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How to engage students in blended learning in a mathematics course: The students' views

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Blended learning strategies are employed at many Australian universities to modernise teaching approaches. However, blended learning implementations may not take into account the views of students during the development process. In this paper, we discuss how students think we, as educators, can engage students in both face-to-face learning and online learning, as components of blended learning. We also report on student suggestions regarding how to build in opportunities to recover if a student has either missed a class, or not completed time-critical online work before coming to a class taught in flipped mode. These are two of a set of seven questions we posed two years ago at this conference, in the context of teaching mathematics in blended mode.

Keywords: flipped classroom, blended learning, mathematics education, engagement.

Introduction

While blended learning has been rolled out at universities across Australia in the last few years, there are few studies of how individual disciplines have implemented these approaches, what challenges they have faced, and how they overcame these challenges. At the 2014 ASCILITE conference, we presented a paper (Loch and Borland, 2014) describing the challenges the discipline of mathematics is facing when blended or flipped learning is introduced on a wider scale. We highlighted the special circumstances of teaching mathematics: the lecture is still the predominant mode of teaching for several well founded reasons; and teaching mathematics online is challenging because it is a visual discipline which requires advanced typesetting skills or manual writing to communicate in the mathematical language. The literature on blending in the mathematics classroom is mostly focused on pre-university teaching, and emerging studies in a university context describe individual lecturers' experiences. While contributing to the knowledge base on what has or has not worked successfully, such studies have limited value for implementations on a wider scale (for example across a whole department, school or faculty), particularly when changes in teaching staff need to be factored in. In our 2014 ASCILITE paper we concluded with a list of seven research questions to guide future research. In our 2015 ASCILITE paper (Borland, Loch and McManus, 2015), we addressed question six, looking at the best approach on a departmental level to support teaching staff in developing and implementing innovative approaches, promoting digital content creation and using technology to enhance learning and teaching outcomes. Questions one and three were:

1. What can we do to ensure students engage with both online content and classroom activities?
3. How can we build in redundancies, e.g. enable students to recover if they have not watched a video beforehand or have not attended class?

In this paper, we don't take the usual approach by answering these questions based on our experiences as lecturers. Instead, we provide preliminary results of students' views regarding how engagement of their peers with online and classroom activities could be achieved, and how opportunities for students to recover when they have missed components of the delivery could be built in. The students we interviewed had just completed a traditional second year engineering mathematics course, while students who responded to the survey had just completed the first offering of this same course in blended mode in the following year. The purpose of this paper is therefore not to provide guidelines for others on successful approaches, but to explore the student perspective.

Blended and flipped learning in mathematics

Blended learning is the careful alignment of online and face to face learning, where both components complement and enhance each other. There are various levels to which a blended learning approach can be taken (Alammary, Sheard and Carbone, 2014). The flipped classroom is one approach which requires students to watch videos explaining concepts before they come to class. Traditional lectures are then transformed into interactive problem-solving sessions. Blended and flipped learning places the onus on students to engage with online material and encourages students to take ownership of their learning. 'To be successful, the model requires students to "develop the skills to self-regulate their own performance and become aware of the gaps in their understanding of complex conceptual tasks" (Loch and Borland, 2014). Thus, the designer of online learning resources has a responsibility to produce components that promote self-directed or self-regulated learning, as discussed by Loch and McLoughlin (2011). This model of learning may or may not be achievable for weak students who lack prerequisite skills, an issue that has occupied mathematics educators for some time (Rylands & Codie, 2009). Below, we revisit the literature relating to the two research questions.

Engaging students in online and face-to-face components of blended learning
Engaging students in face-to-face classes requires them, first of all, to come to class. So why do students attend classes? Loch (2010) reported that mathematics students who were given the choice to be online or face-to-face students, and had chosen face-to-face mode, commented that they attended classes so they could ask questions and benefit from immediate feedback and interaction with the lecturer. This is not possible when learning from video. It appears that these students were intrinsically motivated to attend because of the interaction with teaching staff. There are strong arguments from the literature for the implementation of active learning in the classroom. Freeman et al (2014) undertook a meta-analysis of 225 studies on active learning versus traditional lecturing in STEM disciplines and found that exam scores and the likelihood of passing increase in active learning classes compared to traditional lectures. Prince (2004) reviewed the literature on active learning and demonstrated that student-centred face-to-face sessions, where students learn by doing, lead to active learning. This strategy is employed in the flipped classroom approach to create more engaging face-to-face learning events than transmissive lectures. We indicated in our 2014 ASCILITE paper (Loch and Borland, 2014) that peer-instruction strategies have been used successfully for active student learning (Caldwell, 2007). An example is using audience response systems to collect immediate feedback from students which allows lecturers to judge in real time where students are at, so misconceptions can be addressed (Kowalski, Kowalski & Gardner, 2009). Other findings confirm that students react positively to highly interactive, technology-enhanced mathematics classes where they are able to contribute to the discussion (Donovan & Loch, 2013).

Strategies to engage students in the online content are also needed. McGivney-Burelle & Xue (2013), reported on higher performance when they compared flipped calculus classrooms to traditional teaching. However, with 22% of students not engaging at all with the online content that was expected to be studied before class, one may wonder how these students performed, and how much learning they missed out on. The strategy to have an in class entrance quiz as well as problem-solving group work based on the videos did not work. Brame (2013) suggests providing additional marks as an incentive for students to complete pre-class preparation, while Bagley (2014) suggests students be held accountable for pre-class activities.

Enabling students to recover if they have not engaged with one of the components
If a student has not attended a class, one possible way for them to recover is to watch a recording of this class. Indeed, universities commonly mandate recording of lectures to assist this and allow additional revision opportunities. To investigate the effect of lecture recordings on student performance, Yoon and Sneddon (2011) undertook an investigation into how recorded lectures were used by students in two large undergraduate mathematics courses. Student feedback via online surveys was analysed, and they found that the availability of lecture recordings can have a detrimental effect on the grades of some groups of students: those who did not attend lectures because they knew the recordings were available, and those who 'intended to watch more recorded lectures than they actually did'. These students achieved significantly lower grades than students who were exposed to the whole lecture series. This is an issue that needs to be considered when designing catch-up mechanisms in blended learning.

Non-engagement with the online material, for example, not watching a video before attending class, may of course be addressed through brief revision of the video content in class. Again, we caution that this revision may have the opposite effect. Watching the videos becomes no longer 'time-critical' if students know they can recover in class when they haven't watched the video. Hence they may never go back to watching all content or working through all online quizzes – or they may never seriously consider engaging with these tasks before class. We call for further investigation of this topic.

Engineering Mathematics 3M

Engineering Mathematics 3M is the third in the series of mathematics courses offered to mechanical engineering students at our university. Prior to this implementation, it was taught in a traditional mode, with summative assessment, distributed across three in-semester classroom tests worth 35% and one post-semester final exam worth 65%. There were no regular assignments. The learning management system was used to provide typeset study notes and tutorial sheets, to make announcements to students, and to upload additional documents as needed. Students attended three hours of lectures, one tutorial hour, and one computer lab hour per week.

When we redesigned this course, we concentrated on improvements we wanted to make where blended learning could assist. Since this paper focuses on the students' views of blended and online learning, not the redesign of the course into blended mode, we will provide only a brief overview of how the course was changed. Weekly online summative assignments were introduced to reduce the reliance on invigilated assessment from 100% to 62%. Online material for revision of prerequisites was developed, as well as resources helping students to understand why they needed to study the topics covered in the course (Loch and Lamborn, 2016). Online and face-to-face components were aligned to complement each other, incorporating more active learning in the classroom and videos explaining particular concepts, but no lecture recording. Navigation was made easier with weekly overviews to guide student learning. Students received clear communication to explain the changes made. This approach was guided by feedback received from students before commencing the redesign, some of which is discussed below.

Methodology

Before we embarked on the redesign of the course, we recruited three students who had recently completed the course to a focus group interview to gauge their views of online and blended learning and gather information about how we could implement it in the course. The focus group discussion was recorded and professionally transcribed. After the first offering in blended mode and as part of evaluation of the new mode, we surveyed students enrolled in the course. Of the 114 students enrolled, 23 responded to the anonymous end-of-semester survey. While this is not a high percentage, the number of responses is sufficient to gain an overview of what students were thinking. With a view to finding answers to the two research questions, we undertook an analysis of the focus group transcript and typed survey responses. The summary of outcomes is described below.

A preliminary analysis of the data to answer the two research questions

What can we do to ensure students engage with both online content and classroom activities?

Focus group in 2014

We asked students what they thought about having more online content. They agreed that there was a need for more online learning, mainly for revision purposes or in case a student could not attend. Students commented 'we definitely need online learning', and 'you don't miss anything if it's online'. Students appeared to have a preconception that online learning is limited to learning from videos and that online learning is a mere convenience, recapping content from the face-to-face classes, rather than a vital component of a blended learning approach. On the other hand, there was concern that, although they wanted them created, students might not watch long lecture recordings and that short videos would be preferred. At the same time, students seemed to be very clear that they did not want increased online material at the expense of face-to-face contact hours, as illustrated by this student comment: 'I prefer to be coming in, seeing a teacher face-to-face and learning from them'. Students said they preferred more interaction in the classroom, together with online learning. When we asked what we could do to encourage more students to attend lectures, one student commented pragmatically: 'some people aren't going to turn up… no matter what'.

We feel we need to moderate these students' views, as these students had just completed the course in the traditional mode, and had not had the chance to experience a blended course. However, we acknowledge the point made that it is the student's choice to attend face-to-face classes, and also to engage with online material. We cannot force students to engage with teaching activities if they don't want to.

Survey in 2015
In the context of the flipped classroom requiring videos to be watched before attending class, we asked the students under what conditions they would watch all videos their lecturer suggested to watch. While one commented 'you can never achieve this as some students will and some won't always', others tried to think of incentives. These included:

- 'Constantly tell us that it will be on the exam'
- Provide marks for viewing videos
- 'Only videos under 10 min, easy to get distracted otherwise'
- Provide videos for revision after the lecture, not before
- Send a reminder to students to watch videos before lecture
- 'If perhaps there was a communal screening of the video' in the lecture
- Dedicate 20 minutes in each lecture to go through which videos to watch

One student commented on the difficulty of continuing to work through mathematical concepts if there are steps that weren't understood. This is due to the nature of mathematics learning where content is built hierarchically. It is also important to understand all steps in a solution to be able to reproduce such a solution: 'the annoying part is you do not understand what you are watching and you will spend one hour to watch them all, and if you don't understand, it will be one useless hour'. This comment, and our observations of student learning from online videos (McLoughlin and Loch, 2013) and help-seeking in mathematics support centres (Loch and Elliott, 2012) indicate that to teach mathematics effectively in blended mode, additional support mechanisms need to be made available to students who are stuck, e.g. through specialised face-to-face or online support.

Providing additional online material increases the time students spend on their studies. We considered reducing face-to-face hours, and asked students what they thought of this approach. We were surprised to hear that only four of the 22 students who responded (one skipped this question) were in favour of reducing hours. Nearly all of the 18 students who did not want contact hours reduced voiced strong opinions on the importance of being able to interact with teaching staff, and stated that they can cope with the additional time taken by studying online content. In fact, several of these students asked for more face-to-face time, particularly tutorial time. A comment made was: 'Increase face-to-face hours since it's easier to understand concepts if questions can be asked immediately'.

How can we build in redundancies, e.g. enable students to recover if they have not watched a video beforehand or have not attended class?

Focus group in 2014
To build in opportunities to recover if a student has not watched a video beforehand, students liked the idea of recapping content at the start of class so it is worth attending for everyone. Participants also suggested providing a plan for what is covered in each class so it is easier for students to catch up if classes are missed.

Survey in 2015
A straightforward way to provide opportunities to recover would be to record all classes, as suggested in the survey. However, students may not actually watch long recordings that are made available as indicated in the focus group, and found by Yoon and Sneddon (2011). This option still requires students to self-regulate their learning and engage with the recordings.

Discussion and Conclusions

It appears that many students think that blended or online learning is limited to watching videos of recorded live classes. If they suspect that these videos are provided to replace face-to-face classes and cut costs, students get upset. It is therefore crucial to communicate clearly with students what blended learning is, why it is being introduced, how it works, how they are benefitting, and what is expected from students. A study plan such as a weekly overview to guide student learning is a good way of explaining the interlinking between the online and face-to-face components of a course, enabling students to catch up on material they may have missed. It would also be useful to constantly refer between the online and face-to-face components, such as mentioning videos and online activities to be completed in class, and suggesting that further explanation of material studied online will be given in class.

Students thought that short videos were preferable to long lecture recordings, however they also wanted lecture recordings, despite the suggestion that they would not be watched. This implies that the students wanted a safety blanket, to recover if they could not attend a class. While we have observed that students comment strongly on the lack of lecture recording in teaching evaluation surveys, our evidence indicates that if short, targeted videos and long lecture recordings are provided, students will favour the short recordings (unpublished work).

The issue of students getting stuck while watching videos, with nobody available to ask for help, is one that requires further investigation. A suggestion made by Herbert (2015) may be a solution— to organise computer lab sessions with a tutor on-campus to give students an opportunity to work through the videos and seek help immediately if they get stuck. However, this requires students to be on-campus, and limits the flexibility blended learning offers. Another approach we would suggest is to schedule synchronous online support sessions.

Students, both in the focus group and via the survey, commented that assessment is what drives student behaviour and learning, even suggesting that marks should be provided for watching videos. One comment from a student in the focus group summarised this rather confronting view: "you are aiming for marks, not for understanding". This observation is worrying, as it indicates that learning is less important than passing; education has become a commodity that is purchased and achieved with minimum effort, rather than acquired through inquiry and deep engagement with the material.

In this paper, we have started to answer two of the seven questions we posed two years ago, from the student perspective: how to engage students better online and in the classroom, and how to build recovery opportunities for students who have not completed online activities before class, or who have not attended class. Much more work remains to be done to identify the best approaches for creating effective blended learning environments in mathematics education. We are planning a follow up paper addressing more of the seven questions, with a particular focus on how to create a sustainable approach to developing blended learning modes in mathematics education that other lecturers in the department would feel comfortable to teach.

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