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TAKEAWAYS FROM TEACHING THROUGH A PANDEMIC OPEN ACCESS Check for updates

Any advice? Lessons learned by mathematics lecturers for emergency remote teaching during the COVID-19 pandemic

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ABSTRACT
The COVID-19 pandemic meant a move to emergency remote teaching for many university students around March 2020. Two months later, we undertook an online survey to ascertain experiences of university mathematics lecturers. We received responses from 257 mathematics lecturers from 29 countries. In this paper, we consider their responses when asked what advice they would give to colleagues, based on their experience of online teaching to date. We gather their collective wisdom under a number of themes, including technology options, effective online teaching approaches, and supporting students, as well as reducing stress and setting realistic expectations for both learners and teachers.

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Mathematics education; COVID-19 pandemic; emergency remote teaching; advice

1. Introduction

The move to emergency remote teaching due to the COVID-19 pandemic necessitated a swift, unprecedented change in teaching delivery for universities globally. This paper reports on one part of a larger study into the remote lecturing of mathematics during the initial months of the pandemic. An anonymous survey investigating how mathematics lecturers were coping with teaching remotely was created, piloted and amended based on feedback from a panel of mathematics lecturers, and ethical approval was attained from Dublin City University. The survey was created in Google Forms and distributed in May 2020. We received responses from 257 lecturers based in 29 countries, the majority in Europe. Respondents were at different stages of their semester depending on where they were based. For full details of the study's background, see Ní Fhloinn and Fitzmaurice (2021). Here, we report on the replies given when respondents were asked what advice they would give to colleagues, based on their experiences of remote teaching. We have grouped their comments under the four most common themes: technology options; online teaching approaches; supporting students; and reducing stress and setting realistic expectations.

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2. Technology options

While the choice of technology used was not always up to the lecturers, depending on cost, licences and availability, several hardware options were commonly recommended. In addition to the standard laptop and webcam, the most popular options were a visualizer,[1] and a tablet/graphics tablet with a stylus pen.

Although visualizer usage decreased from a quarter of respondents before the pandemic to 9% during emergency remote teaching, due to lack of access to campus facilities, those that did manage to use one recommended it highly. One respondent stated 'I used my visualiser hooked up to Panopto and the experience was seamless via Microsoft Teams', but advised doing separate recordings afterwards 'to have more precise recordings without interruptions by students'. Another respondent cautioned that 'recording via visualiser produces very large.avi files which couldn't be uploaded to Moodle'. For those unable to source or afford a visualiser, one respondent recommended that 'a smartphone is great as a visualiser, especially for recording and working through maths equations/problems'. This can be achieved in many ways, including downloading a purpose-built app, such as iDocCam or Reflector, or directly via Blackboard Collaborate (https://lta.hw.ac.uk/wp-content/uploads/14_Using-a-mobile-device-as-a-Visualiser_Document-camera.pdf), Teams (https://www.maths.ox.ac.uk/members/teaching-staff/teaching-remotely/android-visualiser), or Zoom (https://www.northwestern.edu/academic-support-learning/documents/how-to-use-your-cell-phone-as-a-document-camera-in-zoom.pdf).

Usage of iPads, tablets or graphic tablets increased during emergency remote teaching, rising from 13% of respondents prior to the pandemic to almost 40%. In general, these were highly recommended by respondents, with one observing that they 'prefer graphic tablet to visualizer because no lighting or focus issues and hand is not obscuring writing'. Respondents highlighted a number of different approaches for using these, such as via Teams ('Used MS Teams for Q + A sessions with students and used Wacom tablet and PowerPoint slides … to answer questions live via the shared screen facility') or Zoom ('I use my iPad on zoom … I write on the GoodNotes App, which auto-backups. The students have access to that file at any time so that they can scroll back up').

Advice in relation to software was far more varied, with respondents mentioning their own personal favourite but with little consensus among individuals (e.g. 'Webwork is the bees-knees', 'Discord is good', 'Explain Everything is great', 'PDF Annotator for writing by hand on a Surface computer is not a blackboard, but not too far from it'). In total, 109 different software packages were mentioned throughout the survey. Recommendations were often made based upon software that easily integrated with that already in use within their own university.

Teaching and learning mathematics online is recognized as challenging for teachers (Engelbrecht & Harding, 2005; Radmer & Goodchild, 2021). Several respondents acknowledged the steep learning curve involved in using new technologies, with one recommending 'Keep the technology as simple as possible. Remember the students have to adapt to this new way of doing things too.' The general advice was to 'attend as many training sessions as possible' and to 'experiment to find the right fit'.

3. Online teaching approach

A number of suggestions were made as to how to increase effectiveness while teaching in this environment. Advice was mixed in terms of live online sessions versus pre-recording material, with some advising 'don't do live lectures – too many things can go wrong', others recommending 'live teaching with interactions is absolutely essential' and more suggesting to 'combine live and non-live sessions'. There was greater consensus around the importance of ensuring easy interaction with students, with suggestions ranging from using 'online chat/ discussion forum for posting any time', to streaming on YouTube, where 'students can comment and ask questions on email or chat'.

The increased time needed to develop online teaching resources was cited numerous times, with lecturers advised to 'allow more time for preparation' and not to 'underestimate how time consuming it can be to put together something that's reasonably OK'. The choice between using pre-existing material or generating something new had respondents firmly in favour of the former, advising that lecturers should 'use existing resources (youtube videos, geogebra activities etc.) as much as possible and focus less on content generation and more on assessing student understanding and engagement', highlighting that 'material already exists that students can study and this material is far better than we produce in a limited time frame. Our job is to support students in learning that material.' Recent research in Ireland uncovered a preference for video resources when given the choice between attending mathematics lectures and/or watching videos online (Howard et al., 2018). The use of videos has been demonstrated to increase student motivation towards mathematics (Kinnari-Korpela, 2015). From a student's perspective, videos are more convenient and allow them to dictate their own pace (Howard et al., 2018; Trenholm et al., 2012).

On a practical level, one respondent advised that you should 'always appoint two class members to be your canaries-in-the-mine and give them the responsibility of providing you with real-time feedback if connection/software problems arise that affect the class' ability to read/hear/see anything.' Research shows that feedback from students to lecturers can have a positive impact on teaching and lead to improvements in delivery (Flodén, 2017; Keane & Labhrainn, 2005; Seldin, 1997).

Additional practical tips included designing your teaching bearing in mind what your students can access ('survey your students (anonymously) to find out what facilities they have, and use this to design what you produce') and in particular to 'prepare your material in bite-size chunks, in a format that ALL your students can access' in order to 'keep video file sizes relatively small'. Given that poor internet speed emerged as a major concern for respondents, both as lecturers and for their students, advice of this nature is a significant takeaway. It is supported by Hyland and O'Shea's (2021) survey of 263 undergraduate mathematics students in Ireland, where more than a third of respondents did not have access to efficient broadband or own a PC/laptop. This appears to be a global issue with similar findings reported in Australia (Dodd et al., 2021), Malaysia (Nassr et al., 2020), and the USA (Soria & Horgos, 2020).

Overall, there was concern about online assessment approaches, with several commenting that they worried about 'loss of integrity' within the assessment system, and that colleagues needed to 'think about how assessment will need to change'. That said, respondents were generally positive about the possibilities of online formative assessments, both

during live sessions using polls ('ask lots of questions or run short polls when giving an online lecture… to keep the students involved and get as much feedback as possible') and using multiple-choice or computer-aided assessment for low-weighted assessments, often embedded into their institutional Virtual Learning Environment[2] (VLE) ('With the Moodle exam, [there are] quite good options (not just simple multi-choice questions)'). Managing assessment overload was another tip from respondents ('I have noticed a tremendous student overload with projects, assignments, and tests'), along with ensuring that students are prepared for the types of assessments they might face ('Our usual methods of teaching prepare students for our usual exams. If there's a risk of alternate exams due to another wave of infections then it would be better if the students were prepared for either type of exam').

The importance of providing feedback to students in an online environment was also the subject of several comments ('I would advise all educators to remember the value of feedback and try to hold Q and A sessions to make sure students understand'). Some suggested achieving this by 'using pre-recorded segments, and using lecture time for discussion, answering questions' while others advised 'acknowledging the work that the students have completed and providing feedback so that students can improve' through the use of homework or regular assignments. Provision of prompt feedback has long been at the centre of effective teaching and learning (Chickering & Gamson, 1987). Feedback engages and motivates students and helps bridge some of the distance that occurs with online learning (Tanis, 2020).

Several respondents highlighted the opportunity inherent in such a dramatic shift in teaching delivery, noting that 'this is a very good time to think about "starting anew" rather than just add on online increments' and that lecturers should not 'just try to replicate face-to-face teaching'.

4. Supporting students

Several commentators stressed the importance of interacting regularly with students to ensure engagement ('a variety of modes of engagement is important for the inclusion of students' differing learning styles and personalities') and provide support ('accept that some students will need a lot more emotional support'). One suggested designing teaching to make sure to give 'students an opportunity to still create bonds with their peers, as a lot of campus learning is by peer instruction'. Communication with students was highlighted as essential, so that they know 'what and how you want them to study each week', because 'as teachers, we say, tell them, tell them, and tell them again; you need to add about 5 "tell thems" to that and put it on all forms of communication: email/VLE announcement etc., keeping it brief and clear.'

Online teaching tends to lead to a reduction in interaction between lecturers and students and between students themselves (Trenholm et al., 2012). Radmer and Goodchild (2021) found the absence of live interaction with lecturers was missed by the majority of mathematics students they surveyed during the Covid-19 pandemic, and that interaction is important to these students. In fact, Tanis (2020) reported that interaction with lecturers is more valued than interaction with peers or content when learning online. Regular communication between lecturers and students can help support learning and alleviate student anxiety (Radmer & Goodchild, 2021).

Respondents also noted that 'online teaching is very difficult for first-year students as it needs a lot of self-discipline and ability to learn alone' and so, lecturers should ensure to 'clearly explain our expectations and provide a structure that students can use to achieve these expectations', with one advising 'do not say that "I have uploaded the material, read it."' Ensuring the student voice is heard was also recommended, by 'running suggestions through student representatives, if possible, as they also provided very useful viewpoints.'

5. Reducing stress and setting realistic expectations

Strikingly, many respondents gave advice on reducing stress and setting realistic expectations. Numerous comments were made along the lines of doing the best that you can ('Do your best, but don't hold yourself to impossible standards, and don't let others hold you to them either'), with one respondent stating that 'the students are not expecting "best practice" and appreciate it if you do your best'. The issue of perfectionism in creating online resources was raised, with respondents advising that 'if you trip over your words in a lecture, you correct yourself and carry on; you don't start again at the beginning' and that it is important to remember that a professional finish to any recording requires 'a lot of hardware, software, support and a LOT of time to spend on it'. One respondent advised 'not being too adventurous initially with unfamiliar tools – try to keep to the familiar', suggesting that maintaining your usual lecturing style in an online environment (using a physical whiteboard and video camera, or a graphic tablet) reduces some of the stress. Another highlighted that 'we have been doing emergency online teaching in a global pandemic, not preparing professional online courses'. Finally, several advised to avoid overworking, saying 'you're not going to develop fully fledged online courses for all modules in the space of one year. Way too much work. Be realistic and set realisable goals'. It is unsurprising that there was so much advice of this nature, given that 72% of respondents found online teaching to be stressful or very stressful initially, and 47% still found it thus when completing the survey.

6. Takeaways

The collated wisdom provided by 257 lecturers based in 29 countries during emergency remote teaching has been presented here. The findings suggest to us that a blend of old and new skills should be utilized moving forward. While some focused on specific technology-based approaches that worked well for them, one observed that 'there's a lot of noise around which is the best software/hardware to use and there is no correct answer. Just keep trying new things until you find the right combination for you'. Particular features that were valued included tools which required little prior training before usage, resulted in small file sizes, interacted well with tools already in use, and allowed for mathematics to be 'written' online. There was also an acknowledgement of how this online teaching experience could influence future teaching styles, as 'there is a vast amount of opportunities to incorporate online teaching into regular classes'. The creation of electronic resources that students can review at their own pace or use for formative assessment purposes can be a valuable reserve to support the teaching and learning of mathematics, and this is further explored in Fitzmaurice and Ní Fhloinn (2021). In terms of student support, consideration of student

access to internet and hardware is crucial. These resources, married with frequent interaction, open lines of communication with lecturers and bi-directional feedback may provide the foundation for a new era of learning mathematics. Finally, although no longer in the early months of emergency remote teaching, the advice to set realistic goals within the context of moving to a new style of teaching is valuable to bear in mind, to ensure greater success in both the teaching and learning of mathematics in the future.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes

1. A visualiser is a mounted camera that projects an image of what a lecturer is writing/demonstrating onto a smart board for their class to see, sometimes called a document camera.
2. A Virtual Learning Environment provides a platform for supporting teaching, learning and assessment by acting as a content repository.

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