University students' engagement with an asynchronous online course on digital technologies for mathematical learning

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Promoting students' active and meaningful engagement in online learning environments, and especially in asynchronous courses where students are not interacting with the lecturer or their peers in real time, can be challenging. This paper presents the initial results from an exploratory study on how the tutors' design considerations of a ten-week online asynchronous master's course, together with their online pedagogic strategies have impacted on students' learning experiences and their engagement with its resources, such as content, peers and tutors. The data we focus on consists of students' online contributions and one-to-one interviews. Our research aims to gain an insight into students' views on how their engagement impacted on their online learning for this course, leading thus to identifying opportunities and barriers to take into account when designing for active learning in an online course.

Keywords: Online learning, asynchronous communication, student engagement, digital technologies, mathematical learning.

Introduction

Active learning has a reputation of being effective in supporting students' retention of knowledge, addressing potential misconceptions, promoting engagement and encouraging positive attitudes towards learning (Michael, 2006). Considering these arguments, educators should be encouraging active learning in every mode of study, such as face-to-face traditional teaching, online synchronous, asynchronous or blended learning. Even though active learning strategies, such as Think-Pair-Share, Role Playing, Group Discussion, etc., are widely used and have been shown to be successful in face-to-face, as well as virtual yet synchronous teaching situations, achieving active learning in an online asynchronous learning environment presents a number of 'new' (as is not widely researched and addressed) challenges (Riggs & Linder, 2016). For example, some authors (e.g. Picciano, 2002) claim that online discussions and learning could distance students from convergent thinking, instructor directed inquiry and scientific thinking compared to face-to-face discussion. Others (e.g. Jiang & Ting, 2000; Dixson, 2010) found that students' online learning very much depends on the quantity and quality of their peers' postings in online discussions, which is certainly an unpredictable factor. Haythornthwaite (2002) and Rovai (2002) found that the greater variability in the online social interactions between students in terms of regular presence, participation, etc. and their sense of belonging in a community and trusting their peers in their mutual learning journey can take longer than face-to-face learning in a classroom environment. And just as importantly, practical issues such as easy access to the online platform and the course resources and student support when technical difficulties arise, need to be offered (e.g. Hewitt, 2003).

There are great benefits of learning in an asynchronous environment. Students have more time to reflect on the resources, the tasks, their tutors' and peers' contributions, but they also have more time to invest in offering more thoughtful and insightful contributions (Collison et al., 2000), than perhaps in a face-to-face interaction. Riggs and Linder (2016) found that more students choose online asynchronous courses due to the flexible mode of study, i.e. managing their time to work on the given tasks as and when their own schedules permit, but also spending as much time as they want per task. For more introvert students and those who are not given the opportunity to share their thoughts in face-to-face learning environments due to time constraints in sessions, the authors concluded that online asynchronous courses can give them more time to compose their thoughts and contribute.

To address the above-mentioned challenges, educators have striven to design asynchronous online courses that promote active learning and meaningful engagement from students and offer support by adapting their own pedagogical strategies accordingly (Riggs & Linder, 2016) and developing new such pedagogical strategies. Considering our own experiences as tutors in teaching such a course for the past four years, we recognized our role shifting from that of a subject matter expert, a course developer and a tutor to that of: (i) a technology trainee, to ensure we were familiar ourselves with various digital tools, (ii) a trainer, to support our students in their interactions with these digital tools and (iii) a facilitator or moderator, to manage our students' online contributions and interactions with their peers in online discussion forums. In particular, our role in promoting students' active and meaningful engagement in online discussion forums has been one of our greatest challenges. To identify strategies that support and maintain such engagement throughout the duration of the course, while at the same time evaluating and revisiting the design of our course, we carried out an exploratory study.

In this paper, we present our online asynchronous master's course on digital technologies for mathematical learning, followed by a description of the methodology of our exploratory study that investigated the extent to which and how the asynchronous online experiences impacted on our taught postgraduate students' learning in this course. The initial analysis from this exploratory study data follows. Some conclusions are then drawn, while the key findings of our study are put forward as key recommendations for nurturing active learning opportunities in any online asynchronous course.

Our online asynchronous course

In 2014, we designed a brand new course *Digital Technologies for mathematical learning,* the first and only online course of the University College London (UCL)'s MA in Mathematics Education master programme, which uses the UCL Moodle platform for its delivery. There are two e-learning aspects of this course: (1) its online delivery and (2) the focus on digital technologies of the course itself, consisting of (i) familiarisation of the students with a wide range of digital tools and resources (graph plotters, dynamic geometry environments, statistical software, fully interactive online packages) and (ii) critical reflection on the implications of using such tools in the learning and teaching of mathematics mainly at secondary school level (11-18 years old students).

The main aim of this 10-week course is to encourage students to reflect critically on the potential and limitations of digital technologies for the learning and teaching of mathematics by providing

opportunities for students to apply knowledge of relevant research and theory in practice. Besides getting familiarised with digital tools and reflecting upon their use as 'learners' and 'users' themselves, students are also encouraged to design activities to use with at least three different digital tools and then evaluate them by trialling them with learners. In this process they carry out mini-research studies and reflect upon the use of digital technologies for mathematical learning. The course is delivered in 10 weeks and each week the tutors upload on the UCL Moodle platform: (1) the learning objectives and a description of the week's content, (2) the key readings: one essential and two indicative ones and (3) the offline and online weekly tasks, which are tightly structured towards the course aims and the learning objectives. Instead of direct teaching, learning is designed to take place as the result of doing short, manageable offline and online tasks. The *offline tasks* include (1) familiarising with a piece of software and going through scaffolded activities using specific software, and (2) designing and trialling mathematics activities involving the specific software that bridge learners' interactions with digital media and the mathematical concepts. The *online tasks* include: (1) engaging with the ideas in the key readings and writing a response about the points they agreed or disagreed with or by contributing to online discussion forums with written observations on views and perspectives of fellow students; (2) reflecting on the application of the ideas encountered in the key readings in specific learning contexts such as the offline tasks they designed and trialled. Every week, the students are required to carry out the reading and the weekly tasks, then post their reflections online, and respond to their peers' posts. There are three themes covered in our course: (a) Visualising, (b) Generalising and Expressing and (c) Modelling. In these three themes, the students interact with many digital tools (DT), such as Excel, GeoGebra, Autograph, the eXpresser microworld, Logo, Scratch and a variety of modelling applications and online digital platforms. Research (e.g., Dixson, 2010) indicated that it can be helpful for instructors of online asynchronous courses to create an architecture for their own engagement, too. As tutors, we made sure that we had social presence demonstrated on a weekly basis through: uploading materials, posting messages, guiding student learning, providing feedback according to set times, sending reminders, contributing to some online discussions.

Methodology

For the four years we have run this course, we have conducted end of theme, as well as end of course evaluations and while the vast majority of our students showed 'online' presence by posting their work and occasionally posting questions to tutors regarding practical issues about the work, we have recognised that they were not engaging in online collaborations with their peers as much as we wanted them to, for a full learning experience. In our efforts to encourage our students' active and meaningful engagement in online collaborations, informed by findings of research (e.g. Dixson, 2010), we trialled some actions, which included: tasks that formed the basis of an online group discussion; collaborative tasks with tutor-nominated groups; pick-a-paper tasks, i.e. 'choose one paper and its commentary from a member of your small group and post your comparative remarks and reflections'. While these strategies worked in terms of increasing the likely hood of students contributing online, we also became interested in why some students were more engaged than others, why they displayed a higher degree of learner autonomy, evidenced in their inquiring further, seeking assistance and generating new threads of discussion, than others. As such, we became interested in enquiring into *our students'*

perceptions of the extent and the way their asynchronous experiences contributed to their active and meaningful engagement on this course.

To address this research question, we decided to carry out an exploratory study focusing on data collected from our latest cohort of students. This data comprises 20-min interviews with a sample of 10 of the 17 students enrolled on this course and their online contributions throughout the delivery of the course (January-March 2018). Of the 10 students who volunteered for the interviews, three were English native speakers, while seven were international students, for whom English was an additional language. The interview questions focused on students' mode of study and students' experiences of online asynchronous learning, in particular their experiences of participating in online discussion forums. Our intention is to use the outcomes of this exploratory study to inform our thinking and identify issues to research further, but also rethink our practices in terms of communicating with our students and providing effective instructional strategies for improved student communication and collaboration. This will lead to the re-design of our course in its next presentation, focusing on encouraging active learning and engagement with the online course resources.

The interview data was analysed in conjunction with the students' online contributions and written assignments, following the grounded theory approach (Strauss and Corbin, 1990) and using NVIVO to organize, manage and analyse this data. Our students' social processes regarding their mode of study and online contributions were analysed by going through the interview transcripts and coding their comments using labels (i.e. short phrases or sentences) that described what they said. This process was repeated a number of times until there were no more issues identified in the data, no improvements to the current codes were needed and no more codes were produced. At the end of this iterative process, these labels had become analytical representations of the data and turned to the identified categories we share later in the Results section. By doing a constant comparative analysis of the emerging categories, we were able to identify two emerging themes and finalised the categories. Next, we present the emerged themes and categories in the way we linked and integrated them aiming at capturing all the variations in our data and allowing a theory to emerge, that of students' motivation and challenges they faced regarding online contributions in an online asynchronous course.

Results

The two main emerging themes grounded in students' responses are: **Motivation to contribute in online asynchronous learning** encouraged and sustained through *Learning from others; Peer Assistance; Peer students' online study patterns; Interest in and enjoyment of topic*s, and **Challenges to contribute in online asynchronous learning** such as *Non-participation; Visibility of learning; Style and Etiquette of communication; Feeling at ease with your peers.* For each of these two emergent themes, students had commented upon the tutors' influence in their learning.

Motivation to contribute in online asynchronous learning: *Learning from others* Those students who engaged with the online activity felt that they benefitted as a result. One international student, Jennie, who enrolled on this course following her undergraduate studies, admitted feeling comfortable to participate in the online discussion forum as she learned a lot from reading the contributions of

what she thought of as 'her more experienced and older than her' peers. She admitted looking specifically for their contributions and trusting their views.

Yvette felt that reading research papers, reading other students' work and having to give feedback and comment on others' contributions helped her with her own learning: gaining a deeper insight into the key readings, thus learning about how to engage with research and how to use it to reflect on mathematical learning when digital technologies were used. Similarly, John reckoned he learned from his peers: "I felt like you were in a classroom with other students in a way. Obviously with it being asynchronous it's a lot slower than that, but you kind of need it to be asynchronous so you can actually go and read what people have written. And then it was easy to find again what you've written and how other people have responded", while Jack said that seeing other students' contributions triggered him to respond, hence explicitly engaging with the knowledge base of this course.

Mary and Anne mentioned the opportunities to learn from others, which were facilitated by the tutors' collated feedback on all students' contributions per theme; they would revisit this feedback often, which helped them be more aware of the expectations of this course and improve their future work.

Motivation to contribute in online asynchronous learning: ***Peer assistance*** All 10 students commented on how useful the UCL Moodle Discussion Forum was for sharing ideas, for reading other students' contributions and reflecting upon their own thinking and understanding of the course material, tasks and resources. "Sometimes if I had no idea how to start my work and I saw how my classmates did it, then I had some directions" (Janet). Having an online record of the peers' contributions enabled the students to revisit aspects of the course at any point throughout the course. One student, Frances, extended this argument by comparing the online contributions to those of a face-to-face learning environment, where "you can only hear a few people's ideas" and mentioned how useful it was to have the time to read and reflect upon them before responding and/or asking questions, which wouldn't have been the case in a time constrained face-to-face interaction: "You have all these online resources to access and explore, and you can ask directly the creators".

Even though there was some peer support offered in Discussion Forums, many students told us that they needed "immediate feedback". For example, Mary argued for the importance of having a tutor 'close by' when learning about and interacting with a new DT. She felt that she needed to ask questions that needed immediate answers in order for her to make progress. Similarly, Patricia and Helen argued about their preference for face-to-face sessions when familiarizing themselves with a new DT, as in that scenario the help was immediate and support was always there (we offered two optional face-to-face sessions as part of this course).

Motivation to contribute in online asynchronous learning: ***Peer students' online study patterns*** The variance in the students' online presence depended on many factors, such as their interest in the topic, their other commitments (work, studying, deadlines to assignments, etc.), but also their preferred style of studying. All the 10 students agreed they liked the flexible mode of study this course offered, as most of them found it very convenient to choose their own time to study.

Six of the 10 students (Janet, Anne, Patricia, Jack, Frances, Mary) admitted that time management was a challenge in this course. In some cases, it was as result of their own struggle at times to self-

manage their work and not because of the structure of the course. But in other cases, it was due to 'wait-time' for others to contribute online to Discussion Forums. Anne agreed that timing is very important even if the course is asynchronous and flexible in that sense. She would never read any postings that were uploaded too late in the week, as she would have already finished her work by then. Similarly, Patricia argued: "I can't be bothered to respond to that now, because I'm on to the next one. It's not fresh in my mind anymore". Frances, too mentioned how important it was for peers to post on time otherwise "You are delaying your partner's work too".

Motivation to contribute in online asynchronous learning: ***Interest in and enjoyment of topics*** & ***tasks*** Looking at the patterns of *all* students' online participation on a weekly basis throughout the course, we noticed that there were weeks when their online presence was much higher than in others. The 10 students we interviewed argued that this was due to their own interests in certain ***topics*** covered during certain weeks. For example, Janet said that being interested in a topic encouraged her to work on the task earlier in the week than when she didn't like the topic or she was not very familiar with it, e.g. programming, and she would engage with others' online contributions too.

All 10 students valued the ***task*** which required them to design and trial an activity with learners, then reflect on the mathematical learning. John and Jack argued how great it was to reflect on pedagogical issues regarding students' learning mathematics with DT. They all commented about learning not only new DT, but also learning how to utilize them in the classroom and use them effectively with learners. Jennie felt that this course was indeed a great preparation for her future career as a mathematics teacher. She felt she got more time to think about the relationship between the DT and mathematics and how it could be used in her own way in mathematics classrooms.

Challenges to contribute in online asynchronous learning: ***Peer students' non-participation*** Lack of sustained participation from students seemed to be a key factor for disengagement from online discussion forums. As the course progressed, Jack noticed that not many of his peers participated nor did they respond to his comments. He felt de-motivated and as a result lost his keenness for ongoing online participation. Similarly, due to the lack of peer participation, Anne found it difficult to contribute online, as there were no contributions from others that she could comment on. Even if there were contributions, if too few, there were only so many opportunities to comment on them.

Challenges to contribute in online asynchronous learning: ***Visibility of learning*** Amongst the reasons mentioned by our students as holding them from contributing online included being afraid of showing their insecurity and lack of confidence in their own expertise with DT or subject matter of the course. Mary confessed: "I know they won't say are you stupid, how can't you not know this? But I still feel people get the impression that you don't know anything and they would hesitate comparing or checking your contributions".

Visibility of online contributions was even more of a challenge for the non-native English students, who were also worried about the clarity of expressing their thinking in written format. Six out of seven of our international students admitted that they were reluctant to submit comments online. Mary admitted that she would probably hesitate to make a contribution in a face-to-face session for that same reason, but online her contributions remain visible to others for the duration of the course. This

was also a concern for Vicky, who commented that she preferred the online mode of communication to the verbal one as it gave her time to think through what she wanted to say, with the advantage that she would 'correct her English and grammar before posting anything'.

Challenges to contribute in online asynchronous learning: ***Style and Etiquette of communication***
Helen mentioned the challenge of communicating in the Discussion Forums; when asking a question, she would need to spend time thinking and articulating the question accurately and in a concise format, whereas a face-to-face scenario is more like having a chat and the question might be formed by itself. The formality of the Moodle discussion forum was mentioned by Anne too. She was put off by the formality of such communications and the fact that tutors would see such contributions and that their posts would also be assessed. Her perception of the role of online contributions led to her being reluctant to upload anything that she hadn't thought through very carefully. Being a native English speaker did not make it easy to adhere to the more formal style of communication; Patricia too admitted feeling occasionally reluctant to post any comments as she had to make them formal.

However, all 10 students admitted that this formality required in all of their online contributions did lead to clarity and coherency of arguments that they were trying to put forward. Having tried to set up a group chat on Facebook Messenger (the seven international students) Jennie found the communications were very informal, with far too many details which she didn't need to read, and with ideas that lacked clarity, although she, like all the others liked the instant feedback.

Challenges to contribute in online asynchronous learning: ***Feeling at ease with your peers***
Another reason for being disengaged from the Moodle Discussion Forum was the lack of familiarity with their peers, having not met them in person before the start of the course, which led to a lack of a sense of being part of a community. For example, for Helen it was difficult to post on the forum discussion and comment on work from students she never met face-to-face. Anne thought that her peers who she was not acquainted to were too 'polite' in their comments to her work, so as not to hurt her feelings. This familiarity and friendship with the people on Messenger allowed them to share comments freely, not thinking that they would be upset or offended. Another disadvantage of posting feedback to a peer in a forum is that the way the feedback is articulated might be considered bad criticism and upset their peer, whereas in a face-to-face situation, they could see that the feedback is expressed in a positive manner and their peers can recognize that a student is trying to help and give constructive feedback. For example, in Messenger you can put a smiley face too, and so no matter how the feedback was articulated (as a criticism, for example) the receiver would not see this as a negative comment.

Some conclusions and our key findings

Some of our findings are similar to the ones by authors we referred to earlier in the introduction. All students were very appreciative of the flexible mode of study of our online asynchronous course and the time given to reflect upon peers' contributions, which are similar results to Riggs and Linder's (2016) work. Our students' learning did depend on the quantity and quality of peers' postings (Dixson, 2010) and the tutors' feedback and their trust in their peers (Haythornthwaite, 2002).

However, our study brought to the fore two important aspects not mentioned in the literature we reviewed. We learned from our data analysis that online communication was perceived by our students as a double-edge sword; on one 'edge' they all liked the flexible mode of study, managing their own time, taking time to think through their responses or others' contributions, but the formality of their contributions deterred them from engaging in conversations with peers more fully. We also learned that we needed to orchestrate better the timing of online contributions in an asynchronous course: while having the flexibility to contribute at their own convenient times, deadlines are even more important to be set and met, in order to ensure an active and meaningful engagement and exchange of views. We thus conclude this paper by putting forward these two key findings as recommendations to designers and tutors of online asynchronous courses, with the aim of nurturing active learning opportunities.

Acknowledgment

This work was supported by UCL Grand Challenge of Transformative Technology, which funded our project: *Supporting active and meaningful engagement in an asynchronous online course.*

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