



Changing times, changing pedagogies

eSTEEeM Final Report

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Executive Summary

The aim of the project was to investigate any lasting impact on how mathematical sciences courses are now taught following the rapid shift in teaching practices during the pandemic. The project investigated whether the online practices and approaches first implemented during the Covid19 pandemic were continued to be employed and whether they had evolved or whether they had been dismissed in favour of a return to more traditional methodologies.

A questionnaire was sent to all mathematical sciences departments in the UK during June 2023 of which 13 responded with comprehensive comments.

Whilst all institutions rapidly innovated to move their teaching and student support online, with many initiatives shared through TALMO, by 2022/23 almost all teaching and support sessions had reverted to in-person delivery. Though the number of respondents to the questionnaire is limited they span a range of universities and provide a consistent set of responses. The only changes which had remained are the use of pre-recorded lecture materials, even though the questionnaire respondents noted the lack of meaningful engagement of students with these recordings, alongside the use of online quizzes which many departments used in assessment methods. Although the project had hoped to identify how changes to online learning had affected the pedagogic way in which mathematical sciences departments approached their teaching and course design, what the survey in fact revealed was that departments reverted

to pre-covid pedagogic with the addition of recordings and quizzes. Perhaps in time the greater portfolio of resources developed during the pandemic will influence course design, particularly as the results here note that student preparedness to study and engagement is currently less than pre-pandemic levels and therefore this aspect of student support needs to be addressed during the years to come.

Aims and scope of the project

During March 2020 there was a high degree of change in the higher education learning and teaching of the mathematical sciences. With the onset of Covid19, universities needed to rapidly adapt their to teaching to an online environment. To support this, novel tools, approaches and ideas were developed across institutions. Within the mathematical sciences, some of these were shared, many from colleagues at the OU, through the TALMO series of events arranged by Grove, Hilliam & Houston (www.talmo.uk), however there was limited work, outside of the OU, which explored the impact of online teaching both for practitioners and students.

As universities moved beyond the need to deliver remote learning there were lessons to be learnt in terms of the pedagogy around theories of learning in the mathematics sciences. This project aimed to explore the potential conflict in HEIs between new methodologies versus the practical elements of teaching and how effective, or otherwise, the resulting learning opportunities were for students. The study investigated whether the online practices and approaches first implemented during the Covid19 pandemic continued to be employed, whether they evolved or were dismissed in favour of a return to more traditional methodologies, and importantly, the reasons behind these changes.

This project built upon an initial survey by Henley et al. (2021) which explored changes to the assessment practices within the mathematics sciences during the onset of the pandemic. Henley's work found that departments of

mathematical sciences had used a range of different approaches regarding the release of their assessments and identified a concerning issue related to the marked increase in reported instances of academic misconduct as a consequence of the transition to online assessment.

There have been other surveys which have focussed on specific areas of practice. In the case of Alarfaja et al. (2021), they explored the delivery of year 1 calculus and linear algebra during the pandemic. What is of particular interest is how the theory of learning changed due, to as Hodges et al. (2020) phrase it, the *“temporary shift of instructional delivery to an alternative delivery mode due to the crisis circumstances”*. The scope of this project was to ascertain whether the observed shift is indeed “temporary”, and if so, what the reasons are for this and whether there exist barriers to longer-term changes to delivery and support practices within the mathematical sciences. The Special issue: *Restarting the new normal of Teaching Mathematics and Its Applications* (Gillard et al., 2021) provides a starting point for collating how this shift affected mathematical sciences department and evidenced the desire within the mathematical sciences to explore it.

This work reported here provides insight into how the pandemic affected the ways in which departments subsequently provided teaching, learning, assessment and support for the mathematical sciences. It explored whether the online practices and approaches first implemented during the Covid19 pandemic continued to be employed and whether they had evolved or whether they were dismissed in favour of a return to more traditional methodologies. The

study provides a baseline for how practices have changed or otherwise and can be used as a foundation for future investigations.

Activities

The aim of the project was to design and pilot a questionnaire which could be used as the baseline for a five-year longitudinal study to investigate the impact of the rapid shift in teaching practices during the pandemic on mathematical sciences departments in higher education institutions and the staff and students who choose to study and work within them. The initial plan was to pilot the questionnaire in 2022 across the UK mathematical sciences higher education sector and analyse the data to establish a baseline for further work.

Unfortunately due to time constraints of the project team the questionnaire design was delayed until Autumn 2022. The initial intention had been to survey all teaching practitioners but in the design of the questionnaire the decision was taken to initially survey Head of Departments and Directors of Teaching. Based on the the results obtained it would then be feasible to follow up any themes that emerged with individual module leaders in a separate study. HREC approval was gained in February 2023, HREC/4616/Hilliam.

The questionnaire was designed to explore whether there exists a legacy for those changes that departments of mathematics made to their teaching and learning in response to restrictions during the Covid-19 pandemic. It aimed to capture whether teaching practices and approaches first introduced during the pandemic remained part of the learning experience for students within mathematical sciences. As background context it was important to gain an understanding of any policies that were first introduced in response to the pandemic in 2020/21, whether these changed during 2021/22 and whether any of these adjustments remained in place through to 2022/23. The questionnaire

then explored approaches which mathematical science departments had taken in 2022/23 when teaching content to students and arrangements for students to consolidate their mathematical learning based upon the taught content. Work by Henley et al, 2022 had explored changes to assessment practices within mathematical sciences during the pandemic and therefore this questionnaire specifically wanted to pick up this theme and explore arrangements for end of module examination and continually assessment components in 2022/23. During many of the TALMO sessions during the pandemic colleagues had expressed the challenges that students faced during the pandemic and how departments had tried to address these. Therefore, the final section of the questionnaire focussed on the general challenges departments felt students might have faced during pandemic-related teaching and the implications for those students with regards their mathematics studies in 2022/23. The full questionnaire can be access via the pdf link below and it should be noted that throughout the questionnaire and subsequent analysis when on-campus provision is referred to, this is taken to mean in-person face-to-face sessions with staff and students both present.



[questionnaire.pdf](#)

The questionnaire was created in Jisc and opened on 12 May. An email was sent to all the Heads of Mathematical Sciences departments on 19th May inviting them to take part in the study and a further email sent to the TALMO mailing list on 30th May, the questionnaire closed on 30th June.

Findings

Background of responses

Thirteen universities responded to the questionnaire. The questionnaire responses were filled in by members of staff who had a responsibility for the oversight of the teaching in their department, with eight responses from the Directors of Teaching or equivalent, one from a Head of Department, one from Head of Education, one from a Head of teaching and learning, one from an exams officer and one from a former Head of School.

Institutional Teaching Strategies and Requirements

Information was requested on any institutional policies or requirements that were first introduced in response to the pandemic and whether any of these adjustments remained in place during 2022/23.

Arrangements from 2020/21 and 2021/22

Respondents were asked whether their institution introduced institutional wide policies in relation to the arrangements of lectures, small group classes and assessment in response to the pandemic in both 2020/21 and 2021/22, the results are summarised in Table 1.

	Yes, which we were required to implement in full	Yes, but we were allowed flexibility in its implementation	There existed no institutional policy or guidance
A1). An institutional policy relating to teaching delivery arrangements of lectures in 2020/21?	4	8	0
A2). An institutional policy relating to teaching delivery arrangements of lectures in 2021/22?	2	10	0
B1). An institutional policy relating to teaching delivery arrangements of small group classes in 2020/21?	2	9	0
B2). An institutional policy relating to teaching delivery arrangements of small group classes in 2021/22?	1	10	0
C1). An institutional policy describing exam or assessment arrangements in 2020/2021?	6	6	0
C2). An institutional policy describing exam or assessment arrangements in 2021/22?	5	7	0

Table 1: Institutional policies in 2020/21 and 2021/22.

Lectures

Most of the respondents reported that in 2020/21 they were not able to deliver in-person large group teaching and suitable alternatives had to be created

which were generally online. There was a mixture of synchronous online lectures and asynchronous recordings provided. However, two institutions were required to deliver face-to-face teaching with a minimum of two hours of face-to-face teaching per week with social distancing restrictions. In both cases this proved to be difficult and the majority if not all the teaching at each of these institutions moved online.

By 2021/22 whilst national social distancing restrictions were eased and fully removed during the Autumn the majority of institutions still had restrictions and in-person large group teaching remained limited. In the majority of cases even where live classes were permitted these had to be recorded or live-streamed for students who were unable to attend. In some cases the lectures were delivered in a hybrid mode with students able to attend in-person or online.

Small group classes

In some cases small group in-person teaching was still permitted in 2020/21 though social distancing measures were in place and many institutions had to provide an online equivalent for any student who required to isolate. The majority of the respondents had fully online small group classes, via Zoom or an equivalent. These measures remained in place during 2021/22 with only one institution reporting that they were mostly able to return to full in-person classes.

Examination and assessment

All institutions reported that online examinations were introduced. There were differences in the time allowed in 2020/21, most of the institutions had a 24 hour

submission window and in many cases this submission window was reduced in 2021/22 to a 3 hour timed open book exam, though this varied between institutions.

Arrangements for 2022/23

Respondents were asked to consider the implications of any institutional policies which affected teaching, learning assessment and student support in their department in 2022/23 which were a legacy of changes made to policies during Covid19.

Large group tuition (lectures)

The majority of respondents indicated that lectures were back to the pre-covid face-to-face norms. In all these responses lecture capture was now expected for students and many of the respondents note that recordings which had been created during the pandemic could also be made available for students. Within the lectures one respondent commented on a greater use of tools such as Vevox and Padlet to engage large classes during sessions, with a further respondent noting that there was greater enthusiasm for flipped learning.

Small group tuition (tutorials, example classes)

All the respondent reported that small group tuition had returned to pre-pandemic norms, with only one institution commenting that students expected there to be an online alternative and a further noting that online classes could be delivered if these were deemed to be appropriate.

Format of assessments (pen and paper exams, online exam, non-exam assessments)

Ten out of the thirteen respondents reported that where mathematics courses had in-person examination pre-pandemic these had returned in 2022/23.

However, there was a clear indication that where continuous assessment had previously been submitted via hard copies these were now submitted electronically. Other innovations which had resulted from the changes during Covid19 included the use of a single pre-prepared sheet of A4 paper on which students could write anything they deemed to be appropriate to take into the exam, together with an increased duration for in-person exams which were initially introduced to mitigate students' lack of experience with in-person exams. Of the three institutions which had not returned to in-person exams, two noted that whilst they would like to return to in-person exams these were no longer permitted by their institution with one noting in-person exams were now considered to be unauthentic and students were given an open book examination to complete at home which had resulted in very high reports of plagiarism. The third institution reported online assessments still existed for years 3 and 4.

Rules regarding assessment (deferrals, resits)

In all but one case there was no change from the pre-covid regulations. In one institution a right to remedy failure, deferral of examination and self-certification policy had been introduced, it was noted that this had significant workload implications for staff as the systems did not support all assessments and manual interventions had to be made.

Student regulations

All respondents except one reported that student regulations had returned to pre-pandemic norms, with the exception noting that students had been advised that attendance was not mandatory.

Delivery arrangements for mathematical content

Respondents were asked about the approach their department took to delivering new mathematical taught content to students, together with their arrangements for students to consolidate their mathematical learning based upon the taught content.

Methods for delivering new mathematical content in 2022/23

It is noticeable that of the thirteen respondents, ten reported that all modules used live in-person lectures (Table 2). Only five respondents reported that live lectures were delivered synchronously. The return to pre-pandemic lectures, given the large shift during the pandemic, is particularly striking. The only permanent change appears to be the release of pre-recorded lecture-based material which was either recorded specifically for 2022/23 or previously recorded.

	We do not use at all	Some modules use	Most modules use	All modules use
Live in-person lectures delivered face-to-face	0	1	2	10
Live lectures delivered synchronously online	8	5	0	0
Release of pre-recorded lectures and lecture-based material that was primarily recorded in a previous academic year	1	12	0	0
Release of pre-recorded lecture-based material but recorded <u>specifically</u> for this 2022/23 academic year	2	8	2	1
Provision of asynchronous material (e.g. lecture notes).	0	0	7	6

Table 2: New mathematical content in 2022/23

The reasons behind the switch back to in-person lectures is highlighted by respondents when they were asked if there were particular challenges with delivering new content online. Such challenges included; lack of interaction, a difficulty of being able to read the room and students (and staff) not possessing the necessary IT equipment to appropriately engage with the online content. One respondent notes there had been examples of students accessing online lectures on mobile phones, though several respondents noted that their institutions provided funds for equipment such as Chromebook or loaned laptops to students whose IT provision at home was insufficient. There were also comments regarding instable internet connections which made synchronous teaching difficult. There were several comments around students not engaging with pre-recorded lecture material or other asynchronous content (such as VLE

quizzes) particularly when lecture notes were provided in almost all cases. A number of respondents commented on a lack of appropriate teaching facilities and software, plus concerns around lack of staff time, technical skills and presentations skills to make good asynchronous content.

Whilst many of these concerns relating to technical skills and equipment could be solved with training and provision, there remained a problem of how to engage students outside of in-person teaching. Only one respondent noted that the pandemic had given them an opportunity to improve their use of discussions boards which they now use to better effect with more engagement from students. One of the few areas where institutions have continued to routinely use resources that were developed during the pandemic is the use of online quizzes.

Methods for providing mathematical support sessions in 2022/23

In the questionnaire a blended approach was defined to mean a combination of online and on-campus sessions that are accessed by all students in the cohort, whereas a hybrid approach was defined to mean some students access the on-campus provision whereas others may choose to access the online components only.

	Face-to-face and in-person	Online only	Blended approach	Hybrid approach
Problem or example classes and/or module-based tutorials (Opportunities for students to consolidate and practise their mathematical learning)	12	0	1	0
Non-module related tutorials (Regular meetings, between a small group of students and a designated academic tutor for them to discuss either academic matters not associated with a particular module or pastoral issues)	7	0	1	5
Computer Laboratories	9	1	1	1
Workshops (Students collaborating on group-based tasks or exercises)	10	0	1	1

Table 3: Mathematical support in 2022/23

As with the content delivery the majority of respondents have also returned to in-person support (Table 3). When asked if their approach for 2022/23 was informed by their experiences during the pandemic it is clear that the return to in-person teaching and support was primarily due to students not engaging with teaching or support online during the pandemic. One respondent reported on various student experience projects that were run during the pandemic at their institution. Their results from the projects suggested formally timetabled in-person sessions generated independent learning with peers, but it was important that the in-person sessions were complemented by online materials

which had a very clear structure, whilst small group online sessions did not work at their institution and were not engaging. Several institutions reported that the pandemic had enforced the idea that students must be together in a physical room led by a figurehead and that students would not ask questions in online sessions, particularly if the session was recorded. One institution noted that many courses now delivered computer labs online and have supplementary pre-recorded videos. These worked well for displaying code and reduced capacity issues in lab rooms which had previously required many repetitions of poorly attended labs.

Examinations and Assessments

Continuous Assessment

Respondents were asked about changes they had made to the number of coursework-only modules that were available to students in 2022/23. Only two out of eleven respondents said the number had increased, but one of these noted that the number had increased due to a curriculum review and not changes during the pandemic.

In addition, respondents were asked if the overall contribution or weighting of continuous assessment components had altered. Again, the majority of respondents indicated that whilst this changed in many cases during the pandemic, the weighting had returned to pre-pandemic levels. Only two institutions mentioned an increase, one of these was specifically around there being more project-based work early in the course and the other noted that

whilst the weighting had increased for some courses, most of the honours courses were still primarily exam based.

What had changed in about half the institutions was the way in which the assessments were submitted, with an increase in electronic submissions and marking. In addition there was also an increased use of online quizzes, with one respondent noting that the complexity of several of the computer-marked quizzes had increased from simple multiple choice questions.

Examinations

Where the assessment of modules were final written exam, respondents were asked what form these took (Table 4).

Invigilated	12
Fully closed book	12
Fully open book	3
Partially open book	2
Hand-written examination	9
Computerised test	2

Table 4: Examination types

The 12 respondents with invigilated exams were also exams which were held face to face. Two respondents said their exam practices had changed since the pandemic with a further 6 reporting their practice had partially changed and

five respondents reporting there had been no change. The changes included students being permitted to take in a given number of pages of handwritten notes, one institution noted that invigilations were now undertaken by hired staff rather than academics, which caused problems as mistakes could not be addressed during the exam but had to be addressed during moderation. Another institution noted that the exam duration had increased, but not the length of the questions. There were a small number of exams in a couple of institutions which now had online examinations.

Plagiarism and collusion

Respondents were asked whether their department experienced instances of plagiarism, collusion or contract cheating during the pandemic. All 12 respondents noted there had been instances in the exams, with 10 noting instances with continuous assessment and 6 noting instances with dissertations and projects. Most institutions reported on the scale of the problem being significant with one institution stating they had gone from one or two cases per year, to around four days (20 mins per case) of reports per term.

Some measures that respondents noted for reducing the opportunities for plagiarism included minimising the time for preparing and uploading pdf solutions to 1 hour, calling students for interview, individualising exam papers and subscribing to Chegg to identify source of contract cheating.

In 2022/23 concerns remained regarding coursework but mainly because of advances in GenAI, but as institutions had moved back to in-person exams in virtually all instances the issue was not such a cause for concern. Four institutions noted that new regulations were being discussed in advance of

2023/24 regarding GenAI which was now thought to be the primary concern for institutions.

General challenges for students

Finally, the questionnaire explored some general changes that student faced during pandemic-related teaching and the implication that those methods may now be having on their current mathematics students in 2022/23.

All respondents noted that the transition to University during the pandemic was problematic for students and various actions were taken in 2022/23 which included a maths resilience outward bound trip for all first year students, one institution introduced specific modules during the pandemic to help with the transition which they have carried on and another institution increased induction activities so students from all year groups have activities before the academic year begins including sessions on study and problem solving skills. As material was removed from A-level and GCSEs during the pandemic one institution has given additional transitional support and addressed the lack of exam technique in these students by providing exam practice sessions.

All respondents noted student isolation during the pandemic was a challenge. One institution noted there was now more interaction and support from colleagues in accommodation services to ensure students were adequately supported; another institution noted they had increased referrals to Student Support and Mental Health specialists. One respondent noted they had employed two Student Support and Wellbeing staff who have purely pastoral roles.

Many of the respondents noted that significant work had gone into creating student community. Examples included movie nights, weekly board games, code club, however it was noted that students seemed more reluctant to engage with anything outside of their modules than pre-pandemic.

Many respondents noted that during the pandemic they had tried to create opportunities for peer support with mechanisms such as dedicated time in online tutorials for students to discuss group coursework in Zoom breakout rooms, time within online lectures for discussion and other drop in times. However as the majority of supported teaching had returned to pre-pandemic face to face delivery these mechanisms no longer existed.

One outcome from the pandemic which was noted was the increased use by students viewing online or recorded sessions. However it was noted by many of the respondents that students didn't engage or learn as much if they used online material, but in addition they also had to actively encourage students to attend face to face sessions. The following quote sums up the nature of the responses:

"Having lectures delivered pre-recorded and having tutorials recorded allowed students to access material even if they had internet issues or illness prevented them attending live online or face-to-face classes. A big issue was students not knowing how to adequately use synchronous material (eg how many notes to take when watching a video) and greater likelihood of not being fully present. This has meant we have moved to mostly face to face teaching as it appears a better way to improve student engagement."

Ironically a further respondent noted:

"[one challenge is] finding some students weaker at core skills than in previous years. Lot more students with social anxiety since covid, and not wanting to come onto campus."

Impact

The project has currently had limited impact within the OU, mainly because of the findings that Mathematical Sciences Department have returned to their pre-pandemic norms for teaching, assessment and student support. However it is clear that students within these institutions do not have the same level of preparedness, engagement with pre-recorded material or resilience. As each of the institutions offered comparable responses we can assume the same is true for a good proportion of OU students, certainly there is no reason to believe this is different for 19 year olds at the OU and perhaps for older students as well.

Therefore in M&S we will be looking again at the resources on the M&S Study Site which help students prepare for their module. In particular we will once again push for including references to the Study Site in Induction material, the (replacement to MILLS) student communication messages and explore once more the possibility of links during registration.

There has been a lot of work in M&S on encouraging student participation in mathematical tutorials (Rogers et al, 2024) and also current work by Cath Brown and others on understanding which types of tutorial recording are most effective (<https://www5.open.ac.uk/scholarship-and-innovation/esteem/projects/themes/supporting-students/how-do-students-use-tutorial-recordings-and-which-formats-are>).

The School has also investigated several ways to provide a sense of community, clearly something that other institutions have found challenging, through use of the Study Site (Hilliam et al, 2021) and more recently in work by Sue Pawley and

others running social events on a large level 1 mathematics modules (MST124) such as talks on non-academics topics <https://www5.open.ac.uk/scholarship-and-innovation/esteem/projects/themes/supporting-students/creating-community-support-through-social-activities>

Hence the main impact of this study has been renewed focus on work already undertaken in the School to improve the learning design, tutorial support and student experience and ensure that work continues to be disseminated in the Mathematical Community as the study has shown all institutions have struggled with these aspects but unlike the OU have reverted to 'traditional' face to face methods.

Figures and tables

Table 1: Institutional policies in 2020/21 and 2021/22.

Table 2: New mathematical content in 2022/23.

Table 3: Mathematical support in 2022/23.

Table 4: Examination types.

References

M. Alarfaja, S. O'Hagan and C. J. Sangwin (2021) Changes made to the teaching of linear algebra and calculus courses in the UK in response to the COVID-19 pandemic, EdArXiv Preprints, Available from <https://edarxiv.org/h72qd/>

J. Gilliard, C. Ketnor, C. Mac an Bhaird, and C. Smith (2021) Special Issue editorial: restarting the new normal, *Teaching Mathematics and its Applications: An International Journal of the IMA*, 40(4), 249–253.

M. Henley, M. Grove and R. Hilliam (2022) 'University Mathematics Assessment Practices During the Covid-19 Pandemic' *MSOR Connections*, Vol 20(3), 5–17.

R. Hilliam, D. Goldrei, G. Arrowsmith, A. Siddons and C. Brown (2021) 'Mathematics and statistics distance learning: more than just online learning' *Teaching Mathematics and Its Applications: An International Journal of the IMA*, Vol 40(4), 374–391.

C. Hodges, S. Moore, B. Lockee, T. Trust, and A. Bond (2020) The Difference between Emergency Remote Teaching and Online Learning *Educause Review*, 27. Available from <https://er.educause.edu/articles/2020/3/the-difference-between-emergency-remote-teaching-and-online-learning>

K. Rogers, C. Thomas and H. Holmes (2024) Encouraging student participation in mathematical activities in synchronous online tuition. *Open Learning: The Journal of Open, Distance and eLearning*, 39(3) pp. 241–257.

University approval processes

If your project required specific approval from university committees, please provide the appropriate information below. This is a necessary requirement for future publication of outputs from your project.

- Ethical review – An ethical review was obtained according to the Open University’s code of practice and procedures before embarking on this project. Reference number HREC/4616/Hilliam.
- Data Protection Impact Assessment/Compliance Check – A Data Protection Impact Assessment/Compliance Check was obtained according to the Open University’s code of practice and procedures before embarking on this project. Data Protection registration number 28-04-122.

