Re-Examining Inequalities in Computer Science Participation from a Bourdieusian Sociological Perspective

Maria Kallia
University of Glasgow
Glasgow, United Kingdom
maria.kallia@glasgow.ac.uk

Quintin Cutts
University of Glasgow
Glasgow, United Kingdom
quintin.cutts@glasgow.ac.uk

ABSTRACT

Concerns about participation in computer science at all levels of education continue to rise, despite the substantial efforts of research, policy, and world-wide education initiatives. In this paper, which is guided by a systematic literature review, we investigate the issue of inequalities in participation by bringing a theoretical lens from the sociology of education, and particularly, Bourdieu's theory of social reproduction. By paying particular attention to Bourdieu's theorising of capital, habitus, and field, we first establish an alignment between Bourdieu's theory and what is known about inequalities in computer science (CS) participation; we demonstrate how the factors affecting participation constitute capital forms that individuals possess to leverage within the computer science field, while students' views and dispositions towards computer science and scientists are rooted in their habitus which influences their successful assimilation in computer science fields. Subsequently, by projecting the issue of inequalities in CS participation to Bourdieu's sociological theorisations, we explain that because most interventions do not consider the issue holistically and not in formal education settings, the reported benefits do not continue in the long-term which reproduces the problem. Most interventions have indeed contributed significantly to the issue, but they have either focused on developing some aspects of computer science capital or on designing activities that, although inclusive in terms of their content and context, attempt to re-construct students' habitus to "fit" in the already "pathologized" computer science fields. Therefore, we argue that to contribute significantly to the equity and participation issue in computer science, research and interventions should focus on restructuring the computer science field and the rules of participation, as well as on building holistically students' computer science capital and habitus within computer science fields.

CCS CONCEPTS

• **Social and professional topics** → **Computing education**; • **Applied computing** → **Sociology**.

KEYWORDS

inequalities, sociology, computing education, Bourdieu, computer science capital

1 INTRODUCTION

Computer science classrooms, whether at the school or university level, provide a suitable context for examining disparities in participation; particular groups (e.g., minorities) remain under-represented which raises concerns about how computer science could be widened to attract and retain diversity in its field. In this paper, we endeavour to provide a new lens for understanding and examining patterns in computer science participation. Our theoretical lens stem from the field of sociology of education and as such, we see education, achievement, and outcome being affected by the interplay between school structural patterns and social class stratifications, among other factors; schools or universities are seen as micro-societies in which issues of authority, democratisation, role structure and position, power and dominance, the interplay between social classes, their culture, language and gesture, hidden structural rules, social stratification, and elitism, are some of the perspectives to understand a given problem.

This paper aims to investigate and build a theoretical framework that could provide the foundation for understanding and addressing unequal patterns in computer science participation. Our framework stems from a systematic literature review which was conducted to explore the design of interventions aiming to tackle the issue of inequalities in computer science participation and to identify the factors that impact and influence this issue. The explanatory power of our framework emanates from Bourdieu's theory of social reproduction. We were particularly interested in employing Bourdieu's theory as a theoretical lens because his work and contribution in the context of class inequalities in education and more generally, on class reproduction in advanced capitalist societies, is regarded as exemplary. We were, therefore, very keen to explore if his ideas may offer new insights into the issue of computer science participation as it has been the case with science education [4][5]. The research questions we aim to address in this paper are the following:

- How can inequalities in computer science participation be understood by applying sociological perspectives and particularly, Bourdieu's theory of social reproduction?

- What new directions and opportunities does this sociological alignment offer for tackling issues in inequalities in computer science participation?

To address the above research questions we conducted a systematic literature review. The role of the systematic literature review was first, two establish the alignment between computing education literature and a sociological theory which was influenced by inequalities in a highly stratified French society. By establishing this alignment, we wanted then to investigate potential new research directions stemming from Bourdieu's theory which have not yet been the focus of computing education research (demonstrated by the systematic literature review). The findings of our study demonstrate firstly, that participation in computer science can be understood as a conjunction of factors, each one of which constitutes a form of capital in Bourdieusian terms and which individuals acquire to leverage within computer science fields; secondly, that the interventions designed and implemented thus far, focused mostly on some of the capital forms and this typically as a result of interventions realised in extra-curricular settings. By applying sociological lens to the issue of inequalities in participation, we suggest that to contribute significantly to the participation issue, there is a need to consider the problem holistically and within formal education settings. This indicates that building students' computer science capital and re-configuring aspects of the habitus should be one of our main priorities, but re-structuring the computer science field and the rules of the participation game so as to legitimise diverse forms of participation needs to be also highly considered in future research designs and interventions. Interventions that do not consider the interface of these three Bourdieusian constructs, but are narrowly focused on some of these, will not reach their full potential and therefore, the participation issue will continue to be reproduced despite the extensive attempts of researchers and policy-makers.

In the following section, we describe our theoretical framework which is based on Bourdieu's sociological theory. Due to limited space, our theoretical framework presents the central Bourdieusian concepts that ground our study while research regarding inequalities in computing education will be presented later in the discussion as a result of our systematic literature review and as a connection to Bourdieusian constructs.

2 THEORETICAL FRAMEWORK: BOURDIEU'S SOCIOLOGY OF EDUCATION

Bourdieu's theory of social and cultural reproduction has created a new coherent view of the sociology of education. His sociological framework is based on the sociology of power [32] and it is particularly useful for investigating how resources are allocated in society and how a person's internal dispositions are influenced by society's external structures [56]. His work on social reproduction has been widely employed in education research to investigate and understand the tenacity of stratified social patterns. Bourdieu argued that the education system contributes to the "reproduction of the structure of power relationships and symbolic relationships between classes" [32, p. 128]. As such, for Bourdieu, schools are regarded as mechanisms for reinforcing the social and cultural inequalities [19].

Bourdieu's view of schools as the primary agents for the reproduction of all social classes constituted opposition to the liberal view of schools being an apparatus of social transformation and equality [38]. For Bourdieu, the social and cultural reproduction within schools is generated purely by the tendency to acknowledge students who are ready to participate in such a school system, whereas, due to the school's structural refusal or inability to discontinue this tendency and to develop a pedagogy that considers nothing for granted, it leaves behind the unprepared working class [38].

Bourdieu's view of school structure highlighted the power that is transferred within schools by the privileged groups in society; by doing so, these groups legitimise their dominant culture at the expense of the less privileged groups that lack the resources and opportunities to obtain the legitimised cultural and social capital [6]. As such, schools reproduce the structure of authoritarian relationships within the society and the social opportunities and injustices experienced by all social classes.

Bourdieu developed a set of constructs to explain his views; understanding these constructs is a prerequisite for comprehending his theories. Therefore, in the following sections, we present the following three central Bourdieusian constructs: capital, field, and habitus. We believe that these three constructs bare a particular importance for the computer science community when seen through the perspectives of participation and inequalities.

2.1 Capital

"The social world is accumulated history, and if it is not to be reduced to a discontinuous series of instantaneous mechanical equilibria between agents who are treated as interchangeable particles, one must reintroduce into it the notion of capital and with it, accumulation and all its effects" [12, p. 242].

For Bourdieu, the notion of capital refers to resources a person holds and can use to acquire some kind of gain or profit. He argued that capital takes time to accumulate, it can be reproduced or expanded, and as a persisting force, it has the power to create possibilities or impossibilities. Bourdieu posited that it is not possible to understand the structure of the social world or the way it functions if one does not accord for the different types of capital that are distributed in society; he, thus, proceeded and postulated that resources or capital can take the following three forms: economic, cultural, and social capital.

Economic capital refers to financial resources, like money, but it can be also institutionalised in the form of property rights [12, p. 243].

Cultural capital is non-financial but under certain circumstances, it can be converted into economic capital. Wilterdink [62, p. 24] summarises cultural capital as "everything profitable that is socially learned, ranging from school knowledge to social manners and cultural taste". Cultural capital can take the following forms:

- embodied capital which includes "long-lasting dispositions of the mind and body" [12, p. 47] and it is usually transferred from person to person (from a parent to a child, e.g., knowledge, manners of speaking); it is transformed into an integral component of the person, into a habitus (another construct) and it functions as symbolic capital; this indicates that it is

not being acknowledged as capital but rather as legitimate competence [12, p. 245].
- objectified capital which refers to cultural goods like books, instruments, machines and it necessitates embodied capital to be fully valued [12].
- institutionalised capital which is a form of objectification e.g., formal qualifications

Social capital refers to relationships between individuals that facilitate the growth of the other forms of capital [56]. Social capital inclines an investment in social relationships that would generate beneficial outcomes [46].

Capital is regarded as an interchangeable resource that can be used to "gain advantage in society" but its value is determined by the field that it's being used [56]. While the volume of capital may determine the ranking in the field, habitus determines the disposition toward the field [56].

2.2 Habitus

"... a subjective but not individual system of internalized structures, schemes of perception, conception, and action common to all members of the same group or class and constituting the precondition for all objectification and apperception: and the objective coordination of practices and the sharing of a world-view could be founded on the perfect impersonality and interchangeability of singular practices and views" [11, p. 86].

The concept of habitus is central to Bourdieu's theoretical work. It is considered as "the way a culture is embodied in the individual", as a system of embodied dispositions that are the groundings of an individual's practice and behaviour [25]. It is Bourdieu's way to rationalize the regularities of behaviour related to social structures (e.g., class, gender, ethnicity) [41]. Habitus is reflected in individuals' predisposed actions that align with the social structures they hold [41]. Thus, habitus is a way of portraying the social structures as being embodied in individuals and as a way they understand and act in the world. This view, however, does not marginalise the individual's own agency, and therefore, it does not imply that social structures are deterministic of behaviour.

Although habitus contributes to individuals' actions, action is seen by Bourdieu as a more complex construct than a single reflection of habitus; it is the outcome of the interface between habitus, capital, and field.

2.3 Field

"... a structured social space, a field of forces, a force field. It contains people who dominate and people who are dominated. Constant, permanent relationships of inequality operate inside this space, which at the same time becomes a space in which various actors struggle for the transformation or preservation of the field. All the individuals in this universe bring to the competition all the (relative) power at their disposal. It is this power that defines their position in the field and, as a result, their strategies" [14, p. 40]

Bourdieu describes the concept of field as a social space of interactions, a space of struggle, and competition. In this field, individuals are classified by the capital they possess and that is the reason why researchers often use the concept of "market" to describe fields as it better emphasises the capital exchanges: individuals have diverse purchasing capital as well as different forms of capital which they can use to their advantage [9]. The nature of the field, therefore, is hierarchical [56] and an individual's classification within the field is determined by what is valued and valid in the field and thus, individuals with a high volume of valued capital will hold the highest rankings. Another construct that is used to describe fields is "game", as it better reflects the idea that fields are dominated by rules, and individuals are players which employ strategies - ways of playing the game - to win or maintain power and position themselves or being positioned in the hierarchy. Therefore, the field regulates how the capital is valued and the way that habitus is legitimate. An individual's practise within the field is guided by its habitus and it is evaluated by criteria internal to the field.

In education settings, the field involves the structures, principles, and values of the classroom (e.g., the expected ways of behaving, norms of interactions, and discourses). In order to succeed, students are supposed to play according to the rules stemming from the field. For example, students who have the appropriate capital to leverage within their lessons and whose habitus suits well with what is anticipated at school/class are likely to succeed with less effort than students whose habitus is not a good "fit" [24].

3 METHODOLOGY

The research method of our study adopts a synthesised approach of a systematic literature review followed by thematic analysis [15]. Thematic analysis was used for identifying patterns across the literature particularly referring to factors influencing participation in computer science. By merging a systematic literature review with thematic analysis, we intended to extend the knowledge of the academic niche around computer science participation and secondly, to create a theoretical framework that depicts the participation issue. By then employing a sociological lens, and particularly, by projecting Bourdieu's theory of social reproduction on to the findings, we demonstrate the alignment of Bourdieu's theory with inequalities in computer science participation which allowed for key ideas to surface and be unified in a cohesive story that highlights new research directions.

For conducting the literature review, we focused on Kitchehham's [29] guidelines which suggest three basic steps: planning, conducting and reporting the review.

3.1 Planning the review

Three databases were included in the literature review, ACM, IEEE, and ERIC and the search terms used were the following: (equity OR inequality OR "participation" OR "access" OR diversity) AND ("computer science" OR "computing" OR "computer education") AND (school OR education OR university OR college OR class)). To assess the relevance of the papers returned, we set specific inclusion and exclusion criteria. The rationale behind the inclusion criteria was to include papers that empirically examine the issue of inequalities in participation in CS rather than examining the issue and offering explanations that have not been empirically tested. The inclusion and exclusion criteria are described below:

Inclusion criteria:

- the paper should identify empirically the factors that impact inequalities in CS participation

- the paper should discuss and describe an empirical intervention implemented to tackle the issue and discuss its effects

Exclusion criteria:

- the paper presents factors impacting students' achievement/performance, engagement, success in computer science but it is not oriented towards inequalities in participation or does not empirically examines these factors
- the paper focuses on students' disabilities
- the paper discusses interventions for teachers but does not report the effects on the factors influencing students' participation
- the paper describes an intervention not targeting the participation issue directly, or it does not provide an empirical investigation on the intervention's effectiveness
- the paper discusses an intervention in the area of digital skills or ICT or computers or data science or technology

3.2 Conducting the review

The literature review was conducted in December 2020 and a total of 3587 papers (including duplicates) were retrieved. By reading the abstract and then applying the inclusion and exclusion criteria, a total of 273 papers were selected for further analysis (without duplicates). From these papers, thematic analysis was employed to identify and synthesise the factors that influence participation in computer science and understand the design, focus and effects of the interventions implemented so far. The inclusion and exclusion criteria were employed once more, and in total 147 papers were included in the final round. The interrater reliability on the selection of studies was substantial with Kappa = .808 ($p < .05$). Disagreement between the researchers was resolved by a discussion.

We started reading the papers and highlighting and coding parts of the text that indicate factors affecting computer science participation, the focus and contexts of the interventions and their impact (the parts we focused mostly for coding where the methodology, results and discussion of the papers). Particularly about the impact of interventions, we did not only focus on what the authors explicitly mention as an impact (e.g., accumulation of knowledge) but on the whole design of their intervention; this was particularly important for identifying effects of interventions on students' social capital. For instance, many papers reported only effects on students' knowledge or students' self-efficacy but a fundamental part of their design was students' collaborative and social activities which enhance students' social capital even if the authors do not explicitly mention that. After the coding process, we grouped together codes into themes/categories which were started to being seen in the light of a general theoretical framework that could formally explain inequalities in computer science participation. One of the authors coded all papers and a second researcher then coded one-third of the papers with a Cohen's Kappa reliability score of .817 ($p < .05$). After finalising the core themes and sub-themes that emerged from the literature, we investigated Bourdieu's theory explanatory power; we employed his theory as a lens for explaining disparities in computer science participation and after its successful projection, we investigated how Bourdieu's theory extends our understandings and can lead us to new research directions. We need to highlight at this point that although we have decided from the beginning of this study to employ Bourdieusian lens on the findings, the coding process was not affected by Bourdieu's theory.

Figure 1 demonstrates the steps of the literature review and the number of papers considered in each phase.

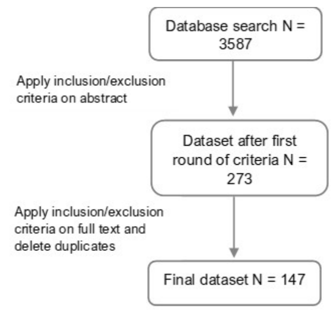

Figure 1: Literature review process

4 RESULTS

In total, 147 papers were considered for further analysis. While reading the full papers and trying to further apply the inclusion and exclusion criteria, we grouped the papers into two broad themes-categories: papers that focus on identifying factors related to inequalities in participation in computer science education, and interventions that were designed and employed to impact inequalities in computer science. The following table 1 depicts for each database, the number of papers that were included in this literature review [1].

Table 1: Number of papers included per-database and category

	ACM	IEEE	ERIC	Total
Factors	33	15	17	65
Interventions	44	22	16	82
Total	77	37	33	147

The thematic analysis of the literature review gave rise to four main themes affecting students' participation in computer science education: economic, cultural, social, psychological factors (Table 2). The cultural theme was further split into two sub-themes: knowledge and skills, and views and dispositions towards computer science/scientists. We also merged the economic theme with the cultural sub-category "access to computer science" as alone it did not provide any further information other than that economic factors may prohibit access to computer science resources which is exactly what the "access to computer science" sub-category reflects. Table 2 summarises all themes, sub-themes and sub-categories of the model and the frequency of papers included in each of the categories [2].

[1] Papers in Factors and Interventions categories were mutually exclusive
[2] Some papers included more than one factor; that is the reason why the number of papers depicted in the table add up to 121 rather than 65 which is the total number of papers belonging to the Factor category

Table 2: Factors influencing participation and inequalities in CS education

Cultural Factors		Social Factors	Psychological Factors
Knowledge & skills related to CS	Views & Dispositions towards CS		
Number of papers: 35	Number of papers: 26	Number of papers: 39	Number of papers: 21
Access to CS courses	Views about CS as a school subject	Supportive environments (e.g., family, teachers, peers)	Self-efficacy & Confidence
Previous experience and skills (e.g., mathematics, programming)	Views & concerns about CS as a career	Access to CS people and role models	Identity & Sense of belonging
	Stereotypes		

4.1 Factors influencing participation

4.1.1 Cultural theme. The cultural theme represents factors stemming from the experiences individuals accrue through time and which have an impact on their participation in computer science. In total, 65% of the papers that focused on identifying factors impacting participation discussed culturally related factors[3]. We further divided this theme into two sub-themes: knowledge and skills, and views and dispositions towards computer science/scientists.

Knowledge and skills. This sub-theme describes factors related to previous knowledge and skills that seem to have an impact on students' participation in computer science. From a total of 65 papers discussing factors influencing participation and inequalities, 54% discusses the importance of access to and previous experience with computer science courses or activities related to computer science and skills that enhance students' engagement in computer science like computational thinking and spatial skills.

Views and dispositions towards computer science/scientists. This sub-theme groups individuals' views and dispositions related to computer science as a subject and career, and related to computer scientists. It is further divided into three categories: views related to computer science as a school or university subject (e.g., perceived difficulty of the subject, male-oriented and impersonal); views and concerns related to computer science as a career (e.g., concerns about work-life conflicts, adversities of the profession and its non-social impact and vague view of what a computing career entails); and stereotypes linked with computer scientists or students majoring in computer science (e.g., geeks, being very smart to belong). In total 40% (26 out of 65) of the factor-related papers discuss these issues.

4.1.2 Social theme. The social theme reflects factors related to the access individuals have to people that support and/or enhance their participation in computing. It highlights relationships individuals form with family, peers, teachers and other individuals who are knowledgeable of computer science or have positive perspectives and dispositions towards computer science. Through these relationships, individuals can share and enhance their sense of identity in computer science and find the support they need to build their knowledge and skills in the field. In total, 60% of the factor-related papers highlight social-related factors. Family, teachers, and peers were the most influential factors followed by career guidance in school and role models.

4.1.3 Psychological theme. This theme refers to emotional and affective factors that impact inequalities in students' participation in computer science. In total, 32% of the papers discuss these factors with self-efficacy and sense of belonging capturing the major affective dimensions influencing students' identities and participation in computer science.

4.2 Intervention Papers

The majority of the papers retrieved from the literature focus on describing interventions aiming at increasing participation in computer science and tackling inequalities. It refers to papers that designed, implemented and discussed specific activities that seem to positively impact students' views and dispositions towards computing, their knowledge and skills, and their self-efficacy and belonging. From a total of 155 intervention papers that were retrieved, 82 papers described their design, focus, and the impact on students' participation while the rest of the papers described the intervention in general terms without testing its effectiveness and therefore, they were not considered further in this review.

In total, 41% of the papers designed an intervention that was implemented within the school or university/college curriculum, leaving the majority of the papers (59%) focusing on enhancing some of the factors of the participation issue through activities implemented in summer camps, competitions, academies, hackathons etc (we call these informal activities, Figure 2).

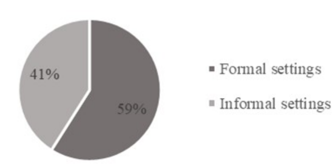

Figure 2: Settings that the interventions were implemented

Regarding the content of the interventions, a large majority of papers (46%) focused particularly on creating cultural responsive

[3] 42 papers in total discussed cultural factors - the two categories in table 2 that describe cultural factors are not mutually exclusive

contents and contexts, demonstrating authentic practices and interdisciplinary connections, and highlighting the social relevant aspect of computing. An important proportion of the papers focused on coding through specific activities like gaming, crafts, e-textiles, arts, and music.

Figure 3 represents the frequency of each of the core factors affecting CS participation that were considered by interventions designed to enhance students' participation. As the figure depicts, most interventions focused on enhancing students' knowledge and skills and then on creating a supportive environment that enhances students' self-efficacy, sense of belonging and identity while the least amount of focus was placed on building students' social relationships.

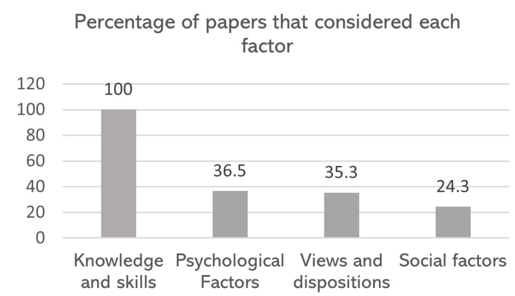

Figure 3: Percentage of papers that considered each factor

Further analysis demonstrates (Figure 4) that in total, only 6% of the intervention papers consider a holistic approach to impact inequalities in participation, meaning that their reported effects targeted all four factors of participation (knowledge and skills, views and dispositions, psychological and social factors). Following that, only 17% of the intervention papers considered three factors, and 44% of papers considered two factors.

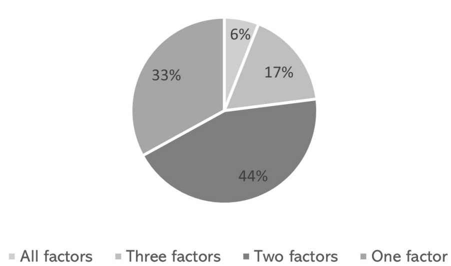

Figure 4: Percentage of papers addressing a number of participation factors

Overall, the results presented in this section highlight that participation in computer science is a multi-faceted problem but most of the attempts made so far to tackle it tend to focus on some of its facets rather than to its totality. Additionally, most of the interventions centre around informal activities, such as summer camps, which despite their usefulness, their long-term effects are questionable, especially for factors related to affect.

5 DISCUSSION

Looking to the results presented in the previous section through Bourdieu's sociological lens, there is a story being unfolded that demonstrates the complexity of the issue, extends our understandings of inequalities in computer science education but most importantly highlights new avenues in research. In the following sub-sections, we first discuss the results of the literature through Bourdieu's sociological lens and then the new directions that stem from this alignment.

5.1 How can inequalities in computer science participation be understood by applying sociological perspectives and particularly, Bourdieu's theory of social reproduction?

In Bourdieu's terms, the different themes appearing in the literature review as factors affecting participation in computer science, constitute capital forms which individuals possess and allow them to leverage within computer science fields; the way these capital forms are structured as well as students' dispositions (habitus) towards computer science/scientists influence attrition and participation in computer science fields and as fields are hardly ever open to all, it is important to account for the different forms of capital, their value on the field, and specifically, their relative importance for particular groups with a habitus that is not favourably oriented towards computer science fields.

5.1.1 Computer science cultural capital. Bourdieu's notion of cultural capital refers to resources (other than economical) that individuals acquire and employ to leverage within fields. Bringing this notion into the computer science field, computer science cultural capital, as stemming from the literature review, reflects individuals' knowledge and skills relevant to computer science or related to computer science, and views and dispositions towards computer science/scientists acquired through social learning.

Knowledge and skills. In computer science education research, there have been many attempts to delineate the knowledge and skills required to succeed in computer science. Characteristic examples stemming from our literature review, which was only oriented towards issues of inequalities and participation, are previous experience with mathematics, spatial skills, computational thinking skills, and more generally, early or previous exposure and experience with computer science courses and particularly programming. For example, Wang et al. [58] found that regardless of the exposure (unstructured or structured), high school girls who had engaged with computer science classes were more likely to consider computer science-related degrees than girls with no such experience. Along the same lines, Weston, Dubow and Kaminsky [61] found that among the main predictors of women persistence in computer science was the programming experience in high school. A lot of other researchers highlighted previous knowledge, skills and participation in computer science practices as pre-requisite for persistence in computer science fields (e.g., [1], [60]). (Literature around success factors in first-year undergraduate students or factors that contribute to students' achievement can shed more lights in this area but it was out of the scope of this literature review which concentrated only on equity and participation).

Views and dispositions towards computer science/scientists. This dimension refers to views and dispositions that individuals develop related to computer science or computer scientists. It is highly linked with what Bourdieu sees as habitus, and it highlights how individuals form cognitive structures and internalised frameworks as a result of their culture and through social relationships. Research in computer science education emphasises the stereotypes students develop towards computer scientists and students majoring in computer science; words like nerds and geeks are usually the main constructs used to describe computer scientists or students in computer science. For instance, Alshahrani et al. [3] described the various perceptions that students develop about computer science students, highlighting attributes like non-social and nerds, and how the perception of the field is regarded as male-oriented and thus, creates a societal bias. Another way that the discipline is perceived is as boring and very competitive targeting mostly the really smart students, or students with a strong mathematical and programming background. Papastergiou [39] investigated students' views regarding computer science as a subject and career and found that the vast majority of the students think that computer science is highly linked with programming, with girls connecting it with its traditional subjects (hardware, algorithms, programming) significantly more than boys do, with the latter focusing more on the human and application orientation of the discipline. Other studies emphasise that a career in computer science is being seen as isolated, individualistic with low social interaction or social impact. For example, in their research, Wang et al. [58] pointed out that students who were interested in a career with social impact were more likely to not want to study computer science, and surprisingly, that was significantly more likely for boys. Lewis et al. [31] also highlighted that the alignment between students' communal values and their perceived affordance of computing to meet these values predicts sense of belonging in computing. Peters [40, p. 47] emphasised that "having technical problem solving as the predominant experience is a breeding ground for dualistic constructions of the discipline, which can exclude, marginalise or silence people with broader competences". Finally, many studies have recorded concerns regarding career prospects and opportunities for specific groups (e.g., women) and work-life balance and conflicts due to the adverse and competitive working conditions which make specific groups and specifically women to avoid this field. Main and Schimpf [48] emphasised that women represent 20-40% of professionals in computing and among the main factors that influence their decision to remain in computing fields is the work-family conflicts and the pervasive occupational culture.

Although research has mostly concentrated on identifying the negative views that students construct about computer scientists and the computer science field, less is known about the positive views that are held by students who major in this discipline, students with a more friendly habitus towards computer science. However, it is reasonable that these views would most probably refer to extrinsic values students assign to computer science careers (e.g., salaries), the access to the labour market that a computer science degree or a computer science qualification can offer, and intrinsic values relevant to their own interests, e.g., being able to create new technologies and tools to help society. These students would see computer scientists as the builders of the digital world. Interestingly, Papastergiou [39] noted in her study that girls' motivation to study computer science is mostly linked with extrinsic factors rather than intrinsic whereas for boys these two factors have the same weight. Mooney et al. [37] also found that the more encouraging factors for studying computer science were job availability, salaries, job security, teachers, impact on society and flexible work conditions.

5.1.2 Social capital related to computer science. To develop the aforementioned skills, knowledge, and particularly, positive dispositions and views towards computer science, a supportive environment and access to computer science opportunities are particularly important. In alignment with Bourdieu's notion of social capital, computer science social capital reflects a social network that an individual can draw upon to gain access to computer science education opportunities, to find support and encouragement and discuss with peers or other people about computer science, and therefore, its acquisition facilitates the growth of the other forms of capital. From the literature review, we identified that a supportive family and/or school (university or college) environment or other initiatives that enhance and support students' interests and provide access to a variety of computer science opportunities play an important role in shaping students' dispositions towards computer science. Specifically, parental qualifications relevant to computer science, or a family environment positively oriented towards computer science was one of the most important factors reported in the literature. In a study about the role of familial influences in computing, Rankin et al. [42] found that families impact persistence in computing in six different ways (early access, emotional support, self-efficacy, education as a value, career guidance, and role models). Buzzetto-More et al.'s [1] research highlighted that among the most important factors for students selecting their major was family first, and then teachers. Indeed, qualified teachers and school counsellors that instil and enhance students' engagement and interest in computer science contribute significantly to students' participation in computing. In her research, Reimer [44] emphasised that school administrators and counsellors who are not aware of what computer science is or are negligent of the importance of coding, as well as the limited number of qualified teachers being willing and able to offer computer science classes impact substantially the participation in computer science. Finally, support from peers with relevant interests, and role models are also factors that enhance students' social, cultural and psychological capital. For instance, Clarke-Midura et al. [17] found promising results when students undertake a near-peer mentor role which seems to increase the mentors' interest, value beliefs, self-efficacy and skills in computer science. In another study about peer relationships, Ross et al. [47] examined the intersection of being black and women and found out that black women experiences are different from those of both black men and non-black women, and that having computer science friends was more important for black women for following a career in computer science.

5.1.3 Psychological capital in computer science. Although Bourdieu's theory did not focus explicitly on the psychological capital, inferences can be made about the role of emotion and affect as underlined in the way he describes and discusses particularly the concept of habitus. For example, Reay [43] attempted to decipher the existence of affect and emotions in Bourdieu's writings about habitus. Reay argues that according to Bourdieu, the conflict of habitus within a field is accompanied by affectivity and goes on to explain that learning that takes place within pathologized fields is often accompanied by shame, fear, anxiety, indignation. On the contrary, within familiar fields, individuals move with ease and comfort. Aarseth et al. [2] also consider the conflicts in habitus within fields and the emotional tensions produced by these. They write that habitus is perfectly adapted to fields where the conditions are aligned with the conditions that habitus was formed; but, when field conditions are significantly different from those with which habitus was generated, a situation of misfit is produced and which is associated with suspended adaptation and taxing transformation. During this process of misfit and discordance, emotional conflicts arise. Therefore, habitus, as a set of dispositions, includes a range of cognitive and affective factors that impact individuals' actions [63]. To provide a corresponding definition of psychological capital that aligns with Bourdieu's notion of capital, we will conceptualise psychological capital as the capital referring to resources related to emotions and affect which individuals can build upon to succeed and persevere in a corresponding field. These emotional and affective resources can be generated by the habitus (e.g., people like us succeed (or not) in this field) but also can contribute to the formation of the habitus within a field.

We regard that the computer science education field can be a particularly prolific field to illuminate how habitus contributes to psychological theorisations and also how psychological considerations might enhance understandings of habitus and its role in participation in computer science. In the papers we reviewed, habitus was evident both in students' views and dispositions towards the subject as well as in the authors' attempt to highlight the importance of affect in participation; affective factors were the result of internalised dispositions as well as the result of an attempt to restructuring the habitus. Specifically, the literature review revealed that self-efficacy and confidence, identity, and sense of belonging were the major affective dimensions that influence participation in computer science classes. For example, Doubé and Lang [21] found out that their computer science female participants experience significantly lower overall expectancy for success than men. Particularly, women had significantly lower levels of self-efficacy for performance and confidence in their abilities to learn to program than men. That is especially true for first-generation women according to Blaney and Stout [10] whose research underlines that first-generation women demonstrate the lowest self-efficacy and sense of belonging in computing compared to continuing generation women, first-generation men, and continuing generation men. On a similar vein, Tsagala and Kordaki [55] found out that although the majority of their women participants in their study expressed self-confidence regarding their competence in CSE, one in three female students felt inferior to their male colleagues while only one in fourteen male students expressed the same feeling. In general, whether these feelings stem from students' formed habitus and the discordance they experience within the computer science field while trying to handle conflicts and negotiate their new identities, or result as a consequence of the field structure (we will revisit this idea in the following section), they constitute prohibited factors for students' attainment in the field.

5.1.4 Interventions. The vast majority of studies identified in the literature, designed interventions to engage young learners with computer science opportunities and practices. Most of the interventions engaged learners with activities set up in informal settings (outside school or university curriculum settings). The evaluation of these interventions demonstrates that participation in activities related to computer science provides students with the opportunity to build the computer science cultural capital through enhancing their knowledge and skills, while other studies also focused on changing students' dispositions towards computer science and computer scientists and changing their views about the subject and its alignment with their professional goals. For example, Marcu et al. [33] designed and tested a computing course for middle school girls (ages 11-13). Their design focused on three principles: hands-on building projects, engineering-focused roles and motivation through the presence of an audience. The results of their study indicate that particularly the engineering-focused role design helped girls to improve their perceptions towards computer science and had an impact on their interest and views of the subject. Richard et al. [45] designed a hardware hackathon called StritchFest with the theme being "Wear and Care", in which undergraduate and graduate students collaborated to designed wearables with the use of LilyPad Arduino. The authors demonstrate the importance of a thematic focus and collaborative learning for diversifying participation and perceptions. In a similar vein, Hoffman et al. [27] report the impact that a Mobile CS Principles course had on their students' interest and attitudes towards computer science. The course design took advantage of the fact that students demonstrate an increased interest in smartphones and it was therefore, designed to emphasise computer science social impact by engaging students with building creative, socially meaningful applications that demonstrate how computing helps their communities.

In other cases, the activities designed and implemented to broaden participation constituted a safe space where students enhanced their computer science identities, self-efficacy, and sense of belonging, and therefore, they contributed to building students' psychological capital. Codding et al. [18] reported the findings of a culturally responsive after-school coding club regarding students' sense of belonging. In their paper, the authors highlight the importance of creating culturally responsive frameworks for building students' sense of belonging as well as the importance of building relationships between students and facilitators for improving access for minoritized groups. Along the same lines, Scott and White [49] discuss a culturally responsive computing approach, COMPUGIRLS, and present the positive impact of this curriculum on students' retention in the program and shift in their identities as contributors of the digital community. Finally, Shaw et al. [50] by focusing on students' identities in computer science, views of the discipline and sense of belonging in the field, engage students in a process of making electronic textile projects. Among other things, the authors highlight how the use of reflective portfolios can be employed to enhance students' identity construction.

Finally, through their intervention designs, some studies focused on building social spaces where students' relationship with the peers, mentors and teachers formed the grounding for students' social capital. Lee [30] highlights the importance of role models and mentors in increasing participation of underrepresented groups. In his paper, the author describes a programming camp for middle school students, led by near-peer-mentors (first-year college student instructors) and which included guest speakers from the local area. At the end of the program, the students reported a strong connection with their near-peer mentors who they saw as role models. Doerschuk et al. [20] discuss the Increasing Student Participation in Research Development Program (INSPIRED), a computing academy for high school students. Apart from the computing curriculum and promoting university students' professional development (as coordinators and teachers), this program paid particular attention to exposing high school students to female and minority computer scientists to provide role models for these students. In the same vein, other studies in this group highlighted the importance of role models, social support and peer relationships (e.g., [54], [16], [57]).

5.1.5 Computer science capital, habitus and its impact on participation. From the literature review presented above and drawing on Bourdieu's notion of capital, particularly being seen as resources individuals possess to leverage within a field, we argue that theorising the notion of computer science capital would be beneficial from organising together factors related to computer science participation and which have the potential to influence policy and other initiative actions accordingly. Therefore, we see computer science capital as referring to cultural, social, and psychological resources related to the field of computer science and which individuals acquire and employ to leverage within computer science fields, and gain the support and capacity to engage, participate and remain in these fields.

Computer science capital is wider than the knowledge and skills related to computer science; it includes also computer science-related social capital, views and dispositions, and psychological capital related to computer science as subject and career and more generally as a scientific field. The activities designed to increase students' engagement, interest and participation can be seen as fields where students' cultural capital related to computer science is developed, and where students have the potential to cultivate the other forms of computer science capital too.

The literature review around inequalities and participation in computing demonstrates the importance of computer science capital on tackling the participation issue. All of the intervention papers reviewed in this paper focused explicitly on improving students' knowledge and skills in the discipline, and some have acknowledged the multifaceted aspects of capital and considered an approach that not only targets students' literacy in computing but the other aspects of computer science capital too. Many research papers have demonstrated how students from different socio-economical classes, ethnic backgrounds, and female students are left out of computing courses due to the limited opportunities these groups had to engage with computer science, whether due to their economic status or due to lack of opportunities and encouragement from their family or school/community environment (e.g., [35], [34]). As a result, this has contributed to a habitus not positively oriented towards computer science and a lack of capital related to computer science (as defined previously) necessary to participate within computer science fields.

Many intervention papers have also implicitly acknowledged the role of habitus mostly as a reflection of views and dispositions and students' psychological capital. This means that in the literature habitus has been depicted in students' views and dispositions, and their affect. These studies demonstrate that even when students are interested in computer science, their habitus may prohibit their participation in computer science; habitus, as a structure of perception, or a suppressed interpretive framework, influences individuals sense of agency and possibility. It is through providing mostly mastery experiences or culturally friendly environments that the interventions we reviewed tried to accommodate or change some aspects of habitus. However, to evaluate whether these interventions have been successful in accommodating or re-structuring habitus, is a challenging task. That is because changing some aspects of habitus requires interventions that span across many years, so, it is not a matter of a change that happens at a particular point in time or as a result of a single intervention that lasts for a month, let alone a week or two; habitus refers to long-lasting dispositions, a system of durable dispositions that mould human behaviour [11] and as such accommodating or changing aspects of the habitus requires systemic continuing interventions. That is not to say interventions employed thus far were deficient; on the contrary, we argue that they could have the potential to make even more significant impact if they had been implemented in the mainstream education and had lasted for much longer.

Overall, the central theme that is highlighted here is that although there is a vast amount of papers that aimed to address inequalities in participation with indeed significant contributions, inequalities continue reproducing until today. Until this point, and by focusing on Bourdieu's notion of capital and habitus, we have identified two potential reasons. First, most of the interventions focused on some of the components of computer science capital instead of considering it as the combination of four aspects: cultural capital as reflected on students' knowledge and skills and views and dispositions, and social and psychological capital. Secondly, most of the interventions were implemented in extracurricular activities, which means that the reported positive changes on students' capital and particularly on students' habitus reflect a particular point in time rather than long term benefits. When students return to formal education settings, the misfits between the habitus and the structure of the field might cause an inner conflict that students may be unable to handle. Therefore, the structure of the field is equally important when we consider the issue of participation but it seems not to have been the focus of studies in computer science education, and thus, the next section focuses explicitly on highlighting its importance, and the new research directions stemming from this.

5.2 What new directions and opportunities does Bourdieusian lens offer for tackling issues in inequalities in computer science participation?

In the previous section, we demonstrated how Bourdieu's notion of capital and habitus are reflected in inequalities in computer science participation and how these have been manifested and handled in research conducted in this area. In this section, we will further project Bourdieu's sociological theory to the issue of participation in computer science and demonstrate how the computer science field and its structure may be a particular prolific source by which the participation issue can be further examined opening new directions for research and policymakers.

5.2.1 Capital and habitus alone are not enough - Computer science field in the research microscope. While computer science capital has been the main focus of research in computer science education and in some cases the habitus as well, the structure of the computer science field, as it is reflected in school and university classrooms or even in occupational environments, may be proved an additional factor that affects students' participation in computer science and thus, another point where Bourdieu's theory may provide a new lens to the participation issue.

Bourdieu advocated that apart from individual behaviour, structures need to be investigated to understand social life [52] and inequalities in social spaces. His notion of field provides a context for investigating the role of agents and their positions within a specific field, and particularly, how an agent's position results from the interface between her habitus, her capital, and the field. The capital that is legitimate in a particular field constitutes a system of meaning and provides the grounding for habitus to act; since fields are sites of conflicts and competition, the legitimate meaning or legitimate capital which is recognised within a field is determined by individuals and groups who win the competition and position themselves higher in the hierarchy of the field [36]. Individuals with different positions cultivate different habits, attitudes, and norms and use these to evaluate the behaviour of others [62]. The extent to which these evaluations are legitimate - have more authority than others - depends on the levels of capital and the position that these individuals hold in the field [62].

Like other field theorists, Bourdieu argued in favour of research that studies the properties of each field. Drawing again on Bourdieu's theory of social reproduction and particularly the notion of field, we believe that the structure of school and university computer science fields is likely to legitimise specific forms of capital - not necessarily depicted in the literature - and thus, favours the students who already possess this capital while unconsciously rejects other capital forms and habitus(es) that do not align with its structure. There is a gap in the literature regarding the way that the computer science field, whether at school, university or occupational level, is organised and structured and how this structure affects participation in computer science. While research has focused on investigating how the content can be more interesting for all students and meaningful by creating engaging contexts, and on educating the teachers on inequalities issues while enhancing their pedagogical content knowledge and creating culturally relevant instruction, less attention has been given to the underlying rules of participation, what exactly constitutes valid, legitimate participation in computer science, how the structural positions of its agents are formed and claimed, and who determines the rules of the game and gives the power to the agents to sustain these rules. For instance, few researchers have tried to explore some of the disturbing behaviours depicted in computer science classrooms. Among these, Garvin-Doxas and Barker [23] illustrated how a university's first-year computer science course, reflected a defensive communication climate in terms of the interactions and behaviours that dominated the classroom. As a result of this "ill-structured" climate, the authors show how the influence of the field's structure alone can impact attrition among women. Barker et al. [8] also highlighted how counterproductive student behaviour can obstruct supportive classroom climates in computer science and Fincher et al. [22] emphasised the competitive environment of practice in computers labs.

5.2.2 An initial examination of the computer science field and the need for a more rigorous investigation. According to Bourdieu [13], analysing the structure of a field, and particularly the position and the role of its agents will often result in agents that are well established in the field and are interested in retaining the established order (dominant class), and those agents that are not (subordinate class).

The dominant class. The dominant class consists of students with higher levels of capital, it is the class that possesses the right amount of capital to leverage within fields and therefore, have the advantage over students of the "subordinate class" because the former joins the field with the necessary resources to succeed and position themselves higher in the hierarchy. In computer science fields, this group consists of students with a good background of knowledge and/or skills related to computer science, and thus, the course content appears familiar to them; these students share a common language and discourse related to computer science, a specific style of communication and interaction with their peers of the same position and with their teachers, a code of interaction relevant to computer science and accessible to those with high computer science capital and positive views and dispositions towards the discipline (habitus) that aligns with their future goals.

The subordinate class. The subordinate class consists of students that do not possess the capital to negotiate their positions within the field. This group is further divided into those who are interested in weakening the symbolic order and those who go through a form of symbolic violence (discussed below) lodged in the habitus [26].

Regarding the former, although it seems that fields are spaces of social reproduction - that is to say that fields reproduce inequalities when those with the dominant capital eliminate resistance from those with 'deficit' habitus – resistance can take place within the fields [53]. In which form this resistance takes place (or if it does not even take place) in computer science fields and whether it succeeds and under what circumstances, is an issue worth investigating as it will allow for insights related to how firm the structure of the computer science field is, who determines the rules of participation and how difficult it is for the field to change or if it has changed, how the changes were initiated, by whom and how they were manifested.

The latter group, however, is the group that is completely dominated. For these students, the computer science class may appear a hostile, alien field, a social-cultural world different from the world they are coming from. A large proportion of these students will realise that the field is not for them, whether because they do not possess the capital recognised in the field and they do not have the means to acquire it (e.g., access to social capital), or their habitus does not align with the field and the discordance that is resulted by this causes conflicts they cannot handle mainly because the field is resistant to recognise alternative forms of participation. The way that the field's rules are imposed may be in form of symbolic violence, a term Bourdieu uses to explain the maintenance of inequalities by forms of symbolic force rather than physical; it is a form of violence expressed through communication and language, cognition, symbolism, and meanings imposed in a way that they are regarded as legitimate [53] and it results when the dominated stop questioning the order of things and perceive the world and their role in it as given and unchanged. Symbolic violence indicates a *"gradual acceptance and internalisation of ideas and structures that tend to subordinate certain groups of people… and because of its invisibility constitutes an effective tool of silent domination and silencing the dominated"* [53, p. 8]. To what extent symbolic violence is part of computer science fields, how it is manifested, and by whom it is produced, is an issue that has not yet been investigated in detail in computer science, let alone, for interventions that halt its manifestation from taking place. Symbolic violence is a notion that carry the need for more investigation in computer science fields and it is particularly related to the psychological capital and habitus; it highlights how the structure of the field and its agents affects individuals' agency, practices and aspirations.

All in all, for the dominated group to be heard and be part of the game, it is not enough to just permit them to speak, nor to increase their capital alone, nor just to introduce content familiar to their "culture" while sustaining a "pathologized" field; but rather systemic and structural changes should be implemented to accord agency to this group [53]. Structuring the field narrowly and creating and reproducing limited definitions of what it means to be engaged and participate in computer science, what it means to be a computer science student or scientist, reproduces dis-advancements particularly for students whose habitus seem not to align with the field.

6 RESEARCH GAPS AND FUTURE RESEARCH DIRECTIONS

Bourdieu's theory utilises three main concepts to explain social inequalities, capital, habitus, and field; the interface between these concepts is used to explain how social inequalities are reproduced within education systems. In other words, participation is not just a result of single factors but rather, a conjunction of influences related to individuals' different forms of capital and habitus when these are particularly considered within a specific field. Therefore, to make computer science education more equitable, there is a need for interventions to focus on two interrelated areas.

First, computer science capital highlights its multifaceted structure and as such emphasises the need for interventions to enhance capital holistically and within formal school education settings. Although research efforts for improving participation in computer science thus far, acknowledge the importance of capital and in some cases the role of habitus, most of these attempts focused on: a. building some of the components of computer science capital, but few papers considered capital in its totality b. some interventions have acknowledged the role of habitus as it is portrayed through affective constructs, and views and dispositions, but due to their short length, the reported benefits could not have "permanently" re-structured aspects of students' habitus which is extremely resistant to change. This is because habitus entails a set of dispositions being formed in early stages of one's life which become apparent in one's thoughts and behaviour and, as Webb et al. [59] highlight, is durable across contexts. As such, Jo [28] highlights that habitus lasts firmly and rigid for a long time and includes resisting behaviours [51]. Backman et al. [7], on a study about self-concept, found out that the greater the number of people that ascribe an aspect of an individual's self-concept, the more resistant this aspect would be to change. This is particular important to the formation of habitus and its resistance, as habitus is influenced by social structures and interactions within different communities (e.g., family, gender group, ethnic background). As a result, the fact that most of the interventions are not implemented in formal education settings but rather as extra-curricular activities limits their full potential but most importantly, questions their long-term benefits. We need to underline at this point that our aim is not to undermine the role of extra-curricular activities; on the contrary, we highly regard extra-curricular activities' role in addressing inequity. What we would like to highlight is that the work that has been done in these activities would be insufficient if the mainstream education, whether at the school level or university level, does not align with these efforts and contribute to changing CS structures of culture (discussed in the following paragraph). The acquisition of computer science capital and habitus influence both students' aspirations towards computer science-related careers as well as their levels of participation and engagement in computer science fields. Therefore, understanding how computer science capital can be built holistically and within formal computer science education fields as well as how students' aspects of habitus could be "re-structured" in a way that produces stability on its structure should be one of the primary aims of interventions and computer science pedagogy for enhancing students' agency and participation, especially for the underrepresented groups.

Second, addressing only the capital, even if that is being done holistically, would not be enough if the structure of the computer science field does not change so that it can accept and legitimise diverse forms of agency and participation. Interventions that focus specifically on changing the structure of the computer science can be the most powerful tool for making computer science more equitable and untangling students' trajectories within computer science social contexts. Computer science fields should be seen as dynamic and ever-changing social space that allows changes to stem both from the field itself and extraneous factors. To change the computer science field, we need first to identify and understand its structure, and specifically, the dominant role and behaviour of its agents (teachers, students, policy), and the relationship between them and students' trajectories in the field. We, therefore, suggest that future research should employ the notion of field (from a sociological perspective) as a tool of analysis to further investigate the issue of participation in computer science. We believe that by putting computer science fields under the microscope at different levels of education and by exploring the different positions occupied by its agents, the legitimate meaning or capital that is (re) produced and by whom (it is very possible this exploration to re-define computer science capital as it is presented here and include, among others, behavioural-attitudinal factors that have been ignored in the literature), the way that its agents read and interpret this meaning and choose to act, the form of symbolic violence that takes place and by whom is initiated and manifested, carry pedagogical qualities critical for the participation issue. Focusing on the microcosms of the computer science field, as they are portrayed in schools and higher institutions, will help us understand the field's social structure, the underlying rules of participation, what is regarded as legitimate computer science identity that restricts other performances and students' engagement with computer science, who determines the rules of participation, the phenomenological experiences of its agents, the relationships between them, their power and how it is enacted (or not), and use these findings to change patterns and rules of participation towards more representatively structures of organisation in computer science fields.

7 LIMITATIONS

One of the limitations of our study is that the literature review focused explicitly on papers around participation and inequalities and not on papers that discuss participation in more general terms e.g., engagement, success factors and achievement. Therefore, the findings should be interpreted under this assumption. Another limitation of the study concerns the included databases. We only included three databases as we regard that these are the most representative for our discipline, but we do acknowledge that we could have extended our research to other databases. However, since we included the most representative databases, we believe that the issues we describe are accurately depicted and explain why inequalities in participation are still a major problem today.

8 CONCLUSION

In this paper, we investigated the issue of inequalities in participation by adapting sociological lens and particularly, Bourdieu's notion of capital, habitus, and field. The paper provides a theoretical framework for understanding inequalities in participation in computer science and its explanatory power stems from Bourdieu's theory of social reproduction which was applied to extend our understandings of how and why inequalities occur and persist in computer science fields and to suggest new research directions.

Through a systematic literature review and by bringing a theoretical lens from Bourdieu's theory of social reproduction and particularly to Bourdieu's main constructs of capital, habitus, and field, we demonstrated first, how the factors affecting participation constitute capital forms (cultural, social and psychological capital) that individuals possess to leverage within the computer science field and second, how students' views and dispositions towards computer science and scientists as well as students' affective constructs are stemming from their habitus which prohibits their successful integration in computer science fields. Having established this alignment between Bourdieu's theory and inequalities in CS participation, we demonstrated that participation is barely a matter of disconnected factors, but it is indeed a complex phenomenon. Subsequently, we suggested that because most interventions do not consider the issue holistically and not in formal school settings, the reported benefits do not continue in the long-term which reproduces the problem. Indeed, interventions should continue to encourage and support individuals to develop their computer science capital but, extra-curricular short-term interventions that target only some of its components, will not reach their full potential (tackling inequalities in participation); these interventions are likely to be inadequate to provide individuals with the necessary resources (other than computer science literacy) to navigate through the adversities of computer science fields and this is due to two main reasons. Firstly, restructuring aspects of students' habitus (both cognitive and affective) so as to be more positively oriented towards computer science, requires interventions that span across a long period of time, mainly because habitus is resistant to change and secondly, because attempts to accommodate or re-construct aspects of students' habitus while retaining the strict, pathologized structure of computer science fields which do no accord agency to all students, will limit their potential.

The alignment between Bourdieu's theory and participation in computer science, and particularly his focus on the interface of capital, habitus, and field made us consider that the structural organisation of computer science fields, the role of its different agents, and more generally the rules of participation and the definition of legitimate identity in computer science, are all issues that have not been investigated much in computer science education. In our paper, we advocate the necessity of future research to consider computer science class as a field of power struggles and students' engagement with computer science as a form of practice produced at the interface of habitus, capital, and field.

Therefore, we suggest that to change the equity and participation issue in computer science significantly, there is an imperative need to begin by re-structuring the computer science field and the rules of participation as well as considering building holistically students' computer science capital within the field. As such, we believe that the Bourdieusian lens and more generally, sociological lens, will give us a better understanding of how and why inequalities persist and reproduced in computer science fields and why specific groups are side-lined from computer science fields even though wide-ranging initiatives are in place.

REFERENCES

[1] Nicole A. Buzzetto-More, Ojiabo Ukoha, and Narendra Rustagi. 2010. Unlocking the Barriers to Women and Minorities in Computer Science and Information Systems Studies: Results from a Multi-Methodolical Study Conducted at Two Minority Serving Institutions. *Journal of Information Technology Education: Research* 9 (2010), 115–131. https://doi.org/10.28945/1167

[2] Helene Aarseth, Lynne Layton, and Harriet Bjerrum Nielsen. 2016. Conflicts in the habitus: The emotional work of becoming modern. *Sociological Review* 64, 1 (2016), 148–165. https://doi.org/10.1111/1467-954X.12347

[3] Amnah Alshahrani, Isla Ross, and Murray I. Wood. 2018. Using social cognitive career theory to understand why students choose to study computer science. *ICER 2018 - Proceedings of the 2018 ACM Conference on International Computing Education Research* (2018), 205–214. https://doi.org/10.1145/3230977.3230994

[4] Louise Archer, Emily Dawson, Jennifer DeWitt, Amy Seakins, and Billy Wong. 2015. "Science capital": A conceptual, methodological, and empirical argument for extending bourdieusian notions of capital beyond the arts. *Journal of Research in Science Teaching* 52, 7 (2015), 922–948. https://doi.org/10.1002/tea.21227

[5] Louise Archer, Jennifer DeWitt, and Beatrice Willis. 2014. Adolescent boys' science aspirations: Masculinity, capital, and power. *Journal of Research in Science Teaching* 51, 1 (2014), 1–30.

[6] Marta Cristina Azaola. 2012. Revisiting Bourdieu: alternative educational systems in the light of the theory of social and cultural reproduction. *International Studies in Sociology of Education* 22, 2 (2012), 81–95. https://doi.org/10.1080/09620214.2012.700187

[7] Carl W Backman, Paul F Secord, and Jerry R Peirce. 1963. Resistance to change in the self-concept as a function of consensus among significant others. *Sociometry* (1963), 102–111.

[8] Lecia J. Barker, Melissa O'Neill, and Nida Kazim. 2014. Framing classroom climate for student learning and retention in computer science. *SIGCSE 2014 - Proceedings of the 45th ACM Technical Symposium on Computer Science Education* (2014), 319–324. https://doi.org/10.1145/2538862.2538959

[9] Ann Marie Bathmaker. 2015. Thinking with Bourdieu: thinking after Bourdieu. Using 'field' to consider in/equalities in the changing field of English higher education. *Cambridge Journal of Education* 45, 1 (2015), 61–80. https://doi.org/10.1080/0305764X.2014.988683

[10] Jennifer M. Blaney and Jane G. Stout. 2017. Examining the relationship between introductory computing course experiences, self-efficacy, and belonging among first-generation college women. *Proceedings of the Conference on Integrating Technology into Computer Science Education, ITiCSE* (2017), 69–74. https://doi.org/10.1145/3017680.3017751

[11] Pierre Bourdieu. 1977. *Outline of a Theory of Practice.* Number 16. Cambridge university press.

[12] Pierre Bourdieu. 1986. Bourdieu, Pierre. 1986. " The Forms of Capital. " Pp. 241-258 in Handbook of Theory and Research for the Sociology of Education , edited by J. G. Richardson. New York: Greenwood Press. *Handbook of Theory and Research for the Sociology of Education* (1986), 241–258. arXiv:arXiv:1011.1669v3

[13] Pierre Bourdieu. 1993. *The field of cultural production: Essays on art and literature.* Columbia University Press.

[14] Pierre Bourdieu. 1998. *Practical reason: On the theory of action.* Stanford University Press.

[15] Virginia Braun and Victoria Clarke. 2006. Using thematic analysis in psychology. *Qualitative research in psychology* 3, 2 (2006), 77–101.

[16] Sandra Cairncross and Karen Gordon. 2008. Valuing diversity: Development of a student support forum for females. *Proceedings - Frontiers in Education Conference, FIE* (2008), 14–19. https://doi.org/10.1109/FIE.2008.4720299

[17] Jody Clarke-Midura, Vicki Allan, and Kevin Close. 2016. Investigating the role of being a mentor as a way of increasing interest in CS. *SIGCSE 2016 - Proceedings of the 47th ACM Technical Symposium on Computing Science Education* (2016), 297–302. https://doi.org/10.1145/2839509.2844581

[18] Diane Codding, Chrystalla Mouza, Rosalie Rolón-Dow, and Lori Pollock. 2019. Positionality and belonging: Analyzing an informally situated and culturally responsive computer science program. *ACM International Conference Proceeding Series* (2019), 132–135. https://doi.org/10.1145/3311890.3311909

[19] James Collins. 2009. Social reproduction in classrooms and schools. *Annual Review of Anthropology* 38 (2009), 33–48. https://doi.org/10.1146/annurev.anthro.37.081407.085242

[20] Peggy Doerschuk, Jiangjiang Liu, and Judith Mann. 2011. INSPIRED High School Computing Academies. *ACM Transactions on Computing Education* 11, 2 (2011), 1–18. https://doi.org/10.1145/1993069.1993071

[21] Wendy Doubé and Catherine Lang. 2012. Gender and stereotypes in motivation to study computer programming for careers in multimedia. *Computer Science Education* 22, 1 (2012), 63–78. https://doi.org/10.1080/08993408.2012.666038

[22] Sally Fincher, Sebastian Dziallas, and Daniel Knox. 2019. Space, Place and Practice in Computing Education. In *Proceedings of the 1st UK & Ireland Computing Education Research Conference.* 1–7.

[23] Kathy Garvin-Doxas and Lecia J. Barker. 2004. Communication in Computer Science Classrooms: Understanding Defensive Climates as a Means of Creating Supportive Behaviors. *ACM Journal on Educational Resources in Computing* 4, 1 (2004), 2. https://doi.org/10.1145/1060071.1060073

[24] Spela Godec, Heather King, Louise Archer, Emily Dawson, and Amy Seakins. 2018. Examining Student Engagement with Science Through a Bourdieusian Notion of Field. *Science and Education* 27, 5-6 (2018), 501–521. https://doi.org/10.1007/s11191-018-9988-5

[25] Richard K. Harker. 1984. On Reproduction, Habitus and Education. *British Journal of Sociology of Education* 5, 2 (1984), 117–127. https://doi.org/10.1080/0142569840050202

[26] Mathieu Hilgers and Eric Mangez. 2014. Introduction to Pierre Bourdieu ' s social fields. *Bourdieu's Theory of Social Fields. Concepts and applications* October 2014 (2014), 1–36.

[27] Beryl Hoffman, Ralph Morelli, and Jennifer Rosato. 2019. Student engagement is key to broadening participation in CS. *SIGCSE 2019 - Proceedings of the 50th ACM Technical Symposium on Computer Science Education* (2019), 1123–1129. https://doi.org/10.1145/3287324.3287438

[28] Hyejeong Jo. 2013. Habitus transformation: Immigrant mother's cultural translation of educational strategies in Korea. *Asia-Pacific Education, Language Minorities and Migration (ELMM) Network Working Paper Series. 7.* (2013).

[29] Barbara Kitchenham. 2004. Procedures for performing systematic reviews. *Keele, UK, Keele University* 33, 2004 (2004), 1–26.

[30] Sarah Lee, Jessica Ivy, and Andrew Stamps. 2019. Providing Equitable Access to Computing Education in Mississippi. *Proceedings of the 2019 Research on Equity and Sustained Participation in Engineering, Computing, and Technology, RESPECT 2019* (2019), 12–15. https://doi.org/10.1109/RESPECT46404.2019.8985981

[31] Colleen Lewis, Paul Bruno, Jonathan Raygoza, and Julia Wang. 2019. Alignment of goals and perceptions of computing predicts students' sense of belonging in computing. *ICER 2019 - Proceedings of the 2019 ACM Conference on International Computing Education Research* (2019), 11–19. https://doi.org/10.1145/3291279.3339426

[32] Bernard Longden. 2004. Interpreting student early departure from higher education through the lens of cultural capital. *Tertiary Education and Management* 10, 2 (2004), 121–138. https://doi.org/10.1080/13583883.2004.9967122

[33] Gabriela Marcu, Samuel J. Kaufman, Jaihee Kate Lee, Rebecca W. Black, Paul Dourish, Gillian R. Hayes, and Debra J. Richardson. 2010. Design and evaluation of a computer science and engineering course for middle school girls. *SIGCSE'10 - Proceedings of the 41st ACM Technical Symposium on Computer Science Education* (2010), 234–238. https://doi.org/10.1145/1734263.1734344

[34] Jane Margolis, Rachel Estrella, Joanna Goode, Jennifer Jellison Holme, and Kim Nao. 2008. *Stuck in the shallow end: Education, race, and computing.* MIT press.

[35] Jane Margolis and Allan Fisher. 2002. *Unlocking the clubhouse: Women in computing.* MIT press.

[36] John W Mohr. 2013. Bourdieu's relational method in theory and in practice: From fields and capitals to networks and institutions (and back again). In *Applying relational sociology: Relations, networks, and society.* Springer, 101–135.

[37] Catherine Mooney, Brett A. Becker, Lana Salmon, and Eleni Mangina. 2018. Computer science identity and sense of belonging: A case study in Ireland. *Proceedings - International Conference on Software Engineering* (2018), 1–4. https://doi.org/10.1145/3195570.3195575

[38] Roy Nash. 1990. Bourdieu on Education and Social and Cultural Reproduction. *British Journal of Sociology of Education* 11, 4 (1990), 431–447. https://doi.org/10.1080/0142569900110405

[39] Marina Papastergiou. 2008. Are Computer Science and Information Technology still masculine fields? High school students' perceptions and career choices. *Computers and Education* 51, 2 (2008), 594–608. https://doi.org/10.1016/j.compedu.2007.06.009

[40] Anne-Kathrin Peters. 2017. *Learning computing at university: Participation and identity: A longitudinal study.* Ph.D. Dissertation. Acta Universitatis Upsaliensis.

[41] Elaine M. Power. 1999. An Introduction to Pierre Bourdieu's Key Theoretical Concepts. *Journal for the Study of Food and Society* 3, 1 (1999), 48–52. https://doi.org/10.2752/152897999786690753

[42] Yolanda A. Rankin and Jakita O. Thomas. 2020. The intersectional experiences of blackwomen in computing. *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE* 1 (2020), 199–205. https://doi.org/10.1145/3328778.3366873

[43] Diane Reay. 2015. Habitus and the psychosocial: Bourdieu with feelings. *Cambridge Journal of Education* 45, 1 (2015), 9–23. https://doi.org/10.1080/0305764X.2014.990420

[44] Yolanda J Reimer. 2019. Computer Science in High School: Identifying and Addressing Common Barriers. *J. Comput. Sci. Coll.* 35, 1 (2019), 14–21.

[45] Gabriela T. Richard, Yasmin B. Kafai, Barrie Adleberg, and Orkan Telhan. 2015. StitchFest: Diversifying a college Hackathon to Broaden participation and perceptions in computing. *SIGCSE 2015 - Proceedings of the 46th ACM Technical Symposium on Computer Science Education* (2015), 114–119. https://doi.org/10.1145/2676723.2677310

[46] Silvia Rogošić and Branislava Baranović. 2016. Socialni kapital in izobraževalni dosežki: Coleman: Bourdieu. *Center for Educational Policy Studies Journal* 6, 2 (2016), 81–100.

[47] Monique Ross, Zahra Hazari, Gerhard Sonnert, and Philip Sadler. 2020. The Intersection of Being Black and Being a Woman. *ACM Transactions on Computing Education* 20, 2 (2020). https://doi.org/10.1145/3377426

[48] Corey Schimpf, Kelly Andronicos, and Joyce Main. 2015. Using life course theory to frame women and girls' trajectories toward (or away) from computing: Pre high-school through college years. *Proceedings - Frontiers in Education Conference, FIE* 2015 (2015), 1–9. https://doi.org/10.1109/FIE.2015.7344064

[49] Kimberly A. Scott and Mary Aleta White. 2013. COMPUGIRLS' Standpoint: Culturally Responsive Computing and Its Effect on Girls of Color. *Urban Education* 48, 5 (2013), 657–681. https://doi.org/10.1177/0042085913491219

[50] Mia S. Shaw, Deborah A. Fields, and Yasmin B. Kafai. 2019. Connecting with computer science: Electronic textile portfolios as ideational identity resources for high school students. *International Journal of Multicultural Education* 21, 1 (2019), 22–41. https://doi.org/10.18251/IJME.V21I1.1740

[51] Baruch Shimoni. 2017. What is resistance to change? A habitus-oriented approach. *Academy of Management Perspectives* 31, 4 (2017), 257–270.

[52] Emily Tabb. 2004. Outline and assess Bourdieu ' s explanation of social inequality . (2004).

[53] Suruchi Thapar-Björkert, Lotta Samelius, and Gurchathen S. Sanghera. 2016. Exploring symbolic violence in the everyday: Misrecognition, condescension, consent and complicity. *Feminist Review* 112, 1 (2016), 144–162. https://doi.org/10.1057/fr.2015.53

[54] Larrabee Tracy, Norouzi Narges, Robinson Carmen, and Quynn Jenny. 2020. Successful Interventions to Eliminate Achievement Gaps in STEM Courses. *2020 Research on Equity and Sustained Participation in Engineering, Computing, and Technology, RESPECT 2020 - Proceedings* (2020). https://doi.org/10.1109/RESPECT49803.2020.9272502

[55] Evrikleia Tsagala and Maria Kordaki. 2008. Computer Science and Engineering Students Addressing Critical Issues Regarding Gender Differences in Computing: A Case Study. *Themes in Science and Technology Education* 1, 2 (2008), 179–194. http://search.ebscohost.com/login.aspx?direct=true{&}db=eric{&}AN=EJ1131324{&}site=ehost-live

[56] Steven Martin Turnbull, Kane Meissel, Kirsten Locke, and Dion R.J. O'Neale. 2020. The Impact of Science Capital on Self-Concept in Science: A Study of University Students in New Zealand. *Frontiers in Education* 5, April (2020), 1–16. https://doi.org/10.3389/feduc.2020.00027

[57] Loïc Wacquant. 2004. Following Pierre Bourdieu into the field. *Ethnography* 5, 4 (2004), 387–414. https://doi.org/10.1177/1466138104052259

[58] Jennifer Wang, Hai Hong, Jason Ravitz, and Marielena Ivory. 2015. Gender differences in factors influencing pursuit of computer science and related fields. *Annual Conference on Innovation and Technology in Computer Science Education, ITiCSE* 2015-June (2015), 117–122. https://doi.org/10.1145/2729094.2742611

[59] Jen Webb, Tony Schirato, and Geoff Danaher. 2001. *Understanding bourdieu*. Sage.

[60] Joanna Weidler-Lewis, Wendy Dubow, and Alexis Kaminsky. 2017. Defining a discipline or shaping a community: Constraints on broadening participation in computing. *Proceedings of the Conference on Integrating Technology into Computer Science Education, ITiCSE* (2017), 627–632. https://doi.org/10.1145/3017680.3017776

[61] Timothy J. Weston, Wendy M. Dubow, and Alexis Kaminsky. 2019. Predicting women's persistence in computer science- And technology-related majors from high school to college. *ACM Transactions on Computing Education* 20, 1 (2019), 1–16. https://doi.org/10.1145/3343195

[62] Nico Wilterdink. 2017. The Dynamics of Inequality and Habitus Formation . Elias , Bourdieu , and the Rise of Nationalist Populism Author (s): Nico Wilterdink Source : Historical Social Research / Historische Sozialforschung , 2017 , Vol . 42 , No . 4 (162), Changing Power R. 42, 4 (2017).

[63] Michalinos Zembylas. 2007. Emotional capital and education: Theoretical insights from Bourdieu. *British Journal of Educational Studies* 55, 4 (2007), 443–463. https://doi.org/10.1111/j.1467-8527.2007.00390.x