coined to distinguish it from traditional online teaching, where the institution and the lecturers plan for online delivery ahead of time. Although many students have access to the internet at home through their mobile phones and other digital devices, there are other factors that make digital teaching and learning challenging and demanding. As mentioned, there is a marked difference between being in classrooms, auditoriums, libraries, the canteen, and other places in school with lecturers, student assistants, and peers, and studying alone at home in the living room or bedroom. While this is in many ways a challenge, however, this has also opened up some opportunities and positive experiences. People have learned to utilize digital tools to communicate in a professional context, such as to conduct meetings. Organizational meetings have become more efficient, as the participants do not have to travel for a long time and incur travel and other expenses. Such transition has also shown us that we are more adaptable than we think.

Although physical human contact has been significantly reduced, we have found other ways and new ways to communicate and interact with each other. Much of this experience, we are likely to bring into the future and will likely affect how we will act in the coming years. For example, they will likely make communication between colleges, lecturers, and students more efficient and make each party more available. Human contact is important, but in exceptional situations, we must find solutions that work. Through the pandemic, we have gained a lot of useful experience in a short time.

While online courses and learning over the internet have been considerably studied over at least a decade, studies on them have significantly increased during the COVID-19 pandemic. This is partly because digital teaching during the pandemic differs from traditional digital teaching due to the limited time available for the preparation of both teachers and students [4]. What has piqued our curiosity is students' experience of being involuntarily online students in a time of much uncertainty. We had many questions regarding how the lockdown has affected students. Because we are working in higher education, that is where we focused our efforts. We summarize these questions in the following main research question:

How are higher education students experiencing digital teaching and learning during the COVID-19 pandemic?

To answer such a question, this paper draws on qualitative data collected through an online survey of bachelor's degree students in Norway. We had published the quantitative results of the survey [5] but not the qualitative results because of the space restrictions of the publication and because qualitative and quantitative results are very different in nature. This paper presents the qualitative results. We will later present a thematic analysis of the student responses to understand their experience of digital teaching and learning during the COVID-19 lockdown.

This paper is divided into six parts. In Section 2, we review the relevant literature. In Section 3, we describe the method used and the analysis performed. We present the findings in Section 4 and discuss them in Section 5. Section 6 concludes this paper and gives suggestions for future studies.

2. Background

The COVID-19 pandemic has significantly affected education worldwide. In a short time, the curriculum has been forced to be delivered in an online format. This has been a challenging process for the people involved [6], including teachers and students. Although digital teaching is not new, there has been a renewed focus on it with the onset of COVID-19. Students and staff who had originally signed up for on-site education were suddenly sent from the classroom to Zoom or other digital platforms. In contrast to the now traditional alternative known as online education, this sudden move to online learning is described as emergency remote teaching (ERT) [2,3]. Hodges et al. described the difference as follows:

> Typical planning, preparation, and development time for a fully online university course is six to nine months before the course is delivered. Faculty are usually more comfortable teaching online by the second or third iteration of their online courses. It will be impossible for every faculty member to suddenly become an expert in online teaching and learning in this current situation, in which lead times range from a single day to a few weeks. [3]

ERT has brought about many and varied experiences, some positive and others more challenging. Among them are the experiences of silence, loneliness, and not being able to meet those whom one wants to meet daily. A study [7] explored how the pandemic affected loneliness across population subgroups in Norway. Data were collected through an online questionnaire in June 2020. The general loneliness was stable or fell during the lockdown. However, some subgroups, individuals, and older women reported slightly increased loneliness during the pandemic. The results of the study indicate that Norwegians seem to have managed the lockdown without an overwhelming increase in loneliness.

Moving on to the impact of COVID-19 on teaching students in higher education programs, Hjelsvold et al. [8] conducted a study in Norway on how teachers experienced the transition from location-based teaching (i.e., teaching face-to-face in physical environments) to online teaching (i.e., teaching through online platforms such as Zoom) during the lockdown. The findings showed that almost every teacher in the field of computer science experienced a positive change. However, the main challenge was related to pedagogical concerns. A study that continued the focus on the teacher perspective [9] yielded similar results. The teachers were mostly content with the tools and their handling of them; however, they saw challenges in inducing the active involvement of students and in conducting two-way communication with them. Various forms of stress were also mentioned. The findings from the previous studies [8,9] are interesting to consider from the perspective of Mittal et al. [10], who looked at performance expectancy (PE) and effort expectancy (EE) as factors that influence teachers' willingness to adopt a system. On the one hand, the teachers did not seem to have issues with the technology. The technology for delivering lectures is not complex and is necessary during the lockdown; that is, the PE should be high and the EE should be low. On the other hand, using technology to deliver lectures while maintaining pedagogical quality seems to be a challenge.

In 2020, Raaen et al. [11] conducted an online survey among students enrolled in a bachelor's degree in IT program capstone project. As a result of the pandemic, the students had to move their working space and collaboration into digital environments in a short time. That study showed that from a student perspective, this sudden change had a significant perceived negative effect on collaboration, communication, and results, an important reason being that had the lockdown not happened, they would have been working together in teams. However, the outcome measured with the grades given to the students implied that the students were unaffected by the situation. Consequently, the students felt affected by the lockdown, but in practice, they handled the stress well. Zawacki-Richter [12] conducted a study in Germany and looked at the effect of COVID-19 in light of ERT. It showed that while acceptance of e-learning tools had been slightly declining before the pandemic, the demand for digital innovations is expected to increase in the future. In other words, the pandemic will have a positive effect on digital innovations in university teaching in Germany. This may also be the case in other countries, such as Norway.

Klapproth et al. [13] performed a study in Germany after the switch to distance teaching due to COVID-19 that showed that teachers experienced medium to high levels of stress due to the situation. Most of the respondents experienced technical barriers, though most of them felt able to handle the stress. Furthermore, male teachers experienced significantly less stress than female teachers. In the context of digital teaching, Castelli and Sarvari [14] found that 90% of the students in their study did not turn on their cameras during synchronous lectures. The students (n = 276) were asked in a survey why they chose not to turn on their cameras. At the university where the data were collected, there was a policy that made it optional for students to turn on their cameras during online classes but encouraged students to do so. The students' reasons for not turning on their camera were, among others, concerns about their appearance and that the people in their household or physical location would be seen behind them; a weak internet connection; their belief that not turning on their camera was the norm; and their feeling that people were looking at them. Castelli and Sarvari state that one should not force the students to put on their cameras, as the student may have different living conditions which make it difficult. However, Castelli and Sarvari also propose to encourage it by explaining the benefits for both the students and the teacher, including the value of nonverbal cues in communication, building instructor-student and student-student relationships, and creating a warmer, closer, and more comfortable environment.

Gonzalez et al. [15] found that in an ERT situation, the digital learning environment must be scaffolded. Students need help in becoming independent and self-motivated; in developing a daily study routine; and in meeting and communicating with their peers. Their daily study routine is affected by the disappearance of the context switch that used to come from their going to school. In ERT, students' homes are their place of leisure, study, and—for students also working from home—work. Thus, student resistance to using video, sound, and chats is a challenge. Not using these means of communication can quickly become the norm, which will hinder students from communicating with their peers, teaching assistants, and teachers. Students are aware that communicating with others is beneficial. However, their resistance to exposure stops them from making use of the possibilities afforded by technology. Some students even resist communicating fully in smaller groups such as for project exams. Regarding daily study routines, Gonzalez et al. found that students saw live lectures as important because such lectures gave them events to organize their studies around, as they studied before and after lectures. As also mentioned by Zhou and Zhang [16], students miss being able to meet their teachers and peers in the online setting. Zhou and Zhang's student subjects further disclosed that the lack of live events is a major barrier to their online learning. They also found that the hybrid learning mode was optimal, as the students on campus reported better support for their studies.

Abou-Khalil et al. [17] identified engagement strategies that students enrolled in higher education programs but who had low resources found effective in the context of emergency online learning. They found that student-content engagement strategies such as screen sharing and class recording were perceived as most effective. Those were followed by student-teacher strategies, such as question-and-answer sessions and reminders. Student-student strategies such as group chat and collaborative work were considered the least effective.

Beyond the purely academic, life itself has been affected by the lockdown. Jun et al. [18] looked at first-year students in Korea. They found that new students felt profound disappointment after having looked forward to university for a long time.

Students also had difficulty adapting. For some, all this turned into depression. Despite this, students found the learning activities meaningful, and those who focused on such thinking handled the situation better.

Baloran et al. [19] conducted a study among students (n = 529) in higher education programs in the Philippines to understand the effect of COVID-19 on students. The findings showed that satisfaction with online teaching was significantly correlated with the engagement among online students. The findings further showed that the students who participated in the survey had the same degree of satisfaction with online teaching but had various levels of online learning engagement based on their year level. In terms of student engagement, Farrell and Brunton [20] conducted a qualitative study in which they followed 24 online students in Ireland for over a year. The results showed that there were several psychosocial factors that influenced successful online student engagement, including an engaging teacher and confidence or self-efficacy among the students. The study also showed that the most challenging aspect of being an online student was balancing studies with other activities, such as work and staying connected with family and friends. This showed, among other things, that there is a smaller difference between schoolwork and other activities during the pandemic. Many students experience these activities as overlapping, without clear distinctions, unlike before.

Tando et al. [21], in a study on facilitators and inhibitors of the adoption of e-learning by undergraduate students, investigated several factors such as PE and hedonic motivation (HE). They found that the students preferred online learning if they perceived it as beneficial for themselves. Thus, it is important to help students develop a habit of using e-learning frequently, and it is important to encourage students to engage with their peers and teachers through interactive digital functions such as the chat functionality and other functionalities based on gamification.

Peimani and Kamalipour [22] conducted a qualitative analysis of the perceptions of student learning during the COVID-19 pandemic. The classes and materials were a mix of synchronous and asynchronous. The students had weekly online reading and discussion seminars using Zoom as the main platform. A high 82.1% of them were satisfied with the online delivery of lectures and reading seminars, and 88.9% were satisfied with the delivery of discussion sessions. The students preferred (82.2%) live lessons over prerecorded lessons because they found the former more helpful. Recording the live lessons facilitated asynchronous learning, enabling the students to review lectures at their own time and pace.

The students could communicate both orally and through text but were more comfortable communicating textually. They were satisfied (85.8%) with their communication with their tutors but were less satisfied with their interaction with their peers (28.6%). Interacting with their peers was a challenge for them as it became more of a monologue, and "many students (with cameras off) were sidelined in the online sessions due to non-participation" [22] (p. 9). Only 50% thought students should be expected to turn on their cameras during live online sessions, which is an interesting contrast to the 78.6% who thought it would be helpful for their learning experience to switch on their cameras specifically for the online discussion session.

To identify predictors of success in online learning, Kovačević et al. [23] identified and statistically verified four key factors: positive experience with the chosen learning platform, motivation to learn in the situation, the importance attributed to learning achievement, and the students' level of digital competency.

To bring this topic further forward, we need to dive deeper into the minds of individual students to mine their thoughts and impressions. Consequently, we see the need for deeper qualitative work exploring the hows and whys of digital learning.

3. Methods

This paper describes a qualitative study based on an online survey. Its purpose was to gather insights into students' experiences of digital learning during the pandemic, in their own words.

3.1. Survey Design

The questions were developed based on the authors' collective experience in teaching at the higher education level. We focused on topics such as participation, recording of lectures, and general experiences linked to digital teaching during COVID-19. The survey consisted of both quantitative questions and open-ended questions so that the respondents could offer qualitative comments and fruitful insights. We strove for a straightforward design, with precise and clear questions. A pilot test was conducted in advance to ensure that the questions were understandable to the target group. After the pilot test, a few adjustments were made.

In this article, we focus on the qualitative findings from the open-ended questions in the survey because as has been mentioned, the quantitative findings have been communicated in a previous paper. The questions are presented below, followed by the number of responses to each question.

1. What do you perceive works well in live lectures in Zoom, and what do you perceive does not work well? (n = 130)
2. Why do you prefer the recording or non-recording of lectures? (n = 130)
3. Why do you participate little or a lot in live lectures using chats, voiced questions, video, and other participation modalities? (n = 128)
4. What would it take to make you participate more actively in the lectures, using chats, voiced questions, video, and other participation modalities? (n = 101)
5. What advice do you want to give teachers to improve their digital lectures? (n = 97)

3.2. Data Collection

We conducted an online survey among bachelor's degree students in information technology (IT) on their first, second, or third years of study. To contact the students, we presented our study concept to them during a lecture and gave them a link to the online survey questionnaire, while assuring them of full anonymity. Thus, participation was voluntary, and we aimed to contact all, approximately 600 students, in the program. The survey was conducted from January to February 2021 using SurveyMonkey and closed with 200 respondents.

3.3. Respondents

The survey respondents were bachelor's degree in IT students. Thirty percent of them were women, 69% were men, and 1% did not want to state their gender. The age distribution is as follows: 48% were 18–24 years old, 46% were 25–34 years old, 5.5% were 35–44 years old, and 0.5% were 45 years old or older. The respondents' year level in university also varied: 59% were on their first year; 12.5%, second year; 28%, third year; and 0.5% answered "other". As part of the introductory questions, we also asked whether the students had paid work alongside their studies, and 35% answered no, 29% worked 1–10 h a week, 29% worked 11–20 h a week, and 8% worked more than 20 h a week (the percentage doesn't total 100% because decimals are rounded up). We were also interested in whether the students had a suitable place to sit when attending digital lectures. The results showed that 78% always had a suitable place to sit, 20% had it only sometimes, and about 3%, never (the percentage doesn't total 100% because decimals are rounded up).

3.4. Qualitative Analysis

The data analyzed in this article came from the answers of the respondents to our open-ended questions. Even though the literature we earlier reviewed had pointed out certain aspects of the digital learning environment during the pandemic, we did not find sufficient literature on how students are experiencing digital lectures in Zoom. Hence, our study was explorative in nature.

As we received many answers to our open-ended questions and we are a team of three researchers, we needed a clear process for analyzing the qualitative data. The answers ranged from descriptive to what the students felt about the situation. To have a more structured analytical process, we chose thematic analysis based on Braun and Clark's [24] six-phase process and Gibbs [25]. Thematic analysis is a tool for the researcher to go through qualitative data in a more predictable manner and to gradually discover overarching themes, that is, to discover patterns. Braun and Clark defined six steps in the process of thematic analysis:

1. Familiarization with the data;
2. Generating the initial codes;
3. Searching for the themes;
4. Reviewing the themes;
5. Defining and naming the themes; and
6. Producing the report.

Although we created questions that focused on specific issues, we wanted to let the data speak for themselves as much as possible, as described by Braun and Clark and Gibbs, instead of us coming in with preconceived assumptions. However, we also acknowledge that coming in blank without any thoughts, meanings, and expectations is not possible, as we, as teachers, are involved in the situation that we are studying. We describe our use of the thematic analysis process in the following paragraphs.

We began by downloading all the responses and entering them into a text document that ended up 80 pages long. In the first phase, our goal was simply to familiarize ourselves with the data. We read and reread the responses while taking notes. We also agreed among ourselves that we should not form conclusions too quickly, that is, that we should not attempt to come up with codes or themes by ourselves but that we should meet to discuss our notes and thoughts.

The next step was to create codes. For this, we made a table where all of us could add codes and notes to the codes as we reread the responses. After two rounds of rereading and adding codes, we began categorizing and merging equal codes to make it easier for us to go into the theme identification phase.

We formulated initial themes and refined them in steps by finding the bigger stories and patterns until we saw that the themes were sufficiently clear and unique. Finally, we used the themes as departure points for both our literature review and our further analysis and discussion in this article.

4. Results

This section is divided into three sections, which included sub-sections. Each of the sections are illustrated in Figure 1, to give an overview of the structure of our analysis. In each of the sections, we provide our findings, highlighted by citations of the respondents related to each of the three topics that emerged from our analysis.

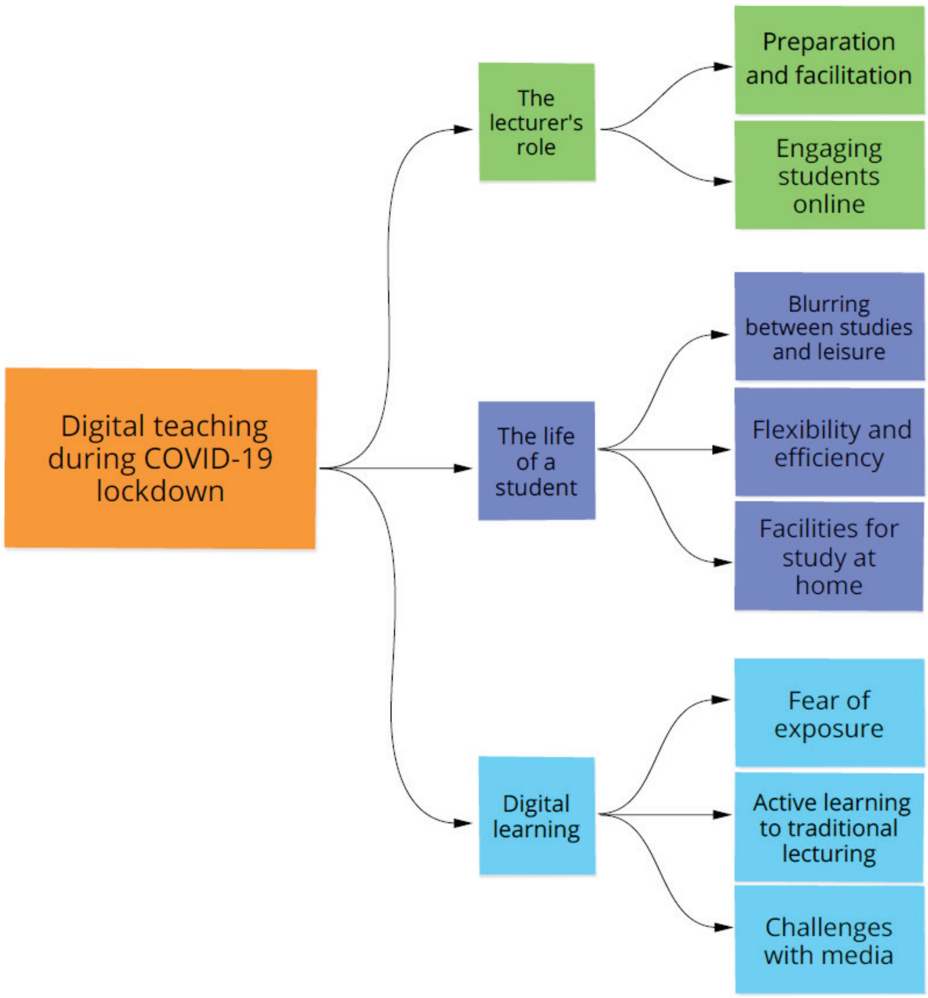

Figure 1. An overview of themes and codes identified in our analysis.

4.1. The Lecturers' Role

Digital teaching requires different and oftentimes greater preparation in advance of the actual teaching session compared to physical teaching. The increased preparation is partly due to technical facilitation through administration, technical competence, recording, use of tools, and other tasks. It is also important to engage the students by creating and facilitating interactions and student activities. These require approaches different from those for physical teaching in a classroom setting.

4.1.1. Preparation and Facilitation

First, a digital teacher must have a different set of skills than a physical teacher. It is important to not only be a good teacher but also to facilitate a digital session that gives students a valuable experience and good learning. This is important both in terms of the content of the lecture and in relation to the actual implementation. Our findings showed that a range of factors play a role in this context. The teacher's way of using online tools and adapting to digital teaching influences the result and the students' experience.

The fundamental requirement for a teacher is to have access to equipment that works well, including computers, internet access, cameras, and microphones. Students should be able to focus on what is being said and not be disturbed by other elements such as poor sound quality and slow internet connection. Regarding this, one of the respondents wrote: "It's okay to follow, but the sound quality is rather poor for most people. An investment in good microphones from the school that the lecturers could make use of would have been better ". In line with this, another respondent said:

> The school should organize so that lecturers have a proper studio, at home or at school, where they can sit. Smaller groups ask everyone to have a camera and talk a little at the beginning of the lecture, before it becomes recorded. Get students involved and invested in the lecture—maybe some surveys along the way?

Moreover, if the teacher uses online tools such as Kahoot, they should also be well planned, and the teacher should be familiar with how such tools work. Furthermore, our findings showed that most of the students preferred that digital lectures be recorded and published afterwards. This requires advance planning by the teacher and the teacher's familiarity with publishing video recordings in the learning platform used. Many students favor recordings of lectures. One of them wrote: "[I] prefer to have recordings, very nice to be able to go through something difficult a few more times". Another student added: "It's worth gold. Lectures should be recorded regardless of whether it is home study or not. It's great to be able to review things several times or see later if things should come up that conflict with the lectures". The quality of the recordings should also be as good as possible.

Our respondents also mentioned that students prefer that the teacher answers their questions via the chat function during the session. For the teacher, however, this will be an "interruption" in the sense that the teacher will be "derailed" from the lecture. Regarding preparation, it is important that the lecturer has a plan for implementing this chat functionality effectively—whether he or she will answer questions continuously as they appear in the chat or collect questions after each lesson or between specific topics in the lecture. Related to this, a participant said: "It is important that breaks are taken so it is possible to have coffee. Do not go overtime unless it is said in advance". This emphasizes the importance of the lecturer planning the time well and sticking to the focus of the individual lecture. This must be done to respect not only the teacher's time but also the students' time.

4.1.2. Engaging Students Online

In many cases, it is easier for the teacher to engage students when they are physically in the same room. They see each other, and they can talk to each other, have a personal interaction with each other, and not least, observe the other's body language and how the other behaves. During digital sessions, such opportunities are often absent. Engaging students "through" the screen is harder, but our findings showed that the students have some preferences for engagement beyond the fact that the technical equipment must work optimally. First, it is important to have a good teaching plan that works and engages—among other things, through the use of tools and not just that the lecturer reads out the text on the PowerPoint slides presented. We also saw another key factor from our findings: that the teacher, during the lecture, encourages the students to be active. Active participation may be asking the teacher questions and answering the teacher's questions, for example, using the chat functionality. However, this also requires the teacher to take the time to answer the questions that come in. If not, it will be perceived as meaningless for the students and can lower their motivation to actively participate in the lectures. Regarding engagement and participation during online lectures, one of the respondents wrote: "Things like, for example, Kahoot can make the lecture a little different and more captivating", but another respondent was somewhat more passive and wrote, "[I] have no advice. Understand that engagement is not easy to convey through a computer screen". Yet another respondent said: "Have assignments or exercises along the way that the student must do to help [keep up] his/her motivation. Live coding, where [students] can code together with the lecturer, is a great example".

4.2. The Life of a Student

Due to COVID-19, the transition from physical to digital teaching came overnight. No one was prepared and many had to make changes, both in their private life and in their student activities. This created some opportunities that would otherwise not have been there, but also some challenges for many students.

4.2.1. Flexibility and Efficiency

Our findings showed that digital teaching provides greater flexibility and efficiency—flexibility because you can study "whenever you want", since lectures are prepared that are available 24/7. The students do not have to be present in a specific classroom at a given time to get the content of the individual lecture. This allows them to take more control of their daily lives, in terms of what to do at any given time. Some working students said this was good, among other things, as it helps them manage their work alongside their studies.

In terms of efficiency, the participants stated that digital teaching, as opposed to physical attendance in school, means less travel time to and from the campus. This is especially noticeable for those who have a long journey and spend a lot of time on trains, buses, and other public transportation. Note that we have no student accommodations on-campus and that housing in the immediate vicinity of our campus is expensive for most students. One participant said: "I think this [online teaching] generally works well; I am a big fan of this. Getting to the lecture is easy when it is live [online], [and] it is easier to combine work and studies".

4.2.2. Blurring between Studies and Leisure

One student put it bluntly: "Zoom works well, but everything being digital makes me lazy". Without fixed attendance times in school and, to a greater extent, with much of the learning left to the students, they experience less distinction between studies and leisure time than before COVID-19. This is not always positive and can lead to a less structured daily life for the students. Digital learning, as an alternative to studying in physical locations in school, provides reduced human contact and reduced communication, such as opportunities to contact a supervisor, teacher, and others. The everyday interaction with fellow human beings is considerably limited, and this entails, among other things, greater isolation and time alone for the individual. As a result, it is more important than ever for the student to plan his/her own time and when different activities are to be performed within a day or a week. A keyword is structure in everyday life. This is not as easy for all students to realize.

4.2.3. Facilities for Study at Home

Since the lockdown of society occurred over a very short period of time, there was little or no time to prepare for home study. Consequently, during the pandemic, some students have experienced challenges related to living conditions and varying degrees of access to suitable premises to follow teaching and studying. There are also marked differences in living conditions among students. Some rent or own an apartment, whereas others live at home with their parents or in a shared accommodation. One of the respondents wrote:

> I think when it comes to online teaching, it's okay that we have a recording to watch in case you were not able to be 100% present at the lecture. If you are sitting in a room at school, at least there are [only a] few distractions. At home, there may be neighbors renovating, building right outside your window, etc. And it's generally harder to focus while at home.

Another respondent wrote:

> The disadvantage is that it is not always suitable to have a lecture on Zoom at home and is often more difficult to follow due to all the disturbances around. The sofa is not a place you want to sit and do schoolwork [in].

This testifies that students experience possible disturbances during digital teaching and that it is easier to focus and concentrate during face-to-face teaching.

4.3. Digital Learning

The digital environment in this context consists of several tools, such as Zoom, Discord, and Slack. The first is a video conferencing tool, and the last two are digital social platforms where students can get help from student assistants. Zoom offers digital meetings where all participants can participate via video, sound, and text chat. It is the main tool for delivering lectures to the participants in this study. Zoom also offers a function called breakout rooms, where the participants are split into groups of any size set by the teacher to enable discussions.

4.3.1. Fear of Exposure

Even though the digital tools make full participation possible, the students were reluctant to participate especially with video and voice during a lecture. The students would not turn on their cameras and would rarely, if ever, use voice. Text chatting during a lecture was more acceptable and was even seen as lowering the psychological threshold for asking a question for some of our students. However, several students thought it uncomfortable even to use the chat functionality out of fear of asking questions that may make them seem dumb. In digital social platforms, some students are reluctant to write posts that everyone can see, for example, to ask their peers and student assistants questions.

Breakout rooms, which could make discussions possible during a lecture, were disliked by the students. It was awkward for them to be with others in such a setting, especially if they did not know the others from before, something that would happen often since the teacher would assign random groups. Hence, although the tools made communication possible, this possibility was not used to its potential. A consequence of the use of digital tools was that some students become increasingly isolated as the semester progressed.

It is difficult to say how the students started being resistant to communicating digitally. One of the respondents said:

> The reason I wasn't so active was that most of the others [who] attended from the start [had] a passive mood. [I] felt a bit stupid [to be] the only one asking questions, and most seemed uncomfortable in breakout rooms.

Another respondent stated:

> It would have helped to know [with whom] I went to class, that there was room for asking, talking, discussing. Breakout rooms seem awkward, and many feel [they are] uncomfortable. [They work] against [their] purpose when many don't want to talk, turn on their camera, or participate.

An additional respondent pointed out: "Never make students discuss in breakout rooms. [It] will not happen. In 99% of the time, it will result in 5+ students sitting still, not saying a word, until the time is over". Technology is in place, but there are strong forces at play within the culture of the digital learning community that hold the students back.

4.3.2. From Active Learning to Traditional Lecturing

Some students perceived the teachers as reacting negatively to how they refused to turn on their cameras when encouraged to do so. Our respondents expressed their understanding of both the teacher's frustration and that it was unnecessary. According to them, the interactiveness declined strongly as time passed, with some teachers reverting to the traditional lecture style with monologues. This was understood to have been a consequence of the low activity level among the students in the digital lectures.

The respondents said they want more interactiveness, although few of them actively participated, and they noticed how the number of questions from the teacher has gone down and that dialogues between the teacher and the students no longer happened. At worst, the students perceived a live session as like watching a prerecorded video when the teacher did not include any form of interactiveness. A respondent spoke about the activity level in some of the lectures: "There's too little [interactiveness]. To just sit there and listen to somebody talk is not motivating". However, students also found the live sessions important because they give them the possibility of asking questions and the feeling of "being in school". Live lectures are preferred to the use of prerecorded lectures. As a respondent explained: "Sometimes, there are just prerecorded videos, and that is even less motivating, because then, I would rather find more engaging videos on the same topic on YouTube". Still, other students reflected on how digital lectures could not substitute for physical lectures and that they missed the feeling of truly being in school. A respondent who wished for increased interactiveness proposed to work during a lecture since the digital lecture is " ... not very interactive and we learn much less by doing exercises on our own afterwards. We should have an arrangement where we also could participate, that we have assignments and tasks together". Breaking up lectures with small work sessions could have made for more interactive sessions.

4.3.3. Challenges with Media

Several technical and non-technical issues arose in the digital lectures. The most common issue was the quality of the sound in the lectures. A number of students found the sound quality problematic and referred to some teachers not having a good enough microphone. They added that background noises during a lecture could be disturbing, such as from children or animals. A respondent said: "Something that has been up and down is the sound quality. [In] 90% of the cases, it works fine ... but at other times, there are birds making noise". Another student commented that " ... the teacher's microphone is of too low quality" and that " ... there are [still] some teachers [who] use the internal microphone on the laptop. The internal microphone hurts the ears of those listening, it records all the sounds in the room, and there's a lot of echo".

Bad habits of some lecturers, such as saying "uhm" or saying certain phrases or words repeatedly, became more pronounced. A student stated: "Some lecturers have bad habits [that] are magnified when they are the only person you see on screen. 'Umm', 'like', 'right', 'you know', etc. This can make it difficult to follow along when one notices this". Students also became very aware of how clear or unclear the teacher's pronunciation was, and how it would vary if the teacher spoke too slowly or too fast. Several of our respondents reported that they found it more difficult to focus on a digital lecture due to several factors such as distractions at home, thus returning to the issue of not having the context switch between leisure and study; and issues concerning sound would make this even worse. Also affecting focus was that some teachers forgot to give breaks, ending in too long and tiresome stretches of lectures. Our students are used to breaks approximately every 45 min, so requests for more frequent breaks refer to this baseline.

Another more pronounced issue for the students was their peers' use of the chat function during a lecture. On the one hand, they found the chat a good option for asking questions, but on the other hand, they found that many of their peers would spam the chat with unnecessary comments or questions they should have been able to find the answer to on their own. Moreover, the chat function in Zoom gives notifications and pop-ups when somebody comments, and this was distracting for some of the students. The students also noted how even the teacher would get distracted by the chat and notifications and how this stopped the lecture because the teacher would have to read the messages, thus disturbing the flow of the lecture. However, in contrast to the negative comments on the use of the chat, there were several positive comments about the students being able to contact the teacher and answer peers' questions, and how this could have a positive effect on the interactiveness in class.

A smaller group of respondents said they chose not to participate with sound or text because they were worried about disturbing the teacher or their fellow students. A further reason given for not wanting to use voice was that there were other people talking or there were other noises where they were sitting. Some respondents mentioned lagging and quality of internet access as issues, but they seem to have been minor for most of the respondents.

5. Discussion

We see that the survey responses can be split into three broad categories that are discussed separately in this section before some broader conclusions are drawn.

5.1. The Teacher's Role

When teachers hold a digital teaching session, it is very different from teaching students in a classroom setting. This requires further preparation and facilitation, including engaging students, which is also a key factor for successful learning. Prior studies [8] have investigated how teachers experienced the switch from face-to-face teaching in physical environments to online teaching. The results showed that almost every computer science teacher experienced a positive change. This may be because, in such a field, one is used to handling technology and various tools in a teaching context, compared to other fields where technology is less important. In addition to facilitation of technology, the findings from our study also revealed the importance of recording lectures, as they provide students opportunities to watch the content afterwards and replay the recording as many times as they want especially if there is a subject matter that they find difficult and want to review.

Moreover, the quality of digital lectures should be as high as possible. Therefore, it is important that emphasis be placed on technical equipment. Suddenly conducting teaching in a different arena than what one is used to introduces pedagogical challenges. The teacher's way of using online tools in digital teaching influences the result and the students' experience. The teacher must have access to equipment that works optimally (light, microphone, camera, etc.) so that the students can focus on learning. The importance of technical facilitation is clearly evident in our findings.

The respondents further highlighted the need for active student engagement. Examples given were the teacher's use of digital tools (e.g., Kahoot) and encouragement of engagement among the students during lectures. Regarding this, previous research related to digital teaching has shown that there are challenges from a teacher's perspective, such as in relation to actively engaging the students and establishing two-way communication during online lectures [9]. In most cases, the teacher talks, and the students listen silently. Previous studies [19] have shown that engagement among online students was correlated with satisfaction. This shows that engagement is an important aspect of the experience associated with learning and satisfaction with the teaching.

While students want teachers to facilitate student engagement, prior research has shown that students do not turn on their cameras during online lectures [14] and therefore, in many cases, contribute to reduced engagement. In some contexts, it probably makes sense that students have not turned on the camera; but cases in which the teacher encourages it are different. From a student's point of view, it is sometimes easy to make demands about how a teacher should behave and at the same time, be passive and hide in the crowd with fellow students. From our findings, we also saw that some students want the teacher to ask them for activity and commitment, while other students thrive best on being passive listeners and on not being forced to actively participate in online lectures.

In line with previous research [17,22], screen sharing and recording have been found to be effective in terms of learning among students, while question-and-answer sessions and reminders are also perceived as effective. Our survey respondents found recordings of lectures useful. The recordings mean that the students have access to lectures 24/7 and can use them, among other things, for exam preparations. It is therefore important that teachers record their lectures in subjects where recordings are appropriate to use.

5.2. Student Life during a Lockdown

We, as teachers, tend to view the learning experience based on what we are doing or telling our students to do. However, it may be argued that life itself and informal interactions between students are even more important for learning. Although we do our best to facilitate learning even during a lockdown, this informal part of studies is difficult for us to improve. From getting up in the morning, getting dressed, and commuting to campus, to going out drinking with fellow students, students have experienced profound changes to life itself during the pandemic that are important to how they handle the change.

Compared to the Korean students in a previous study [18], our students have somewhat lower expectations of life as a student. Many of them continue to live with their parents, and others move only short distances or go to college with old friends. These choices, combined with the lack of on-campus accommodations, also mean that university life is not as all-encompassing for these students as in the Korean case. Nevertheless, our students also miss the social aspects and the human interaction.

Furthermore, the blurring of lines between work and leisure demands a difficult balancing act. This is in line with previous studies [20], which found that the most challenging aspect of being an online student was related to balancing studies with other activities such as work and family life. Some students struggle to focus, while others feel more focused with fewer external distractions. The individual differences here are clearly important.

Interestingly, many students felt positive effects on their life of the pandemic changes. The reduction in commutes had saved them much time. The lack of social opportunities had increased the time available to them for studying. Combining this extra time with the flexibility of recorded lectures gives them great opportunities for focus and hard work. Even teachers who themselves blur the lines between work and leisure through heavy workloads contribute in many cases by being available for answering questions at any time. In contrast, some students feel that it is difficult to focus at home with all the distractions around them. The lack of a structure in such a flexible daily life is also difficult for many of the students to manage.

5.3. Digital Learning

Educational institutions strive to follow the tenets of active learning both online and in physical locations. Having active students participate in class, discussions, group work, and other forms of collaborative work make for better and deeper learning. Technology provides us several ways in which we can communicate and share information effectively, but we see in ERT that students are hesitant to engage fully, as would be most beneficial for them. For example, while communication through digital means would make it easier for students to communicate, communication seems to have been reduced dramatically overall in the digital learning space, judging by how students, especially in bigger classes, never turn on their cameras nor use voice, and some are even hesitant to write in the chat for all to see.

The reasons for students not participating fully in the digital learning environment in our study match those in literature [14,15]. The issue is exposure, which may be seen from two angles. In the first angle, students are wary about exposing themselves and how they look to others. Students are at home in their private quarters, such as in their bedrooms or living rooms, and may feel that it is unnatural to dress up for the occasion, as would be normal if they were to travel to school to meet their peers. In the second angle, the issue of exposure may seem to some to be expressed as a fear of appearing dumb in front of others when asking questions and finding it awkward to speak in breakout rooms even in smaller groups, and even in important contexts such as in group exams. Our findings hint that an issue here is how well the students know each other. Some of our respondents wish they could know their peers before joining conversations with them through digital means. This leads us to a problem that is difficult to solve—for students to get to know each other, they must meet and talk with each other, but because they do not want to talk to strangers digitally, new relationships will not be initiated.

The best possible way that was seen to make students join discussions was breakout rooms, where students could meet in smaller groups of, for example, 4–6 students. However, our findings showed that in some cases, student groups ended up being silent for the entire allotted time, as was also reported by Gonzalez et al. [15] and Peimani and Kalamipour [22]. The students found this situation very awkward and uncomfortable. An important question is when and how this culture among the students started. Some answers indicate that they had been like that from the start. A few active students seem to have tried to start a new trend, but they quickly reverted as the group pressure to conform to the established culture of being invisible and silent became too strong. Some students further commented that they felt somewhat dumb for being the only one asking questions. In a physical classroom with many students, one may, of course, not have the most active students, but under the right conditions and as time passes, one may see an increase in participating students. In the digital learning environment in our study, we experienced that even the most active students do indeed fall back to inactivity. This fully reflects the phenomenon where the students express that they want more interactiveness but other students dislike it and do not partake in one of the most interactive forms possible. As found in [22], some students do think it would be a good learning experience for them to turn on their cameras. In addition to the issue of exposure, we see that the situation becomes so partly because of the students not knowing each other well enough or at all, as online environments offer fewer opportunities to engage with peers. To add other possible reasons, it may be asked if the teacher let the students prepare well enough to engage in a satisfactory manner, considering that in ERT, many activities could not be planned and adapted thoroughly to the new situation. These factors combined may cause students to feel less prepared and less confident to join group discussions.

The situation has not only affected the students but the teachers as well, according to the students' observations. The students noted how the teachers have made lectures less interactive, for example, lacking discussions between the teacher and the students or between peers in class. Some students noted how some teachers have reverted to monologues in class. Instead of engaging students in student-centered activities, some teachers have fallen back into exclusive instruction and transmission. We do not suppose it is their conscious decision to do so, but rather, a consequence of the situation.

The teacher may be hoping for dialogues, activities, and discussions in class, as we saw signs of in our findings. The students noted how teachers were trying to push for discussions in breakout rooms and asking the students questions during lectures in Zoom. It seems, however, that the teachers had given up after some unsuccessful attempts. After all, the teachers cannot force the students to turn on their cameras or use voice. Talking into a Zoom screen and watching black boxes with names instead of seeing students' faces is not the most motivating situation for the teacher. This entire situation is a prominent issue in the mentioned ERT situation. Students want interactiveness, but they may not be willing to fully engage. One may have the best of intentions to engage students, but the reality of the situation may not make it possible to achieve—at least not without knowing how the students may react and without planning how to prepare the students for such engagement.

On the bright side, even though the students are somewhat split, the chat functionality seems to have made possible some interaction between the students and teachers and among peers, as also found in previous studies [15,22]. On the one hand, the chat could get spammed by irrelevant, distracting, and sometimes unnecessary questions, from the perspective of some of the students. On the other hand, this was the form of communication that was most used, as opposed to video and sound. A respondent in our study suggested having moderators in the chat, which may be a promising idea, especially in bigger classes. Moderators who could both moderate and answer questions to alleviate the work of the teacher in the chat could be beneficial. This may also help diminish the teachers' distraction due to too many messages in the chat, thus breaking the flow of the lecture. Students do not want to be distracted by the chat, but if they use it to ask questions, they expect, as also mentioned in [22], that the teacher is keeping track of their questions and answering them as they come.

Challenges with quality need to be addressed. Improving sound quality is relatively easy, and buying a good microphone for each lecturer should help. However, since the communication between teacher and student has been reduced, it could be that the extent of the issue did not reach the teachers or administrators as quickly as it should have. Sound and noise issues are important because we saw the respondents struggling with focusing at home, and this issue aggravated the situation. The teachers should also be aware of the quality of their articulation; their bad habits in speech such as pauses, use of superfluous expressions; and the speed at which they speak.

5.4. Limitations

The limitations of this study are typical of qualitative research. First, we asked the students how they have experienced digital learning during the COVID-19 lockdown, and how they answer may depend on what they emphasize, their subjective opinion, and what they best remember. In addition, the students in our sample belonged to a specific group—students enrolled in a bachelor's degree in an IT program in Oslo, Norway—and thus, they possibly have a different skill set and familiarity level with technology than other groups of students. Regarding differences between countries, it should also be noted that the students in this study do not live on-campus, as do students in some countries, but live at home, in their own apartment, or in student dormitories found in or around Oslo.

In addition, in the Norwegian context, Norway has had a relatively soft lockdown, in that the state and municipalities did not force their citizens to stay inside their homes, unless in specific cases of quarantine upon arriving in Norway from travel abroad. In general, the lockdown in Norway meant you could go outside as much as you liked. Visiting businesses and other homes was however severely limited at times.

Despite these local considerations, much of what we learned in this study should be internationally relevant. All activities were simultaneously moved from the campus to the home, which paralleled the experience across much of the world. While not living on campus, our students lived in shared apartments or dorm rooms provided by the student association. Some stayed with their parents during the pandemic. Thus, there is little reason to assume that our students had significantly different and better facilities for studying at home than do students from other places. Moreover, while cultures are different, life as a student is an important phase of people's lives across the world. Thus, we conclude that except for some details, our general results are relevant for most countries and cultures.

6. Conclusions

In conclusion, we saw that the students' experience in recording lectures was very useful in terms of flexibility and also so that the subject matter can be repeated and used in preparations for exams. Higher education students have many different requirements and needs. This requires that the lecturer understand the students well and facilitate interaction and interactiveness during digital lectures. Technical equipment must function optimally during digital lectures, and sound and video quality must not be distracting. Moreover, students prefer live lectures to prerecorded lectures because live lectures allow students to structure their day around such lectures. In addition, students find it difficult to turn on their camera during digital lectures; but when the camera and the sound are off, active learning is reduced which leads to unfavorable student learning outcomes. We also found that frequent breaks are even more important online than during physical lectures.

6.1. Further Work

To fill a gap and increase understanding of digital teaching, as well as use findings from this study, there are several interesting studies that can add to the body of knowledge. The fear of exposing oneself with video and audio among students is something that recurs. It would be interesting to find out how to make the students more comfortable with the use of sound and image during lectures.

Our findings also show that many students are uncomfortable in group settings such as breakout rooms in Zoom. Discussions with fellow students often have a good learning effect and contribute to active learning. Therefore, one approach could be to investigate student involvement in online group discussions, which issues the students perceive as holding them back from communicating with their peers, and how to facilitate a comfortable setting from a student point of view.

6.2. Advise to Administrators

Many of the themes found in this work are complex and require dedicated work over time to improve. Fortunately, other findings are immediately fixable. We recommend the following:

- Consider recording and publishing online lectures.
- Provide each online lecturer with a professional-quality microphone and a quick course on how to use them.
- Make sure lecturers take frequent breaks after up to 45 min of sessions.
- Make sure to have a consistent and common set of tools and procedures for online lectures to reduce the workload of both the lecturers and the students.

Other issues, such as the passivity of the students and the lack of interaction, require more complex solutions that each institution and we, the research community, must continue working on together to deliver.

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Data Availability Statement: This paper presents a qualitative analysis of free-text responses. These are personal in nature and include information on third parties. Thus, we cannot publish the data without violating privacy.

Conflicts of Interest: The authors declare no conflict of interest.

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education sciences

Article

The Post-Pandemic Lecture: Views from Academic Staff across the UK

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Abstract: COVID-19 forced the closure of UK universities. One effect of this was a change in how lectures, and their recordings, were made and used. In this research, we aimed to address two related research questions. Firstly, we aimed to understand how UK universities replaced in-person lectures and, secondly, to establish what academic staff believed the post-pandemic lecture would look like. In a mixed-methods study, we collected anonymous quantitative and qualitative data from 87 academics at 36 UK institutions. Analysis revealed that respondents recognised the value and importance of interactive teaching and indicated that the post-pandemic lecture would and should make greater use of this. Data also revealed positive views of lecture capture, in contrast to pre-pandemic studies, and demonstrated that staff recognised their value for those who were unable to attend, or who had specific learning differences. However, staff also recognised the value of asynchronous lecture videos within a blended or flipped approach. This study provides evidence that the pandemic has engendered changes in attitudes and practices within UK higher education that are conducive to educational reform.

Keywords: COVID-19; lecturing; lecture capture; higher education; flipped teaching; blended learning

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1. Introduction

In March 2020, the World Health Organisation declared COVID-19 a pandemic and, subsequently, COVID has significantly impacted on all aspects of society worldwide, including higher education (HE) [1]. The pandemic resulted in many university campuses closing around the world and all teaching, learning and assessment transitioning online [2]. In the UK, universities were forced to pivot all teaching online in March 2020, with online teaching remaining in place for the remainder of the academic year (to September 2020). This sudden online transition can be seen as a rapid acceleration of a slower pace of change in this direction in pre-pandemic years [3]. Prior to the pandemic, most universities were moving towards blended learning, with face-to-face teaching supported by virtual learning environments (VLEs)/learning management systems (LMS) and tools such as lecture capture (LC) [4–7]. Previously, the pace of change had been slow and risk averse [8] but the pandemic forced academic staff and institutions to rapidly adopt approaches that were (for them) novel [9]. Despite the exceptional circumstances in which changes have arisen, it is highly probable that many universities will continue with their new online modes of teaching long-term with a recent report based on the views of over 1000 sector leaders, staff and students indicating that the future of universities was blended delivery [10].

One teaching method engrained within universities is the lecture, which provides an efficient way to teach large numbers of students [11]. Previous research shows that students value lectures highly as a means of providing core knowledge [7,12] but they can also support development of independent thinking and problem solving [13]. Although the common approach to lecturing prior to COVID-19 was to lecture live and in person, recording of live lectures through LC was common pre-pandemic, with recordings typically made available via VLEs soon after the live event [14–16]. Research shows that students feel that the availability of capture supports their well-being [12]; and for those with disabilities, it can be extremely helpful [7]. However, the use of LC is contentious, especially where students utilise it in place of attendance [17]. Furthermore, staff have expressed significant concerns about LC, including that it reinforces an acquisition-transfer model of learning, which is unlikely to result in deep learning, and can inhibit the use of anecdotes and controversial material, which may support learning [12]. Staff have also expressed concern that the availability of video recordings of lectures may negatively impact their intellectual property, performance reviews and autonomy, ultimately affecting job security [18].

Although use of video recordings of lectures was controversial prior to the pandemic, the COVID-19 shift to online learning has meant that pre-recorded lectures have become the new normal for many. Subsequently there has been a shift in the narrative around lectures and the use of video, such that questions are now being asked about whether conventional live lectures will return. Within this debate, we may see greater acceptance of video media and greater reliance and acceptance of LC by staff, who have previously shown some resistance [18]. Furthermore, the flexibility of lecture capture is likely to be more widely recognised by both staff and students now that both have been forced to work and study in sub-optimal conditions. In the current study, we aimed to understand staff perceptions of what the post-pandemic lecture would and should look like in UK universities. By focusing on academic staff directly involved in teaching, we are focusing on a group who have been previously identified as critical in the success of pedagogical reform [19] and who will be directly affected by changes in how lecturers are delivered. The current study aimed to address the following key questions: (i) How were in-class lectures replaced during the emergency online pivot? (ii) Has the pandemic has changed attitudes towards LC? (iii) Will staff return to conventional lecturing, and what might future lectures look like in post-pandemic education? (iv) What role will lecture capture technology play in future lectures?

2. Materials and Methods

2.1. Study Design

This study adopted a mixed-methods methodology with a concurrent design such that both quantitative and qualitative data were collected simultaneously. This approach allowed us to obtain broad trend data on how lectures were replaced and whether views of pedagogy and technology had changed but also obtain the detail of qualitative research to examine beliefs of staff and therefore yield greater insights than either method alone [20]. All data were collected via an anonymous online survey.

2.2. Researcher Positionality

All authors of this work have been actively using and evaluating education technology for several years. The second and third authors (BG, EJD) have been conducting research focusing on lecture capture and video tools for over five years, investigating staff and student attitudes to lectures and their capture both from a teaching and learning perspective and a policy point of view. All authors taught throughout the pandemic, across three universities collectively. In conducting this research, the authors wanted to better understand how to COVID-19 had impacted lecture-based teaching and the views of lecturers specifically regarding the use of lecture capture.

2.3. Survey Distribution

The survey was advertised using several methods to recruit academics across UK universities. Adverts were placed on social media, in institutional research circulars, via the Higher Education Academy Principal Fellows network and HE Advance website. The survey ran from 16th March 2021 to 19th April 2021. Ethical approval was granted by the corresponding author's Institutional Research Ethics Committee (MRA-20/21-22320).

2.4. Survey Structure and Procedure

Participants were provided with study information and gave consent online, prior to gaining access to the survey. The survey consisted of three sections.

Section 1: collected demographic information (age, gender, ethnicity and disability) using a pre-determined list of options.

Section 2: focussed on teaching experience, utilising a series of closed questions relating to their current position (duration in role, full time equivalency, focus of role, proportion spent teaching, discipline and level of teaching). Participants also had the option of including the name of the university they worked for.

Participants were then asked to indicate if they had previous experience of LC, followed by rating agreement (1 = strongly disagree, 7 = strong agree) with several attitudinal measures towards LC aimed at both instrumental (good/bad) and experiential (pleasant/unpleasant) aspects of attitude [21]. Finally, participants were asked to indicate if their attitude towards LC had changed since the pandemic. If they responded that it had, they were asked to provide an open-text explanation.

Section 3: participants indicated how their in-person lectures were replaced from a pre-determined list (synchronous with technologies like Zoom; pre-recorded asynchronous using non-LC technology, pre-recorded asynchronous using LC technology; synchronous using LC technology), with the option of adding an unlisted alternative. Where participants indicated synchronous lecturing was used, they were asked if they used anything to introduce interactivity, with a free-text answer format. For participants answering this question there was a follow-up question asking why they adopted this approach and whether they felt it was effective. All participants were asked whether they ran additional online activities to support learning of lecture materials. This was again followed up with a question about rationale and effectiveness.

All participants were then asked whether they foresaw a return to conventional lecturing when public health and government guidance permitted this (Yes, No, Maybe, I don't know), and asked to explain their answer. Participants where then asked what they imagined the post-pandemic lecture will look like and what they would ideally like it to be. They were then asked if they felt LC technology would play a role in the post-pandemic lecture and what features these technologies would need to do so.

2.5. Data Analysis

Quantitative data: Data collected regarding demographic characteristics and teaching experience were analysed using descriptive statistics (i.e., frequencies), to characterise the sample. Similarly, some of the data collected to identify the teaching methods adopted during the pandemic were analysed in terms of frequencies. Additionally, free-text responses regarding techniques used for interactivity and activities were inductively categorised and category frequencies were reported. Eight questions regarding attitudes towards LC were grouped according to the underlying construct. The four items assessing instrumental attitudes were averaged to create a single measure (Cronbach's alpha = 0.852). The same approach was taken with experiential attitude (Cronbach's alpha = 0.852). For these measures a rating of 4 represented the midpoint (neither agreement or disagreement) and they were analysed with a one-sample Wilcoxon tests to assess whether the distribution of responses was significantly different to that midpoint of '4', with standardised Z values reported.

Qualitative data: Free-text responses to open questions were typically brief, precluding the emergence of rich themes [22,23]. Instead, data were analysed using open coding procedures to identify and describe discrete instances within the data, a procedure is common to many qualitative methodologies [22,24,25]. This strategy was sufficient to summarise the core concepts within the qualitative data, and to meet the aims of the qualitative analysis, i.e., to complement and enrich understanding of the quantitative analysis. Quotes are provided to illustrate concepts throughout [26]. Qualitative analysis was initially completed by two of the authors independently (LR, EJD) who identified core concepts. Following independent identification, codes were shared, discussed, refined and consolidated to provide a final list of concepts. The final list of concepts and their description was then verified by the third author (BG), a senior qualitative analyst.

3. Results

3.1. Participant Demographics and Teaching Experience

The sampling approach taken precludes response rate calculations. Of the 143 participants starting the survey, 88 (62%) completed it. Of these, one was excluded because they were based outside of the UK, leaving a final sample of 87 (Table 1). Sixty participants opted to identify their university, with academics from 36 UK universities representing Oxbridge, the Russell Group and Post-92 universities participating.

Table 1. Staff demographic characteristics where total N and % reflect number answering question. [a] 17 categories were consolidated into three; [b] no participant reported a sensory impairment.

Characteristic	N	%
Gender		
Male	54	63.5
Female	28	32.9
Other/Prefer not to say	3	3.6
Age (years)		
21–30	7	8.2
31–40	33	38.9
41–50	21	24.7
51–60	21	24.7
61+	3	3.5
Ethnicity [a]		
White British	64	75.3
White Other	13	15.3
BAME	6	7.1
Other/Prefer not to say	2	2.4
Disability [b]		
Physical disability	10	11.4
Learning difference	5	5.7
Mental health condition	10	11.4
Long-term condition	5	5.7
None	58	66.7
Prefer not to say	1	1.1

Within the surveyed population, most were working full time (n = 66, 77.6%), with only approximately one-fifth part time (n = 19, 22.4%), and two not reporting employment status. Of those in part time employment, most were working 0.6 FTE (n = 6, 31.6%), although the range of employment was wide at 0.1–0.8 FTE. Most participants were in dual teaching and research positions (n = 38, 45.2%), closely followed by those focusing on teaching (n = 34, 40.5%). Only three (3.6%) were in research-focused roles. A further nine participants (10.7%) stated that their role focused on other areas, with free-text answers indicating a range of activities including teaching development, management and dual clinical—academic roles, often combined with teaching. Most participants were teaching undergraduates (n = 61, 72.6%) rather than postgraduates (n = 23, 27.4%), with three not specifying (Table 2). Finally, of those participating, most had previously used LC (n = 60, 74.1%), in comparison to 21 (25.9%) who had not, with six not disclosing this information.

Table 2. Teaching experience of participants where total N and % reflect number answering question.

	N	%
Teaching experience (years)		
<2	8	9.4
2–5	19	22.4
6–10	19	22.4
11–15	10	11.8
16–20	9	10.6
21–25	12	14.1
25+	8	9.4
Discipline		
Science and maths	33	39.3
Clinical based	15	17.9
Arts and humanities	13	15.5
Social science	20	23.8
Engineering	3	3.6
Teaching proportion (last 2 years)		
1–20%	15	17.9
21–40%	20	23.8
41–60%	21	25.0
61–80%	14	16.7
81–100%	14	16.7

3.2. Approaches to Replacing the Face-to-Face Lecture

To gain insight into how staff replaced lectures, we examined the specific approach they took, their reasoning behind this and what they thought about the effectiveness of their approach, both whether it was effective and what determined this. Additionally, we considered what interactivity they used within synchronous online lectures and any other activities they used to support lecture-based learning.

3.2.1. Methods of Online Lecturing

Table 3 shows the approaches used to replace lectures. Although 8 (9.2%) participants did not provide any details of replacement approaches, of those that did most reported using multiple methods (57.5%); 37 (42.5%) used two approaches, 7 (8%) used three approaches and 6 (6.9%) used all four listed approaches. Additionally, 13 (14.9%) selected ‘other’, with free-text answers suggesting that most combined the listed options (e.g., recording in PowerPoint and uploading via LC technology or recording audio-only lectures). Only one participant detailed using written learning rather than multimedia, indicating that almost all made use of visual or audio media.

Table 3. Lecture replacement methods.

	Number	%
Synchronous lecturing using non-LC technologies, e.g., Zoom	63	72.4
Synchronous lecturing using LC technologies, e.g., Echo360	11	12.6
Asynchronous lecturing using non-LC technologies, e.g., Kaltura	43	49.4
Asynchronous lecturing using LC technologies, e.g., Echo360	31	35.6

3.2.2. Interactivity in Online Live Lectures

Of the 74 academics using synchronous methods, 52 answered the follow-up question about how they introduced interactivity into online lectures. Answers consisted of statements specifying an approach, for example “questioning techniques” (P8) or specifying a technology, such as “questions via Poll Everywhere, mini quizzes via zoom polls” (P2) and therefore responses were categorised into different techniques. Fifty of the responses could be categorised as at least one of: Polling/questioning (n = 34; 68%); Discussion (n = 32; 64%); Breakout activities (n = 25, 50%); Collaborative activities (e.g., sharing and co-producing documents, n = 8, 16%). Most staff (64%) reported using more than one method. Of the two that could not be categorised, one did not provide a response and the one said no interactivity was possible.

Qualitative analysis of the rationale provided for the interactivity approach taken revealed that staff chose based on what they felt they needed to achieve in their teaching and five core needs were identified, three of which related to pedagogy. Firstly, and most reported was the need to promote active learning and interaction ("Interactive teaching keeps students engaged and seems to increase their understanding" P38). When explaining this, staff expressed views relating to teaching ideals ("Any synchronous time with students should be more than didactic" P18) and student expectations ("the students really wanted interactions" P18). Secondly, staff noted a need to replicate face-to-face approaches ("I moved to a more interactive synchronous style that is more typical of the model I used pre-pandemic" P27). Thirdly, staff wanted to have a means of assessing students' understanding ("[To] see how understanding was with the students, as can't see students faces" P57). The remaining two needs identified were the need to create a sense of belonging for the students (I wanted them to have a sense of being in a group." P6) and, finally, taking a 'needs must' approach. The latter could be divided into (i) available tools ("we had to make do with what was available at short notice to get on with the semester" P24) and (ii) staff abilities ("It was the only way I could see", P26).

Comments about whether their chosen approach was effective were limited, with most indicating that effects were mixed, "sometimes it worked, but not always" (P16). Further analysis therefore focused on the reasons staff gave for effectiveness. Within this context, two key reasons were identified by staff when explaining effectiveness of interactive approaches: student engagement and familiarity/transferability. In terms of student engagement, staff reported that students were not always willing to engage with interactive activities ("a significant proportion of students would not engage", P16). In addition to willingness, there were technical barriers to student engagement that prevented approaches being effective (e.g., "issues related to digital poverty and/or connectivity issues did prove problematic to some students" P24). Staff reported that engagement could be increased by allowing anonymity ("giving them an option to give an anonymous answer encouraged participation", P40). Large group sizes were noted as challenging for many with "very few students want to talk in large zoom calls" (P4), whilst smaller groups supported better engagement ("I think the students found the small group discussions helpful" P86). Familiarity and transferability were noted to impact on perceived effectiveness, in that where a technique for interaction had been used pre-pandemic and transferred well to the online context, this was perceived as more likely to be effective ("this session transferred brilliantly from the face-to-face in person session I used to do to [online]" P43). However, it was also noted that where something was not initially considered effective, more familiarity could increase perceived effectiveness ("It was moderately effective, although I think it could become more effective if we worked to accustom students more to that way of operating." P85).

3.2.3. Additional Online Activities Supporting Lecture-Based Learning Online

As well as interactivity during synchronous lectures, staff were asked about additional online activities they had used to support learning of lecture materials. Fifty-three staff answered this question, and the most used activities were quizzes within the VLE and opportunities for discussion, either formal or informal. A full summary is provided in Table 4. When questioned about the rationale for their choice of online activities, coding analysis revealed very similar responses to those given for interactivity. Firstly, many staff reported a need to ensure active learning ("This prevented the overall online learning experience from being too passive" P81) and to support interactivity ("[I wanted to] encourage direct student to student contact." P14). Secondly, staff reported attempting to replicate pre-pandemic face-to-face teaching ("Questions embedded within lectures to replace questions in F2F lectures" P10). Additionally, they also chose activities to create a sense of belonging ("to keep cohorts' identity there—sense of belonging" P25). An additional code that emerged when considering online activities but not interactivity was simply to help learning ("it helped to address any questions and clarify if anything was not clear" P53). Staff also noted a need for variety in the learning ("give them multiple ways to engage with course material" P80). For effectiveness, the few staff who provided details noted that it varied considerably, as was the case for lecture interactivity. They typically reported that for the students who had accessed additional activities they had been helpful, but many did not engage ("The discussion boards and live Q&A sessions have been effective for some students, but it is a core of students who use them, encouraging all to interact has been very difficult" P10). Variation was driven by a range of factors including whether students had "discovered" the additional activities and the specific cohorts involved ("The same type of session received different responses depending on cohort/topic and what students felt was effective varied." P42). Some staff felt that for effort taken, engagement had been disappointing ("so it was a bit disappointing for the amount of effort it took" P37).

Table 4. Additional activities used to support learning of lecture material.

Additional Activity	Example	N (%)
Tests of knowledge	"Quiz activities in VLE" (P27)	19 (36)
Discussions	"I set up a regular 'virtual water cooler' at the same time [each day], for students and staff alike to 'bump into me' for a chat about anything, as if they had called by my office or bumped into me on campus." (P19)	14 (26)
Opportunities for students to ask questions	"We ran numerous Q&A sessions, and provided padlet for anonymous questions" (P20)	8 (15)
Drop-in sessions	"Extra 'office hours' type sessions on Zoom." (P39)	6 (11)
Other forms of teaching	"I recorded additional equipment demonstrations on YouTube for students with further curiosity" (P45)	6 (11)
Group work	"divided students into pre set groups for some activities" (P79)	3 (6)
Engagement checks	"Each 'lecture' then completed with an online quiz. Engagement with quizzes monitored and students emails red-amber-green individualised emails" (P61)	2 (4)
Non-academic support	"Started a departmental podcast to allow the students to get to know us better." (P37)	2 (4)
Extra communications	"Use Slack workspace for daily random communications and courtesy reminders" (P67)	1 (2)
Extra resources	"Also gave links to YouTube videos to support teaching." (P38)	1 (2)

3.3. Attitudes to Lecture Capture

Both instrumental and experiential attitudes to LC were assessed and compared to a hypothetical midpoint as detailed in the Section 2.5. Results from one-sample Wilcoxon tests are shown demonstrate that both instrumental (M = 5.45, SD = 1.27, Z = 6.802, $p < 0.001$) and experiential (M = 4.84, SD = 1.25, Z = 5.077, $p < 0.001$) attitudes were significantly different from the hypothetical mid-point. In all cases, the responses indicated a positive attitude towards LC, although arguably these were more positive for instrumental attitudes.

Although most participants indicated that their attitude to LC had not changed (N = 48, 57.8%) since the pandemic, approximately two-fifths (n = 35, 42.2%) reported a change. Four declined to answer. Thirty-two of those who indicated that their attitude had changed provided a free-text explanation. Analysis of the responses revealed five codes, or reasons for the attitude change. Firstly, and the most cited, was that staff now perceived there to be a 'greater value' to captured or recorded lectures. The explanations for the greater value could be divided into three distinct areas: Inclusivity ("Previously they seemed inconvenient now however, it would be essential to provide the learning if a student is unable to come to a lecture because of illness" P70); Blended/Flipped ("reinforced the need to blend teaching to create better learning experiences and online recordings are indeed important to this whole learning solution" P22) and Chunking ("Having used shorter, more focussed videos for the past year, I find these a much better way to communicate the necessary information." P81). Secondly, there was sense of 'digital positivity' identified which indicated that attitudes to lecture capture had become more positive because of a general increase in positive attitude to all digital tools rather than specifically towards LC ("I'm more positive about digital opportunities in general" P21). Thirdly staff also recognised a 'general acceptance' of LC use ("I have come to accept videoed lectures more so a more positive view" P14). Arguably more specific to LC were the final two reasons of familiarity and production quality. Staff indicated that they had become more familiar with the functions available within LC and this had changed their views ("I have had to learn how to use it properly, now knowing all the features has changed my outlook" P69). At the same time, recognising that the production quality did not have to be perfect was another factor in attitude change ("I have realised that recordings don't need to exhibit Hollywood/"Royal Institution Christmas Lecture" production values" P34).

3.4. The Future of the Lecture

Staff were asked about how they expected the lecture to be in future. However, because these expectations may be underpinned, at least in part, by what their university has communicated and may not fully represent what they would like the lecture to look like, they were also asked about their ideal lecture.

3.4.1. Expectations of the Future Lecture

Of the 73 (88%) participants who responded to the question about whether they expected a return to conventional lecturing when government and public health guidance allows, responses were relatively evenly split with 28 (38.4%) believing we would return to conventional lectures in contrast to 23 (31.5%) who did not believe we would. The remaining 22 (30.1%) were unsure. Open coding of the expectations of the future lecture identified into four categories of expectation: returning to the pre-pandemic lecture; changes to face-to-face lecturing; retaining online components and greater use of blended learning. Within each of these, several specific ideas were expressed. Reasons for returning to the pre-pandemic lecture tended to focus on practical elements such as the need to teach large numbers of students in a cost-effective way ("Better value, [you can] fit money for students [in]" P28) and the requirement for staff to be able to redress workload inequalities that had arisen due to the extensive teaching workload detracting from research activities during COVID ("I think that will happen because everyone is exhausted, and behind with their research, and it will be the only way to cope with meeting the demands of teaching and researching." P58).

In contrast, those suggesting that there would be changes to face-to-face lectures commented more on learning experiences, identifying a need for interactivity and active learning ("the massive upskilling and reflection will result in more considered lecturing, more interaction, more active learning during lectures" P21). Staff also noted that smaller chunks of lectures would be used rather than 1–2 h of lecturing ("traditional long lectures will be split into shorter 15–20 sections, with mini-breaks" P16). Although some staff noted that lecture capture technology was in place prior to the pandemic at their institution, this was not universally the case and therefore, some noted that this would become used as standard. The main reason for this was that the technology was now available, having been brought in as a response to COVID-19 at a significant cost to the university and, therefore, must be used ("All our teaching rooms now have moving cameras that capture mobility of lecturer—and this has cost the university significant money—I find it hard to believe that we will not be expected to use this tech next year" P45).

As well as changes to face-to-face lectures, staff also felt that some aspects of online teaching in place of lectures would be retained post-pandemic. The most retained component was the use of pre-recorded lectures, although not necessarily to replace the entire lecture experience but more didactic components and to be completed at specific times (“Lectures will be online as shorter videos that students will be expected to watch within a certain timeframe” P61). Asynchronous support around lecture learning was also considered an element to keep (“I expect to continue the asynchronous supporting activities.” P10). The key reason given for retaining some elements of online learning was cost-effectiveness. As with the pre-recorded videos, these activities had taken so long to produce staff felt they needed to use them for more than one year (“stick with our ‘emergency’ mode with recorded material and the structure of this because it already exists and time is pressed” P40).

The final expectation was greater use of blended learning. Within this, many staff mentioned flipped learning by name, whilst others simply described a flipped approach of students viewing lecture videos or other resources in advance and coming onto campus for more interactive sessions (“I will probably ask students to watch short videos before coming to lectures and then do exercises and other interactive activities with them in the class itself.” P84) [27]. The second idea within this was that blended learning allowed greater flexibility for students (“I think there will be a blend of both ‘conventional’ lecturing and online learning. I think this will allow learning to be more flexible for students.” P54).

3.4.2. Ideal Views of the Future Lecture

Analysis of responses about the ideal lecture revealed the same four categories as the expected lecture. Most commonly staff reported a desire to adopt a blended approach, with many willing to have the interactive sessions online or in-person, or both suggesting flexibility: “Higher quality asynchronous mini lectures, supported with small-group focussed live workshops (mix of face-to-face or virtual in a single space)” (P32). Within the overall topic of blended, staff frequently mentioned flipped approaches specifically “I like the idea of shorter videos for students and then class time being used to check understanding and discuss any confusing points (flipped classroom)” (P34). Staff also expressed a desire to retain online components “Lectures should remain online, seminars and workshops should be in person” (P24). Where staff wanted to see face-to-face lecturing return, they did so with notable changes, as for the expected lecture analyses, with greater interactivity and active learning “more interactive, will probably still keep polls and whiteboards in” (P31). Similarly, they also referred to changes around technology, for example “It would be a slightly enhanced version of the pre-pandemic lecture, with enhanced graphics/animation/use of videoclips, and probably more clearly structured. It would be captured and made available to the students on the module” (P16). Relatively few staff expressed a desire to return to the pre-pandemic lecture and where they did, they cited a need for ‘in the room’ engagement: “I think ideally lectures take place in real time with the lecturer and students in the same room. In short: for energy, enthusiasm, pacing, concentration, enjoyment, etc.” (P37).

3.5. The Role of Technology in the Post-Pandemic Lecture

Analysis of staff responses about what role LC technology would play in the future identified three possible roles: recording of synchronous lectures; recording of asynchronous lectures; no role for capture technology. The most cited use was recording of synchronous lectures, within which three core ideas were expressed. Firstly, staff noted that the recording of synchronous lectures would support learning by allowing students to replay and revise the lecture (“Act as a revision aid and a chance for students to ‘replay’ parts which they want more clarification on.” P10). Secondly, it was noted that recording these would allow students to view lectures they could not attend (“Lecture capture will be critical for including students who could not be there on the day for whatever reason.” (P65)). Finally, it was noted that these recordings supported more flexible and inclusive learning with specific learning difficulties and first language differences mentioned (“For those with an SpLD or who do not have English as their first language to revisit the lecture and fill in gaps they missed during live teaching.” P21).The use of LC to record asynchronous lectures was typically in relation to flipped teaching approaches (“I would like to use the system to record shorter videos for the students, and then use class time differently." P34). The most infrequently cited code was that there would be no role for lecture capture technology and within this, three key ideas emerged. Firstly, personal choice, with staff indicating that use would be determined by individual staff members ("I'm not sure that lecturers will use lecture capture." P39). Secondly, staff noted that LC technology would not be as useful for recording live events because lectures had become more interactive since the pandemic ("I think it might play a more minor role than it has previously because my large-group sessions are likely to be interactive and hence less susceptible to lecture capture." P84). Finally, staff noted that standard LC technologies may be replaced by alternative technologies which are easier to use for editing, for example ("Redundant. Will use something like kaltura" P34), suggesting recording would take place but just not using LC technologies.

The follow-up question regarding what features LC would need to support student learning if it were to be used in future, yielded a range of responses. These could be divided into two areas; those that directly supported student learning and those that provided indirect support by giving functionality to staff, which in turn make lecture capture more helpful for students. Each of these could be further subdivided as summarised in Figure 1, which also provides a summary of the rationale for each specific technology requirement. The most cited technology was the need for captioning which was driven by the desire to create inclusive and accessible learning but also legal requirements. Interactivity tools were also frequently mentioned with suggestions of quizzes, discussion or chat options. The rationale for interactivity fell into two areas; a desire to assess what students were understanding and a need to create an engaging, community building learning experience. Staff also wanted to see lecture capture technologies have multiple inputs rather than just slides, audio and video of the lecturer. They felt that this allowed a better capture of their teaching which may include ad hoc use of visualisers or whiteboards to respond to the classroom environment. Finally, the existing functionality of replaying and revisiting capture was noted to be important for students. In terms of indirect learning support, staff felt analytics data from the lecture capture system could allow them to better understand what areas students may need extra help with and so to improve on teaching. Additionally, they noted that an easy to edit interface would be beneficial because they could create more effective resources efficiently and have a clear understanding of the student view.

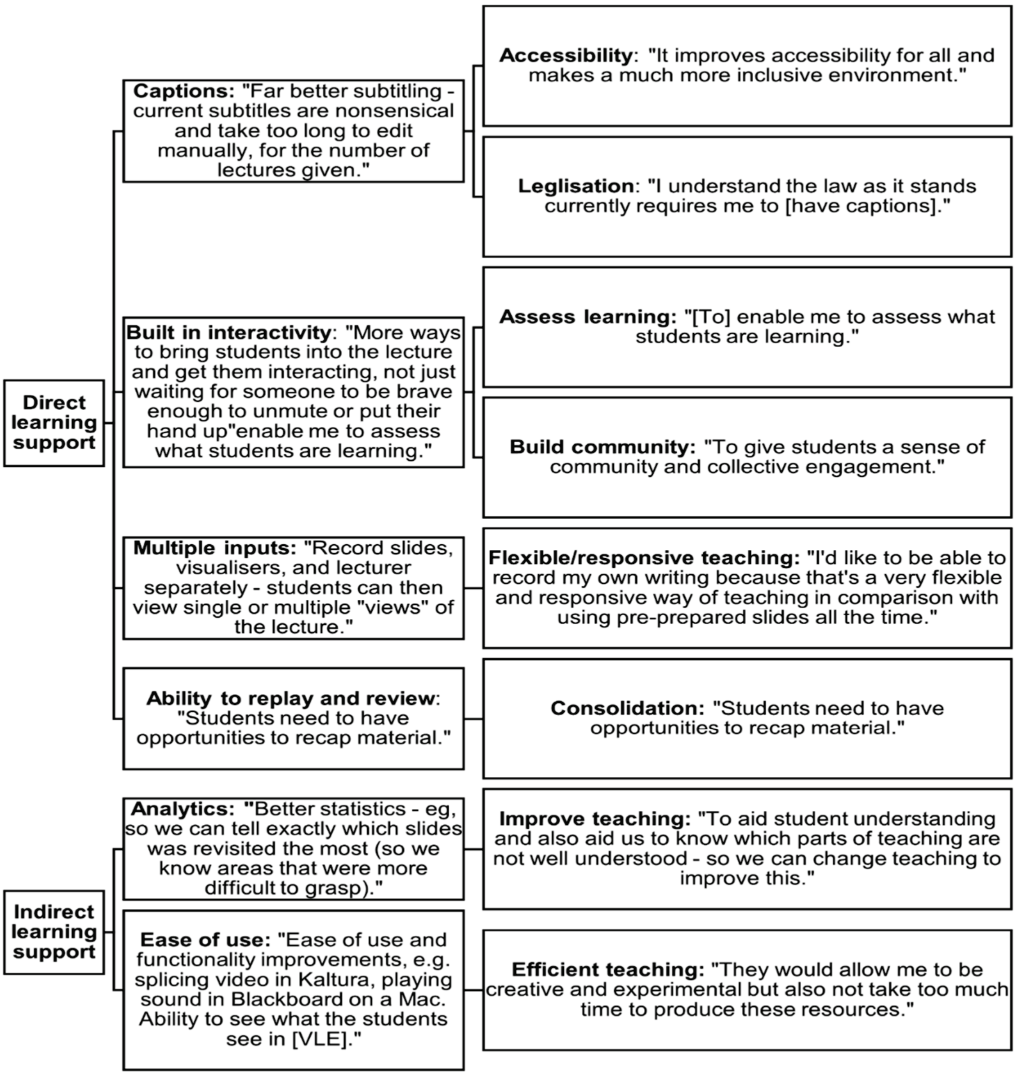

Figure 1. Staff requests for specific features in lecture capture technology.

4. Discussion

In the current study, we aimed to, firstly, understand how UK university staff had replaced their face-to-face lectures during the emergency pivot online, and secondly, ascertain their perceptions of what the post-pandemic lecture would and should look like with reference to both pedagogy and technology.

4.1. How Were in-Class Lectures Replaced during the Emergency Online Pivot?

In terms of understanding how staff had replaced lectures during the online pivot, we found that most staff replaced lectures with multiple methods utilising a range of media and offered both synchronous and asynchronous activities. This use of multiple methods is likely to reflect not only the choice of the academic, but also specific institutional policy. Previous research in this area is understandably limited due to the context of the pandemic but research from outside of the UK, in Spain, reveals little diversity of the methods for online teaching [28], suggesting that the findings here may not be reflected in other countries. Irrespective of this, it is clear that most staff in the current study recognised the value of using a range of approaches to delivery teaching online. Where staff used synchronous teaching, most employed several interactive activities such as polls and discussions. Choice of activities was largely driven by a desire to ensure active learning with interaction, replicate face-to-face teaching, create a sense of belonging and test student understanding. Reflections on the effectiveness of approaches taken indicated that no one size fits all, with student engagement and familiarity impacting on effectiveness. Similar approaches and reasoning were found for activities used to support lecture-based learning outside of synchronous sessions.

4.2. Will Staff Return to Conventional Lecturing, and What Might Future Lectures Look Like in Post-Pandemic Education?

Staff expectations of post-pandemic lectures suggested that the majority felt that they would not return to conventional lecturing. Instead, lectures would typically become more interactive. This is likely be to a popular approach for students; research conducted during the pandemic indicates that greater interactions between staff and students is welcomed by students because the amount of interaction is directly correlated with students perceptions of the quality of online teaching [29]. They also expected retention of some online components and to make more use of blended learning, with flipped learning frequently mentioned. Underpinning most expectations was a need for active learning and interaction as well as making effective use of class time. Where staff expected a return to the pre-pandemic lecture, it was notable that the reasons given were not pedagogic but related to cost effectiveness and workload. Importantly, staff views of the ideal lecture were similar to the expected lecture, suggesting that universities may move in the direction many staff would like. The desires of staff to utilise active learning are in line with the general trajectory of teaching approaches in recent years prior to the pandemic [30]. Furthermore, efforts to introduce active learning in lecture settings have met with mixed responses from students [31] meaning flipped or blended approaches may be preferable.

Greater use of blended learning could yield several benefits; it has been shown to improve retention, engagement [32–34] and attainment [35,36] and may enhance widening participation [37]. Flipped learning in particular has been found to be associated with better student performance than traditional approaches [38] and students show positive motivations towards the method [39]. Furthermore, some of the previously noted barriers to active learning approaches have likely been reduced by the pandemic. For example, concerns about students being able to work effectively with the online materials [40,41] will likely diminish because students have now experienced remote online learning, either at school or university. Moreover, from a staff perspective, previous barriers included lack of time, training and incentive to reform [30]. Whilst these have not been completely removed by the pandemic, many resources have already been created and staff upskilled as part of the emergency transition, which served as a rapid, albeit forced rather than incentivised, education reform. Indeed, research has shown that staff increased their use of professional development centred on online learning during the pandemic demonstrating a level of up-skilling, although further support is needed [42]. Research also shows that universities do not need to invest in repurposing spaces because active learning can be facilitated effectively in lecture spaces [43]. Finally, COVID-19 is likely to remain a public health concern [44] meaning blended learning may be the most pragmatic approach for the short term [45].

4.3. Has the Pandemic Has Changed Attitudes towards LC?

The staff completing the survey showed positive attitudes to LC, in contrast to previous research [12], and almost half noted that their attitude had become more positive since the pandemic. Most reported now seeing the benefits of the technology, specifically noting that it can support more inclusive learning, blended or flipped learning and chunking of lecture material. Greater acceptance and familiarity of the technology because of teaching online during the pandemic appeared to have contributed to attitude change. Staff also felt that they could produce videos of a sufficient quality. Finally, there was a general digital positivity which impacted on LC attitudes. When asked specifically about the role LC would play in future, most foresaw a role for recording synchronous lectures for students to revisit material or catch up on missed lectures as well as offering support for students with specific learning requirements, in line with previous research [12]. However, in addition to this, staff also noted that it could be valuable in recording material for asynchronous delivery within a flipped learning approach. Some did not see a role of LC either through personal choice, because lectures would become too interactive to be recorded or because other technologies were more suitable for recording asynchronous video content. A link between active learning approaches and attitudes towards LC has been reported previously in a study which found appreciation of active learning approaches predicted positive attitudes towards LC [46]. The previous study was correlational and therefore, direction of causality could not be confirmed, only estimated. However, in the present study staff reported that their attitude towards LC became more positive because it offered options for active learning and blended learning, suggesting that the pedagogic approach drives the use of technology. This aligns with the common dictate that pedagogy must come before technology, despite arguments that the two have a more complex interaction [47].

4.4. What Role Will Lecture Capture Technology Play in Future Lectures?

Staff identified several features of LC that would be useful to directly support learning including captioning, interactivity, multiple inputs and the function of replaying. They also noted functions that would indirectly support better learning including analytics and an easy to use interface that would allow simply and quick editing. As might be expected, given the emphasis on active learning in previous responses, the rationale for these centred on active, student-centred learning that allowed staff to assess student learning to improve teaching and provide an inclusive, accessible resource. Prior to the pandemic the rationale behind capture was rarely stated but inclusivity was seen as a key driver [48–50]. Additionally, the functions noted by staff here have some precedent in research. For example, the replay feature is commonly used by students [51–54]. The use of captioning, whilst newer, is also gaining importance. This is partly driven by recent legislation about accessibility of websites, including LC videos on VLEs in the UK and Europe [55] but also by theoretical approaches, such as the Cognitive Theory of Multimedia Learning (Mayer, 2014). This theory assumes that (i) people have separate channels for processing visual and verbal information, (ii) people have a limited capacity in working memory for each of these channels, and (iii) we must actively process information for meaningful to learning to occur. The theory proposes that captioned lectures (whether live or pre-recorded) can provide a dual-channel approach to processing, with the spoken word (verbal) and caption (visual) operating together.

4.5. Limitations of the Current Study

The current study has identified the direction of travel that academics expect and want to see post-pandemic, with a move away from didactic lectures to flipped and blended approaches, supported with technologies facilitating interactivity and inclusivity. However, limitations of this study must be acknowledged. Firstly, the sample size was relatively small, although broad and therefore arguably generalisable. The small sample size overall meant that subgroup analysis, for example by academic discipline or teaching experience was not viable. Although this would arguably have been very interesting, it does not negate the current findings because the pandemic affected all staff irrespective of individual characteristics. Secondly, the use of a mixed-methods approach within a survey limited the richness of qualitative data, in contrast to, for example, semi-structured interviews. However, the context in which the data were collected meant that surveying data was likely to be most convenient to the targeted staff who had seen an unprecedented increase in workload meaning time-consuming interviews would be hard to schedule. Furthermore, the anonymity encouraged more honest views of the controversial period in higher education. Thirdly, the survey instruments used had not previously been validated. This is unsurprising given the unprecedented circumstances of the research but nonetheless can be viewed as a limitation. Finally, this study focused on the immediate period after the emergency transition and therefore it is possible that longer-term effects may differ from those reported here. However, capturing this information still provides a vital insight into the impact of the pandemic on HE in the UK.

5. Conclusions

This study set out to, firstly, examine how UK academic staff had replaced in-person lectures during the pandemic and, secondly, establish what they expected and wanted the post-pandemic lecture to be like. The research offers a unique insight into staff views of the future of the lecture after one of the most turbulent times in higher education. In response to our first aim, we demonstrated that staff used a diversity of methods to replace the lecture, including synchronous and asynchronous learning activities, both typically supported by interactive components. The approaches taken were underpinned by a range of factors including a desire to foster active learning, test student understanding and instil a sense of belonging in the students studying remotely.

In addressing our second aim, we demonstrate that there is little appetite for a return to the didactic lecture that has become so engrained in HE [11]. There is a clear desire to move to blended learning making use of pre-recorded lectures and suitable technologies to interact and engage students in addition to active learning in face-to-face teaching. Flipped learning, a method students respond well to [38,39], was commonly referred to as an area of future travel. Interestingly, for most staff, their views of what the future lecture should and would look like aligned suggesting that they felt comfortable with the direction universities would take, although practical constrains such as time and workload were also noted. Furthermore, acceptance of technologies and, in particular LC, which has previously been controversial, has increased [7,12,18]. These results suggest that the significant impact COVID is reported to have had on HE [1] is unlikely to end with the pandemic and rather this has kick-started a long overdue educational reform, at least with regard to lectures.

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Article

Digital Divide Issues Affecting Undergraduates at a Hispanic-Serving Institution during the Pandemic: A Mixed-Methods Approach

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Abstract: Before COVID-19, digital divide research among college students was scarce, reinforcing the idea that technology access was nearly universal, with few demographic differences. Pandemic-era research found some technical challenges, but most studies were conducted nationally or at research-intensive (R1) universities, indicating a paucity in research among underrepresented populations, notably at Hispanic-Serving Institutions (HSI). This mixed-methods study aimed to assess digital inequities and pandemic-related technological challenges at an HSI, with high percentages of low-income and first-generation students. This study also sought to determine if findings were consistent with national and R1 research. We surveyed a representative sample of 2188 undergraduates and conducted semi-structured interviews with 26 students. Results showed many students had inadequate technology. Just 79% had the optimal combination of smartphone plus laptop or desktop, with first-generation, low-income, Black, and older students significantly less likely to have this combination and often having to share devices within their households. Internet quality significantly affected all coursework-related challenges, as almost half of students with unstable internet reported trouble completing assignments compared to 20% with stable internet. Finally, results suggest the digital divide may be more prevalent at HSIs than at previously studied institutions, while also offering insight into how these challenges affect similar universities.

Keywords: digital divide; undergraduates; internet access; technology access; Hispanic-Serving Institution; underserved and vulnerable students

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1. Introduction

As COVID-19 turned homes into classrooms nearly overnight in Spring 2020, the magnitude of the impact of remote instruction became a pressing concern at every university. Along with concerns about basic needs, questions about the adequacy of students' computers and internet connections became urgent and continued to be so into the following academic year. Pre-pandemic digital divide research among college students, although sparse, suggested device access was no longer a problem. Although, for underserved students in particular, reliable internet remained an issue. How these findings on connectedness would translate to a Hispanic-Serving Institution (HSI) in the United States, where more than half of students are low-income enough (i.e., family income of $60,000 or less) to qualify for Pell Grants remained unknown. [1]. Raising further questions was that most pre-pandemic research on the adequacy of technology among college students was conducted nationally or at research-intensive universities (R1) [2], which collectively may fail to properly portray the technological inequities faced by underserved students.

Campus computing resources have offered an avenue for students who have poor internet or lack the necessary devices (for context, during the fall 2019 semester, our library computer lab recorded 132,996 sessions totaling almost 100 h). However, once pandemic restrictions eliminated campus Wi-Fi and computer labs and other places offering Wi-Fi were closed, we launched an in-depth study of undergraduates' reported barriers at an HSI to completing coursework and the extent to which the students were affected by the digital divide, i.e., the inequitable access to technology and its effective use.

1.1. Literature

The awareness of, and concerns about, inequalities in access to information, and the means to produce and disseminate information, is hardly new [3–5]. With the dawning of the internet age, "digital divide" became a well-known phrase, one that has evolved significantly as information technology has become embedded in day-to-day life [6]. Today, scholars view the digital divide as having multiple levels. Although this study focuses on the first-level divide, some background on the other two levels is important for context.

1.1.1. First-Level Divide

The "first-level" of this divide, i.e., inequality in access to devices and internet connections, has received significant attention from researchers during the past three decades [7–12]. However, as the price of computing devices dropped and ownership of smartphones and tablets became widespread, an annual survey by the United States Census Bureau (though over the years different methodologies have been used to collect data) found that between 1980 and 2018, the number of homes in the United States with access to a device capable of connecting to the internet grew from 8% to 92%, and at least 85% of households have broadband internet connection [13].

Although inequalities in device ownership and internet access have lessened, a first-level divide still exists, primarily for low-income or ethnically and racially diverse families, especially concerning internet access. For example, more than 40% of households with incomes below $30,000 have neither broadband service nor a traditional computer [14]. Moreover, according to the U.S. Census Bureau, although 92.3% of Asian households have access to broadband internet, only 77.7% of Black households enjoy that same access [13]. As concerning as this is, it is only part of a larger picture. Katz [15] has argued that, in contrast to the dichotomous framing of the digital divide, a state of "under-connectedness" exists because of any number of factors including inadequate devices, device sharing, and a loss of internet service because of financial circumstances. This was further exacerbated by the pandemic [16].

As information and communication technologies (ICT) have advanced, access definitions expanded to include the means to maintain devices (e.g., broken hardware, data limits, and connectivity problems). For those unable to sustain access to ICTs equal to the task of utilizing the modern internet, the digital divide has persisted [12,17–20]. Given the increasing importance and integration of technology into education, research into the impact of this first-level divide on academic achievement is well documented, primarily at the K–12 level [21–26]. Over time a consensus has emerged that access to devices, though not without some drawbacks, is an important factor to academic success in the increasingly digitized classrooms of most colleges and universities.

1.1.2. Second-Level and Third-Level Divides

Viewing the digital divide as simply a matter of access to technology "is too narrow at best and quite problematic at worst" [27]. As Chen observed, there is more than one single divide, and although access to the internet is undoubtedly important, "what [individuals] use it for, and the returns they gain" represent "multidimensional and multilayered" digital divides of their own [28]. As a result, two other levels at which the divide may be found are as follows: a second-level inequality in "skills to use technologies in ways that enhance professional practices and social life" [29] (para. 86), that may be even more significant than that of access [8,30–32]; and a third-level inequality of outcomes related to social status and connectedness which are tied to internet access [28,33,34].

Indeed, some of the same factors that contribute to inequalities in internet access (e.g., race and ethnicity, educational attainment, and socioeconomic status) also contribute to disparities in the adoption, use, acquisition of skills, and outcomes of technology use [5,28,35–40]. Moreover, it has been argued that "existing social stratifications may even be reinforced" [8] (p. 2704).

1.1.3. Higher Education Research

Digital divide research in higher education, though sparse before the pandemic [41,42], has reported device ownership among U.S. students as exceeding 90% in recent years, with few demographic differences [20,24,43–46]. However, reliance on smartphones has been shown to be greater among non-White, lower income and first-generation students [43,45]. Pre-pandemic research findings on internet access and quality have been more uneven. Educause, which has been surveying tens of thousands of U.S. students for more than a decade, has found 61–72% of students living off campus rating their internet quality as good or excellent compared to 46–51% of those living on campus. Although most students report excellent Wi-Fi experiences in libraries and classrooms, outdoor Wi-Fi and dormitory connections are reported as subpar [43,47].

Pre-pandemic higher education research has also found a new aspect of the first-level divide: technology maintenance problems. Gonzales et al. found that about 20% of students "had difficulty maintaining access to technology (e.g., broken hardware, data limits, connectivity problems, etc.). Students of lower socioeconomic status and students of color disproportionately experienced hardships, and reliance on poorly functioning laptops was associated with lower grade point averages" [20] (p. 750).

Since the pandemic, more technology access challenges have emerged despite campus programs to loan equipment. For example, administrators surveyed by Educause in April 2020 reported that 36% of students had moderate to extreme difficulty accessing the internet [48]. Furthermore, two recent California studies found that more than 12% of students lacked either adequate devices or internet access with higher proportions among Black and Latinx (we use Latinx, Hispanic/Latino/Latina, or Hispanic alone consistent with the source's terminology) students, community college students, and low-income students [49,50]. Other studies also uncovered technology access challenges which more severely affect first-generation students and/or underrepresented groups [42,51,52].

However, beyond device and internet access, and maintenance challenges, technology barriers continue amongst college students at the second and third levels of the divide, including use in the classroom, technology proficiency, and differing achievement in online courses, with underserved groups more commonly on the "wrong" side of the divide [51,53–57].

This study was prompted by research suggesting that data differ by types of institutions. For example, Galanek et al. found that undergraduates at masters-level and doctorate-level private universities were less likely to report good or excellent overall technology experiences [47], whereas recently, Jaggars et al. found more inadequate technology at non-R1 campuses than at R1 institutions [42]. Meanwhile, Buzzetto-Hollywood et al. reported lower device access at historically Black universities [58]. Although we could find no pre-pandemic research on technology adequacy at Hispanic-Serving Institutions (HSI), substantial numbers of students in two recent studies in California, which has a large number of HSIs, reported technology challenges [49,50].

2. Methods

2.1. Study Aims and Research Questions

Past literature has shown that technology inequities and the digital divide affect underrepresented groups of college students, but most studies regarding this topic were conducted nationally or at R1 universities. The paucity of research focusing on Hispanic-Serving Institutions, both before and during the pandemic, prompted our overall research goal: determining whether undergraduates at an HSI with large numbers of low-income and first-generation students had adequate device access and internet quality. We also sought to understand how the pandemic created technology-access challenges for both coursework and remote learning. More specifically, we addressed the following three areas:

- RQ1: Access to devices, device reliability and internet quality.
- RQ2: Coursework-specific technology challenges.
- RQ3: Challenges related to attending school from home.

We also sought to understand if these issues were comparable to those found in studies nationally and at R1 institutions. Finally, we wanted to explore how specific demographic factors affected technology challenges, which may shed light on issues facing these underserved and understudied populations. To explore this topic, the following demographic items were key for our analysis:

- Race and ethnicity;
- Gender;
- Age (e.g., traditional vs. non-traditional students);
- Enrollment status (e.g., part-time vs. full-time);
- First-generation status (whether the student was the first in their family to attend college);
- Pell Grant eligibility, as a proxy for low-income;
- Academic success risk (low-income and first-generation students).

2.2. Participants and Procedures

This study utilized a mixed-method approach through an online survey (Appendix A) and semi-structured interviews. The quantitative portion is a subsection of a campus-wide student survey conducted in December 2020. Emails with the study link were sent to the nearly 40,000 enrolled students. Unduplicated responses were received from 2543 undergraduate and 460 graduate students (total response rate of 8%) who answered all or part of the survey and provided a campus identification number. The survey had three sections: satisfaction with campus responses to the pandemic and issues related to housing and financial assistance; issues with technology and working from home; and student learning and academic readiness for the upcoming spring semester.

Because a portion of the digital divide includes technology access, only responses from undergraduates who indicated which devices they used during the online academic year were analyzed. Demographic data were compiled through the campus office of Institutional Research & Analytics. In total, this study assessed responses from 2188 undergraduates.

To complement the quantitative responses, 26 undergraduates, recruited via convenience sampling, participated in semi-structured interviews during the fall semester. Participants were asked questions on technology and working from home similar to those in the survey, but they were prompted to elaborate on any issues. The interviews averaged 14.8 min, not including informed consent and introductions. All responses were audio recorded and transcribed for data analysis. Participants were not offered an incentive for either the quantitative or qualitative portion of this study. All procedures were approved by the Institutional Review Board at California State University, Long Beach.

2.3. Measures

The following outcomes were assessed in both the survey and semi-structured interviews. In the survey, participants were presented the question and response options in a close-ended format in which they could select their best response(s). For the interviews, participants were read questions (e.g., "What type of technology-related issues do you have with completing schoolwork?") and asked to elaborate on their experiences through an open-ended dialogue.

2.3.1. Access to Technology

Participants were asked what devices were available to them; if they shared their devices with others; their awareness and usage of the campus' Student Laptop/Hotspot Loan Program; device-specific issues; and the quality of their internet.

2.3.2. Technology-Specific Challenges

Participants were asked to select technology-specific challenges that resulted in difficulties completing coursework. Options included accessing live lectures (e.g., Zoom calls), communicating with instructors and classmates, watching pre-recorded videos (e.g., asynchronous courses), completing assignments and readings, and using the campus learning management system (LMS). Furthermore, participants were asked to rate their comfort in using the LMS based on the following items, "Very confused"; "Comfortable"; and "Proficient."

2.3.3. Challenges of Working at Home

Participants were asked to select specific challenges they encountered while working from home. These included assuming responsibility for childcare or family needs, dealing with unanticipated noises or distractions, and having insufficient workspace.

2.4. Data Analysis

All data analysis was completed using SPSS version 27. Descriptive statistics and frequencies were calculated for relevant study variables. Chi-squared tests were calculated to determine possible disparities in key study variables that may have existed between predictors.

This study had 1538 females and 648 males. Classification included 18% freshmen, 16% sophomores, 26% juniors, and 40% seniors, with 87% enrolled full time. Ages ranged from 17 to 67 ($M = 23.04$; $SD = 6.42$), and 79% of the sample were considered traditional students (under 25). Additionally, 34% of participants were first-generation and 56% of the overall sample were Pell-eligible students. Students who identify as Hispanic/Latino/Latina had the highest representation, at 45%. Compared to the university population, our sample was representative across all categories, except for gender, with this study's sample consisting of 70% females against 57% for the university (Table 1).

Table 1. Study sample demographics compared to university population.

	Study Sample (%)	**University Population (%)**
Classification		
Freshmen	18	17
Sophomores	16	15
Juniors	26	26
Seniors	40	42
Race/Ethnicity		
Hispanic/Latino	45	46
Asian	19	21
White	17	16
Black	4	4
Two or more races	5	5
International	7	6
Unknown or other	2	2
Gender		
Female	70	57
Male	30	43
Age		
Under 25	79	80
25 & older	21	20
Enrollment		
Full-time	87	85
Part-time	13	15
First-Generation		
Yes	34	31
No	66	69
Income		
Pell-Eligible	56	57
Non-Pell-Eligible	44	43

3. Results

3.1. Access to Technology

RQ1 aimed to understand students' access to technology during the transition to alternative modes of instruction, with a particular focus on the types of devices, their reliability, and the quality of their internet (Table 2). The vast majority of our sample had access to either a laptop (89%) or smartphone (82%). Less than a third (31%) of participants had access to a tablet or Chromebook, and 27% had a desktop computer. Past literature has suggested that students with access to a smartphone and a laptop or desktop computer found their technology to be best for academic success [44,45,54]. Thus, we operationalized those with a smartphone and either a laptop or desktop computer as those with "optimal technology," accounting for 79% of our sample. Additionally, 84% had access to more than one device, and 15% of participants shared their device. For device reliability, 30% indicated that their devices stopped working at one point during the semester, and 36% reported equipment needs or Wi-Fi issues at home.

Although results from the survey suggest that device access is high, the qualitative portion uncovered potential issues regarding device access, even if students have technology at their disposal. Some remarked that their device did not have the proper hardware or software to be successful in their courses (e.g., the lack of a camera or necessary programs such as word processors, statistical packages, or presentation tools). For software issues, students who normally relied on university resources, such as the library or on-campus computer labs for their work, now had to resort to using personal devices that were not up to par. One student expressed, "I just wish my software would be fast. I used to rely a lot on the computers [on campus]. They were more updated; they had the latest software all the time." Another key finding from the interviews was that students suddenly needed to purchase newer equipment. As one student explained: "I've had my laptop since 2014, but I upgraded this year because I couldn't get Zoom to download . . . I really did not want to upgrade my old laptop functioned enough if I needed to write a paper but working online 24/7 just wasn't doing it." Another student who bought a new laptop echoed these sentiments: "I used an older laptop that I guess wasn't really cutting it. I was using a Chromebook."

Table 2. Technology Access.

	N	Laptop (%)	Smartphone (%)	Desktop (%)	Tablet (%)	Optimal Technology (%)	Shared Device (%)	Borrowed Device from Campus (%)	Equipment Challenge (%)	Device Not Working (%)	Unstable Internet (%)
Total Sample	2188	89	82	27	31	79	15	8	36	30	29
Race/Ethnicity											
Hispanic	979	88	81	22	29	78	20	9	35	32	29
Asian	417	89	84	36	36	83	10	8	40	30	30
White	392	91	87	29	29	85	11	4	37	29	27
Black	85	87	77	25	29	69	11	9	39	20	19
2 or more races	117	89	86	33	34	84	5	4	32	29	31
Gender											
Female	1538	**91**	83	**20**	32	80	16	**9**	37	31	**31**
Male	648	**84**	82	**42**	29	79	14	**6**	34	27	**24**
Age											
Under 25	1730	**90**	**85**	**25**	30	**82**	**14**	**6**	37	**31**	**30**
25 and older	458	**85**	**73**	**32**	35	**68**	**19**	**15**	35	**25**	**24**
Enrollment											
Full-time	1913	89	**83**	26	31	**80**	15	**7**	**37**	30	**30**
Part-time	275	88	**76**	30	35	**73**	16	**11**	**31**	26	**22**
First-Generation											
Yes	659	**85**	**77**	25	29	**72**	**21**	**12**	35	30	30
No	1290	**91**	**86**	28	32	**85**	**12**	**5**	36	30	28
Income											
Pell-Eligible	1207	**87**	**81**	**24**	31	**77**	**18**	**10**	38	31	30
Not Pell-Eligible	968	**90**	**85**	**29**	32	**82**	**12**	**4**	35	29	27
Academic Success Risk											
Yes	521	**85**	**75**	**23**	29	**70**	**21**	**13**	36	31	**30**
No	735	**91**	**87**	**30**	32	**85**	**11**	**4**	35	29	**26**

Note: Tablet includes Chromebooks; Unstable internet = bad or unpredictable; Optimal Technology = smartphone and laptop or desktop; Academic success risk (yes) = first-generation and Pell-eligible. Bold numbers are significant at $p < 0.05$ for the difference between groups. International students were omitted because we could not verify their race or ethnicity.

Although concerns about the quality of devices and software were expressed, only 8% of students borrowed equipment from the university, despite 79% being aware of the university's Student Laptop/Hotspot Loan Program. When looking at outcomes that are influenced by demographic predictors, sharing and borrowing devices were impacted by income, first-generation status, and age. Pell-eligible ($\chi 2$ (1, N = 211) = 11.52, p < 0.001) and first-generation students ($\chi 2$ (1, N = 141) = 33.45, p < 0.001) had greater incidences of sharing their devices with someone else. Furthermore, Pell-eligible ($\chi 2$ (1, N = 124) = 25.77, p < 0.001) and first-generation students ($\chi 2$ (1, N = 77) = 31.05, p < 0.001) were more reliant on borrowing equipment from the university program. Conversely, very few continuing-generation students (5%) and non-Pell-eligible students (4%) utilized these resources. Students 25 and older had higher percentages of sharing devices ($\chi 2$ (1, N = 85) = 4.79, p < 0.05) and utilizing the university's equipment-loan program ($\chi 2$ (1, N = 70) = 47.27, p < 0.001).

Furthermore, internet quality varied greatly across our sample. In total, 29% of participants described their internet as either bad or unpredictable, 57% deemed it as OK, whereas only 14% considered their internet quality to be great. To better understand the impact of internet quality, we operationalized those with "unstable" internet as either bad or unpredictable and "stable" internet as either OK or great. Students who were of traditional age ($\chi 2$ (1, N = 517) = 7.07, p < 0.01), female ($\chi 2$ (1, N = 469) = 9.41, p < 0.01), or full-time ($\chi 2$ (1, N = 564) = 6.22, p < 0.05) were significantly more likely to report unstable internet quality compared to their counterparts. During interviews, students often mentioned internet quality issues. As one student observed: "So it's supposed to be high-speed, but it's really not. It lags, it stops... it's really annoying." Another bemoaned, "I'm trying to do so much, it's gotten to the point where half of the time my Zoom freezes it goes out probably once or twice a week." In addition, students said there were more people on the connection than before, with students' siblings, parents, or roommates simultaneously working from home. Sample responses included, "Although [the internet connection] is good, if there are a lot of people in the house, it tends to slow down" and "I have two roommates, so all three of us are in school and we're all doing online learning."

3.2. Coursework-Specific Technology Challenges

RQ2 aimed to assess coursework-specific technology challenges students faced (Table 3). Across the sample, only 17% reported no coursework-specific technology challenges. The most common challenge was accessing live lectures (e.g., Zoom lectures during synchronous courses), which affected more than half the sample (58%). Other, less common challenges included communicating with instructors or classmates (42%), viewing videos (e.g., pre-recorded lectures) (29%), and completing assignments (27%), using the campus LMS (20%) or required readings (14%).

Similar to access to technology, income was a key predictor for technology-specific challenges. Those who were Pell-eligible had more difficulties in viewing videos needed for courses ($\chi 2$ (1, N = 370) = 5.88, p < 0.05), completing assignments ($\chi 2$ (1, N = 362) = 10.17, p < 0.01), and using the LMS ($\chi 2$ (1, N = 262) = 5.80, p < 0.05). A higher proportion of traditional-aged students had challenges accessing live lectures ($\chi 2$ (1, N = 1041) = 25.10, p < 0.001) and using LMS ($\chi 2$ (1, N = 360) = 5.41, p < 0.05) compared to non-traditional students. Similarly, more full-time students had issues accessing live lectures ($\chi 2$ (1, N = 1118) = 6.13, p < 0.05), viewing videos ($\chi 2$ (1, N = 567) = 10.16, p < 0.01), and using LMS ($\chi 2$ (1, N = 397) = 8.90, p < 0.01. Regarding gender, females reported more issues accessing live lectures ($\chi 2$ (1, N = 916) = 8.97, p < 0.01) than males.

In addition to the demographic predictors, we sought to investigate how internet quality may be linked to the technology-specific challenges. Across all technology-specific challenges, those with unstable internet were significantly more affected than students whose internet was stable. Accessing live lectures was a challenge for 58% of the sample, but 80% of participants with unstable internet reported this to be problematic compared to 49% with stable internet. Moreover, a greater proportion of users with unstable internet reported issues with communicating with others ($\chi2$ (1, N = 326) = 35.70, $p < 0.001$); watching videos ($\chi2$ (1, N = 265) = 83.13, $p < 0.001$); using the LMS ($\chi2$ (1, N = 207) = 98.04, $p < 0.001$); and reading required materials for their courses ($\chi2$ (1, N = 139) = 48.45, $p < 0.001$). Perhaps most worrying is that only 20% of those with stable internet reported issues in completing assignments, whereas nearly half (46%) with unstable internet had struggles doing so. When looking at the total sample, 27% had problems completing assignments, which appears modest; however, it is clear that completing assignments may be linked to the quality of the students' internet. In addition to negative impacts on grades, being unable due to complete assignments can also lead to distress. As one student explained, "... if my Wi-Fi drops and I'm in the middle of something and it doesn't save or something like that. Doing every single thing online, you're always like, 'Oh God, is it going to drop in between?'"

Table 3. Coursework-Specific Technology Challenges.

	N	Accessing Live Lectures (%)	Viewing Videos (%)	Communicating (%)	Completing Assignments (%)	Reading (%)	Using LMS (%)
Total Sample	2188	58	29	42	27	14	20
Race/Ethnicity							
Hispanic/Latino	979	60	30	40	29	13	22
Asian	417	55	24	44	25	16	16
White	392	44	33	44	28	16	20
Black	85	47	26	40	26	12	18
Two or more races	117	61	24	43	24	12	21
Gender							
Female	1538	**60**	29	41	27	14	20
Male	648	**53**	27	45	29	15	19
Age							
Under 25	1730	**60**	29	43	28	14	**21**
25 and older	458	**47**	25	41	26	14	**16**
Enrollment							
Full-time	1913	**58**	**30**	42	28	14	**21**
Part-time	275	**51**	**20**	42	26	15	**13**
First-Generation							
Yes	659	56	29	**39**	29	15	20
No	1290	59	28	**44**	27	13	20
Income							
Pell-Eligible	1207	57	**31**	41	**30**	15	**22**
Non-Pell-Eligible	968	58	**26**	44	**24**	13	**18**
Academic success risk							
Yes	521	57	30	**39**	**30**	15	21
No	735	61	26	**45**	**24**	12	18
Optimal Technology							
Yes	1735	58	28	42	27	15	20
No	453	57	30	45	29	12	19
Internet Quality							
Unstable	625	**80**	**42**	**52**	**46**	**22**	**33**
Stable	1558	**58**	**23**	**38**	**20**	**11**	**14**

Note: Bold numbers are significant at $p < 0.05$ for the difference between groups.

3.3. Challenges of Working at Home

RQ3 aimed to assess the challenges students experience while attending class at home (Table 4). A majority of participants (72%) reported unanticipated noise as a challenge. Over half (52%) experienced insufficient workspace, and 31% expressed challenges regarding childcare or other family-related obligations. Only 18% of our sample reported zero working from home challenges.

Table 4. Working from Home Challenges.

	N	Childcare/Family Needs (%)	Unanticipated Noise (%)	Insufficient Space (%)
Total Sample	2188	31	72	52
Race/Ethnicity				
Hispanic/Latino	979	39	77	57
Asian	417	27	69	49
White	392	23	70	51
Black	85	28	68	45
Two or more races	117	23	69	49
Gender				
Female	1538	**32**	**75**	**55**
Male	648	**27**	**67**	**47**
Age				
Under 25	1730	31	**74**	53
25 and older	458	31	**66**	48
Enrollment				
Full-time	1913	31	73	52
Part-time	275	31	69	52
First-Generation				
Yes	659	**4**	72	**56**
No	1290	**25**	73	**50**
Income				
Pell-Eligible	1207	**37**	**76**	**56**
Non-Pell-Eligible	968	**2**	**69**	**47**
Academic-success risk				
Yes	521	**44**	75	**60**
No	735	**22**	70	**48**
Optimal Technology				
Yes	1735	30	**74**	52
No	453	34	**66**	51

Note: Bold numbers are significant at $p < 0.05$ for the difference between groups.

Inequities from working at home were highly prevalent for Pell-eligible, first-generation, female, or Hispanic/Latino/Latina students. Pell-eligible students had a higher incidence of unanticipated noise challenges ($\chi 2$ (1, N = 912) = 13.06, $p < 0.001$) compared to non-Pell-eligible students, as well as more concerns about insufficient space ($\chi 2$ (1, N = 681) = 17.86, $p < 0.001$). Furthermore, Pell-eligible students were more likely to experience childcare or family challenges ($\chi 2$ (1, N = 451) = 56.41, $p < 0.01$). Similarly, a higher proportion of first-generation students experienced issues with insufficient space ($\chi 2$ (1, N = 372) = 7.45, $p < 0.01$) and childcare or family needs ($\chi 2$ (1, N = 269) = 53.61, $p < 0.001$). Students who are deemed most at risk for academic success (i.e., Pell-eligible and first-generation students) were twice as likely to report childcare or family challenges ($\chi 2$ (1, N = 229) = 69.23, $p < 0.001$) compared to students who were not at risk. Collectively, female students had more issues with childcare or family needs ($\chi 2$ (1, N = 499) = 7.07, $p < 0.01$), unanticipated noise ($\chi 2$ (1, N = 1150) = 15.54, $p < 0.001$), and insufficient space ($\chi 2$ (1, N = 838) = 10.48, $p < 0.01$). Finally, across all racial and ethnic demographics, Hispanic/Latino/Latina students had the highest percentage of challenges of working at home.

Interviews offered insight into how these challenges negatively impacted students' ability to complete their coursework. Unanticipated noise and distractions often came from others in the home. Not only was this problematic for concentration, but it also affected students' participation during live lectures. Several students remarked that there was so much going on in the background that they were forced to have their camera off or be muted, which often complemented issues of insufficient space. One student explained, "Because I live with my family, when I'd work outside in a kitchen or the dining room, my family would try to talk to me, or they'd be doing their other work and we'd be disrupting each other." Another elaborated on the lack of space, but also mentioned that other obligations interfered with their work:

"There's a lot of chaos in my house. You have the dogs, you have other people working, and there's a lot of noise and the TV. There's a lot of distractions, so being able to focus on what you need to do isn't always easy. Also, not having a dedicated space for work can be difficult because it's uncomfortable or it's too comfortable. It's not the best environment for necessarily focusing on what you need to do. And of course, if you look around the house like, 'Oh gosh, I need to do this or I need to do that.' There's always something else that needs to be done when you're in this space."

Finally, one key theme emerged from the qualitative data that was not captured in the survey: students struggled separating their academic and personal lives. As one student mentioned, "Working from home, there's no separation. You don't feel relaxed, and your room is no longer sacred, or your home is no longer relaxing." Another said, "It's hard to focus . . . pretty much my whole life is in this one room."

4. Discussion

The purpose of this study was to better understand the technology challenges undergraduates faced at a large, Hispanic-serving public university where 57% of students are low-income and almost a third are first-generation. We also aimed to determine how the results from our study compared to those reported among college students in national studies and at R1 universities. The results from this study offer insight into the digital divide inequities faced by the students at the 87 public, four-year Hispanic-serving campuses in the United States, which have a combined enrollment of more than 1.5 million students [59]. Additionally, we hope to open the door for future research involving universities that primarily serve underrepresented populations. This is especially important in light of the expectation that institutions of all stripes will continue to expand online learning options.

Students in our study were most affected by internet quality and device reliability and adequacy, with close to a third of them reporting problems with one or more of these issues. Although measures vary among studies, this high incidence of the first-level of the digital divide is more comparable to that found in a national study of college-bound high school students [23] or among K–12 households in California [60], than what is found among college students in nationwide studies and at R1 institutions.

More specifically, 21% of students in our sample lacked the optimal device combination of a smartphone and either a laptop or desktop, and 3% reported having only a phone and/or tablet. Comparatively, a recent study (*N* = 86,236) of higher education in California reported that 10% of students across 23 California State University campuses, 15 of which are HSIs and none of which are R1s, reported "not having a computer readily available" [50] (p. 11). Meanwhile, that same study reported that 8% of students at the nine undergraduate University of California (UC) campuses, all but one of which is an R1 institution and five of which are HSIs, lacked computers.

Furthermore, the gap in internet quality was considerably greater but directionally consistent. Unstable internet access was reported by 29% of students in our study, compared to 17% of students nationally [61], 14% of students at other California State University campuses and 9% of students at UC campuses [50]. The nonprofit Education Trust—West found just 12% of students nationally (*N* = 1010), and overall, in California (*N* = 321), reporting "no, limited, or sporadic access to the internet" [49] (p. 4). Although it is hard to compare results of studies with differently worded questions and different sample sizes, there appears to be a consistent difference for device access and internet connectivity at HSI campuses with high percentages of low-income students relative to studies at R1 institutions (see Figure 1).

Although specific technology challenges were more prevalent among some demographic groups, coursework-related challenges were especially apparent among students with unstable internet access and the academically most at-risk students (those who are both low-income and first-generation). Significantly fewer at-risk students had access to the device combination that students say they consider optimal (i.e., a smartphone for convenience plus either a laptop or desktop for videos and learning management systems) than students who were higher income and whose parents went to college. These vulnerable students were also almost twice as likely to share devices. Even more troubling was that those with unstable internet had significantly more coursework-related struggles than those with stable internet. This was most apparent when accessing live lectures, where 80% of participants with unstable internet reported this to be a problem compared to 58% with stable internet.

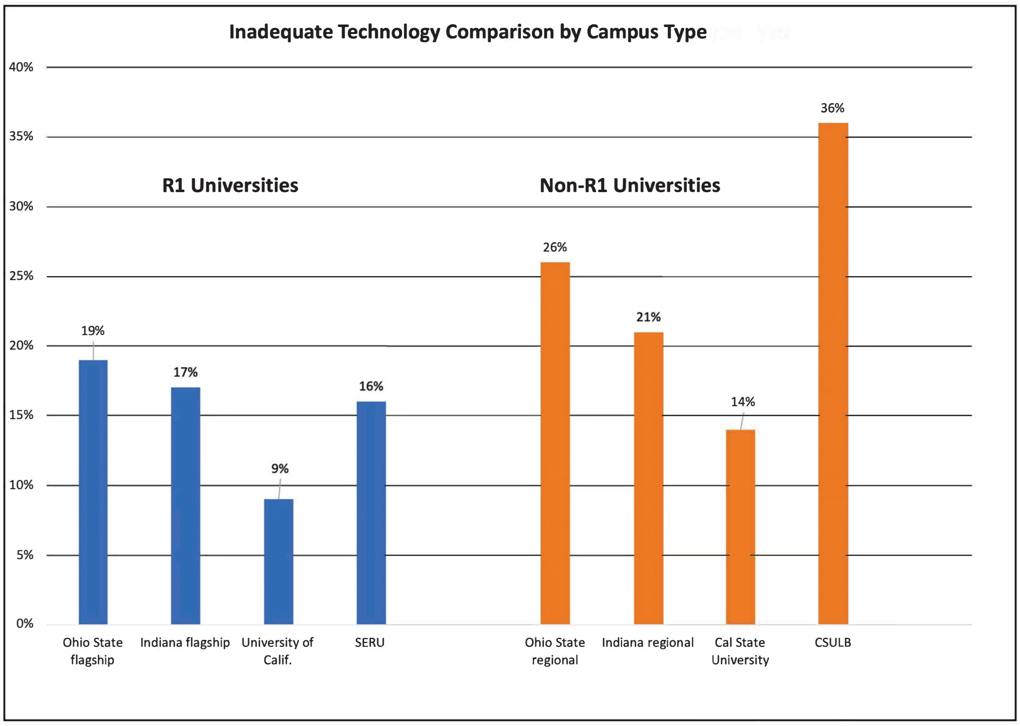

Figure 1. Inadequate Technology Comparison by Campus Type. Sources: Jaggars et al. [42], Reed et al. [50], Soria et al. [62]. SERU: Student Experience in the Research University Consortium.

In addition to the key results noted above, in contrast to the 2018 Galanek et al. study which found that "U.S. students. appear to have overcome the problem of access to internet-enabled devices and reliable Wi-Fi" [45] (p. 7), we found significant percentage differences by gender, age, enrollment status, first-generation, and income:

- Gender: More women reported unstable internet.
- Age: More students under 25 had the optimal combination of devices, but they also reported more incidences of their devices not working and unstable internet. Older students were more likely to share a device or borrow technology from the university.
- Enrollment status: Full-time students were more likely to have the optimal device combination, but less likely to have stable internet access.
- First-generation: Students who were first in their family to attend college were less likely to have the optimal technology combination and more likely to share devices or borrow technology.
- Income: Pell-eligible students were less likely to have the optimal devices, and more likely to share or borrow technology.

Problems prompting the sharing of devices and the burdens of it were aptly described by one student, "Midway through the semester, I broke my computer, so I've been surviving on my iPad and trying to borrow my brother's computer, but he's also a full-time student." Comments such as this illustrate the concept of the technology maintenance construct introduced by Gonzales in 2015 [19]. The construct proposes that "as access to information and communication technology peaks, the digital divide is increasingly characterized by the (in)ability to maintain access," especially for lower income students and students of color [20] (p. 750). Thirty percent of our study respondents reported problems with devices not working, with the issue more prevalent among younger students and Black students.

Given the high incidence of technology inadequacy, coursework-specific technology challenges could be part of either the access-driven first level of the digital divide, or the skills-driven second level. This study found significant percentage differences in the challenges among several groups, especially for the most frequent problem, accessing live lectures:

- Gender: Women reported more difficulties accessing live lectures than men.
- Age: Younger students reported more problems accessing live lectures than older students.
- Race/Ethnicity: More Hispanic/Latino/Latina students and those of two or more races reported problems accessing live lectures.
- Enrollment status: Full-time students were more likely to report problems accessing live lectures and videos than part-time students.
- First-generation: These students were less likely to report difficulties communicating with instructors and classmates than students whose parents went to college.
- Income: Pell-eligible students were more likely to report challenges viewing videos and completing assignments than higher income students.

Limitations and Future Directions

The data in this study are cross-sectional; thus, we are unable to determine how challenges related to access to technology, technology-specific items, and working from home changed over time. Future studies should take a longitudinal approach to better assess how issues surrounding the digital divide develop, as well as a more in-depth analysis into the approaches that students take to overcome any barriers. In addition, this study took place during nearly universal remote classes. Although some of the technology issues are undoubtedly ameliorated by campus computing labs and Wi-Fi for students attending class in-person, the increasing move to hybrid and online classes raises many questions about whether students at universities with high numbers of low-income and first-generation students have the technology resources to thrive in hybrid and online courses.

Future studies would benefit from looking at the nuances within each level of the digital divide, as well as a clearer focus on, and the operationalization of, particular issues with access to technology. For example, our survey found that access to laptops was relatively high at 89%, but specific issues about these devices were only uncovered during the qualitative portion. Furthermore, more research is needed to better understand students' perceptions surrounding the quality of internet access.

Additionally, the literature suggests that lending equipment was a step taken by many universities in response to the pandemic [63,64]. Our university had a similar initiative, yet only 8% of our sample used the program, despite 79% being aware and about a third of students mentioning problems with devices not working (30%) or equipment challenges (36%). Although this lack of participation may only be applicable to this university, future research could examine the steps taken by universities to create effective equipment programs, as well as conduct studies with students to understand why they utilize such programs or not.

Our sample is limited to current undergraduates. Prior research has shown that the digital divide is a predictor for students' likelihood of attending college. Studies have found that access to high-speed internet is related to students' college application decisions and outcomes and their performance on the SAT [21,65], especially considering the recent decision to take the SAT all-digital by 2024. We recommend that future research investigates multiple education levels to better understand how access to technology, and its effective use, can lead to informed decision-making regarding higher education. Training in the effective use of these 21st-century tools, at all education levels, along with reliable, adequate, universal internet access is paramount if there is to be an equitable technological future because "digital access and proficiency [has] become essential for competitiveness in nearly every aspect of life" [66].

Finally, the national and R1 studies used in this study are not perfect comparisons and were used to provide context. Future research would benefit from looking at the differences among R1 universities, HSIs, and other institutions comprising a variety of demographics.

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Appendix A

Technology Survey

- **Which of the following concerns have you encountered in navigating and completing your courses during alternative course delivery during the Fall 2020 term? (Select all that apply):**
  - ○ Accessing technology (computer, internet, headphones, microphones, etc.) needed for your online classes
  - ○ Social/Political environment
  - ○ Academic advising
  - ○ Workload
  - ○ Food insecurity
  - ○ Housing insecurity
  - ○ Emergency grant aid
- **Are you aware that {redacted} has a program to assist students with access to technology (including internet access and devices)? (Yes/No)**
- **Are you currently using technology provided by {redacted}? (Yes/No)**
- **Which of the following types of devices do you have access to? Please choose all that apply:**
  - ○ Chromebook
  - ○ Laptop
  - ○ Smartphone
  - ○ Tablet
  - ○ Desktop
  - ○ Other
- **Do you share your principal device with others? (Yes/No)**
- **How much time per day do you usually have available to use your principle device?**
  - ○ 1–2 h

- ○ 3–4 h
- ○ 5–6 h
- ○ Unlimited time

- **If you found it challenging to work from your home, please indicate why (please select all that apply):**
  - ○ Childcare/Family needs
  - ○ Economic hardship
  - ○ Equipment/Wi-Fi/Technology needs
  - ○ Unanticipated noise/disturbances
  - ○ Insufficient workspace
- **At home, which of the following methods gives you access to the internet? Please choose all that apply.**
  - ○ Cellular data plan
  - ○ High-speed internet
  - ○ Hotspot
  - ○ I do not know how I have home internet access
  - ○ I do not access the internet at home
- **How would you describe the quality of the internet connection where you do most of your academic work that requires online access?**
  - ○ Bad. My internet access is slow and works poorly most of the time.
  - ○ Unpredictable. Sometimes the internet connection is good; sometimes it is bad.
  - ○ Ok. Most days I have a good internet connection.
  - ○ Great. I never have problems.
- **Have you had technological difficulties completing any of the following school-related activities? Please check all that apply.**
  - ○ Accessing live lectures (e.g., Zoom)
  - ○ Checking grades/homework (accessing, doing, submitting)
  - ○ Required readings
  - ○ Problems with device not working
  - ○ Writing essays or papers
  - ○ Using learning management system {name redacted}
  - ○ Communicating with classmates
  - ○ Watching videos (recorded lectures, assigned movies, etc.)
  - ○ Communicating with instructor
  - ○ Researching/Finding information

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Article

Studying Abroad from Home: An Exploration of International Graduate Students' Perceptions and Experiences of Emergency Remote Teaching

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Abstract: The temporary shift from face-to-face instruction to online teaching at North American universities as an alternative solution in response to the COVID-19 pandemic brought significant challenges to international students who had to study abroad from their home countries. Studies on how international students perceive their study-abroad-from-home experiences in such an emergency remote teaching (ERT) context remain scarce. Through the lens of community of inquiry and an additional perspective of emotional presence, this study explored 13 first-year international graduate students' perceptions and experiences of their learning in ERT. Based on the analyses of the pre-learning questionnaire survey results and a series of three reflection journal entries, the study finds that teaching presence has played a vital role in shaping students' understanding and experiences when they participated in a study-abroad graduate program from their home countries. In addition, the participants demonstrated mixed emotions of both frustration and appreciation/thankfulness as well as an isolation–connectedness emotional trajectory during their learning process. The study inspires an exploration of more diverse options for international education programs and continued effort in providing institutional support to ensure better learning experiences in a post-COVID community of inquiry.

Keywords: study abroad; international education; community of inquiry; CoI; emergency remote teaching; ERT; online learning; COVID-19; graduate students

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1. Introduction

As one of the top study-abroad destinations, Canada hosts a large population of international students every year. In 2020, international students represented 23.7% of the total enrolments in Canada [1]. Students who choose to study abroad usually aim at being immersed in the languages and cultures of the host countries while enjoying a quality education. However, the prevalence of COVID-19 in 2020 has made it very challenging for a large number of international students, particularly first-year international students, to come to Canada for their study-abroad programs. With international travels restricted, university campuses shut down, and classes moved online, they had no other choice but to study abroad from home by taking online courses.

Although online learning is not something new, it is worth noting that the courses that were temporarily shifted online in response to the COVID-19 crisis were situated within the emergency remote teaching (ERT) context, in which access to instruction is provided "in a manner that is quick to set up and is reliably available during an emergency or crisis" [2] (p. 7). They are different from the courses that are initially planned and designed to be taught online.

According to Khotimah [3], during the COVID-19 pandemic, 107 countries implemented national school closures on 18 March 2020. Higher education in many countries was forced to switch to ERT on that day or roughly around the same time. Since the outbreak of COVID-19, there has been a growing body of literature that explores students' ERT experiences in many parts of the world such as Jordan [4], the US [5], Serbia [6], South Africa [7], Slovakia [8], the UK [9,10], and Hong Kong [11]. However, these studies focus on students in general with no special attention to international students. In addition, there has been little discussion about international students' ERT experiences in a Canadian context. This study intends to fill these gaps by exploring the experiences of first-year international students who were admitted to a Canadian university in the fall of 2020 and studied remotely from their home countries during the first semester into their graduate program. In light of the ongoing concern of COVID-19 and its long-term impact on future international education, it is crucial to obtain a better understanding of international students' learning experiences in the ERT context and to explore practical implications for optimizing international students' learning experiences in the post-COVID era.

2. Theoretical Framework and Literature Review

2.1. Community of Inquiry

This study draws on the community of inquiry (CoI) framework [12]. Since its initial publication in 2000, the CoI framework has been widely used, cited, and developed and has become one of the most extensively used frameworks in the research and practice of online learning [13–16]. The CoI framework provides a comprehensive model that includes three elements: cognitive presence, social presence and teaching presence [12].

In this model, cognitive presence involves four phases of practical inquiry (the exploration, construction, resolution, and confirmation of understanding) and is considered as being vital for critical thinking and academic success [12]. While cognitive presence is used to describe the process of practical inquiry, social presence refers to the creation of a climate that supports and encourages such intellectual inquiries. It includes three broad categories: emotional expression, open communication, and group cohesion [12]. Emotional expression refers to the ability to express feelings that are associated with educational experience and is often conveyed through the use of symbolic representations in an online learning context, such as emoticons, as well as the expression of humor and self-disclosure. Reflecting trust and acceptance, open communication encourages constructive responses to community members by asking questions, expressing agreement, quoting other's messages, expressing appreciation, and so forth. The third category, group cohesion, refers to a sense of belonging and community building. The third element of the CoI model, teaching presence, involves instructional design and organization, facilitating discourse and direct instruction [17,18]. In light of the purpose of achieving meaningful online learning experiences, teaching presence plays a vital role in integrating and supporting the cognitive and social processes [17]. Instead of using teacher presence, as Garrison [17] explained, teaching presence allows every member of the community to make a contribution to achieving self-directed and self-disciplined learning outcome.

The CoI model provides a comprehensive guide for the understanding and research of online learning experiences [12]. During the past two decades, the CoI framework has been extensively applied and examined [19–23], both qualitatively and quantitatively, resulting in a critical understanding of the relationships among the three presences and how they are connected to other elements. Some researchers suggest considering other possible presences, such as learning presence [24], autonomy presence [25], and emotional presence [26–28]. Although these presences are closely related to the elements in the original CoI framework, there seems to be an increasing interest in exploring the possibility of viewing them as an additional component of the framework.

2.2. Emotional Presence

Among these additional components, emotional presence has been receiving more attention particularly due to recent discussions on the relationship between emotion and online learning [29–31]. As Tores and Evans [30] stress, emotion plays a significant role in preventing an isolated online learning experience and is as important as the curriculum itself. However, it has not been extensively examined or considered in research and practice [26,30]. In the CoI framework, "emotional expression" is referred to as both conventional and unconventional expressions of emotion (such as punctuation, capitalization, and emoticons) and is placed as a sub-component of social presence [17]. Cleveland-Innes and Campbell's [26] findings indicate that emotion is present in online learning communities and plays a role in all three presences of the CoI framework. Based on their findings, Cleveland-Innes and Campbell [26] (p. 283) provide the following definition for emotional presence:

Emotional presence is the outward expression of emotion, affect, and feeling by individuals and among individuals in a community of inquiry, as they relate to and interact with the learning technology, course content, students, and the instructor.

Cleveland-Innes and Campbell's [26] proposal has inspired further explorations of emotional presence as an additional component of the CoI model. For example, Majeski et al.'s [28] study investigated the relationship between emotional presence and teaching presence. With an understanding of emotional presence as emotional perception, understanding, regulation, and facilitation, they conceptualized emotional presence as part of teaching presence that affects learner emotional presence, social presence, and cognitive presence. Using Cleveland-Innes and Campbell's [26] emotional constructs, a recent study by Jiang and Koo [27] examined the emotional presence and relationship building in a group of non-traditional graduate students' online learning and identified mixed emotions and a desperate need for emotional support. While the CoI model [12,17] provides a holistic model to guide the design and conduction of the present study, the additional element of emotional presence is carefully considered in the analysis of the research findings with particular concerns regarding the impact of COVID-19 on students' emotions in online learning.

2.3. Online Learning and Emergency Remote Teaching (ERT)

The current teaching system, condition, and context that emerged from the COVID-19 pandemic have been conceptualized with multiple terms, such as online learning and distance education [5]. However, these concepts are inaccurate as they have developed to embody different learning and teaching environments [2,32,33]. To be more specific, distance education theories were developed when "resources, platforms and teaching methods were carefully considered and took time to develop and curate" [34] (p. 61). To distinguish from these contexts, Hodges et al. [2] have proposed "emergent remote teaching (ERT)" as an alternative term to describe the current classroom system introduced under the COVID-19 pandemic. According to them, ERT is a "forced" transition to online teaching or learning due to the crisis that was initially planned to be offered face-to-face, blended, or in a hybrid form [2]. Bozkurt and Sharma [33] iterate this point as follows: "while distance education has always been an alternative and flexible *option* for learners, emergency remote teaching is an *obligation*" (p. II, emphasis original).

Due to its crisis-responsive nature, ERT is "a temporary solution" that is implemented only during a crisis or disaster and is supposed to be abated afterward [2,33]. In this emergency, the focus is on how institutions can make this massive, drastic transformation of their education system, rather than whether implemented online teaching methods can guarantee quality education [35]. This certainly depends on each institution, and for the successful transformation, it is imperative for institutions to secure "[r]eliability and sufficient availability of Information Communication Technology [ICT] infrastructure, learning tools, digital learning resources in the form of Massive Open Online Courses, e-books, e-notes" [35] (p. 18). Available technological resources significantly affect pedagogical possibilities at the classroom level. In addition, students and instructors have to deal with the forced transition to online teaching, regardless of their previous online teaching/learning experience, digital competence, and level of comfort with that environment.

Although the present study is conceptualized as ERT, it also requires attention that the ongoing almost-two-year-long ERT situation under the COVID-19 pandemic has consequently created so-called "new-normals". In the context of higher education, the pandemic promoted the implementation of online learning systems and the training of instructors to teach online. In other words, studies conducted during this pandemic could present practical implications for future online learning systems and models [8].

2.4. ERT during the COVID-19 Pandemic

As of today, ERT studies have been conducted largely in two areas: effective teaching approaches and students' learning experiences. Garrison et al. [12] claimed that students' overall learning experiences and community building depend on instructors' effective presence and leadership, particularly in an online classroom context. Likewise, during the COVID-19 pandemic, studies have found the multiple, important roles that instructors took in their ERT classrooms [5,7,10,11,36,37]. For example, through their survey research on undergraduate students in Hong Kong, Tsang et al. [11] concluded that course design was a key predictor of perceived learning experiences and effectiveness. In Gelles et al.'s [5] case study of engineering undergraduate students in the US, instructors' facilitation and mentorship were particularly appreciated by students, pointing to the need for shifting the focus from making courses rigorous to being compassionate to students during ERT. Studies, such as those of Doll et al. [36] and Kifle Mekonen and Chiamaka Nneoma [37], found that teachers also had to play a tech-support role in the ERT context to troubleshoot unexpected technical issues that students faced.

The precarious roles that instructors had to take amid the pandemic were a reflection of students' diverse expectations and demands during the crisis. Studies on students' ERT experiences have been conducted in many parts of the world [4–11]. These findings overall suggest how various factors—both in- and inter-dependently—shaped students' learning. One of the most explored are factors that smoothened students' ERT experiences. In Kovačević et al.'s [6] survey research on university students in Serbia, previous online learning experience and familiarity with learning platforms were the predictors of students' learning satisfaction. On the contrary, Poláková and Klímová [8] found in their survey that participating students in Slovakia did not consider lack of experience with online learning hindered their learning. The researchers concluded that this inexperience was compensated by students' existing digital competence.

The previous studies have also shed light on the importance of paying attention to localized and personalized situations in the ERT context. For example, in Makgahlela et al.'s [7] study on a rural university in South Africa, the students' narrative vividly conveyed the contextual reality where they struggled with multiple issues such as the lack of sufficient devices, data, and a safe, quiet space to study, calling for their university to reopen because their online learning was not functioning at all. From a different context, in aforementioned Gelles et al.'s [5] case study on American university undergraduates, gendered responses in their ERT experience were prominent: Female students tended to have more housework and family duties, whereas males tended to feel there was more free time during the pandemic. Issues surrounding digital equity were prominent in Greenhow et al.'s [38] review of newspaper articles in the US and the UK, revealing how technology access and social support played a role in widening the gaps between students from low- and high-income families in these two countries.

The previous literature, in sum, points to the fact that students' ERT experiences have been shaped through numerous factors, including the availability of support from the institution and/or instructors and students' assets—from financial, sociocultural, to technological ones. This means that faculties and institutions must reflect on the assumptions that they make about their students and pay attention to students' personal lives for a successful ERT experience [5]. This is a challenge for almost any school and educator, but especially for the ones that accommodate international students. Especially notable are the experiences of first-year international students, most of whom had to stay in their home countries due to border restrictions during the year 2020. Unfamiliar with new education systems and physically apart from the academic communities, these students started their "study-abroad-from-home" journey alone. International students' ERT experiences and, in particular, first-year international graduate students' ERT experiences have received scant attention in the existing literature. To fill this gap, the present study focuses on this specific group of students with an aim to explore the following questions:

1. What are international graduate students' perceptions of online learning and study abroad in an ERT context?
2. What are international graduate students' ERT experiences when studying abroad from home?

3. Methods

3.1. Research Site

This study took place in a large public research university located on the West Coast of Canada. According to the official website of the university, more than one-fourth of the enrolled students were international students in the year 2020. The university's Faculty of Education offers graduate programs in various disciplinary areas such as language and literacy education, curriculum and pedagogy, educational studies, and educational counselling and special education, and so forth.

3.2. Participants

The study recruited 15 international graduate students from the university's Faculty of Education, among whom two withdrew during the data collection. A combination of snowball and convenience sampling was used to recruit the participants who: (1) started their graduate program at the university in September 2020, (2) resided outside of Canada in 2020 Winter Term 1 (September–December, 2020), and (3) took one or more courses in 2020 Winter Term 1.

International graduate students who participated in this study were enrolled in the following degree programs: Doctor of Philosophy (PhD, n = 1), Master of Arts (MA, n = 2), and Master of Education (MEd, n = 10). Ten of the participants were in their 20s, and three of them were in their 30s. Eleven students identified themselves as female, whereas two did as male. All the participants were studying in their home countries during 2020 Winter Term 1. The participants were taking one to three courses during the term, and the course formats included synchronous, asynchronous, and hybrid courses. Detailed demographic information of the participants is listed in Table 1.

Table 1. The demographic information of the participants.

Participant	Where They Were during Term 1 2020	Degree	Program	Gender	Number of Courses Taken	Course Formats
P1	China	MEd	Language education	F	3	Synchronous (1) Asynchronous (2)
P2	China	MEd	Educational counseling and special education	F	3	Synchronous (2) Asynchronous (1)
P3	China	MA	Language education	M	3	Synchronous (2) Asynchronous (1)
P4	East Asia *	MEd	Language education	F	2	Synchronous (1) Asynchronous (1)
P5	China	MEd	Language education	F	2	Synchronous (1) Asynchronous (1)
P6	China	MEd	Educational counseling and special education	F	2	Synchronous (1) Asynchronous (1)
P7	Japan	MEd	Curriculum and pedagogy	F	2	Synchronous (2)
P8	Nigeria	MEd	Curriculum and pedagogy	M	1	Synchronous (1)

Table 1. *Cont.*

Participant	Where They Were during Term 1 2020	Degree	Program	Gender	Number of Courses Taken	Course Formats
P9	Russia	MA	Educational counseling and special education	F	3	Synchronous (3)
P10	East Asia *	PhD	n/a	F	2	Synchronous (1) Hybrid (1)
P11	Nigeria	MEd	Curriculum and pedagogy	F	2	n/a
P12	East Asia *	MEd	Educational counselling and special education	F	3	Synchronous (1) Asynchronous (2)
P13	Cambodia	MEd	Education studies	F	2	Synchronous (1) Hybrid (1)

* P4, P10, and P12 indicated their preference for not disclosing their specific location and nationality.

3.3. Data Collection and Analysis

Employing a mixed-method approach, the present study consisted of two phases of data collection: (1) pre-learning questionnaire survey before the semester started, and (2) three reflection journal entries during the semester. In the first phase of data collection, the participants were invited to respond to the pre-learning survey questionnaire, which was designed to elicit information regarding their personal background information (e.g., nationality and age), experiences and perceptions of online learning, pre-learning activities, and understanding of "study abroad" and "study abroad from home". The questions were asked in various formats such as multiple choice, Likert scale, and open-ended questions. In the second phase of data collection, the participants wrote three short (around 200 to 300 words) reflection journal entries where they reflected on their experiences of learning in their registered courses at the beginning, middle, and end of their first semester in their graduate program. Some prompts were provided to help develop ideas, but the participants were encouraged to write anything that stood out to them (refer to the Appendix A for details). This unique approach of using multiple reflection journal entries throughout the semester is different from the ones used in the previous studies. It enabled us not only to explore what the students experienced in this specific learning context but also to trace how their understandings and emotions develop as their learning progressed. This approach is beneficial for capturing the complexities of the issues being explored in this study.

Garrison's [17] CoI coding template was used when analyzing the three presences (cognitive, social, and teaching presences). Although emotional expression is only one of the categories in social presence in the original CoI framework [12], it is worth being viewed as a unique presence in addition to the three presences since emotional expression emerged as an exceptionally recurrent theme in the journal data. To capture this emerging theme in depth, we coded emotional presence by drawing on the 23 emotional constructs proposed by Cleveland-Innes and Campbell [26]. Since loneliness and isolation have become highly concerning due to the impact of such measures as emergent lockdowns and social distancing during the pandemic [39], we considered it necessary to pay special attention to this emotion when analyzing the participants' emotional presence. In opposition to being isolated, the feeling of being connected might also be looked at in this context.

The two authors first coded 15% of the journal data (i.e., two participants' sets of journals) independently and reviewed their code consistency. The inter-rater reliability rate was high (86%). Inconsistent codes were identified, discussed, clarified, and adjusted. Then, the second author coded the rest of the journal data, which was reviewed by the first author.

4. Results and Discussion

To obtain a comprehensive understanding of first-year international graduate students' perceptions and experiences of online learning and study abroad in an ERT context, we analyzed the participants' pre-learning survey results and the three reflection journal entries that they completed at the beginning, middle, and end of the semester.

4.1. Perceptions of Online Learning and Study Abroad in an ERT Context

According to the results of the pre-learning survey, more than 60% of the participants had never taken any online courses before. About 80% of those who had previous online learning experiences took asynchronous courses, but none of them showed strong satisfaction towards those learning experiences. Although they liked the flexibility of learning schedules and locations as well as easy access to learning content, they were not satisfied with the communication with teachers and peers in online learning.

The participants were invited to explain why they applied for the graduate program at the participating university. Since all the participants were enrolled in at least one course in the semester when the study was conducted, they were also required to explain why they did not defer their admission when they knew they had to take all the courses online without being able to come to campus. The reasons for their program application were mainly related to the ranking of the university and the expectation for studying abroad in Canada. Time and scheduling concerns were the major considerations for their reluctance to defer admission. Although the courses were temporally shifted online, they held the expectation for completing the program within the initially planned time frame. As one participant wrote in their open-ended response, "online or not, I will learn".

In the pre-learning survey, the participants were also invited to describe their understanding of study abroad and study abroad from home. While a new environment, people, and cultures appeared to be the defining characteristics in the participants' understanding of study abroad, many described their expectation for an immersive experience of studying and living in another country, which was in great contrast to their understanding of studying abroad from home. The latter appeared to be much less attractive as evident in such descriptions: spending "way more time in front of screens", "lost the chance of going to new places", "an isolating experience", "there is nothing meaningful to study abroad from home", and so forth. Although some participants tried to be more optimistic and mentioned the advantage of saving living expenses, it was apparently not something they cared about most. One participant even described a study-abroad-from-home program as a "cheap program" featuring "low bars for entry". According to the participants' understanding, having to attend a study-abroad program from one's home country lacks the most important elements that attract learners to study abroad and is associated with a negative vision of an isolated learning experience—isolated from the place, people, and cultures that learners could have explored and experienced otherwise.

In addition to these questions in the pre-learning survey, the participants were also asked to provide a metaphor to describe their overall study-abroad-from-home experiences in their third reflection, which was collected at the end of the semester. Surprisingly, the metaphors were not associated with an entirely negative image. In fact, some of these metaphors showed a sense of positiveness with the use of such terms as "adventure", "life-changing", or "comfortable". Some of the metaphors conveyed a sense of unreality and loneliness through the use of such terms as "dream", "an artificial wave pool", and "a race with myself". Although none of the participants depicted it as a negative experience, their expectations for a study-abroad program did not seem to have been fully fulfilled. As one participant wrote, "Studying abroad from home is like having a meal blended together and drank, you get all the relevant nutrients but the process of 'eating' is less enjoyable". It is worth digging deeper into their detailed reflection notes to explore what they had experienced that led to these understandings and emotions.

4.2. ERT Experiences

Both the pre-learning survey results and the three reflection journal entries were analyzed to explore the participants' ERT experiences. The CoI model [12,17] was employed as a framework to guide the understanding of students' reports and reflections. In addition, 25 emotional constructs adapted from Cleveland-Innes and Campbell [26] were used to analyze the participants' emotional presence and change of emotions throughout the whole semester.

4.2.1. Cognitive Presence

Cognitive presence relates closely to students' learning process in terms of how they recognize problems, explore relevant issues through critical reflections and discourse, construct meaning, and apply what they learn [12]. However, when the participants reflected on their learning, instead of commenting on the practical inquiry, most of them focused on the challenges brought by the format of learning during ERT. Challenges such as technical issues, time differences, and the mental pressures due to the format of online learning strongly affected students' cognitive presence. As a participant from Russia, P9, described in her first reflection, "It's harder with the studies all being in my laptop: usually they contained from several activities, like checking class notes, reading book, watching additional videos. Now it's all there, so I get tired much faster". Several participants complained about the challenges brought by ineffective time management and huge time differences. The participant mentioned that she had to take live learning sessions when her partner was sleeping, so she had to study "in a small kitchen, with a little light and no noise". Several other participants, too, experienced such frustrations as having to take courses at 12 a.m., 3 a.m., or 6 a.m. The narrative reflection of a participant from Nigeria, P8, clearly illustrates the challenges for cognitive presence in such an ERT context:

> It is Wednesday, almost 12 am WAT, my eyes are heavy but I have to purchase a large sum of data internet subscription that will be more than enough for the next 3 h, hoping for a stable bandwidth without interruption as class is in session, my torchlight by my side just in case of a power outage. . . . The timing for classes is still of a huge disadvantage to me, having classes once a week doesn't look bad except that you have 8 h difference between both countries involved. I am a teacher and I currently go to work every day, my classes are usually 12am WAT so I have to either stay awake till then or set my alarm, so I have lectures 12 am–3 am, 2 h sleeping time and then I am up in preparation for work. If classes were held in-person, I will be restricted to four working hours if I have to work and I will have much time for studies but you don't find such employers here that understands your situation and the need for a lesser working hours. Also, I am not satisfied with my productivity level, no after class discussions with my amazing course mates which can yield good fruits.

To reduce internet consumption, the participant also reported having to use a mobile phone instead of a laptop for the online courses, which prevented him from performing "proper class participation in class activities". A participant from Cambodia, P13's learning was also affected by such financial challenges. She noted that,

> I have been considering that taking a break from my job would provide me the time I need, but the tuition isn't going to pay itself and so isn't the insurance fee I am being charged for though I am not physically there.

Besides the impact of financial issues, students' learning was also negatively affected by the social environment of their home countries. Because of the high tensions and unrest in his home country, P8 noted that "I feared for my life during the day as I step out and I try to remain calm in every class putting aside the squabbles of the day".

These notes reflect great concerns about the several hindering elements that have been recently investigated [7,40–42]. All these factors, time differences, access to the Internet, and financial and security issues have made educational equity a big concern in this specific learning context. As Ezra et al. [40] advocated, relevant mitigating strategies should be considered to identify and address educational equity issues in order to meet the needs of vulnerable populations.

Teaching presence, particularly, the instructor's discourse facilitation in online discussions, had a great impact on students' cognitive presence. A lack of instructor feedback may negatively affect students' inquiry process. As a participant from East Asia, P4, reflected in her second reflection, she felt frustrated with online discussions not because of the task of writing discussion posts but because of the uncertainties and self-deprecation she felt when the instructor did not respond to her posts. She noted that,

> Posting itself is not very difficult for me now, but I would like some comments from professors on my posting to know whether I was on the right track. Even when I read the required readings and receive replies from my classmates, I still don't know if my reflections hit the nail on the head. When I receive no comments from professors, I always feel like my reflections are meaningless and deserve low marks. It's discouraging and makes me nervous.

Although, as the participant clearly understood, it might be impossible for the instructor to respond to every student, facilitation of discourse is particularly important in such an ERT context where personal one-on-one communications are largely limited.

4.2.2. Social Presence

Pertaining to the ability of "projecting themselves socially and emotionally, as 'real people'" [12] (p. 94), social presence involves every member of a community of inquiry and faces great challenges in building the connectedness in an ERT context. According to the CoI framework, social presence consists of three indicators: emotional expression, open communication, and group cohesion [12]. Evidence related to emotional expression is presented and analyzed in detail in the section of emotional presence.

The process of how the participants built the online community, just as Brown [43] identified, went through three stages, from online interactions to thoughtful exchange of ideas and finally to achieving a feeling of camaraderie. The participants' reflections show that open communication and group cohesion played equally important roles in this process and were both affected by course formats (synchronous vs. asynchronous), participants' backgrounds, and teaching presence. The participants seemed to find it easier to start the community-building process with the synchronous courses where they "feel connected" (e.g., P4) with the instructors and classmates. They also found it easier to connect with the classmates who share the same cultures or nationalities (e.g., P5). Interestingly, as a participant from China, P5, explained, she felt closer to other students who were also in China majorly because they could have more interactions through a shared SNS tool—WeChat. In fact, the use of WeChat also helped extend their communication from academic discussions to personal ones because of the access to personal WeChat postings. While these participants seemed to have no difficulty interacting with classmates from the same country, they came across big challenges getting to "know" more about classmates from other countries. Some students (e.g., P6, P9) noted their expectations for learning more about their classmates but made little progress throughout the whole semester due to not having enough opportunities for more in-depth personal interactions.

Teaching presence, specifically, instructional design and discourse facilitation, contributed to stronger group cohesion, which is particularly important for community construction in an e-learning context [17]. The feeling of connectedness became stronger as more group interactions occurred for the purpose of completing group discussions or group assignments. As a participant from East Asia, P12, noted, her instructors encouraged peer feedback, which led to an active exchange of ideas in the online discussion forum. This not only helped her think more critically about the course content but also gave her the chance to work more closely with a classmate who greatly supported her studies. The increasingly stronger group cohesion, as mentioned in P4's final reflection, made her feel as if she were together with her classmates in the classroom (rather than in a virtual classroom).

In this ERT context where students had to (rather than chose to) study online, they had stronger expectations for community building and put greater effort into learning more about each other. For example, although P13 was very sleepy when attending synchronous sessions because of the time difference, she managed to join earlier every time in order to chitchat with her classmates or even just to listen to them. The sense of "real" connections with instructors and classmates seemed to be especially important and valuable in an isolated and physically distanced environment brought by the pandemic.

4.2.3. Teaching Presence

Teaching presence is conceptualized as having three components: instructional design and organization, facilitating discourse, and direct instruction [17]. A lot of the participants' survey responses and reflection notes that were related to teaching presence connected to the component of instructional design and organization. They commented on both the instructional support before and during the course delivery and the instructional design of the online courses. As found in the survey results, all the participants had received the course syllabi and emails from the instructors before the courses started. Almost all (12 out of 13) of them received access to the online learning platform prior to the start of their courses. The pre-learning information and support were perceived to be very helpful. As a participant from Japan, P7, commented, the course syllabi she received before the courses were very "informative and helpful", which made her "feel a lot secured". In fact, this pre-learning instructional support may strongly affect students' initial experience when they embarked on their ERT journey. One participant from China, P1, experienced significant challenges when downloading the reading materials due to internet restrictions until one of the instructors helped her with the issue. Being a tech-support, as noted in previous research (e.g., [36,37]), becomes an important role that instructors are expected to take on in ERT. The participants also found it helpful when the instructors were clear about their expectations, open to questions, and willing to make adjustments. For instance, three participants (P2, P4, P6) mentioned that their instructors offered an extension for the submission of their final papers, which was "so helpful" and "really great".

The participants appreciated not only their instructors' support but also how they designed the courses, both synchronous and asynchronous ones, to accommodate the needs of all the students in the ERT context. Although most of the participants provided very positive comments on the course design and appreciated the instructors' effort in designing and organizing the courses, particularly in terms of their clarity, they showed clear preferences towards some course designs that worked more effectively in easing the pressure of learning and encouraging group interactions. Higher student satisfaction was shown when the course designs matched students' learning styles. These findings are consistent with those of Tsang et al. [11], who emphasized students' appreciation towards instructors' facilitation and course design in an ERT context.

It is worth noting that the university where the study was conducted offered a series of workshops before the 2020 fall term, which offered topics relevant to online course design strategies and principles, examples and templates, technologies and tools, and one-on-one consultations. Such institutional support might have played a very important role in achieving student satisfaction with the course designs. At the same time, as VanLeeuwen et al. [44] indicate, there is an emergent need for professional development in digital education and this need has become "pressing" due to the impact of the pandemic.

As Garrison [17] clarifies, both teachers and learners contribute to teaching presence. Some participants noted down how they exerted great effort into monitoring and managing their own learning in order to achieve better learning efficiency and outcome. P3 noted that online learning made him "think ahead" and "make plans". They also showed initiative in facilitating discourse by actively exchanging ideas and giving and receiving feedback in their online discussion forums, which positively affected the cognitive and social presences in their learning community.

4.2.4. Emotional Presence

Emotional expression is housed under the dimension of social presence in the original CoI framework. However, it is proposed that emotion should be addressed as a unique presence independent from social presence (e.g., [27]). Because of the uniqueness of the ERT context in which the study was conducted and its potential impact on learners' emotions, we considered it reasonable to pay special attention to emotional presence and how it relates to the other three presences of the CoI framework. Before the start of their study-abroad-from-home program, most of the participants self-identified their emotions as being uncertain (62%), with a small number of participants identifying themselves as being excited (38%) or concerned (38%). These complex feelings were also identified in their reflection notes. Using the 25 emotional constructs adapted from Cleveland-Innes and Campbell [26] (see Table 2), we identified 20 emotions, with appreciation being the most recognized (83 times) emotion, followed by frustration (75 times) and thankfulness (62 times). Surprisingly, a closer look at loneliness/isolation and connectedness, the two additional emotions we added to Cleveland-Innes and Campbell's list of emotional constructs, finds that connectedness was recognized more times (17 times) than loneliness/isolation (11 times). Table 2 shows the times of recognition for each emotion and the example quotes:

Table 2. Emotional presence identified in the reflection journals.

Emotional Construct	Times of Recognition	Example Quotes
Appreciation	83	I am very appreciative of ...
Delight	5	I am glad ...
Desire	4	I would love to ...
Disappointment	19	I wish we could ...
Dislike	0	
Emphatics	20	... is mucccccch harder.
Enjoyment	6	I enjoy ...
Excitement	8	I was excited ...
Fear	24	... can be a real nightmare
Frustration	75	I'm struggling with ...
Happiness	6	I feel happy that ...
Hope	18	I hoped that I can ...
Humor	0	
Irony/sarcasm	0	
Like	11	I like ...
Passion	0	
Preference	13	I prefer to ...
Pride	2	I am proud to ...
Surprise	4	To my surprise ...
Thankfulness	62	I am thankful for that ...
Unhappiness	1	I am not satisfied with ...
Wonder	2	... feels surreal.
Yearning	0	... is my dream
Loneliness/Isolation	11	... feels distanced.
Connectedness	17	I feel more connected ...

It is probably not surprising at all to find frustration to be one of the most recognized emotions, considering the unique situation in which a study-abroad program was pursued remotely from students' home countries. The frustrations were majorly caused by technological issues, heavy workload, time differences, time management, limited communication channels, and so forth. However, it is somehow unexpected to find more recognitions of positive emotions of appreciation and thankfulness. Additionally, these two emotions were often expressed simultaneously. For example, P3 expressed his feeling of appreciation and thankfulness when reflecting on the support received from an instructor before the course started:

> A fascinating thing is one of my course instructors contacted us in advance (by sending us a long email) and told us about the required textbook and learning materials for the class. I appreciate such responsible teachers.

The emotion of loneliness/isolation emerged 11 times. Some participants felt that they were not connected to their classmates or with the community, although they could communicate with their teachers and classmates online. In P3's words, "It seems that we are separated by something". Unexpectedly, the emotion of connectedness emerged more times than loneliness/isolation. A comparison of the coding of each participants' three reflection journal entries finds that loneliness/isolation was mostly spotted in the participants' first reflection, yet connectedness was majorly spotted in the second or third reflections. As evident from the participants' notes, social and teaching presences' positive impact on community building began to influence participants' feeling of connectedness to the community as the courses progressed. P2 noted that,

> After corresponding frequently through emails and several chances to have direct conversations (one-on-one Zoom meeting/Zoom meeting for small groups), I do feel more connected to my teachers, and I sense that my teachers might know me better in terms of my interests and areas of expertise.

P4 also noted the feeling of connectedness in her second reflection:

> After a couple of months, I feel more connected with my classmates and my professors. Group assignments that I had in my courses gave me opportunities to talk and interact with my classmates. These opportunities are valuable to get to know them. I also met my professors online, and I felt stronger connections with them than before.

In addition, some participants' agentive effort in actively seeking opportunities for both academic and personal interactions (e.g., exchanging thoughtful ideas and liking classmates' SNS posts) led to a stronger sense of belonging to the community.

In line with Jiang and Koo [27], the study finds mixed emotions among the participants, among which frustration was one of the most recognized emotions. Nevertheless, different features of emotional presence were identified. For example, instead of demonstrating a strong emotion of happiness or enjoyment, participants in this study showed a greater sense of appreciation and thankfulness towards the situation and every community members', particularly the instructors', effort and contribution. They understood the challenges that everyone was facing in this ERT context and thus appreciated the support they could receive to help them overcome the frustrations. In addition, as the participants in this study were invited to note down their reflections three times during the semester, it is possible to identify the change of emotions in this process (such as the spot of isolation and connectedness). Tracing these emotional changes allows us to obtain a better understanding of the interrelated impacts of cognitive, social, and teaching presences on participants' emotional presence.

5. Conclusions

The present study was designed to explore first-year international graduate students' perceptions and experiences of a study-abroad-from-home program in an ERT context. By investigating the results of a pre-learning survey and participants' self-reflections collected throughout the first semester of their program, the study finds that students were aware of the advantages and challenges of online learning. The participants in the study were determined to complete their graduate program even though they had to take online courses without physically being in Canada, but they had a clear understanding of the differences between study abroad and study abroad from home before the program started. Although a few participants changed their views after the completion of their first semester (e.g., one participant considered it as a "life-changing" experience), most of the participants viewed it as something unreal due to a physical disconnectedness from the place, people and cultures of the host country.

Through the lens of the CoI framework [12,17], we analyzed the survey results and reflection notes in order to obtain an understanding of students' learning experiences from the aspects of three presences (cognitive, social, and teaching presences) and an additional aspect of emotional presence. Supporting and extending the previous understanding of the importance of teaching presence [39], the study finds that teaching presence played a vital role in shaping students' ERT experiences and had a positive impact on cognitive, social, and emotional presences. Some participants highly appreciated the significant role of teachers in defining their online learning experiences. This finding confirms the pressing need for institutional support and professional development programs in digital education. It is also worth noting that the impact of teachers' role, as students perceived, was actually implemented through teaching presence that involves the contribution of both teachers and learners in the community of inquiry [17]. It is important not to ignore the positive impact of learner agency in shaping their own ERT experiences.

The investigation of students' emotional presence finds complex emotions of both positive and negative ones. While students experienced a lot of frustrations, which is very understandable considering the unique learning and social contexts, they also showed strong emotions of appreciation and thankfulness, showing their empathetic understanding of the situation in which every community member was trying their best to adapt to the "new normal". In addition, although many participants experienced emotional isolation at the beginning of the ERT journey, there emerged an increasing sense of connectedness as the journey progressed. This emotional trajectory confirms the positive effects of teaching and social presences, and at the same time, reveals the effectiveness of students' agentive effort in actively building up community and connecting with each other in such an isolated learning context.

Since the participants of the study were limited to graduate students who majored in education, the findings may not be directly generalizable to other disciplinary areas. For example, students who took lab courses might have experienced other types of challenges that were not identified in this study. A cross-disciplinary investigation on similar topics would be helpful for providing more insights into the issues discussed in the study. Similarly, while our study relied on convenience sampling and involved a small number of participants, a larger scale of this study with different sampling methods (e.g., random-quota sampling) will enhance the validity of the utilized frameworks. Additionally, since emotional presence can be a good indicator of students' ERT experiences, more empirical studies that focus on emotional presence are necessary to explore a better understanding of students' emotional trajectories in various remote learning contexts and the interrelationship between emotional presences and the other three presences.

The prevalence of the COVID-19 pandemic has brought ongoing concerns to the planning and implementation of international education. Although international students would accept study-abroad-from-home programs as an, or actually the only, option in an ERT context, it is different from their vision of and expectation for study-abroad programs. Considering the importance of international education, the importance of the international student population to Canada and many other countries, as well as the long-term impact of COVID-19 on international education, an exploration of more diverse options for international education programs in and out of crisis circumstances would be necessary. The newly gained insights into international graduate students' perceptions and experiences in ERT also imply the necessity of continued institutional support to ensure better learning experiences in a post-COVID community of inquiry.

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Appendix A The Reflection Journal Prompts

Reflection journal #1

Please reflect on your learning experience during the past few weeks and briefly note down things related to:

- your teachers (e.g., Have you got to know them? Have you got any chance to directly communicate with them? Did they make their expectations clear? Do you like the teachers' course designs?)
- your classmates (e.g., Have you got to know them? Have you got any chance to interact with some of them? What are your impressions of your peers?)
- your learning (e.g., Are you clear about how each course works? Have you figured out how to manage your learning? What challenges have you come across up to now? Did you solve the problems? Are you planning to make any adjustments for the next few weeks?)

The above guiding questions are just for your reference. You don't need to answer all of them. It will be good to focus on things that stood out to you. Feel free to make any comments or note down any relevant examples or incidents. Please do not mention the course number/title or the name of any instructor or student in your reflection journal.

Reflection journal #2

Please reflect on your learning experience during the past few weeks (since you completed your first reflection) and briefly note down things related to:

- your teachers (e.g., How well do you know the teachers now? Did you get any feedback from the teachers on your assignments or discussion posts? How do you like it? Did you find it easy to communicate with your teachers virtually?)
- your classmates (e.g., How well do you know your classmates now? Have you got any chance to work together with them? Have you got any feedback from them? How do you like it? What are your impressions of your peers now?)
- your learning (e.g., How did you manage your learning? How well were you engaged in the course content? Have you figured out how to solve some of the problems you came across at the beginning of the term? Have you come across any new challenges? How did you solve them? Did you find the help you need?)

The above guiding questions are just for your reference. You don't need to answer all of them. It will be good to focus on things that stood out to you. Feel free to make any comments or note down any relevant examples or incidents. Please do not mention the course number/title or the name of any instructor or student in your reflection journal.

Reflection journal #3

Please reflect on your learning experience during the past few weeks (since you completed your second reflection) and briefly note down things related to:

- your teachers (e.g., How would you describe your impression of your teachers during the past few weeks? Did your teachers offer support to help with your assignments? Did you find it helpful? Did you find some instructors' support more effective than others? How?)

- your classmates (e.g., How would you describe your relationship with your classmates during the past few weeks? Did you get to know more about your classmates? How? How did that help with your learning? Did you feel that your classmates have had a better understanding of you? How did you tell? How did that help with your learning?)
- your learning (e.g., How would you describe your learning during the past few weeks? Have you changed your view on the role of online discussions in your remote learning? How? Did you find the end-of-term exams or assignments challenging? Did you reach out for support? To whom? Was that helpful? Did you come across any new challenges during the past few weeks? Did you find the support you need to solve these problems?)

The above guiding questions are just for your reference. You don't need to answer all of them. It will be good to focus on things that stood out to you. Feel free to make any comments or note down any relevant examples or incidents. Please do not mention the course number/title or the name of any instructor or student in your reflection journal.

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Article

Social Connectedness in Physical Isolation: Online Teaching Practices That Support Under-Represented Undergraduate Students' Feelings of Belonging and Engagement in STEM

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Abstract: The COVID-19 outbreak spurred unplanned closures and transitions to online classes. Physical environments that once fostered social interaction and community were rendered inactive. We conducted interviews and administered surveys to examine undergraduate STEM students' feelings of belonging and engagement while in physical isolation, and identified online teaching modes associated with these feelings. Surveys from a racially diverse group of 43 undergraduate students at a Hispanic Serving Institution (HSI) revealed that interactive synchronous instruction was positively associated with feelings of interest and belonging, particularly for students of color, while noninteractive instruction reduced social belonging, but was related to more cognitive engagement. Small group and one-on-one interviews with 23 of these students suggest that students derived feelings of connectedness from their instructors, peers, and prior experiences and relied on their sense of competency to motivate themselves in the course and feel a sense of belonging. Two embedded cases of students in physics classrooms are compared to highlight the range of student feelings of connectedness and competency during the lockdown. Findings reaffirm that social interaction tends to support belonging and engagement, particularly for under-represented (Black or African American and Hispanic) racial groups in STEM. STEM instructors who aim to support feelings of belonging and engagement in virtual learning environments should consider increasing opportunities for student–student and student–teacher interactions, as well as taking a flexible approach that validates and integrates student voice into instruction. Future research is needed to further explore the themes of relatedness and competency that emerged as aspects of course belonging.

Keywords: COVID-19; online instruction; belongingness; engagement; STEM education

The COVID-19 outbreak caused unprecedented disruptions to educational institutions, including temporary closures and unplanned switches to online classes during the spring of 2020 [1], which disproportionately affected women and students of color [2–4]. These rapid changes led to the closure of physical environments that foster social interactions and learning communities. Collaborative learning environments such as laboratories, libraries, maker spaces, tutoring centers, and physical spaces that support office hours and study groups were rendered inactive, potentially dissolving associated social structures and learning communities that are crucial for learning.

Interpersonal engagement is considered central in the sociocultural learning theory [5–7] and fulfills basic psychological needs to feel connected and to belong in a learning community [8]. This engagement is particularly important for supporting women and students of color to forge STEM identities [9] and persist in STEM fields [10–12]. Schools and educators across the world undertook efforts to adapt to rapidly changing circumstances of COVID-19 and to support their students through academic and life challenges [1]. However, little empirical research has studied the specific instructional methods that instructors used to adapt to the ever-changing circumstances of the pandemic and how these practices affected under-represented groups of students' belonging to critical transition classes in STEM. Understanding how to better support students' sense of belonging and community online is key to their retention and matriculation in STEM.

Feelings of inclusion and belonging are a fundamental psychological need and are essential for belonging and engagement, particularly for under-represented racial/ethnic and gender groups in STEM [11,13–16]. A sense of belonging among women in virtual computer science undergraduate classrooms can mitigate the negative impacts of apparent stereotypes [17], and interpersonal interaction in virtual environments can support feelings of belonging and positive emotion [18]. However, much of this prior research was in contexts where faculty and students had willingly chosen virtual environments for STEM instruction, where virtual instruction could be readily supplemented with physical learning spaces (e.g., libraries and laboratory settings). It is also important to discern the extent to which belonging is important for under-represented racial/ethnic groups, particularly in a context of transition from in-person learning to mandated physical isolation. The purpose of this study is to identify online teaching practices that undergraduate STEM instructors employed after the transition to mandated online instruction during the COVID-19 pandemic and to explore their impacts on students' sense of belonging and engagement.

In the following, we summarize the theory on the role of students' sense of belonging, community, and engagement in supporting retention, matriculation in STEM, and particularly for students of color. We also summarize literature on how to design online learning environments that support such a sense of community. Then, we present a multi-method study investigating the impacts of different online learning practices on undergraduate students' motivation and engagement in STEM at a Hispanic Serving Institution (HSI).

1. Theoretical Framework

To examine the influence of different modes of distance instruction on student belonging and engagement, we drew from the literature on belonging from the Self-Determination Theory and from Kahu's sociocultural model of student engagement [19].

1.1. Self-Determination Theory and the Need to Belong

The Self-Determination Theory [20] proposes that students are more likely to engage, learn, and grow when they are able to determine choices that affect key aspects of their lives. People are most likely to grow when three fundamental psychological needs are met. Students need to feel (a) competent to meet and master challenges of their schoolwork, (b) autonomous insofar as their actions stem from their own interests and values, and (c) a sense of social belonging and relatedness in the classroom, academic community, as well as a general connection to others [21]. Once these needs are met, students' academic performance reflects an internal locus of causality. They take ownership of their learning, view their academic behaviors as stemming from their own volition, and develop an intrinsic motivation and engagement [22].

Of the three fundamental psychological needs in the Self-Determination Theory, the need for relatedness is most central to this study. Relatedness is the need to feel connected with others, including with instructors and other students, and to feel general belonging [8,20,22–24]. Belonging helps students internalize the goals and values of the instructor and the community and leads them to view extrinsically rewarded tasks (e.g., completing homework for a grade) as more personally meaningful (e.g., performing homework because it is important and aligns with their goals and values [25]). Feelings of belonging and academic engagement can be supported through teacher–student relationships [26,27], and relationships with peers [22] and parents [28]. Further, students' sense of belonging to their institution and classroom community is a key factor that motivates them to pursue and persist through undergraduate STEM programs, and is associated with achievement and motivational outcomes, particularly for women and students of color [24,29–37].

Nevertheless, some students feel out of place in some academic settings. Under-represented racial/ethnic groups of students can be stigmatized in some academic settings, where they are caused to feel that they do not "fit in" [14]. Walton and Cohen found that motivation and achievement of students of color were disproportionately impacted by doubts seeded about whether they belong in a field of study [38].

Doubts of belonging may have been exasperated by the sudden transition to online learning during the early stages of the COVID-19 pandemic. Under-represented racial groups in STEM may have been particularly susceptible to feelings of exclusion as a result of relying exclusively on platforms created by instructors and universities rather than having opportunities to connect with others face-to-face in physical situations and on their own terms. Students of color may also have disparate access to digital learning resources at home (e.g., internet, computer access, and access to quiet and private spaces [39]), which may further exacerbate a lack of belonging. One of the aims of this research was to examine how students' sense of belonging was affected by the virtual transition online, with particular attention paid to under-represented racial groups in STEM.

1.2. Engagement

Academic engagement can be defined in multiple ways, often referring to how students act, feel, and think. It is a multidimensional construct that consists of behavioral, affective, cognitive, and social dimensions [19,40,41]. According to research summarized by Fredricks and colleagues (2004), behavioral engagement can be defined as an individuals' involvement in academic activities [41]. It is operationalized as behavioral participation and time spent on academic activities (e.g., "time on-task"). Affective engagement refers to positive and negative reactions to academic situations, including students' feelings about their peers and instructors, and their attitudes about and interest in the course content. Cognitive engagement is students' investment in their own learning and involves a willingness to expend effort and attention to make sense of complex topics. These three framings of engagement are distinct yet interrelated, and dynamically linked with social and cultural context and broadly tend to predict positive learning and motivational outcomes [41]. To incorporate interrelations between multiple forms of engagement and to frame our study in terms of instructional modes that support this engagement, social interaction, and belonging, we drew from Kahu's (2013) sociocultural model of engagement [14].

Kahu (2013) explains how learning environments can be designed to enhance affective, cognitive, and behavioral engagement and belonging by supporting interpersonal relationships between students and teachers [14]. This conceptual framework incorporates elements of multiple framings of engagement to show how interrelationships between students and faculty can support multiple dimensions of engagement: affective engagement (interest and belonging), cognitive engagement (characterized by regulation and deep learning), and behavioral engagement (time, effort, interaction, and participation), all of which are thought to support academic achievement, social well-being, long-term persistence and retention, and personal growth. Furthermore, Kahu suggests that this process is situated within the larger social and political environment, which may include economic or cultural pressures. Drawing from this model, we distinguished between affective, cognitive, and behavioral engagement outcomes and adjusted quantitative models for contextual impacts and pressures stemming from the COVID-19 pandemic.

1.3. Online Practices That Support Interaction and Engagement

Prior empirical research shows that increased opportunities for social interaction in online STEM learning environments leads to positive engagement outcomes, whether those interactions occurred asynchronously or synchronously. A review of the distance learning literature shows that asynchronous online interactions (e.g., using discussion boards) can encourage university students to contemplate content more deeply before connecting with the learning community and is positively associated with cognitive engagement [42]. In comparison, synchronous interactions (e.g., via live-streamed instruction or breakout groups) can allow for more instantaneous feedback from instructors and peers, more comfortable and natural interactions, and is positively associated with behavioral and affective engagement outcomes [42,43].

Concerning STEM courses specifically, Jeong and colleagues (2019) conducted a metanalysis of 143 experimental and quasi-experimental studies revealing that collaborative online learning environments in STEM had an average effect size of g = 0.55 when compared across a variety of cognitive, affective, and behavioral outcomes [44]. These effects were similar across different modes of social collaboration, whether face-to-face (g = 0.51, n = 146), synchronous (g = 0.51, n = 75), or asynchronous (g = 0.50, n = 73). The average effect was positive for undergraduate populations (g = 0.45, n = 94). Given these findings, we expected that the use of online instructional techniques that emphasize social interaction—such as synchronous or asynchronous discussion, synchronous chat, or breakout groups—would facilitate social relationships and a sense of belonging when compared with non-interactive slide show presentations, individual work, or live presentations that limit interpersonal interactions [18,44]. Although these findings are informative in highlighting the importance of interpersonal interaction in online learning, they focused exclusively on online learning environments prior to the COVID-19 pandemic—a time when interpersonal connections could be readily reinforced with physical infrastructure, and virtual learning was not mandated.

One of the aims of the current study was to understand how engagement might be maintained and fostered by instructors in a time of forced mass transition to online learning and physical distancing. Towards this end, we conducted online group interviews and surveys with undergraduate students taking math-intensive STEM courses shortly after all courses transitioned online and a local lockdown was instituted during the COVID-19 pandemic.

1.4. Current Study

We sought to better understand relationships between virtual instructional practices in STEM and student engagement and belonging during the pandemic. We collected both qualitative and quantitative data from a diverse group of undergraduate students enrolled in math-intensive STEM courses over the span of three weeks in April and May of 2020 during the early stages of the pandemic. We had three research questions which were addressed separately by quantitative and qualitative data.

1.4.1. Research Questions Addressed with Quantitative Data

1. To what extent are student-reported online teaching methods related to their sense of belonging and affective/cognitive engagement in STEM during times of crises?
2. Are the impacts of these teaching methods different for ethnically/racially underrepresented students?

1.4.2. Research Question Addressed with Qualitative Data

3. Which online social interactions do students experience as supporting or hindering their belonging and engagement?

To answer these research questions, we conducted a two-part multi-methods study, simultaneously collected with students enrolled in mathematics-intensive STEM courses at a large HSI. Students volunteered to participate in a virtual group interview session that involved two parts—(a) a group interview (qualitative data), followed by (b) a survey with quantitative measures. Quantitative survey data were collected to allow us to examine relationships between online teaching practices and student belonging and engagement in STEM. Qualitative data were collected to provide a deeper and richer understanding of why certain virtual practices fared better than others in this unusual context [45–47], and so we probed students during in-depth group interviews on their STEM learning experiences and belonging and engagement. All quantitative and qualitative data were collected toward the end of the spring semester (24 April–21 May) of 2020, five weeks after the university transitioned to online learning (18 March 2020). Note that, because the unanticipated transition from in-person to virtual instruction occurred mid-semester, students did not know ahead of time whether they would be registering for a course that would eventually be taught synchronously or asynchronously. Course format was at the discretion of the instructor after the online transition.

2. Methods

2.1. Participants

Participants for this study were recruited from a pool of students who had previously taken or were currently taking either Calculus II or a calculus-based Newtonian physics course. Students from these courses were targeted for the study because disaggregated institutional data from 2011 to 2017 revealed that two series taken by engineering and science students had high failure rates and achievement gaps. Data from the 2018 to 2019 school year suggested the Calculus-based Physics and Calculus II courses had 15% and 29% failure rates, respectively. As such, these courses were identified as first-year critical transition courses. Course GPA gaps also existed for under-represented minority students (16% Physics, 18% for Calculus II), first-generation students (14% Physics, 10% for Calculus II), Pell-eligible students (14% Physics, 10% Calculus), and women in Physics (90%).

Participants were contacted through email and invited to participate in small virtual group interviews. At the end of each group interview, students completed a survey about their STEM courses during COVID-19. Students were compensated with USD 50 of funding to their on-campus account. They were also provided with links to counseling, housing, and financial campus resources. Students from the same participant pool were also given the option to complete the survey without participating in group interviews through their course website without compensation.

2.2. Survey

Survey participants were $N = 43$ undergraduate students. Students' reported gender, age, and race/ethnicity representative of the university. Students had completed an average of 2.1 years as an undergraduate (see Table 1 for descriptive statistics for student characteristics). We ran a post hoc sensitivity analysis using G-POWER to assess the minimum detectable effect for our most demanding hypothesis with respect to sample size, which revealed that we were able to detect an effect size of 0.5 for a linear multiple regression model with power of 0.8, alpha level of 0.005, and 14 predictors total [48]. For our less demanding models that included seven predictors, the minimum detectable effect size was 0.3.

Table 1. Descriptive statistics for student characteristics ($N = 43$).

Variable	n	%	M	SD	Min	Med	Max	α
Student Characteristics								
Hispanic, Latino, or Spanish in origin	43	40%						
Asian (Japanese, Chinese, Vietnamese)	43	30%						
White (English, Russian, Scandinavian)	43	28%						
Black or African American (e.g., Haitian, Ethiopian, South African)	43	5%						
Female	43	42%						
Male	43	56%						
Other gender/Prefer not to say	43	2%						
Survey Time (minutes)	43		29.1	8.75	12.1	29.4	56.7	
Age	43		19.8	2.2	18	19	30	
Year of Study	43		2.1	1.4	1	2	7	

Table 1. *Cont.*

Variable	n	%	M	SD	Min	Med	Max	α
Reported Frequency of Instructional Method								
Prerecorded lecture	43		2.8	1.6	1	2	6	
Noninteractive live lecture	43		2.8	1.6	1	3	6	
Interactive live lecture	43		2.9	1.7	1	3	6	
Discussion	43		1.7	0.9	1	1	5	
Breakout groups	43		1.9	0.9	1	2	5	
Individual work	43		3.8	2.1	1	5	6	
Motivation Scales								
Belonging since COVID-19	34		4.9	0.9	2.6	4.8	6.8	0.90
Positive emotion	43		2.9	1.4	0.9	2.6	6	0.93
Negative emotion	42		2.5	1.6	1	1.8	7	0.88
Perceptions of teaching quality	43		5.3	1.4	1	5.3	8	0.96
Cognitive engagement	43		4.4	1.0	1.6	4.6	6.1	0.86
Interest in STEM	42		4.9	1.7	1	5	7	0.89
COVID-19 Threat								
Concern about COVID-19	43		4.8	1.4	1	4.8	7	0.90
Financial impacts	43		4.5	1.9	1	4.5	7	0.87
Impacts on resources	43		3.0	1.5	1	3.5	6.5	0.71
Psychological impacts	43		3.0	1.5	1	3.5	6.5	0.71
Mean of COVID-19 Threat Variables	43		4.3	1.2	2.3	4.4	6.6	0.85

Student surveys contained ten scales, seven of which are presented in detail in the current study. Two scales were used in our models as explanatory variables and five were included as separate response variables. The mean time to complete the survey was 29 min. All survey materials are included in the Supplemental Materials.

2.2.1. Explanatory Variables

Online teaching methods. Students reported the percentage of time that their Math/Physics or STEM class sessions were delivered via the following instructional modes after the virtual online transition: Pre-recorded lecture (e.g., PowerPoint voiceover), non-interactive lecture (e.g., live Zoom lecture where mainly the instructor is talking), interactive lecture (e.g., live lecture that includes polls, chats, or questions), whole-class discussion, small group work or discussion in breakout rooms, and individual work. Responses were reported on a five-point interval scale (1 = 0–20%; 2 = 20–40%; 3 = 40–60%; 4 = 60–80%; 5 = 80–100% of the time). Items were adapted from Wieman Group (2020) [49].

COVID-19 threat and impacts. Basic needs impacted by COVID-19 were measured using the Coronavirus Threat and Impacts Questionnaire [50] consisting of ten items capturing concern, financial impacts, resource impacts, and psychological impacts. Responses were provided on an agreement scale that ranged from 1 = Strongly Disagree to 7 = Strongly Agree (from hereon, called an agreement scale). The scale was reliable in this study at conventional levels (α = 0.85).

2.2.2. Response Variables

Belonging. Course belonging was measured after the transition to online teaching using an adapted version of the Psychological Sense of School Membership scale (PSSM) [32]. This scale consisted of 21 items that prompted students to report feelings of connectedness in their Math/Physics course or STEM courses on a scale from 1 = not at all true to 7 = very true (α = 0.88).

Positive and Negative Emotion. Emotions were measured using a modified version of the differential emotions scale [51]. The 22 item scale prompted students to report the frequency of emotions experienced during their STEM classes ranging from negative (10 items; α = 0.88) to positive (12 items; α = 0.93). Responses ranged from 1 = never to 7 = always.

STEM interest. Interest was measured using two items (e.g., "My STEM course fascinates me") adapted from Hulleman et al. (2010) on a seven-point agreement scale ($\alpha = 0.89$) [52].

Cognitive engagement. Cognitive engagement was measured using the 16-item scale developed by Greene and Miller (1996) that prompted students to report their levels of cognitive engagement (e.g., "I compare and contrast different concepts") on a seven-point agreement scale ($\alpha = 0.86$) [53].

Perceptions of instructor quality. The Collegiate Teaching Proficiency Scale [54] tapped into students' perceptions of teaching quality with 20 items (e.g., "my instructor motivates students to learn online") on a seven-point agreement scale ($\alpha = 0.96$).

2.3. Group Interviews

A total of n = 21 students who completed the survey also participated in small group interviews. These students were similar demographically to the students who completed the survey (see Table 1 for descriptive statistics of student characteristics).

Students participated in semi-structured interviews on Zoom in groups of one to three from 24 April to 8 May 2020. Small groups and individual interviews (1 to 3 interviewees) were conducted to keep discussions manageable, short, and to maximize interactivity and engagement among all participants [55]. Small group interviews also allowed students enough time to share their individual perspectives and build upon one another's experiences [56]. All interviews were proctored by one of the two leading authors of this study, both of whom identified as White, one identified as female, one as male, and one was faculty at the same institution as students in the current study.

Students were asked a series of 11 semi-structured questions along with potential follow-up questions and probes focused specifically on their Calculus II or Physics courses (see Supplemental Materials for all interview prompts). For example, interviewers asked participants to share how they were personally coping with the changes due to COVID-19 and the virtual transition, how their Calculus II or Physics course was going during the transition, how this transition affected their academic performance, motivation, classroom community, and feelings of "belongingness." All participants responded to each question. Interviews had an average duration of 45.8 min (SD = 13.8 min), not including survey completion time.

3. Results

3.1. Quantitative Analysis

To explore the impacts of the faculty instruction mode during the virtual online transition prompted by the COVID-19 pandemic, we computed descriptive statistics, examined intercorrelations between variables, and ran ordinary least squares (OLS) multiple regression models. Concerning the latter, we ran regressions with belonging and engagement indicators as main outcomes, the instruction mode as the predictor, and race/ethnicity as a moderating variable. Financial and health impacts of COVID-19 were included as a covariate to adjust for threats to students' basic needs. All variables were standardized around the mean to ease interpretation. Quantitative analyses were conducted using R version 4.0.3.

We also tested for interactions between teaching practices and gender. No significant interactions were found for all outcomes and including interaction terms did not substantially change the significance or sign of any results. Results of the gender interactions are presented in Table S1 of the Supplemental Materials.

3.2. Quantitative Findings

The predictor and response variables were examined for skewness and kurtosis. Skewness ranged between -0.59 and 1.52 and kurtosis ranged between -1.68 and 2.47, which were both acceptable [57]. We also inspected graphs of residual variances and conducted Breusch–Pagan tests for each model to confirm that the data did not violate homoskedasticity assumptions (all $p > 0.172$). Descriptive statistics are presented in Table 1.

Notably, descriptive statistics showed that students reported that their instructors most frequently required individual work from students (median = "80–100% of the time"), interactive live lectures (median = "40–60% of the time"), noninteractive live lectures (median = "40–60% of the time"), prerecorded lectures, (median = "20–40% of the time"), breakout groups (median = "20–40% of the time"), and least frequently engaged in synchronous discussion (median = "0–20% of the time").

Teaching Methods That Explain Belonging and Engagement (RQ1), Particularly for Racially Under-Represented Students (RQ2)

Our first and second research questions were: "To what extent are student-reported online teaching methods related to their sense of belonging and affective/cognitive engagement in STEM during times of crises? Are the impacts of these teaching methods different for ethnically/racially under-represented students?" To address these questions, we ran three OLS regression models for each of the four response variables (belonging, emotions, cognitive engagement, and STEM interest). The first model included only students' reports of their instructors' teaching methods as explanatory variables, the second model included the same predictors as well as the COVID-19 threat and impacts scale, and the third model also included interactions between race/ethnicity and teaching methods. Namely, an indicator variable was created to represent Black or African American or Hispanic or Latino students (making up 42% of the sample, hereafter referred to as "Black/Hispanic"). Full results of race/ethnicity interactions, including all standardized coefficients, are presented in Table 2.

Table 2. Standardized OLS regression coefficients for instructional practices predicting psychological and cognitive well-being outcomes.

Predictor	Belonging β (SE)			Positive Emotions β (SE)			Negative Emotions β (SE)		
Prerecorded Lecture	0.108	0.159	0.198	−0.126	−0.1	0.011	0.270 ~	0.206	0.094
	(0.189)	(0.188)	(0.228)	(0.189)	(0.192)	(0.293)	(0.155)	(0.159)	(0.242)
Noninteractive Live Lecture	−0.339 ~	−0.454 *	−0.554 *	−0.066	−0.129	0.057	−0.051	0.110	0.087
	(0.192)	(0.204)	(0.248)	(0.156)	(0.174)	(0.264)	(0.155)	(0.162)	(0.250)
Interactive Live Lecture	−0.122	−0.093	−0.452	0.144	0.140	0.102	0.087	0.095	−0.001
	(0.253)	(0.248)	(0.276)	(0.192)	(0.193)	(0.291)	(0.190)	(0.180)	(0.275)
Discussion	−0.201	−0.095	−0.208	−0.085	−0.056	−0.259	0.021	−0.053	−0.278
	(0.190)	(0.199)	(0.274)	(0.181)	(0.185)	(0.310)	(0.179)	(0.172)	(0.293)
Breakout groups	0.216	0.0360~	0.712 *	0.440 *	0.513 *	0.524 ~	−0.074	−0.259	−0.083
	(0.186)	(0.207)	(0.251)	(0.171)	(0.192)	(0.259)	(0.173)	(0.182)	(0.245)
Individual work	−0.247	−0.095	−0.019	0.166	0.221	0.141	0.361 *	0.221	0.148
	(0.230)	(0.248)	(0.292)	(0.174)	(0.186)	(0.281)	(0.176)	(0.177)	(0.266)
COVID-19 Threat		−0.379	−0.617 *		−0.166	−0.124		0.420 *	0.426 *
		(0.258)	(0.251)		(0.196)	(0.214)		(0.183)	(0.203)
Black/Hispanic			−0.210			−0.404			0.090
			(0.375)			(0.346)			(0.334)
Prerecorded Lecture * Black/Hispanic			0.599			−0.286			0.376
			(0.416)			(0.346)			(0.335)
Noninteractive Lecture * Black/Hispanic			0.424			−0.398			0.042
			(0.387)			(0.348)			(0.332)
Interactive Lecture * Black/Hispanic			1.578 **			0.179			0.089
			(0.520)			(0.434)			(0.411)
Discussion * Black/Hispanic			0.356			0.387			0.443
			(0.399)			(0.423)			(0.400)
Breakout groups * Black/Hispanic			−0.561			0.003			−0.437
			(0.401)			(0.418)			(0.429)
Individual work * Black/Hispanic			0.446			0.414			0.020
			(0.475)			(0.407)			(0.393)
Observations	34	34	34	43	43	43	42	42	42
R^2	0.209	0.27	0.571	0.204	0.22	0.337	0.223	0.328	0.413
Adjusted R^2	0.033	0.073	0.255	0.071	0.064	0.005	0.090	0.189	0.109

Table 2. *Cont.*

Predictor	STEM Interest β (SE)			Cognitive Engagement β (SE)			Perceptions of Teaching Quality β (SE)		
Prerecorded Lecture	−0.197 (0.158)	−0.128 (0.152)	−0.038 (0.219)	0.06 (0.164)	0.127 (0.149)	0.239 (0.229)	0.055 (0.155)	0.076 (0.149)	−0.089 (0.229)
Noninteractive Live Lecture	−0.487 ** (0.147)	−0.684 ** (0.152)	−0.502 * (0.222)	−0.084 (0.158)	−0.249 (0.166)	−0.016 (0.239)	0.043 (0.145)	−0.009 (0.162)	−0.072 (0.251)
Interactive Live Lecture	−0.092 (0.179)	−0.104 (0.164)	−0.004 (0.244)	0.106 (0.195)	0.097 (0.184)	0.333 (0.264)	0.397 * (0.179)	0.395 * (0.180)	0.054 (0.277)
Discussion	0.178 (0.170)	0.279 ~ (0.160)	0.100 (0.260)	0.167 (0.183)	0.242 (0.176)	−0.053 (0.281)	0.030 (0.168)	0.054 (0.172)	0.197 (0.294)
Breakout groups	−0.075 (0.162)	0.112 (0.163)	0.329 (0.219)	0.216 (0.173)	0.403 * (0.183)	0.438 ~ (0.235)	0.164 (0.159)	0.223 (0.179)	0.187 (0.246)
Individual work	0.235 (0.165)	0.371* (0.159)	0.589 * (0.236)	0.314 ~ (0.176)	0.455 * (0.178)	0.517 ~ (0.254)	−0.133 (0.162)	−0.088 (0.173)	−0.253 (0.267)
COVID-19 Threat		−0.476 ** (0.172)	−0.584 ** (0.191)		−0.429 * (0.187)	−0.291 (0.194)		−0.135 (0.183)	−0.211 (0.203)
Black/African American or Hispanic			0.377 (0.304)			−0.659 * (0.314)			0.168 (0.329)
Prerecorded Lecture * Black/Hispanic			0.051 (0.290)			−0.213 (0.314)			0.276 (0.329)
Noninteractive Lecture * Black/Hispanic			−0.331 (0.293)			−0.353 (0.316)			−0.035 (0.331)
Interactive Lecture * Black/Hispanic			−0.008 (0.367)			−0.391 (0.394)			0.644 (0.413)
Discussion * Black/Hispanic			0.114 (0.354)			0.619 (0.383)			−0.242 (0.402)
Breakout groups * Black/Hispanic			−0.487 (0.358)			−0.264 (0.379)			0.167 (0.397)
Individual work * Black/Hispanic			−0.368 (0.351)			0.148 (0.369)			0.263 (0.387)
Observations	42	42	42	43	43	43	43	43	43
R^2	0.313	0.44	0.54	0.183	0.29	0.455	0.311	0.322	0.401
Adjusted R^2	0.196	0.325	0.301	0.047	0.148	0.182	0.197	0.186	0.101

Note. Boldfaced values indicate statistically significant results for predictors. ~ $p < 0.1$; * $p < 0.05$; ** $p < 0.01$.

Belonging. After adjusting for the COVID-19 threat, belonging was negatively predicted by exposure to non-interactive synchronous lectures (p = 0.035), and was marginally positively predicted by engaging in breakout groups (p = 0.094). We found similar results after including the Black/Hispanic indicator and interaction terms for noninteractive lectures (p = 0.038) and breakout groups (p = 0.011), as well as a significant and positive interaction effect of Black/Hispanic students who reported higher belonging with interactive lectures (p = 0.007) and negative effects of the COVID-19 threat (p = 0.024).

Emotions. When positive emotions were the main outcome, we found that the reported use of breakout groups was a positive predictor before and after adjusting for COVID-19 threats and interactions (with *p*s ranging from 0.014 to 0.053). Higher negative emotions were related to individual work (p = 0.049) and marginally associated with prerecorded lectures (p = 0.090). After including the COVID-19 threat, however, teaching methods were no longer significant predictors of negative emotions. We found no significant interactions with race/ethnicity.

STEM Interest. Non-interactive lectures predicted a lower reported interest in STEM for all three models (*p*s ranging from less than 0.001 to 0.032). When the COVID-19 threat was included as a covariate, individual work was positively associated with higher STEM interest (p = 0.026), and the COVID-19 threat was negatively associated with STEM interest (p = 0.009). The significance of these associations was maintained after interaction terms were included. No significant interactions emerged with teaching practices and race/ethnicity.

Cognitive Engagement. Cognitive engagement was positively predicted by individual work for all three models (*p*s from 0.015 to 0.083). The reported use of breakout groups was significant only after adjusting for COVID-19 threats (p = 0.035). Black/Hispanic students were associated with a lower cognitive engagement than white students (p = 0.045).

Student Perceptions of Teaching Quality. Students' perceptions of teaching quality were significantly predicted by the use of interactive live lectures, before ($p = 0.033$) and after adjusting for COVID-19 threats ($p = 0.035$), but not after including race interaction terms ($p = 0.848$).

3.3. Qualitative Analysis

All interviews were recorded through Zoom, transcribed, and open coded by the lead author. Through open coding, several themes emerged related to student perceptions of instruction that students received, as well as the sources, dimensions, and impacts of student feelings of inclusion, belonging, and interpersonal connection. Codes were created, compared, consolidated, and used to create a codebook, which was revised by another author before it was used by two undergraduate research assistants who independently coded all transcripts using NVivo 12. Over the course of eight weekly meetings, the coders met with the lead author and other research team members on occasion as they progressed through coding to discuss, interpret, consolidate, and occasionally revise the definition of codes as part of the calibration process [58]. When coders had completed coding all transcripts independently (other than the exemplar interviews, which were partially coded together), an NVivo query was used to compute an inter-rater agreement, which revealed that all central codes had an agreement greater than 95% at the sentence level. Incidents of codes were included in analyses if they were coded by one or more of the coders. The final codebook with definitions is presented in the Supplementary Materials. To improve trustworthiness, we also reported negative cases that differed from the typical trends found in the data [59,60].

3.4. Qualitative Findings

Findings provided insights into how students' interactions with faculty and peers affected their engagement and feelings of belonging in STEM. Interviews highlighted both positive and negative interactions with students and faculty and delineated various teaching approaches that facilitated or hindered belonging. In this section, we present a summary of student perceptions, followed by a case study to illustrate the codes and dimensions uncovered in the interviews.

3.4.1. Online Interactions That Support or Hinder Belonging and Engagement (RQ3)

Students shared their experiences of interactions that supported their feelings of belonging and affective engagement. Interactions that supported belonging stemmed primarily from interactions with peers, faculty, and derived from their own sense of confidence. In what follows, we presented examples of these sources of student belonging and engagement. A summary of the codes and frequencies of students' reported sources of belonging and engagement are shown in Table 3.

Table 3. Students' reported sources of belonging and affective engagement during interviews ($N = 21$).

Sources of Belonging	Number of Students	%
Positive peer–peer interaction (in class)	10	46%
Positive peer–peer interaction (outside of class)	8	38%
Campus communities	17	8%
Faculty caring	13	62%
Competency belonging	8	38%

A key theme that emerged from the data was the presence of two different types of belonging in students' calculus and physics courses during the virtual transition. Social belonging was linked to social interactions and friendships with students and faculty in synchronous instructional settings. Competency belonging emerged as a separate source of belonging where students felt as if they belonged in the course based on the level of competency they had consistently demonstrated in their current and prior STEM courses. We detailed these findings below.

Student–student interactions. A majority (61%) of students reported during interviews that they felt a sense of social connection with their peers, reporting the presence of positive interpersonal relationships, feelings of acceptance, inclusion, or belonging as stemming from their interactions with peers in STEM. One student's remark underscored many students' perceptions of the centrality of synchronous classrooms in initiating connections with peers:

> I would say that going to lecture is what really, is what keeps me connected to the classroom community, but also I had friends in the class, so we keep in contact through social media. [We] just text each other. "Oh, when's this due?" for example, or "Oh, you're going to lecture, right?", "Oh, did you understand this? I'm a little bit confused. You get that?" You know, [we] just text each other and ask questions. But it's really helpful going to lecture because there's like students watching so they can enter questions into the chat.

In contrast, students in asynchronous courses often shared challenges of connecting with their peers. A student in an asynchronous physics course stated that connecting with peers was near impossible, "Honestly, sometimes I forget there's other people in the class." Another in the same class elaborated:

> ...now you don't have any physical interaction, I really don't feel included as a part of a class. I'm just looking at a screen the whole time. I don't know how you can really feel any inclusion there unless there was like a chat forum or something like that.

This illustrates that, in most cases, students expressed feelings of motivation and positive affect associated with peer-to-peer interactions facilitated by live, synchronous interactions and negative affect in the absence of social interaction. However, in seeking negative cases that did not fit the general trend [59,60], we found that some students were able to maintain connections with students despite the isolation imposed by their asynchronous courses. A student in an asynchronous physics course commented on the importance of her engineering friends during the transition for "exchanging information," noting that "We still remind each other to do homework, to study for the test, and stuff. We are all engineering and computer science girls. So that always motivates me." We also found that students in synchronous courses sometimes found it difficult to make new friends, "But in terms of like talking to new people in the classroom and like asking them for help. Like, I haven't really done that. I feel like that's more difficult because it's kind of like, where do I start? Like it's kind of awkward in that sense."

Students also shared feelings of social belonging in STEM resulting from peer relations that were not connected to the classroom. Some (8%) derived a sense of peer connection through campus communities outside of their STEM courses (e.g., clubs, sororities, etc.). For example, a student noted that they felt a sense of membership as a result of being in a campus club, "We're talking to each other almost every night on Discord or just playing video games together if we have time." We found no evidence that this form of connection was supported through instruction.

Student–faculty interactions. The majority of students (62%) derived a sense of social connection and belonging from interactions with their professors. This was expressed in terms of positive relationships and feelings of acceptance and inclusion from the professor. Some underlined the importance of feeling cared for by faculty:

> I know [the instructor] cares about every single one of us. She even mentions it . . . it's almost like a second family in the sense that she does the little, little things to make you feel like you are included, such as, you know, addressing her by her first name rather than the professor or, you know, just asking how our day is, sharing our own day. So definitely you usually don't feel like you're excluded or isolated away from that.

Others expressed a positive affect and motivation linked to feelings of personal identification and relatability with their professor. A student in an asynchronous course stated, "And she's a, she's a very good professor in the fact that she always like cheers us up like, she always motivates us to keep working. And she herself is very hardworking as well so, yeah." Conversely, some students lamented that their professors teaching asynchronously had become less available for support during the onset of the pandemic:

> I thought [the instructor] would have done videos and then posted them online, but she's kind of distanced herself from the class...Which is a shame because I like her as a person, like I think she's so sweet, but I just, I don't like how the class is now. Because she's not really teaching it.

These contrasting statements illustrate the importance that students placed on feeling close with faculty during this time of crisis and feeling their presence in videos, even in an asynchronous mode. Warm affect and motivation seemed to stem from students' feelings of connection and relatability with faculty, whereas students who lost contact with their instructors expressed less hope and more apathy. Clearly, social connections with faculty were also important after the virtual transition.

Competency belonging. Some students, regardless of the challenges they faced in their courses, experienced what we term competency belonging, which is feeling a sense of inclusion in a course, major, or field by drawing on their positive past performance in STEM courses and their demonstrated high levels of competency in the subject matter. As such, they feel they belong in the course because they are competent in the subject matter. For example, after expressing feelings of disconnection from peers in her class, one student noted, "I feel like I'm still, I still belong in the class... in the sense that I know, I like I have the background knowledge of, I know enough math to be in calculus." This type of belonging appeared to be less about belonging on a social level with other faculty and students but rather belonging to the STEM course due to their ability and performance.

Other students shared feeling low-competency belonging, expressing that they felt as if they do not belong because of negative prior experiences in their STEM courses that signaled little STEM ability or competency:

In grade school, I was never really good at math. I had a professor. I went to a professor's office hours for help. And I was like, hey I'm confused on this question. And he said after kind of like a conversation we had about this question. He ended up telling me, oh, you have the liberal arts brain. I have the math brain. Maybe this isn't for you . . . I still struggle with that feeling of belongingness because I don't have the STEM background.

Overall, this suggested that students' sense of competency served as a source of belonging in the course. It is important to note that this type of belonging appears to be qualitatively different than the construct of relatedness (belonging) as outlined in the Self-Determination Theory. Relatedness in the Self-Determination Theory refers to a "connectedness with others" [21]. Our data suggest that competency belonging is an alternate type of belonging that emerges from performance in a course or field rather than interpersonal relationships. Competency belonging rests on students' judgment of their abilities to excel in the subject matter of the course, whereas relatedness is based on students' perceptions of the quality of their social relationships, connections, and may implicate their social identities. This novel concept—belonging competency—warrants further investigation in future research.

3.4.2. Summary

The interviews suggested that students meet their belonging needs both inside and outside the classroom through social interaction and connecting with both peers and faculty. Students reported that genuine faculty caring facilitated a sense of social belonging. Students with greater feelings of competency and subject matter knowledge described feeling a higher sense of competency belonging in the course, even if they did not feel a sense of connectedness with peers or the faculty member (social belonging).

3.5. Embedded Case Studies

To further explore how students' experiences either supported or hindered their belonging and engagement in rich detail [47], we synthesized the data and illustrated the themes, codes, and quantitative findings presented in the sections above in two embedded case studies [59–62] presented in the form of short vignettes. The cases we considered were bounded by the classroom [62], and each classroom consisted of multiple units of analysis—student experiences (secondary unit) within classrooms (primary unit) [61].

In the vignettes that follow, we highlighted four students' experiences in two virtual classrooms led by two different instructors (two students per classroom). We compared two cases to highlight classrooms that varied in how their approaches to the virtual transition (synchronous vs. asynchronous teaching methods) were perceived by students. We told the story of two physics classrooms (rather than one physics and one mathematics class) to ease comparison between cases and we also showcased two students within each of these classrooms to illustrate the range of experiences within each setting. All names were pseudonyms, and the gender of faculty members were disguised to protect their identity and pronouns changed to "They/Them/Their."

3.5.1. A Synchronous Physics Course

The first physics course we present was taught by an adjunct professor who, as evidenced by student interviews, represented the case of an instructor who cared about the students, showed a substantial grading flexibility and adaptability, and responded swiftly to crises with action. Prior to the pandemic, this course was delivered face-to-face, but after transitioning to online learning, the instructor adopted a synchronous platform. The instructor conducted the online course synchronously multiple times per week, structured each session around a lecture, provided live demonstrations of physics concepts, and encouraged students to make frequent use of the chat function in the live-stream. This classroom represented the case of a synchronous course, where students had multiple outlets to connect with peers and the instructor, and the faculty seemed to exhibit pedagogical decisions and technological skills that nurtured students' feelings of inclusion and engagement, which we provided evidence for in the following cases.

Ananya. The first student from the synchronous course we present was Ananya, a first-year student majoring in Civil Engineering. Ananya identified her race/ethnicity as "Asian (e.g., Japanese, Chinese, Vietnamese)" and gender as "female." She participated in a one-on-one interview from her private bedroom in her family's home. She is the case of a student who responded well to synchronous instruction, with the added support of a pre-existing friendship network.

When asked how her life had changed as a result of the pandemic, Ananya stated that the transition was difficult, "I actually enjoyed going to class every day and getting to collaborate with my friends ... But now that I'm online, it's just simply not the same experience," adding that "it's really hard to focus." She reported keeping busy by doubling down on schoolwork and learning how to play the guitar through YouTube videos to cope with the changes. She noted that the physics course had been a positive experience for her, despite having to transition to YouTube because of Zoombombing. "[The instructor is] actually making a really big effort to actually teach us everything and make sure that we walk out of physics with like a good understanding of what's happening."

When asked about the classroom community and if/how she stays connected with her peers and professors, Ananya responded by emphasizing the importance she placed on attending the synchronous lecture: "I would say that going to lecture is what really, is what keeps me connected to the classroom community ... ". She later elaborated that, "[The instructor's] face being there kind of helps" and that engaging with the professor and other students using the chat function during Q&A was particularly helpful for her understanding.

She also expressed that she stayed connected through her friendship circle, "... also I had friends in the class, so we keep in contact through social media." She added that she and her friends managed to keep each other on track academically though text message to check in on due dates and lecture announcements. When asked if she felt as if she belonged in physics, she responded "I would say I do feel like I belong in physics ... I think it's a really positive environment. No one's judging you for like asking questions or anything like that. Yeah."

Benita. The second student that we present from this synchronous course was Benita, a biochemistry major. On the survey, she identified as "female" and "Hispanic, Latinx, or Spanish origin" and participated in this interview along with another student. Benita was displaced as a result of the pandemic, seemed to have less of a pre-existing support network of peers to rely on for help, but remained optimistic with the support from feeling connected to her class through synchronous chat, email, and office hours.

She began the interview by noting that she was "just crashing at [her] friends' place," not wanting to risk infecting her grandparents by moving home. She also noted that she had, "very limited resources. So, it's really hard for me to go anywhere, to go get groceries, to just do anything in general." Similar to Benita, many students interviewed had to make significant changes to their living situation and were under financial strains, some losing their jobs due to closures.

When asked how class had been going in Physics, Benita began by noting the positive changes to instruction. She stated that the instructor sometimes "talks really fast and it's hard for me to take down notes," but appreciated that virtual lectures allowed her to slow things down and review lectures. She also stated, "I don't have to be afraid of asking questions because no one's going to see me. No one's going to look at me. So, it's definitely helped me in a more positive direction." Similar to Benita, many female students in challenging STEM majors noted that they appreciated that the virtual transition brought more anonymous participation by using chat features on synchronous platforms. In particular, two additional female students of color mentioned feeling more comfortable to ask questions in class as their questions would not be associated with their physical characteristics. Benita later elaborated on her appreciation of synchronous chat when asked if she had maintained a sense of belonging in class,

> I mean, I was never a physics person, and I can't say that I feel like I belong in the first place, but ... I feel like I'm able to learn better now, and that the people in the chat, its people are very positive and very happy. And it just makes like the whole class feel like it's normal and everything feels fine when you're in that class.

Benita noted that she did not stay socially connected with her peers. She stated, "I don't know a lot of people in physics. But ... one of my roommates I'm living with, he has taken physics before, so I just ask him for help..." Her main source of connection to the physics class was through her professor, who she contacted through email and synchronous office hours, "It's easy to talk to [the instructor] as long as you reach out [through email] and [the instructor] also holds office hours."

Benita highlighted the common situation of a student who faced challenges due to the pandemic, was not particularly well-connected with students in the classroom, but was able to feel social belonging through her connection with the professor and using the chat feature during a synchronous lecture. Benita highlighted the importance of creating and protecting comfortable spaces for students to stay in contact with each other, the instructor, and to learn. Further, her case highlighted the general resilience and adaptability of students and the positive impacts of faculty's responsiveness during a time of crisis.

3.5.2. An Asynchronous Physics Course

The second physics course we present was also taught by an adjunct professor. Prior to the pandemic, the course was delivered in a physical classroom and was received positively from students. Due to the transition to online learning, this course adopted an asynchronous physics platform, wherein students completed a series of online modules that included videos, slideshows, animations, and built-in homework and assessments presented in a specific order, for which students received both formative and summative feedback. The curriculum materials were premade, but allowed the instructor to make modifications. The instructor held regular office hours for their very large classes (~120 students) and, to our knowledge, this course did not include an online discussion forum for student interaction.

This classroom represented the case of an asynchronous course where students had relatively few outlets to connect with peers or the instructor, and the faculty exhibited less flexibility to changing circumstances. Students in this course generally expressed negative affective experiences as a result, while a rare few were able to adapt, self-teach, and draw from their competency belonging and prior experiences and personal identity to persist in the challenging environment.

Chris. The first student that we present from this asynchronous course was Chris, a second year Mechanical Engineering major that identified as "White" and "male." He represented the case of a student who, despite having physical and social resources of his own, felt unsupported by his Physics professor after the transition to online learning due to a loss of interpersonal contact.

When asked how his life had changed as a result of the pandemic, Chris noted that, while he took the pandemic seriously, he did not endure any major changes to his living or financial situation. He shared that "it was not like a super hard change for me in particular." He continued to do schoolwork from home and maintained connections with his peers in class through text messages.

However, when asked about how physics was going, Chris expressed that the transition to asynchronous learning was a negative one due to decreased opportunities for interpersonal contact with the professor. He thought that, in general, demanding STEM courses required "a bit more social interaction with your professor" to ask questions and receive help, but that, in this asynchronous course "that doesn't happen." He stated, "I remember, the first time I tried to go to office hours. I probably waited like an hour or two and then, basically the thing ended because [the professor] was outside office hours at that point... that was difficult." Chris seemed to highly value contact with the professor and having the space to ask questions in real time.

When asked about classroom community and if/how connections were maintained in physics, he communicated a sense of loss in interpersonal communication, commenting that office hours were a particularly difficult loss for him,

> ... talking with someone, you know, outside of class or after class or in class, talking with your professors during the office hours. A lot of stuff just flat out doesn't happen now honestly . . . But as far as me trying to adapt and change and try and continue those relationships, it's really hard because the office hour thing, you know, I can't really chit chat with my professors in a lighthearted manner because the fact that they usually have one office hour time available for all of our students.

Chris seemed to highly value informal contact with his peers and professor, later saying that he missed having "... the lightheartedness of the conversation," "body language," and "the comfort of having another person there in your learning experience that it might help to ease whatever stress you're having." Chris expressed that human contact with his professors gave the challenging, abstract physics content a human quality, ultimately reducing his levels of stress. While comparing physics class to his prior experiences in calculus classes, he noted that, "after like going into their office hours and being able to talk to them, it kind of eases you up a little bit."

Additionally, Chris seemed to perceive a general sense of inflexibility from the instructor with regard to assignments. He noted that, "The formats of the tests didn't change at all . . . [the professor] gave us like 10 min to submit like the document or whatever, the Blackboard or scan it and do all that stuff." The pressures of submitting virtual assignments that had strict time limits was a common source of stress for many students that we interviewed in this course.

Similar to many students in this asynchronous class, Chris expressed feelings of being unsupported by the professor, stemming from the inflexibility and impersonal nature of the online modules. Similar to Chris, many students highly valued interpersonal experiences with their peers and the professor and shared a sense of profound loss in the changed circumstances. Yet, despite generally negative sentiment, a few students were able to experience a sense of course belonging by relying on their existing social network.

Denise. Denise was another student in the asynchronous physics course. She was an international student learning English as a second language who identified as Asian and as a woman majoring in Mechanical Engineering. When asked how things were going in physics, she expressed a general air of positivity and self-sufficiency:

> I'm doing pretty well, actually, because like, I've been, like, I'm pretty good at self-study... I always read the materials like before classes so that I will be able to understand more, so I actually do things on my own. So ever since we went online, it was not hard for me because I got used to doing everything on my own.

When asked about the transition in physics in particular, she explained her initial shock at the drastic change from live lectures to online modules, "we were all scared . . . we just watched [video lectures] and then answer some questions . . . we have all gotten used to [the professor] talking about the materials because the way [the professor] explains the concepts is very understandable." The contrast between pre- and post-pandemic was palpable among students in the instructor's class. Denise sympathized with her peers' feelings of inflexibility, noting that the class was only given fifteen minutes to complete quizzes and that, "many students cannot finish it on time and then we have to also upload it on [the course website]. So, we all think that the time limit is not enough for us to finish."

However, despite these challenges, she stated that she eventually "got used to it," explaining that the videos, homework, and quizzes seemed straightforward. Her confidence in her abilities and her academic performance stood out as a salient source of feeling connected and belonging in the physics class. That is, she demonstrated the case of relying on her competency belonging as a way to motivate herself to persevere in the course. Denise remarked, "Because my performance is overall pretty good. It's not like, the worst." She later noted that "I picture myself as a woman engineer and like, I have to do this . . . I see people around me like working . . . We're all fighting for this engineering dream. So yeah, that, there's no reason for me to give up."

Denise also derived a sense of social belonging from interactions with her peers. When asked specifically about classroom community and staying connected with peers and to the professor, she noted that, although the physics class did "not feel very united," she drew a sense of belonging from her peers:

> So, we were still like exchanging information and stuff. We still remind each other to do homework, to study for the test, and stuff. So, and we are all like, we are all engineering and computer science girls. So, that always motivates me.

Similar to many students we interviewed from this course and other courses, Denise showed a keen sense of resiliency and sustained motivation in the face of relentless changes. Similar to some students, Denise also derived some feelings of belonging from her peers. However, what was unique about Denise was that she specifically mentioned her own performance as a source of belonging in STEM.

4. Discussion

We sought to explore whether the use of different online teaching methods supported undergraduate students' engagement and belongingness in their STEM courses at an HSI during the onset of the COVID-19 pandemic. Student surveys and interviews revealed a range of classroom modifications and accommodations determined by faculty to adapt to the transition to online learning.

4.1. Teaching Methods That Support Belonging and Engagement

Surveys of students revealed that non-interactive live lectures negatively predicted their sense of social belonging and interest in STEM, whereas the use of interactive live lectures and breakout groups positively predicted of belonging and positive emotions. That is, instructional strategies that brought students and instructors together in live interactions seemed to boost affective engagement. Interactive live lectures had additional benefits for Hispanic and African American students in supporting their feelings of course belongingness, which was consistent with previous findings [18]. This was corroborated by student interview data suggesting that students highly valued their interactions with other students and faculty, particularly for receiving academic and personal support. Students who had very few means of connecting with the professor or peers were on their own, having to self-study and seek out support independently, and with their efforts for support sometimes thwarted, for example, when instructor office hours were too crowded to meet with them even after waiting for an hour. Other than a resilient few, less interactivity had a negative impact on students' sense of social belonging and engagement in their courses. This was consistent with prior empirical research [18,42] and supported the idea that engaging learning environments were those that enabled interpersonal interaction [19].

Student surveys also revealed that higher reported levels of work to be completed individually were associated with more negative emotions. Although this association was not statistically significant in all statistical models, interview data highlighted that the relationship between negative emotions and individual assignments might partly be explained by students' feelings of stress stemming from the inflexibility of timed assessments delivered virtually, a theme uncovered in interview data. Curiously, we also found that individual work was associated with a greater cognitive engagement and STEM interest overall. One explanation for this is that individual work may have required students to exert more effort, which may have been captured in the cognitive engagement measure. This finding reflects the complex nature of group versus individual work found in the existing literature, showing that the effectiveness of group work is dependent on a host of contextual factors [18,63,64]. Future research should investigate why and under what conditions individual work is supportive of student engagement outcomes.

Generally, these findings suggest that individual synchronous practices were associated with greater levels of cognitive engagement and STEM interest. They shed light on practices employed by STEM instructors that positively supported or hindered cognitive and affective engagement and feelings of belonging during the COVID-19 lockdown. Strategies that were especially valued by students of color were (a) interactive lectures, which were associated with greater belonging, and (b) the chat feature, which, based on interview data, seemed to help some women of color feel less judged when asking questions in class.

4.2. Social Interactions That Support STEM Belonging and Engagement

In addition to corroborating the quantitative findings, the qualitative findings provided a more in-depth understanding of student experiences of belonging that could be broadly segmented into two types of belonging. Transcripts from group interviews revealed that students experienced feelings of social belonging stemming from connections with peers, professors, and campus communities, and also feelings of competency belonging stemming from prior experiences and interactions.

Social belonging in courses concerns the social interactions that students have with their instructor and their peers as a function of their enrollment in the course. These interactions can lead to friendships, interpersonal connection, and a sense of belonging to a group and becoming part of a wider community. This specifically concerns students' needs for belonging in terms of interpersonal connection and relatedness with other people [8,22,65]. This type of belonging seemed to be most supported by synchronous modes of instruction.

Interviews also suggested that, particularly in the asynchronous modes of instruction, competency was implicated as a source of belonging in the course. Yet, this type of belonging did not seem related to interpersonal relationships. Rather, if students felt competent based on their positive performance in past STEM courses, they tended to speak about that competency as a basis for belonging in the course. We termed this type of belonging as competency belonging because it specifically concerned whether the student related to the subject matter of the course through their previous experiences of successes. In the terms outlined by the Self-Determination Theory [21,22], relatedness and competency are cast as fundamental psychological needs that facilitate motivation and learning. Our findings supported this theory and provided some emerging evidence that competency can support feelings of relatedness. Needs to feel connected to a larger community need not always happen through live interaction, but can be derived from feelings of mastery and prior performance. These two different sources of course belonging—social belonging and competency belonging—merit more in-depth research.

4.3. Limitations

Similar to all studies, our study had several limitations. First, the generalizability of the quantitative findings could have been improved with an increased sample size, along a wider variety of student characteristics. Namely, with greater numbers of students from different ethnicities and racial groups, we might have been able to determine whether identification with specific racial groups might moderate the impacts of instructional practices on belonging rather than using a binary comparison between Hispanic or African American students and other races. For the same reason, we were unable to adjust for classroom clustering effects. However, regression analyses were sufficiently powered for the current analyses. Second, the survey that we used to identify teaching methods may not have captured nuances in how these teaching methods were employed by instructors. For example, breakout groups may have varied in size, activity type, or method for assigning students to groups depending on the course and its instructor. For this reason, we also chose to include a qualitative component to this study to investigate student perceptions of such nuances. Third, there were tradeoffs regarding the size of our group interviews. Due to scheduling conflicts with students, many were only able to meet individually with our interview team, and our group interviews were small groups of one to three. As such, although our data may not have benefitted from the collective synergy of a focus-group interview of eight to ten students, these smaller interviews provided all students an opportunity to verbally respond at length to every prompt while maintaining our time limits and creating a more intimate environment for students to share personal feelings and impacts from the pandemic.

4.4. Implications for Practice

This study has implications for college instructors, students, and policy makers re-designing online learning environments to best support student engagement and close the racial equity gap in STEM. In this section, we share tentative recommendations that follow from our findings.

4.4.1. Increase Opportunities for Interaction

Increasing opportunities for synchronous peer–peer and student–faculty interactions may be key for helping students navigate the feelings of isolation and lack of belonging that can result from a purely virtual college experience. Interactive lectures, chat windows, synchronous office hours, and breakout rooms are standard options for online teaching, but our findings suggest that rates of instructor use of these options could be significantly increased. As the benefits of these synchronous and interactive pedagogical methods were strongest among students of color and students with weaker pre-existing friendship networks, these strategies may be especially important for supporting those who face the greatest obstacles to success in STEM. Some of these lessons may also carry over to in-person instruction. For example, some instructors already encouraged their students to use online chat features during in-person instruction to ask questions, which was notable, given that several students, especially women of color, reported a greater willingness to participate via chat than in person.

4.4.2. Incentivize Student–Student Interaction

Our findings further suggested that asynchronous online teaching was associated with hindered cognitive and affective engagement and feelings of belonging, thereby highlighting the importance of innovating ways for students to meet their academic and social needs in fully asynchronous courses. Perhaps instructors could incentivize students in these sections to interact more with each other, such as by organizing "viewing sessions" to watch pre-recorded lectures together with other students (e.g., over platforms, including Discord or Zoom), thereby encouraging students to chat with each other about the lecture content. Instructors may also consider organizing students into study groups that are incentivized to meet synchronously. Further, qualitative data revealed that students may sometimes feel as if they belong in STEM because they feel competent in their performance on individually assigned exams and homework assignments. Such feelings of competency belonging may partly rely on feelings of personal accomplishment and performance on individual assignments. As such, instructors might consider supporting students' sense of competency by scaffolding learning through feedback, examples, providing clear expectations of learners [66], and normalizing the academic struggle that students inevitably face when learning challenging STEM content [67].

4.4.3. Be Intentional about How Direct Instruction Is Delivered

Instructors might consider delivering instruction synchronously only when it involves some level of interactivity. We found that noninteractive synchronous lecturing was associated with lower levels of belonging and interest in STEM, whereas both interactive synchronous and asynchronous lecturing were not. For this reason, we recommend that instructors consider making use of asynchronous lecture methods when no social interaction is necessary, but providing a synchronous lecture when it is.

4.4.4. Individual Work Is Still Important

Although synchronous interaction does seem to help satisfy the psychological need to belong, social interaction is not a magic bullet, nor should it be considered the only source of student motivation. We found that individual work was a positive predictor of student cognitive engagement and interest in STEM and marginally predictive of student cognitive engagement, showing that the completion of individual asynchronous assignments may remain an important space for people to privately engage in critical reflection and develop individual interests.

4.4.5. Incorporate Student Voice

Finally, our findings stressed the importance of asking students what they need, and what does and does not work in online courses. Although it is common to denigrate online education as an inferior form of instruction, our findings suggested that, under the right conditions, these courses can actively promote student engagement and belonging. As institutions of higher learning continue to decide momentous decisions about future campus technologies and modes of instruction, it is crucial that the voices of teachers and learners are heard.

5. Conclusions

Our quantitative findings supported the idea that students, particularly students of color, felt higher course belonging from live human interaction in synchronous courses and more cognitive engagement in asynchronous courses during the virtual transition spurred by the COVID-19 pandemic. Qualitative results highlighted varied types of course belonging (social belonging and competency belonging). Undergraduate STEM instructors and administrators who want to improve student engagement in virtual settings might, therefore, consider our central findings that:

- Providing opportunities for classroom interaction can support feelings of social belonging and engagement. We found that students' feelings of social belonging in STEM were related to their interactions with their peers and instructors during breakout groups and discussion, and benefits were pronounced for students of color.
- Students' feelings of competency can serve as the basis for belonginess in STEM. We found that some students explained their feelings of belonging in STEM in terms of their prior experiences of success and sense of competence.
- Individually completed coursework (e.g., exams and quizzes) have tradeoffs. Individual assignments can sometimes be linked to negative student emotions, particularly when strict time limits are imposed. However, they also seem to be important for supporting competency belonging and interest in STEM and may be linked to cognitive engagement.

Overall, these findings have the potential to inform the efforts of university instructors, administrators, and policy makers in helping to optimize instruction in online learning environments.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/educsci12020061/s1, Table S1: Standardized Regression Coefficients for Instructional Practices Predicting Psychological and Cognitive Well-Being with Gender Interactions Included.; All survey materials, interview prompts, and codebooks.

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