

<b>Project title</b>	Changing times, changing pedagogies
<b>Principal supervisor</b>	Rachel Hilliam
<b>Second supervisors</b>	Michael Grove (University of Birmingham), Jotham Gaudoin and Catriona Queen
<b>Discipline</b>	Mathematical Sciences Higher Education
<b>Research area/keywords</b>	COVID-19, mathematical sciences education, the new normal
<b>Suitable for</b>	Full-time or part-time applicants with a strong interest in pedagogic developments in mathematics and/or statistics. Note that AL applicants who are interested in this project can use their staff fee waiver to fund their part-time research degree study.

### **Project background and description**

Since March 2020, a great deal has changed in terms of the learning and teaching of the mathematical sciences. With the onset of COVID-19, all universities had to rapidly adapt to the teaching of mathematics and statistics in an online environment, where before this was the purview of a very small number of institutions. To support this, novel tools, approaches and ideas will have been developed across the country. Within the mathematical sciences, some of these ideas have been shared at the TALMO series of events arranged by Grove, Hilliam & Houston on behalf of the IMA, RSS and LMS respectively (see <http://talmo.uk>).

However, there has been limited work to explore the impact of online teaching both for practitioners and students. One such survey by Henley (2021), supervised by Grove, explored changes to assessment practices within the mathematical sciences and, amongst other things, highlighted the increase in academic misconduct due to online assessment. Another survey, this time by Alarfaja, O'Hagan & Sangwin (2021), focused on the delivery of year 1 calculus and linear algebra modules during the pandemic.

As universities now move beyond the need to deliver remote learning due to COVID-19, there are lessons to be learnt in terms of the pedagogy around theories of learning in the mathematical sciences. During COVID-19, as Hodges et al. (2020) note, there was a "temporary shift of instructional delivery to an alternative delivery mode due to crisis circumstances". What is now of interest is how the theory of learning has changed due to this shift in the mathematical sciences. Are departments developing new theories of learning based on their experiences during COVID-19 and how will this change during the next five years, as face-to-face learning and teaching opportunities return? Similarly, what impact will these new theories of learning have upon pedagogical practices in both the on-campus and online environments? Alongside potential methodological changes, there are also practical considerations for mathematical sciences departments. One area of exploration is the potential conflict between new methodologies versus the practical elements of teaching and how effective or otherwise the resulting learning

opportunities are for students.

This PhD project will form part of a larger longitudinal study to explore to what extent and in what ways pedagogy in the mathematical sciences has changed as a result of COVID-19. The special issue of Teaching Mathematics and Its Applications (TEAMAT) to be published in November 2021 provides a basis for this study, with papers describing how the authors' teaching changed during COVID-19, together with early developments of new theories of learning. A systematic review of theories of learning in relation to mathematical sciences will be undertaken by the candidate. This will contribute to literature that will aid departments with future course design.

In addition, the longitudinal study will explore over a five-year period 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 longitudinal study will survey practitioners during 2022, 2024 and 2027 to provide insights into how the pandemic has affected the ways in which departments are now providing teaching, learning, assessment and support for the mathematical sciences. Importantly, it will explore whether the online practices and approaches first implemented during the COVID-19 pandemic are continuing to be employed, whether they have evolved, or whether they have been dismissed in favour of a return to more traditional methodologies. The study will also explore the broader impacts that any changes to pedagogy and practice have had upon both academic staff and institutions.

Significantly, all surveys undertaken assessing the impact of COVID-19 on teaching and learning practices within the mathematical sciences have focused upon staff members. A key feature of this longitudinal study will be to additionally explore the impact of changes to teaching and learning practices upon the student learning experience. This is significant not only with the increased focus seen upon the student voice and the National Student Survey, but also in terms of recruitment to undergraduate programmes by universities. In doing so, this work will aim to identify mechanisms by which mathematical sciences departments can effectively embed a blended learning approach to ensure high quality delivery that meets the expectations of learners. This work will also aim to determine strategies for best supporting staff to enable the development and implementation of new and innovative teaching and learning practices.

Depending on the interests of the student, in addition to a contribution to the literature on theories of learning in the mathematical sciences, it is envisaged that the thesis for a full-time candidate would include work contributing to the first two phases of the longitudinal study (with scope to continue working on publications from the project after submission of their thesis), while a part-time candidate would participate in and analyse all three phases of the study within their final thesis.

Some of the research questions of interest for this study include the following:

1. What aspects of online delivery first implemented during the COVID-19 pandemic have mathematical sciences departments retained and why?
2. How has the pedagogy around teaching, learning, assessment and support within the mathematical sciences changed since the onset of the COVID-19 pandemic in March 2020?
3. Has there been a shift in the theories of learning in the mathematical sciences during and since COVID-19 and how have these theories evolved with the return to face-to-face learning?
4. How have student outcomes and satisfaction towards their learning experiences changed within the mathematical sciences since the start of 2020?
5. What effect have the changes to teaching and learning practices implemented as a result of COVID-19 had upon student study choices and patterns?

## Background reading/references

- <http://talmo.uk/>
- Henley, M. (2021). University Mathematics Education and the Covid-19 Pandemic. Unpublished Bachelors Thesis, The University of Birmingham, Birmingham, UK.
- 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/>.
- 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>