

CASE STUDY

Reflections on Designing and Delivering an Online Distance Learning Programme in the Mathematical Sciences

Eilidh Jack, School of Mathematics and Statistics, University of Glasgow, Glasgow, United Kingdom. Email: Eilidh.Jack@glasgow.ac.uk

Craig Alexander, School of Mathematics and Statistics, University of Glasgow, Glasgow, United Kingdom. Email: Craig.Alexander.2@glasgow.ac.uk

David McArthur, School of Mathematics and Statistics, University of Glasgow, Glasgow, United Kingdom. Email: David.Mcarthur.2@glasgow.ac.uk

Colette Mair, School of Mathematics and Statistics, University of Glasgow, Glasgow, United Kingdom. Email: Colette.Mair@glasgow.ac.uk

Abstract

In 2013, the University of Glasgow set out a Blended and Online Learning Development scheme focussing on fully online distance learning programmes and blended programmes. In 2017 the School of Mathematics and Statistics within the University of Glasgow developed part-time, online distance learning programmes (PG Diploma/PG Certificate/MSc) in Data Analytics. The programmes have used considerable innovation in terms of course content, assessment, course management and delivery, and in student support. In this case study, we will reflect our experiences of developing and delivering online distance learning programmes and provide future recommendations considering the recent expansion of remote learning across higher educational institutes globally.

Keywords: Blended and Online Learning, Data Analytics, Learning Technology.

1. Introduction

In response to the University of Glasgow's Blended and Online Learning Development scheme, the School of Mathematics and Statistics within the University of Glasgow developed part-time, online distance learning (ODL) programmes (PGDip/PGCert/MSc) in Data Analytics and an online distance learning MSc/PGDip/PGCert in Data Analytics for Government programme in collaboration with the Office for National Statistics tailored for public sector organisations (Office for National Statistics, 2022). The programmes' targeted audience comes from all over the world, is already in employment and has professional experience from a variety of sectors. Furthermore, the programme is accessible to students coming from a broad range of backgrounds, educational experiences, and levels of knowledge in programming, mathematics, and statistics. Our students also tend to be older and more likely to have caring responsibilities, when compared to traditional on-campus undergraduate and postgraduate programmes. These characteristics, along with large time-zone differences, present unique challenges when designing and delivering a programme of this nature and developing a teaching style to meet the needs of such a varied audience is continually of high importance.

The aim of this paper is to share our lived experience of designing and delivering an ODL programme over 5 years, providing valuable insight to others who are considering

launching, or have recently launched, ODL programmes in Mathematical Sciences. We will discuss the learner characteristics and expectations of students who have studied on our programme, and the key design principles that have shaped our programme. We will also discuss some of the learning technologies we have adopted, student experiences of these, and the vital role a learning technologist should play in the development of an ODL programme. Finally, we will highlight some of the challenges we have faced and discuss potential solutions to mitigate these.

2. Learner characteristics and perceptions

Factors that influence a student's choice to study online, as opposed to being forced to study remotely, for example during the COVID-19 pandemic, include age, education history, employment and personal commitments, suggesting that the nature and demands of online learning is different to that of on-campus learning with a greater emphasis on self-directed learning for online students (Roddy *et al.*, 2017). During the 2020/21 academic year, we conducted a small study to understand student demographics and perceptions of online learning. Ethical approval for the study was granted by the College of Science and Engineering ethics committee (application number 300200272). Here, we present the results from 21 of our online distance learning students.

The median age of students was 34 and ranged between 24 and 56. 29% of students identified as female, 67% identified as male while 4% preferred not to respond. 81% of students worked full time and the remaining 19% worked part time while studying. 48% of students identified as having caring responsibilities, 48% did not identify as having caring responsibilities and the remaining 4% preferred not to answer. 43% identified as British, 33% European, 10% North American, 5% South American, and 5% Asian while 4% preferred not to respond. Although these statistics are for a self-selected sample of students registered on our programme, from our experience these demographics are reasonably representative of our ODL student population (unpublished data).

To determine students' learner characteristics and perceptions of online learning, the Online Learning Readiness Scale (OLRS) (Hung, Chen and Own, 2010) was used, alongside some open-response questions. The OLRs consisted of 18 5-point Likert scale questions ranging from strongly agree, agree, neutral, disagree and strongly disagree. The responses to these questions are presented in Figure 1.

95% of students strongly agreed that they were open to new ideas and 90% of students strongly agreed that they were motivated to learn. This contrasts with a study conducted by Pearson and Wonkhe (2020) who surveyed 3,500 students who experienced remote learning during the COVID-19 pandemic and found that 71% said they would struggle with motivation to learn. Reassuringly, 100% of students either agreed or strongly agreed that they were confident performing basic functions, managing software, and using the internet. Most students were also confident in self-directed learning, with 75% or more agreeing or strongly agreeing that they can carry out their own study plan, manage time well, set learning goals and have high expectations of learning performance. Again, this contrasts with findings from Pearson and Wonkhe (2020) who found that half of respondents would have difficulty managing time and keeping track of everything. We believe that these characteristics of our ODL students are crucial to their success on the programme and distinguish them from a more traditional learner. However, 15% of students disagreed that they have confidence posting to online discussions or seeking help when faced with learning problems and 30% of students either disagreed or strongly disagreed that they were not distracted by other online activities.

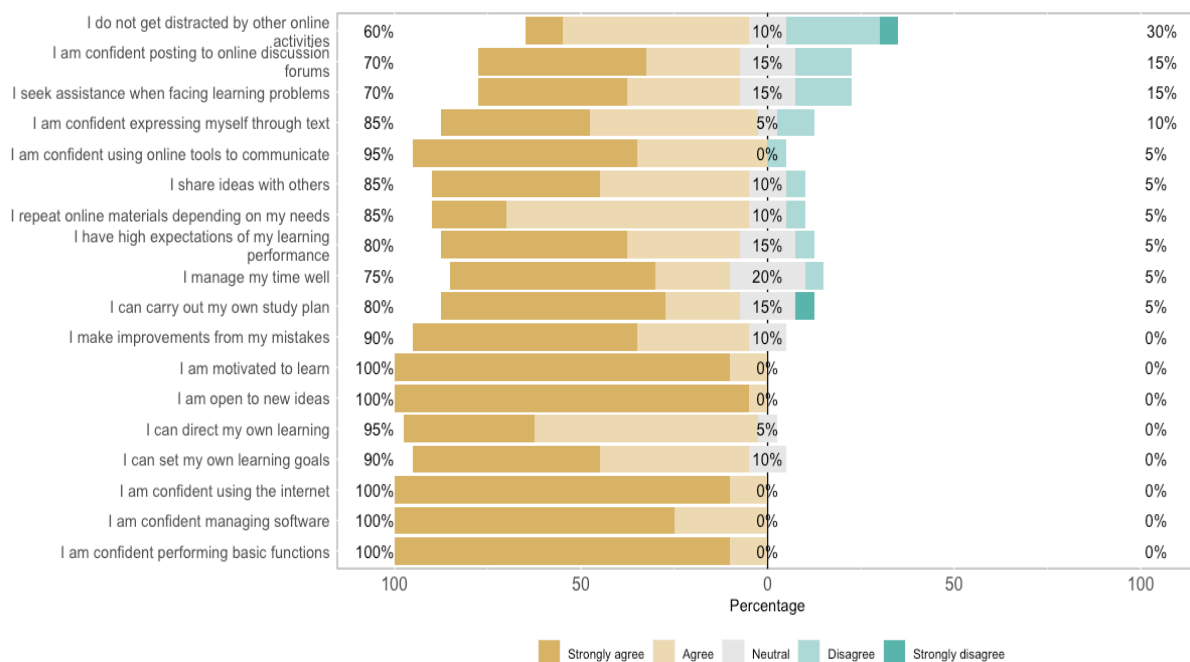


Figure 1. Summary of the results from the Likert scale questions from the Online Learning Readiness Scale. Percentages given on the left-hand side indicate the percent who either agreed or strongly agreed, the percentages given in grey indicate the percent of neutral responses and the percentages given on the right-hand side indicate the percent who either disagreed or strongly disagreed for each question (given on the x-axis).

Students were also asked the following open questions:

- What aspects of online learning did you like? Please explain why.
- What aspects of online learning did you dislike? Please explain why.
- Do you feel elements of online learning contributed to your performance in courses (positively or negatively)?

We have summarised student responses using thematic analysis to identify key themes. Categories were identified based on descriptive coding and then collated into meaningful themes (Saldana, 2021).

Theme 1: Freedom and flexibility

Students commonly noted the flexibility of online learning made their learning possible. They didn't have to travel or commit to a full-time on-campus programme. Students commented on their work-life balance. For the most part, students noted that being able to set their own timetable made it possible to study while working.

"I liked not having to travel and the flexibility that online learning offers. It helps with work life balance."

Theme 2: Assessments

All courses in this programme are continuously assessed. Students noted the importance of providing the assessment dates and when course materials would be available in advance to help them organise their schedule. The continuous nature of assessment may have acted as a reassurance to students, especially within an online setting.

“The dates for assignments, dates for release of course material, course agenda, etc are very important (and these were communicated well) because with the distance, and also part-time nature of the course meant that it’s really important to feel organized”

Theme 3: Connection and interaction

Most students commented that while the freedom and flexibility around online distance learning made further education possible for them, the interaction, or lack of, with their peers and lecturers created additional barriers in comparison to learning on-campus. Generally, communicating remotely may not have been as effective as in-person. Students also noted that discussing problems online or over email was not always effective.

“I sometimes didn’t understand a topic and tended to skim past it. This may have been the same on-campus as well, but the distance / lack of people to talk to probably didn’t help”

Theme 4: Learning material

Students noted that the weekly learning material was the main connection to the programme. Students commented on the structure of the learning materials, usually a PDF with embedded tasks and short videos that explain the main concepts and relevant examples. Several students noted that due to their work commitments or local time zone, they could not attend any synchronous sessions but found the recordings useful.

“I found the mixture of modalities to be very helpful. The text is a must for understanding the mathematics, but online lectures are also really useful.”

Although we have identified some common learner characteristics and elements of our programme which have contributed to positive experiences and success for our students, it is equally important that we have identified areas for further consideration. In particular, some students identified hesitancy in seeking help or posting to online forums and there was a general feeling of lack of interaction with peers and staff. This will be discussed further in section 5.

3. Design principles and considerations

Planning, preparation, and development of a successful online programme takes time, with each course requiring an estimate of between 6-9 months (Hodges et al, 2020), or over 100 hours’ design time (Kolowich, 2013). It is also important that online learning is supported in online pedagogy and that design principles not only align intended learning outcomes with content delivery, assessment, and activities but also build in opportunities for interaction with instructors and students. Some of the key design principles considered when designing this online programme are discussed below.

Given the expected audience for this programme, incorporating as much flexibility as possible was fundamental. Global Online Academy (GOA) (2020) reported that 82.54% of their summer

programme students want flexibility and 58.92% want asynchronous experiences in their online courses, with only 0.38% and 2.89% hoping these elements wouldn't be a focus, respectively. Our fully accessible course material (see section 4) is released in two-week blocks, and is asynchronous, allowing our students to study at a time that suits them and work ahead if desired.

Our assessment structure is also designed with flexibility in mind, with most courses being assessed fully by various pieces of work during each course (continuous assessment), including online quizzes, written reports, programming assignments, and mini-vivas. Deadlines for assessments are generous, with a minimum of 10 working days between an assessment being released and the submission date for most assessments. Assessment and feedback calendars are also published for each course individually in advance of the courses beginning to allow students to plan their schedule around these deadlines.

We know how important it is for students to feel connected and supported throughout their university journey, and this is no different for our online students (Wilcox, Winn and Fyvie-Gauld, 2005). GOA (2020) reported that 93.47% of their online learners expected to feel connected with academics, and 83.17% expected to feel connected with their peers. We have a variety of different methods for interaction. These include regular, optional live sessions which allow lecturers and students to discuss the course material and go through some of the practice tasks as a group; one-to-one appointments that students can book with a course lecturer to discuss individual questions, and discussion forums where students are encouraged to discuss concepts from the weekly material with one another. Students are also encouraged to set up informal methods of communication with one-another (e.g. WhatsApp) and peer study sessions. However, in our experience this is best done organically and driven by the students themselves, rather than forced upon them. Another key connection which should not be overlooked is that of the student-academic adviser relationship. Regular, early contact with an academic adviser can be imperative in student retention and in the potentially isolating world of online distance learning, the importance of pastoral care should not be overlooked (Hilliam and Williams, 2019).

The key design principles listed above align with the Universal Design for Learning (UDL) framework (Meyer, Rose and Gordon, 2014) which aims to address the variability found in student's learning and provide a learning environment that allows for successful learning for all students. It is based on three main principles: Multiple Modes of Representation, Multiple Means of Action, and Multiple Means of Engagement. Based on these three principles, curriculum design would provide multiple ways to allow learners to acquire information, demonstrate their knowledge and motivate them to learn. Although UDL has not been specifically developed for designing online courses, the fundamental concept of UDL to incorporate different modes of learning into course design to allow all learners to flourish is essential for a successful online programme given the diverse learners that these courses attract.

4. Importance of a learning technologist

Digital technologies are now an integral part of the student experience and have been promoted as having the potential to transform teaching and learning (Conole, 2014). When designing ODL programmes, integration of technology enhanced learning approaches is common and most often

necessary for such programmes to succeed (Zhang and Nunamaker, 2003). For learners engaging in online learning, it is important to consider the two concepts of the “digital visitor” and the “digital resident”, as proposed in White and Le Cornu (2012). Online learning requires effective engagement from the learner, and utilising appropriate technology enhanced learning and teaching (TELT) methods to assist with the learning experience of both the digital visitor and resident.

With the growth of digital technologies in teaching, and a specific focus on building digital capability and developing digital practice in further education and higher education from Jisc (Jisc, 2020), there has been a focus on pedagogy based academic support roles such as learning technologists (Englund, Olofsson and Price, 2017). The learning technologist role involves supporting the active use of technology for learner engagement and to expand the range of learning and assessment opportunities, though the role can incorporate other factors such as streamlining of administrative tasks (Oliver, 2002). Since the inception of this ODL programme, the learning technologist has played a key role in the development of learning technologies implemented on the programme. The tools mentioned below would only have been possible with the technical expertise of the learning technologist. Many academic teaching staff lack the technical expertise and time required to develop such tools, highlighting the importance of the skill set of the learning technologist to provide bespoke teaching technologies. We conducted a small survey of lecturers in 2020 to assess preparedness for online teaching and only 43% of respondents agreed that they were prepared for online teaching while only 36% of respondents agreed that they understood the university’s accessibility policies. Ethical approval for the study was granted by the College of Science and Engineering ethics committee (application number 300200272).

Within our asynchronous course notes, we provide students with short lecture-style videos which provide an illustrative description of the materials that follow. These videos are developed within our bespoke recording studio using our custom built “light board”, developed by the learning technologist, which consists of a glass board which faces the camera. This setup allows the lecturer to write solutions to a problem while directly facing the camera, avoiding the need to turn to face a board. This recording is then flipped so that the text is facing the correct way. See for example:

<https://www.youtube.com/watch?v=b6R79xKUcZc&t=189s>

This approach is useful for working through structured equations and diagrammatic explanations (McCorkle and Whitener, 2020). A short study was carried out to gather students’ impressions of the light board content, finding similar outcomes to Southard and Young (2018) that students like the contextualised problems often shown in these videos and a preference for this delivery style over alternative formats.

Both digital accessibility and UDL focus on inclusive educational practices. This can raise several challenges in terms of learning material design. Some common issues which can occur are consistency in course materials across a programme, interpretation of figures, reading and typesetting of equations, and choice of colour palettes for plotting. Our course materials are provided to students in both a PDF format and a recently developed accessible HTML format:

https://bold-web.maths.gla.ac.uk/mdatagov/assets/pdfs/sample_materials/PSF_week8_samp.pdf

<https://bold-web.maths.gla.ac.uk/mdatagov/assets/html/week-8.html>

These notes are split into weekly units and contain full written explanations of weekly topics, worked examples, additional practice tasks and pre-recorded lecture videos. Both formats are created using a bespoke formatting tool developed by the learning technologist which allows the integration of

mathematical typesetting, inclusion of statistical programming code and output, and incorporate our unique ODL programme branding. The accessible HTML notes include a sidebar with a table of contents to facilitate easy navigation and solutions embedded in with tasks to avoid excessive scrolling to the end of the document. Accessible features such as colour scheme, word and line spacing, and word size are available in an options pane which allows the student to modify the notes to their requirements. Though this tool is designed specifically for the programme, there exist tools such as RMarkdown (Allaire et al. (2022)) which create HTML formatted notes which can incorporate some of the accessible features mentioned above. An initial study shows that students enjoy the tidier layout of these notes, attaching task solutions to the task and contents menu useful additions for study. Features such as colour theme and font size are used regularly by students (McArthur et al, 2022). Displaying appealing material facilitates learning, especially for ODL students who rely on written material as their principal source of learning. Both sets of materials have been designed to include features that focus on simplicity and can be widely used by all students. The study also found that students use both formats for personal study, favouring the PDF for personal annotation, and the adaptability of the HTML notes for different modes of study using different device types such as tablets and mobile devices.

5. Challenges and suggestions

This paper has discussed the experiences of designing and delivering a successful ODL programme. We will conclude with a discussion of the main challenges we have faced and some suggestions for those who have recently launched, or are considering launching, an ODL programme in the mathematical sciences.

Firstly, as identified in section 2, some emerging themes from our cohort when asked specifically about interaction included a feeling of no community, not seeing friends, lack of interactions, no communication with peers, no connection with peers and no connection with lecturers. This is not unique to our ODL programme and lack of interaction has been identified as a major barrier to the success of such online distance learners (Muilenbury and Berge, 2005). Creating a sense of community with online students can improve success and retention in online programmes (Berry, 2019). In online distance learning programmes, instructors also identified community beyond course work as important for student success (Bolliger, Shepard and Bryant, 2019). In our experience, frequent live sessions, offering one-to-one support and lecture-style videos where students can see the course lecturer can help to build relationships between learners and lecturers. It is also essential to provide pastoral care through an academic adviser. Learner to learner interaction can be harder to control and, in our experience, should be allowed to happen organically, rather than forced. However, there are areas where this can be facilitated, such as encouraging students to introduce themselves at the beginning of the programme via a student forum, encouraging students to respond to each other's posts, facilitating peer-to-peer study sessions and engaging with a class representative.

The time and effort required to develop and run a successful online distance learning programme should not be underestimated. Creating high quality online material for a diverse audience can be time consuming. Student retention can also be challenging, particularly in the first few months of the programme due to misalignment with student expectations often related to time management. We have found that early, frequent contact can get students on track and that creating similar routines that face-to-face students experience, for example weekly release of course material and optional live sessions, can help students to manage their time and create their own study plan.

Online learning has never been more topical since the COVID-19 pandemic forced many programmes usually delivered face-to-face to be delivered online. Although interest in online learning was increasing pre-pandemic (University Business, 2017), online learning platform Coursera's 2021 Impact Report showed more than 20 million new learners registered for courses in that year globally - equivalent to total growth in the three years pre-pandemic (Coursera, 2021). This has led to a more competitive market in ODL programmes. It has also raised discussions as to whether the pandemic has lowered the quality or perception of online learning (Bates, 2022). It is therefore imperative that ODL programmes are carefully designed and supported in online pedagogy so as not to reinforce this negative perception.

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