Final project report for eSTEeM project:

Active learning in synchronous online tuition: increasing student interaction

Executive summary

There is significant evidence that incorporating active learning in STEM teaching programmes results in higher scores and pass rates than traditional lecturing (Freeman *et al.*, 2014). Alongside this there is significant evidence, including anecdotal evidence from tutorial observations, that online tutorials have a tendency towards traditional lecturing (Anderson, 2003; Ng, 2007; Butler, 2019), which may have been exacerbated by the higher online attendance numbers we have seen at times during the introduction of GTP.

We investigated techniques for increasing active learning in online tutorials using Adobe Connect, by assessing the effectiveness of three specific interactive techniques in online maths tutorials: polling, asking academic questions (to be answered by microphone, in the chat box or on the board) and on-screen activities such as moving or matching objects on the board. We collected both quantitative and qualitative data, from recordings of 11 designated tutorials, student and tutor surveys following each of these tutorials, 9 in-depth student interviews and a tutor focus group.

Our results were encouraging with high student engagement in all types of activity, and students reporting that they found them both useful and enjoyable. Some differences were apparent between the different types of activity, with chat-box activities being less favoured. Lack of time and confidence were given as the main reasons for not participating, and perceived benefits of engaging included the ability to attempt similar questions and benchmarking against other students.

We also found that technological problems remain significant, and that the demands on tutors are high. Further AL staff development is necessary to encourage more wide-spread use of these tools for active learning in online tutorials in Adobe Connect; our results provide motivation and practical tips.

Aims and scope of the project

The main research question was: How effective are polling, academic questions and on-screen interactions in engaging undergraduate maths students in active learning during online tutorials in Adobe Connect?

We also aimed to investigate student perceptions of these activities.

To address this, we selected three experienced tutors, confident with using interactive tools in Adobe Connect, at all three levels of undergraduate mathematics study. We investigated their practice in using polling, asking academic questions (to be answered by microphone, in the chat box or on the board) and on-screen activities such as drawing or moving objects on the board. We observed recordings of 11 designated tutorials and used the following measures for the level of student engagement: number of students engaging, number of student engagements and time spent on the activity. We also investigated how each type of activity was perceived by students and tutors through surveys, interviews and a focus group.

The results were intended to inform AL staff development with the aim of increasing active learning in online tutorials, and to add to the current research literature on active learning in synchronous

online tuition. According to the meta-analysis in (Freeman *et al.*, 2014) this should ultimately improve student retention and success.

Note: We have submitted an article on some of the findings of this project to *Research in Learning Technology*, and we will make the article available as soon as it is published. Most of the rest of our results are included in the appendices, with only any additional information included here.

Activities

We made few changes to our original plan, which did include a stage 2 plan to add student interviews and a tutor focus group to the initially proposed tutorial observations and surveys. The main change was that more time was needed for the outputs than anticipated.

Findings

Dissemination to key stakeholders is evident in our list of deliverables. One unexpected finding, which is mentioned briefly in our publication, is that more subject-specific pedagogic training is needed for tutors. See the discussion of the TPACK framework in (Koehler, Mishra and Cain, 2013).

Impact

The results have informed ALSD (see deliverables), and will continue to do so through the M&S ALSD group. The aim is to increase active learning in online tutorials, and to add to the current research literature on active learning in synchronous online tuition, thereby reaching students both within and outside the OU. According to the meta-analysis in (Freeman *et al.*, 2014) this should ultimately improve student retention and success.

List of deliverables

Publication: Rogers, K.S., Thomas, C.B., Holmes, H. (2019) 'Engaging students in mathematical activities in synchronous online tuition', submitted to *Research in Learning Technology*

Advance HE STEM conference presentation (Rogers, 2019)

eSTEeM conference presentation (http://www.open.ac.uk/about/teaching-and-learning/esteem/resources/presentations/the-8th-esteem-annual-conference-2019, under Parallel Session E)

M&S ALSD event in Adobe Connect:
- Resources ("Embedding interactive exercises in Adobe Connect tutorials" under "Help Sheets"): https://learn3.open.ac.uk/mod/subpage/view.php?id=132324
- Recording (M&S online room on the STEM AL website: "Adobe Connect Training, Claudi Thomas", 17th March 2019): https://learn3.open.ac.uk/mod/connecthosted/viewrecordings.php?id=147279&group=0&filter=2)

AL best practice document (Appendix A)

Key findings on recordings (Appendix B)

References

Anderson, T. (2003) 'Getting the mix right again: An updated and theoretical rationale for interaction', *International Review of Research in Open and Distance Learning*, 4(2), pp. 126–141. doi: 10.19173/irrodl.v4i2.149.

Butler, D. (2019) 'eSTEeM Tuition Projects Summary 2016 – 2019 Contents : Projects', *eSTEM final report*, (January), pp. 1–11.

Freeman, S. *et al.* (2014) 'Active learning increases student performance in science, engineering, and mathematics', *Proceedings of the National Academy of Sciences*, 111(23), pp. 8410–8415. doi: 10.1073/pnas.1319030111.

Koehler, M. J., Mishra, P. and Cain, W. (2013) 'What is Technological Pedagogical Content Knowledge (TPACK)?', *Journal of Education*, 193(3), pp. 13–19. doi: 10.1177/002205741319300303.

Ng, K. C. (2007) 'Replacing face-to-face tutorials by synchronous online technologies: Challenges and pedagogical implications', *International Review of Research in Open and Distance Learning*, 8(1), pp. 1–15.

Rogers, K. S. (2019) 'Achieving active learning through student participation in online tutorials', in *Advance HE STEM Conference 2019: Delivering Next Generation Higher Education in STEM*. 30-31 January 2019, Millennium Point, Birmingham, UK.

Statement of 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/2744/Rogers

Appendices

Appendix A – AL best practice/tips for maths activities in online tutorials

Some of these ideas are illustrated in the staff development session recording here (Adobe Connect Training, Claudi Thomas, 17th March 2019): https://learn3.open.ac.uk/mod/connecthosted/viewrecordings.php?id=147279&group=0&filter=2

and in the Powerpoint slides here ("Embedding interactive exercises in Adobe Connect tutorials" under "Help Sheets"): https://learn3.open.ac.uk/mod/subpage/view.php?id=132324

Polls

- Do not broadcast results to start with, but do broadcast them before moving on and give students time to see the results. Some commentary while waiting for the final votes can be good, after allowing some quiet time. This can be along the lines of how many results are in and whether it is a split decision.
- Design polling questions so that incorrect options target a common misconception, and be prepared to explain that misconception if anyone votes for it.
- Emphasise that poll answers are anonymous.
- Include a 'Don't know' option and encourage everyone to take part in the poll.
- Vote for unpopular options yourself to prevent students from feeling discouraged by being the only one who got it wrong.
- Consider pausing the recording during thinking-time if you feel you have the capacity to do so. Some students can find thinking-time frustrating when watching recordings, but don't let this prevent you from targeting your tutorial at live participants, who appreciate the activities and thinking-time.
- Set an extension question for those who finish early or offer two polls at the same time targeted at two different levels of understanding.
- Easy questions can be used to give students confidence.
- Early polls can identify topics and misconceptions which need further time, so can be helpful in gauging both the pace and content of the tutorial. Be prepared to adapt to the results from such early polls.
- Polling questions tend to get engagement from a greater proportion of attendees than chat-box questions.
- Polling questions used at the start and end of a tutorial can be used to check what progress was made during the tutorial. Be prepared to address any discovered shortcomings.
- Circulate questions in advance of the tutorials. Then use a poll to gather responses to each question – helps to determine what needs to be covered in the tutorial. This can be particularly useful for revision, if mock or past exam questions have been circulated.
- Polling questions can be used to ask if the presented solution is correct so far, whether anything else needs to be considered and/or what the next step is.
- Give clear instructions on how to answer a question, i.e. how to use the polling pod and discourage answers by text chat.
- Make sure you give students enough time to have a go (in peace!).
- Students seem to value the anonymity of using polls, as opposed to text chat.
- Consider using some polling activities at the end of your tutorial as a revision tool.

Types of poll

- True/False or Yes/No - you can re-use a True/False poll repeatedly by editing the question on the fly.
- Short answer poll - better than text chat as it's anonymous and student answers are not immediately revealed encouraging more attendees to participate. Allows only one answer per student (i.e. overwrites previous answer if a student submits a second answer).
- Multiple choice – very easy to use as the presentation can show the options and the poll can just be A-E and Don't know. You can reuse the same polling pod throughout the tutorial. Multiple choice questions can highlight common misconceptions.
- Polls with more than one right answer.
- Polls can target conceptual knowledge as well as ability to solve mathematical questions.
- `Off the cuff' poll – for example, the tutor makes deliberate error and asks is this right or wrong?
- Method poll – which method/step should we use?
- Process poll – often used at the start of a tutorial, for example to check the audio is set up, or to choose topics.

Chat box

- Be aware that some students are acutely aware of chat-box answers not being anonymous.
- Consider using short-text-answer polls as an alternative, or letting students write directly on the screen, as both are anonymous and likely to get more students involved.
- Be aware that students, while finding them generally useful, don't seem to find chat-box activities as enjoyable as polling and screen activities.
- Chat-box questions can move the tutorial on quite quickly, but some students may feel left out if you move at the pace of the fastest students.
- Use for students to ask questions but consider using the anonymous Q&A poll instead.
- Good for student-student interaction, for example for students to help each other.
- Use to answer questions; you can put solutions to a problem on the screen and answer questions from the students in the chat box.
- Put up a question with deliberate errors and ask students to report them in the chat box.
- Participation tends to be lower than in polls, as when one or two students have answered others don't bother, so ask whether the others agree with the answers given so far, to increase participation.
- Remember that students can copy the answers given by others, as all answers are visible.
- Give clear guidelines as chat-box activity can be disruptive. Some students pre-empt what you are going to say, type answers in too quickly for most, suggest alternative approaches not covered in the module or ask irrelevant or inappropriate questions (or make such comments).
- Be aware that it can take a long time for students to type in their questions. You can try to encourage microphone use to address this.
- If a single student is taking a long time to understand a concept and type questions, you may need to refer them to their own tutor, so that the tutorial can progress.

Screen activities

- Encourage students to change the default pen thickness from 2 to 1, to avoid lines that are too thick.
- Keep numbers below approximately 10 students working simultaneously on the whiteboard, as this can slow things down as well as create a very messy whiteboard.
- Although screen activities can require a lot of time, they can be used to address several points visually in one go.
- Provide enough icons for all who are likely to participate, if using drag and drop.
- These are anonymous (not even the tutor can see who is doing what).
- Screen activities are particularly good for visual activities such as graphs and diagrams.
- They are fairly easy to do with appropriate guidance.
- The tutor can see students changing their minds, for example in drag and drop activities.
- Draggable objects must be built in the room. This can be done in advance as follows: create your own layout with a new share pod (avoid copying someone else's share pod). Give this layout a name that starts with your initials. Load the presentation into the share pod and add draggables to the relevant slide(s). Leave everything in place without stopping to present but move your layout down the list of layouts on the right-hand side of Adobe Connect to avoid others interfering with it. The draggables should remain, even if you exit and re-enter Adobe Connect.
- Give very clear instructions on how to use the screen to answer questions – it can easily get messy and chaotic otherwise.
- If the question is designed for one student to interact at a time, then this can be very time-consuming.
- Screen activities can work well as a final plenary activity covering topics from across the tutorial with draggable ticks and crosses.
- Keep the draggable objects simple.
- If you want to split students into groups, you can use differently coloured draggables for groupings or drag to different sections of the screen.
- Consider whether a screen activity is suitable given the topic.
- Consider asking students to each work on one part of the activity.

Types of screen activity

- Drawing/writing on screen
- Drag and drop with draggable objects
- Highlighting (or ringing), for example mistakes or parts of a diagram/graph
- True/False
- Sorting into categories

General recommendations to encourage interaction

- Explain questions and how to answer clearly, and make sure everything the student needs is visible and to hand (for example parts of the handbook).

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- Give some warm-up introduction and/or reminders of the module materials before asking students to attempt questions.
- Use informal language such as: "this is an exciting one" or "chappy" to describe a function.
- Give lots of encouragement with phrases such as: "great stuff", "good stuff", "well done", "don't be shy", "nice to have a chat", "good question".
- Recognise that it can be hard with phrases such as: "after this we can all go and have a lie down!", "this is a hard question".
- Ask for confirmation (for example a green tick) that the students are OK.
- Encourage questions at the start, end and in between, pausing to give time for questions (note that it can take students quite a while to build up the courage to ask and type in questions) and ask for feedback.
- Consider pausing the recording a few times during the tutorial to encourage more questions.
- Thank students for participating, for example by saying "I appreciate you having a go".
- Reassure students that it's OK to get things wrong – the questions are designed to catch common misconceptions because that's how we learn.
- Give *some* quiet time for students to think, and include only a few long activities where students need a lot of time to think. Perhaps start giving some tips part way in, but allow enough time. An extension exercise can minimise waiting time for faster students.
- Consider pausing the recording during thinking-time.
- Keep an eye on the chat box and be responsive.
- Allow time to fully explain the correct answer and address any incorrect answers.
- Use warm-up activities to increase engagement.
- Focus on one question at a time.
- Encourage more questions on the forum or to their own tutor by email.
- Don't press to cover a certain amount of material, and don't plan to cover too much. Don't rush, but address what you do cover thoroughly.
- Feel reassured that students like interaction and are attempting the questions even if they don't visibly participate.
- Emphasise anonymity where appropriate.
- Remind students how to use AC tools for activities in your introductory session and more frequently if needed.
- Make some mistakes yourself to illustrate checking, persistence and how to recover.
- Consider giving set or vague thinking-times, such as a couple of minutes, but extend this if it becomes clear that more time is needed.
- Send out questions in advance (possibly more appropriate for higher levels).
- Don't put people on the spot.
- Remember that some students may not respond because they have gone off to do something else.
- Consider teaching with a second tutor to watch the chat box (feel free to contact your staff tutor to discuss this). This may be helpful for larger attendances.
- Send out a reminder giving a list of planned topics and asking for any requests 4-5 days before each tutorial, to your own group, any students who have booked, and on the tutorial forum.
- Post questions and solutions in the student forum if appropriate.
- Occasionally, you might like to encourage chat between students by leaving the room for a little while. This tends to encourage a student to take the lead and others to interact.
- Encourage tutorial attendance as much as possible, including in your introductory email, by sending out regular reminders and explaining their importance and purpose.

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Dealing with recordings

- Make the slides available, to make navigation of the recordings easier.
- Label recordings carefully, giving the tutorial title and tutor name. Also use the 'Description' column to explain the content in more detail.
- Consider pausing the recording while students are working out the answer to a question, and/or to encourage questions.
- If pausing the recording, do not forget to switch it on again at the right moment!
- Consider what students who only watch the recording might want included.
- Consider how recording might be used in future, for example for revision or help with a TMA question.
- Some students cannot get to live sessions, so providing recordings is important. However, not all tutorials need to be recorded. On modules where there are a lot of online tutorials, some can be designated to be recorded and others might be designated not to be recorded. The assumption in M&S tends to be that most tutors record, but please contact your staff tutor to discuss whether to record. Bear your audience in mind when planning content and activities either way.

Other best practice tips

- Send out problems in advance.
- Make sure everything the student needs to answer a question is displayed on the screen.
- Have a clear purpose behind each activity: design activities so that you can catch misconceptions and correct them and allow sufficient time for this.
- Be aware that we can add short amounts of extra detail to tutorial titles when timetabling, which then show up in the booking system, to help students identify what each tutorial will cover (for example add: "topics from Unit 3" to the usual title – ask your staff tutor to arrange this, ideally during timetabling).
- It's good to have a mix of reminders, activities and tutor-led explanations, and a balance between activities and tutor input.

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Appendix B – Key findings concerning tutorial recordings

The following observations are based on the data collected during the 9 student interviews, together with a small amount of data from relevant student survey comments.

1. Students want everything to be recorded

The five students who commented on this all wanted full recordings, in order to be able to re-play specific points from a tutorial they had attended live and to ensure that the explanations were complete. Student B mentioned that it was fine to record everything as it would be shared only with students on the module.

Quote from Student F

If my making a mess of a question helps somebody else realise that they wouldn't have got it right then that is cool, I haven't got a problem with it being recorded.

2. Students say that recording tutorials has no effect on their live participation, but they seem to like anonymity where this is possible

Eight out of the nine students said that they were not affected by the tutorial being recorded. Just one out of nine (Student E) said that they were cautious not to reveal how little s/he had read or understood because of the many students who watch the recordings. Student I thought that anonymising the text chat for recordings might increase participation as it might make students feel more comfortable to contribute.

Quote from Student E

I think at the back of your mind is that dozens of people will be watching this and maybe watching it next year as well because sometimes good tutorials get put up on a screencast or something. Umm, so I think it is a slight inhibition but not, I don't think, enough to make me not get any value from it.

Quote from Student C

Well we were always asked if we were happy with the tutorial being recorded. Each tutor asked that before-hand and you saw the red light coming on at the top and after that I didn't think any more about it.

3. Students use recordings for a variety of purposes, but are less likely to attempt the activities than when attending live

Many students used the recordings for revision or to find help for specific problems, either with assignment questions or when working through the module material. Some students listened to relevant bits over and over again, until they understood the maths. Some students looked for steps that might have got missed out in the module material, or for a different explanation to that given elsewhere. Student E observed a twofold purpose of recordings: understanding the concepts before reading the material and concentrating on the maths after reading the material.

The interview data and survey comments indicate a lower rate of participation in the activities for students watching the recordings than for those attending live tutorials: four out of the nine students interviewed reported that they skipped the activities in the recordings, one reported that s/he searched only for topics of interest, one reported that s/he used screencasts instead of

recordings and the other three reported that they did attempt the activities. (In comparison, these nine students reported to have attempted some if not most activities during the live tutorials.) While the student survey responses were mixed, many reported that they attempted some or all the activities and a small number said that they found the activities a waste of their time. This is in striking contrast to the extremely high engagement reported in the survey responses for students attending live.

Quote from Student E that explains why s/he does not attempt the activities during recordings
It is probably because I have watched the live one, but also you know, I am not going to get a reaction so to me it is a waste of space.

Quote from Student G
I think in the recordings, if they were to have polling activities I think for me personally it would be better at the end, kind of like a revision of the whole tutorial.

Quotes from surveys included:
- Attempted all the questions. More questions in the tutorial would be useful.
- I attempted many but felt that the long pauses while waiting for all students to participate were not beneficial.
- The length of the tutorial is quite short. It seems a waste of useful time to wait several minutes while students grapple with the questions, especially since the questions had been posted beforehand.

4. Students perceive many advantages to recording tutorials, but also a few disadvantages
It was noted that the recordings allowed students to go through the calculations more slowly and repeatedly, sometimes watching several tutors present similar content in different ways, but also to skim over parts with which the students felt confident. Furthermore, there was less pressure on students as they could pause the recording to work something out.
However, it was noted that recordings allowed the tutor to rush and say that students would need to go through some of the slides using the recording. Also, some students commented that tutorial recordings were not efficient when trying to locate relevant pieces of information; screencasts were shorter and more specific.

Quote from Student H
If I am struggling on a particular unit I will watch back the ones that I have attended and also go and find other ones from other tutors on the same unit because it helps to have a couple of different people talking about the same thing. Sometimes questions will come up in different tutorials and it is good to watch them back.

Quote from Student A
The great thing about recordings is that I can get lost and actually the consequences are not as serious because I know that I can retrieve it again and go through it at a slower place and then not be lost.

Quote from Student C
I can't necessarily remember things by only seeing them once but going over things a number of times is very, very important to me.

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5. There are quite a few technological issues with recordings

Three out of the nine students interviewed thought that the recordings were easy to use, but six out of nine mentioned technological issues including:

- recordings being hard to navigate to find the relevant parts,
- poor overall descriptions of contents of tutorial recordings,
- no iPad access to recordings,
- slow movement through the recording as going back by a few seconds reloads the recording.

The student surveys also highlighted some technological issues including that:

- it is hard to see everything as sometimes the slides obscure other parts of the screen such as the chat pod or polling pod, and
- the whiteboard in one recording was blank after 45 minutes when it was fine in the live session.

The students provided various suggestions for improvements, including:

- the use of indexing or bookmarking,
- providing slides to aid navigation of the recording,
- using more informative titles and descriptions for recordings,
- using the same format as screencasts to allow downloading, and
- allowing students to jump from questions straight to answers rather than having to wait for students that attended the live session to work out the answers.