Blended Tutorials: Blended Synchronous Learning in Mathematics

Andrew Potter, School of Mathematics and Statistics, The Open University, Milton Keynes, UK.
Email: Andrew.Potter@open.ac.uk
Colin Blundell, School of Mathematics and Statistics, The Open University, Milton Keynes, UK.
Email: Colin.Blundell@open.ac.uk

Abstract

A *blended* tutorial is a single learning event which gives students the opportunity of attending face-to-face or online. This article reports the findings of a scholarship of teaching and learning project conducted at The Open University, and considers the barriers and opportunities to using blended tutorials to support distance learning. Two pilot blended tutorials were carried out on the honours mathematics module M337 *Complex Analysis*, and the results of the evaluation are presented. Using qualitative data from practitioner reflections, lesson observations and semi-structured student interviews, this project uses thematic analysis to identify barriers and opportunities to using blended tutorials. Particular emphasis is given to the unique challenges in learning mathematics, and in the distance learning context of The Open University. The report concludes with recommendations for the design of blended tutorials, and recommendations for future research.

Keywords: blended, hybrid, synchronous, synchromodal, tutorials.

1. Background and Literature Review

By *blended tutorials*, we refer to *blended synchronous learning*, where a single synchronous learning event is held simultaneously as a face-to-face event and an online event. Other terms used in the literature are *synchromodal learning* (Bell et al., 2014), *Here or There (HOT) Instruction* (Zydney et al., 2018), and *synchronous hybrid learning* (Raes et al., 2020).

Historically in The Open University (OU), tutorials have typically taken place as *either* face-to-face events, *or* online events. This project explores the research questions:

1. What are the barriers and opportunities to offering blended tutorials in the context of an honours OU mathematics module, M337 Complex Analysis?
2. How should practitioners design a blended tutorial for a distance context?
3. What specific challenges to a blended approach are present in a mathematics context?

In partial answer to Questions 1 and 2, Bower et al. (2015) conduct a cross-case analysis of design and implementation factors in blended synchronous learning, and offer a "Blended Synchronous Learning Design Framework". Aspects of this framework were used in our design of blended tutorials; however, the OU context presents additional institutional and logistical challenges not covered by this framework. For example, the geographical spread of our students and tutors adds institutional challenges, and the fact that study centres are typically not equipped with OU equipment presents logistical challenges.

Although Bower et al. (2015) do consider a case of blended synchronous learning in a statistics class, there is, in general, a gap in the literature on the unique challenges that mathematics faces in a blended environment. For example, it is well known that rendering mathematical symbols in synchronous web environments (such as Adobe Connect) can be challenging. Smith and Ferguson (2004) report the

difficulty in communicating diagrams and mathematical notation, while Loch and McDonald (2007) point to the awkwardness of being restricted to typed communication, which requires either mathematical typesetting skills or the use of embedded image files. Hodges and Hunger (2011) offer shared electronic whiteboards as a solution to what they see as a "lack of dynamism" (p.42), and this is the approach we have taken.

2. Methodology

2.1. Evaluation strategy

We planned two blended tutorials to take place during the 2019/2020 presentation of M337 *Complex Analysis*, and designed an evaluation strategy that would explore the barriers and opportunities of blended tuition in a distance context.

We gathered perspectives from three sources:

- The *practitioner* perspective – through our own reflections;
- The *outside expert* perspective – through observations of the blended tutorials by experienced Associate Lecturers (ALs) on M337;
- The *student* perspective – through semi-structured interviews with attendees of blended tutorials.

Both of the authors are experienced teaching practitioners on M337. To gain a more objective perspective, however, we recruited two experienced ALs on M337 to conduct observations – one for each blended tutorial. For the student perspective, we invited students to take part in semi-structured telephone interviews, where students were asked about their experiences of the blended tutorials.

All three sources of qualitative data were subjected to thematic analysis, the results of which will be discussed in the Findings section below.

2.2. Technological setup

Technological worries dominated the early stages of planning the blended tutorials. We decided that both project leaders would facilitate each session – Andrew in the room as the lead facilitator, and Colin facilitating the online environment from home. If the connection between face-to-face and online environments proved impossible to maintain, then Andrew would be still be able to continue the tutorial with the face-to-face students, and Colin would still be able to continue the tutorials with the online students.

To enable a shared visual space for both face-to-face and online students, Andrew used a Microsoft Surface Pro with a stylus pen for handwritten annotation. This was connected to an overhead data projector, so that students in the room would see what was being written on the Surface behind Andrew's head (see Figure 1). At the same time, Andrew's screen was shared via Adobe Connect screen sharing, so that online students would see the same view (see Figure 2).

Figure 1. A photo of the blended tutorial from the face-to-face students' perspective
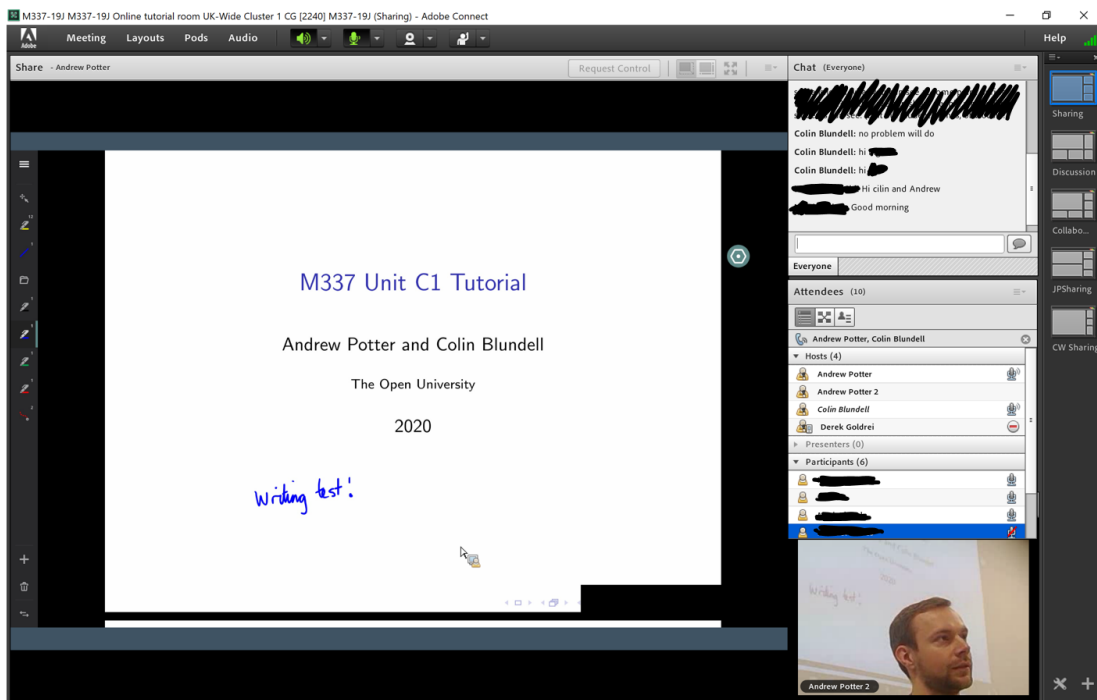

Figure 2. A screenshot of the blended tutorial from the online students' perspective

2.3. Pedagogical approach

We adopted a largely tutor-led approach to the pedagogical design of the sessions. Andrew was concerned that other approaches might not work because of the technological setup. The only ways to communicate between the face-to-face students and the online students were (by audio) through the conferencing microphone/speaker and (visually) through the shared screen, both of which were near to Andrew only. As such, Andrew felt that the only way to proceed was for both tutors to act as facilitators across both modes. Critical reflection on this approach will be found in the Findings section below.

The format of each tutorial was designed as an examples class with the opportunity for whole-class discussion. Students who signed up to the tutorial received by email a problem sheet one week in advance. The tutor then led the students through the problems, using tutorial slides with the questions and various teaching points pre-prepared on them, and writing solutions to the problems by hand on blank spaces left on the slides. Students were encouraged to ask and answer questions throughout to stimulate discussion.

2.4. Participation in numbers

All students on the 2019/2020 presentation of M337 (around 200 students) were invited to attend the blended tutorials. To make sure that no students felt disadvantaged by the experimental nature of this pilot scheme, we were very clear to students that these tutorials were *additional* to the usual tutorial programme.

On a typical presentation, students have the option of attending around 30 online sessions spread across the year, and around 3-5 face-to-face tutorials are offered in each of the following locations: London, Reading, Leeds, Birmingham and Cambridge. The addition of the blended tutorials provided 2 extra sessions based in Edinburgh.

The attendance numbers per tutorial were:

- 11 January 2020: 8 face-to-face students, 16 online students, 52 students watched recording;
- 29 February 2020: 3 face-to-face students, 15 online students, 28 students watched recording.

In total, 14 students attended both tutorials live (3 face-to-face, 8 online, and 3 one of each). Of these, 4 watched (some of) both recordings, and a further 5 watched (some of) one recording.

From all students who had some interaction with at least one blended tutorial, 28 were identified by the University's Student Research Project Panel as approachable for interview, and 7 students consented to be interviewed. Of these, 2 attended both face-to-face, 1 attended one face-to-face and the other online, 3 attended both online, and 1 attended one face-to-face and listened to the recording of the other. Thus, although a response rate of 25% (7 out of 28 respondents) would appear disappointing at first, we were able to interview 6 out of the 14 students who attended both events live (43% response rate).

3. Findings

The thematic analysis of our practitioner reflections, lesson observations, and student interviews drew out the following five themes, which we will consider in turn:

- Two different worlds
- Blended pedagogy
- Audio communication

- Visual communication
- Organisational issues

3.1. Two different worlds

Student interviewees reported that the tutorial "felt like a normal tutorial" – whether they had attended face-to-face or online. Indeed, one online attendee did not realise that there had been students who attended face-to-face! In that sense, the blended tutorials seemed to replicate the style of tutorial that students were used to. We acknowledge that student comfort does not always lead to student learning! However, in a distance context, where tutorials are optional and students can often lack confidence from learning in isolation, a greater emphasis is placed on ensuring a comfortable learning environment.

One AL observer remarked that, at several points, there was a rich discussion happening 'here' (in the room) and also 'there' (in the text chat of Adobe Connect), but there was not much discussion or interaction *across the boundary of the two modes*. This seemed to confirm the students' observation that there was not much difference from what they were used to.

For both of us as practitioners, this gave rise to the reflection that this was probably due to the way in which we had set ourselves up as gatekeepers of each mode. Students would have to get through us, the tutors, in order to communicate across the modes. This had not been our intention in designing the sessions, and gives rise to the question of whether a truly blended experience is possible. Can the experiences of face-to-face and online students ever be truly equivalent?

Student interviewees reported an *acceptance* that the experience for online students was fundamentally different to the experience for face-to-face students. This was not considered to be positive nor negative, with each of the options for attendance bringing benefits that the other lacked. Online students talked of the convenience of attending from home, the benefits of recording, and the relative security of being 'unseen' passive observers. Face-to-face students, on the other hand, enjoyed the opportunity to meet tutors in person, ask questions dynamically, see body language, and meet other students. Perhaps a better question for future research is: is there any benefit at all to attempting to make the experiences equivalent?

3.2. Blended pedagogy

As mentioned above, we adopted a largely tutor-led pedagogy in the design of the blended tutorials, motivated primarily by Andrew's technological worries. This appears to be an example, noted by Cornelius (2014), of practitioner anxiety in technology-enhanced learning leading to a "retreat towards teacher-led approaches" (p.261).

For the student interviewees, the tutor-led approach was not seen to be a negative, with face-to-face students in particular valuing the opportunity to engage in rich discussions about the material, despite the approach. Two online students reported a very minor increase in interaction from what they would expect, with one student saying it was good to be able to hear student questions. However, many of the face-to-face students reported issues of not wanting to disrupt "the flow" of the tutorial, which suggests an excessive tutor-led approach inhibiting interaction. One face-to-face student didn't want to "interrupt" or "derail the tutorial" with tangential questions; another face-to-face student didn't want to "waste other students' time", and be seen by other students as "showing off". One face-to-face student also reported that the recording made them a little bit self-conscious, not being accustomed to being recorded in a face-to-face tutorial.

One AL observer also commented on the pacing of the tutorial. Audio interruptions, sound checks, reporting across modes and technical breakdowns all served to slow the pacing down somewhat. However, when asked about it, students in both modes either reported that they didn't notice a difference, or that it was a positive to keep things slower. One student reported, for example, that in online tutorials, she often finds it difficult to type quickly enough to be able to ask a question, and often the moment passes before she has a chance to ask it.

Bower et al. (2015) report that blended synchronous learning can often place considerable extra cognitive effort on the practitioner, and this is certainly confirmed by Andrew's experience, who was exhausted after each tutorial! Bower et al. (2015) also recommend that pedagogy be given first consideration in learning design, and in retrospect, both Andrew and Colin would be keen to embed more of a student-led approach from the beginning. Colin, in particular, would be keen to experiment in future with more student-led pedagogy in a blended environment, giving students more of the work to do.

3.3. Audio communication

Many of the student interviewees in both modes talked about minor audio issues during the tutorials. However, none of the interviewees reported that this seriously diminished the student experience – "I'm used to it" was a common response. This caused Andrew and Colin to reflect that perhaps they had spent too much time worrying about technological issues, and that the students were more resilient to technical glitches than anticipated.

One face-to-face student made the observation that, as the number of attendees grows, the problems associated with turn-taking, and the potential for audio lag and talking over one another also increase, and so inhibited him from wanting to contribute too much. Another student (online) said that he prefers speaking, but since no one else does, he doesn't contribute. This suggests greater care is needed in facilitating audio interaction in a blended environment.

Because of the positioning of the conferencing speaker/microphone near to Andrew, one online student (who is hearing impaired) reported that he couldn't really hear any of the face-to-face student contributions, but could hear Andrew. Although care had been taken to ensure accessibility of the blended tutorials, this was an unanticipated issue, and would require careful consideration in future blended sessions.

An unintended positive consequence of audio communication emerged when Andrew accidentally left the conferencing microphone open during a ten-minute coffee break. One online interviewee reported that she found listening to the informal chatter which was captured between the students comforting. During this time, they chatted about future module choice, which parts of the module they found difficult, and other informal topics. The online student reported that this made her feel part of a community of learners that she had not before experienced.

3.4. Visual communication

Because not much use of a webcam was made, online student interviewees commented that it was difficult to discern meaning without the visual cues present in normal speech. This accords with Price et al. (2007), who report student frustrations due to the lack of "paralinguistic cues". When asked about the use of the webcam in the second tutorial, one online student said it was good to see the human side. However, another online student remarked, "It was nice to see [Andrew], but it didn't really add much." A third online student said that it was, in fact, a bit distracting because the video was not synced to the audio.

Students and practitioners alike agreed that the shared screen was vital to a mathematics tutorial, and being able to see what Andrew was writing was crucial to understanding. However, this meant that visual space was at a premium, both for online and face-to-face students. For online students, having the text chat was important for communication, but it came at the expense of being able to see what was going on in the room. Even if webcam use was extended, the size of the window would be so small as to have been useless. On the other hand, students in the room had no access to the text chat, because it would have been too small to read on the projected screen. As such, they relied on Andrew and Colin to relay any salient questions or comments from the text chat. For this reason, one of the AL observers recommended that face-to-face attendees be invited to bring a laptop so they could access the text chat if they wished.

3.5. Organisational issues

A key question for both Andrew and Colin was whether a blended tutorial be facilitated by a single tutor only. A key benefit of blended tutorials ought to be that it obviates the need for two separate sessions, optimising practitioner time and student choice. In the context of the COVID-19 pandemic, there is also a benefit of allowing greater flexibility in the mode of delivery, as institutions wrestle with closures and social distancing guidelines.

At the first tutorial, Andrew relied on Colin to mediate the text chat, but at the second tutorial, he had a second machine set up so he could see the text chat directly and so had more autonomy. This led us to speculate that the role of the online tutor did not need to be a tutor at all, but could, for example, be a student monitor.

When asked about whether they would support blended tutorials being used in the future, students demonstrated a nuanced understanding of the resourcing constraints that the university faces in tutorial provision. However, it was clear that the face-to-face students were particularly keen to preserve as many face-to-face opportunities as possible, and the online students were keen to have as many tutorials (in whatever medium) as possible. If blended tutorials allow for a greater number of tutorials (and face-to-face opportunities), then students appeared to be in favour.

4. Conclusion and recommendations

The five themes we have explored give the main barriers and opportunities to using blended tutorials, based on the practitioner perspective, the outside expert perspective, and the student perspective. On the whole, all three groups of stakeholders were positive about the future of blended tutorials, showing that more research into this area is needed. We conclude this section of the report with some recommendations, which seek to answer all of the research questions posed in the Background and Literature Review section.

- Blended tutorials offer a tremendous opportunity to **maximise face-to-face opportunities** for students, and **increase the number of tutorials** for all students.
- The design of blended tutorials needs to place **pedagogy** and **accessibility** first, before any technological considerations.
- Blended tutorials **do not need to offer equivalent experiences** to face-to-face and online students – students are aware of the advantages of each mode and **value the choice**.
- **Leave the microphone on** during coffee breaks – the vicarious consumption of natural, spontaneous interactions offers online students a key benefit over online tutorials.
- Allow face-to-face students the opportunity to participate in **text chat** (a key benefit of blended tutorials for face-to-face students), and allow online students the opportunity to par-ticipate in **audio chat**. Consider the use of **polling systems** as a simple way to facilitate participation across both modes.

- For blended synchronous learning in **mathematics** specifically, having a **shared visual space** is vital.
- An opportunity for blended tutorials is that it has the potential to optimise practitioner time, by negating the need for separate face-to-face and online sessions to reap the benefits of both. More research needs to be done into **facilitating blended tutorials with a single practitioner**, perhaps with the help of a **student online monitor**.
- More research needs to be done into **facilitating student-led pedagogies** in a blended environment where **visual and audio space are both at a premium**. An easy first step would be to explore the use of collaborative **group work**, using wholly face-to-face groups and wholly online groups.

5. Acknowledgements

6. References

Bell, J., Sawaya, S. and Cain, W., 2014. Synchromodal Classes: Designing for Shared Learning Experiences Between Face-to-Face and Online Students. *International Journal of Designs for Learning,* 5(1), pp.68-82. Available at https://www.learntechlib.org/p/209656/article_209656.pdf [Accessed 25 October 2021].

Cornelius, S., 2014. Facilitating in a demanding environment: experiences of teaching in virtual classrooms using web conferencing. *British Journal of Educational Technology*, 45(2), pp.260-271. https://doi.org/10.1111/bjet.12016

Bower, M., Dalgarno, B., Kennedy, G.E., Lee, M.J.W., Kenney, J., 2015. Design and Implementation Factors in Blended Synchronous Learning Environments: Outcomes from a Cross-Case Analysis. *Computers & Education*, 86, pp.1-17. https://doi.org/10.1016/j.compedu.2015.03.006

Hodges, C.B. and Hunger, G.M. (2011). Communicating mathematics on the internet: synchronous and asynchronous tools. *TechTrends*, 55(5), pp.39-45. Available at https://www.academia.edu/download/50620785/s11528-011-0526-420161129-7923-ikctgo.pdf [Accessed 25 October 2021].

Loch, B. and McDonald, C., 2007. Synchronous chat and electronic ink for distance support in mathematics. *Innovate: Journal of Online Education*, 3(3), Article 3. Available at https://www.learntechlib.org/p/104256/article_104256.pdf [Accessed 25 October 2021].

Price, L., Richardson, J.T.E. and Jelfs, A., 2007. Face-to-face versus online tutoring support in distance education. *Studies in Higher Education*, 32, pp.1-20. https://doi.org/10.1080/03075070601004366

Raes, A., Detienne, L., Windey, I. and Depaepe, F., 2020. A Systematic Literature Review on Synchronous Hybrid Learning: Gaps Identified. *Learning Environments Research,* 23, pp.269-290. Available at https://lirias.kuleuven.be/retrieve/549667 [Accessed 25 October 2021].

Smith, G.G. and Ferguson, D., 2007. Diagrams and math notation in e-learning: growing pains of a new generation. *International Journal of Mathematical Education in Science and Technology*, 35(5), pp.681-695. https://doi.org/10.1080/0020739042000232583

Zydney, J.M., McKimmy, P., Lindberg, R. and Schmidt, M., 2019. Here or There Instruction: Lessons Learned in Implementing Innovative Approaches to Blended Synchronous Learning. *TechTrends,* 63, pp.123-132. https://doi.org/10.1007/s11528-018-0344-z