

# THE ENACTMENT OF A FLIPPED CLASSROOM APPROACH IN A SENIOR SECONDARY MATHEMATICS CLASS AND ITS IMPACT ON STUDENT ENGAGEMENT

Tracey Muir

University of Tasmania

*Once considered the domain of higher education, the flipped classroom is increasingly being implemented in secondary school settings. Although enactments of the approach vary, it typically involves the use of digital technologies to shift direct instruction to the home environment, providing for more targeted in-class teaching. This paper describes how a flipped classroom approach was enacted in a senior secondary mathematics classroom and reports on the students' and teacher's perceptions of the impact of the approach in terms of students' engagement with mathematics. It adds to the limited research in this area through providing an account of how flipping the classroom works in practice and its potential for engaging students in mathematics.*

## BACKGROUND

According to Bergmann and Sams (2012), there is no such thing as *the* flipped classroom, but the basic concept is “what is traditionally done in class is now done at home, and that which is traditionally done as homework is now completed in class” (p. 36). Bergmann and Sams (2012), who have been credited with pioneering the approach, advocate that there is no single way to flip a classroom, no specific methodology to be replicated or checklist to follow; hence the importance of providing descriptions of cases such as the one documented in this paper. Proponents of the approach note benefits such as differentiated teaching for a range of student abilities, increased student-teacher interaction, self-pacing and greater student engagement. The potential for the approach to engage students is an important consideration as student disengagement in mathematics is of ongoing concern (e.g., Skilling, Bobis, & Martin, 2015). The autonomous nature of the flipped classroom approach suggests that it may influence students' motivation to engage in mathematics, as autonomy, along with competence, and relatedness, has been linked with increasing extrinsic and intrinsic motivation (Abeysekera & Dawson, 2015). The study discussed in this paper investigates those links through specifically addressing the following research questions: What is the nature of a flipped classroom approach enacted within a senior mathematics classroom? What are the students' and teacher's perceptions of the impact of this approach on their engagement with mathematics?

## REVIEW OF THE LITERATURE

The terms ‘flipped classroom’, ‘inverted classroom’ and ‘flipped learning’ appear to be used interchangeably in the literature, but a flipped classroom does not necessarily mean flipped learning, which is defined as:

... a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a dynamic, interactive learning environment where the educator guides students as they apply concepts and engage creatively in the subject matter.

(Flipped Learning Network (FLN), 2014, para. 1)

There are different interpretations of the approach and associated variations in implementation strategies, with flipped learning and mastery of topics being the ultimate goal. According to Bergmann, Overmyer, and Wilie (2013), flipped learning is characterized as a: means to increase interaction and personalized contact time between students and teachers; space where students take responsibility for their own learning; classroom where students who are absent do not get left behind; class content is permanently archived for review or remediation; class where all students are engaged in their learning; place where students can receive a personalized education. Straw, Quinlan, Harland and Walker (2015), who explored how flipped learning could be delivered in UK classrooms, identified the following features that distinguished flipped learning from more traditional approaches: Homework time is typically used to deliver new content to prepare students for lessons, as opposed to being used for consolidation and revision; greater use is made of online learning such as videos, presentations and exercises than offline learning such as textbooks and worksheets; teachers spend more time in lessons coaching and facilitating learning and less time providing whole class instruction and demonstration. While the ultimate aim of flipped learning may be for students to achieve mastery of topics that are “individually based and student paced” (Guskey & Gates, 1986, p. 74), Bergmann and Sams (2013) acknowledge that teachers may adopt flipped learning principles to varying degrees, without necessarily achieving full mastery.

### **Enacting the flipped classroom**

A variety of enactments of the flipped classroom are represented in empirical studies. The most prevalent appears to be the model typically used in tertiary settings whereby lectures and instructional videos are prepared and recorded by teachers for their students to access at home, and class time is spent on more practical tasks with the students essentially working at the same pace (e.g., Clarke, 2015; Strayer, 2012). Other studies document enactments whereby teachers access online resources, such as Khan Academy, and make those available for students to view prior to attending class (Straw, et al., 2015). A limited number of studies have documented enactments of varying degrees of mastery (e.g., Muir, 2016). Common findings from the studies indicate positive impacts upon teaching and learning practices and students’ engagement, learning and skills. Straw et al. (2015), for example, found that the approach provided more time for practicing and applying knowledge and skills, questioning and higher level discussions, individualised support and increased understanding of students’ learning styles. They also reported that students showed increases in engagement in learning, knowledge and understanding, Fulton (2012) reported that students in a secondary school context enjoyed working at their own

pace, appreciated being able to review material by replaying videos, and completing more challenging problems in class rather than at home. In a study conducted in senior secondary mathematics classes, Muir (2016) found that in contrast with traditional teaching practices experienced in the past, students found the video tutorials prepared by their teachers to be relevant, engaged their attention, provided for greater autonomy over their learning and enabled them to attain their goal of mastery over their learning.

## **THEORETICAL FRAMEWORKS**

The study discussed in this paper uses the Four Pillars of FLIP framework (Flipped Learning Network (FLN), 2014), to interpret the enactment of the flipped classroom approach as it occurred in a selected senior mathematics class. The framework identifies and describes key features necessary for learning to occur in a flipped classroom: flexible environment; a shift in the learning culture; intentional content; and professional educators. These features are enacted for example, when teachers create flexible learning environments, prioritise concepts used in direct instruction, differentiate content to make it accessible and relevant, and make themselves available to students as required (FLN, 2014). In order to investigate the impact of the flipped classroom on the teaching and learning of mathematics with the selected class, self-determination theory (SDT) (Deci & Ryan, 2008) was used to investigate whether or not students' needs of competence, autonomy and relatedness were being met. According to Deci and Ryan (2008), intrinsic motivation (a natural inclination toward assimilation, mastery, spontaneous interest, and exploration), is catalyzed when conditions such as competence, autonomy and relatedness are present. Motivation is considered to underpin engagement, with both playing a large part in influencing students' drive to participate and learn at school (Martin, 2007).

## **METHODOLOGY**

The study employed a mixed-methods approach (Creswell, 2003) whereby sequential methods were used to inform the collection of qualitative data. An exploratory case study methodology was selected in order to bring new understandings to the fore (O'Leary, 2010) with data sources including an online survey, interviews and classroom observations. The survey contained 24 questions consisting of responses to Likert-scale items about the use of online resources and seven open-ended questions. The items were adapted from an existing instrument designed to investigate students' self-initiated use of video tutorials including logistical and attitudinal aspects (see Muir & Chick, 2014). Semi-structured interviews were designed to allow the researcher to probe more deeply into students' experiences of the flipped classroom approach as reported through the survey and were conducted with focus groups. The teacher interview schedule was designed to elicit information about the enactment of the approach and its impact upon the teaching and learning of mathematics. Classroom observations were used to triangulate the data collected from the surveys and interviews and to answer the first research question.

The participants were 15 Grade 12 students (aged approximately 17 years) who completed the survey (5 male and 10 female) and their Grade 12 mathematics teacher, Ms Brown<sup>1</sup>. Eight students participated in focus group interviews which were audio-taped and conducted after survey completion and classroom observations. The study was conducted in a large independent metropolitan school with a 'Mathematics Methods' class. Mathematics Methods is a senior secondary pre-tertiary course which covers topics such as functions, calculus and statistics and is externally examined. This was the fifth year that Ms Brown had taught the course and her first year with producing her own videos (she had used Khan Academy videos in the past). Quantitative data from the survey were analysed using descriptive statistics expressed in percentages for the Likert scale items. Qualitative data from the surveys and interviews were transcribed and analysed using reflexive iteration (Srivastava, 2009) whereby each sentence in the transcripts was coded, initially through emerging themes. The transcripts were then re-analysed and instances of the components related to the Four Pillars Framework and SDT were identified. This process limited researcher bias in that the researcher was open to the possibility of other themes emerging and not restricted to narrowing the data to pre-determined themes.

## RESULTS

### The flipped classroom in practice

Lesson observations showed that Ms Brown's enactment of the flipped classroom involved an expectation that her students had watched her pre-prepared video tutorial prior coming to class, with the majority of class time spent on completing exercises in the prescribed textbook. The two lessons observed for the purpose of this paper involved the students solving simultaneous equations using matrices. Figure 1 shows an example from the textbook that students were expected to solve.

Find the determinant of the matrices:

$$\text{a } A = \begin{bmatrix} 2 & 3 \\ 3 & 5 \end{bmatrix} \quad \text{b } B = \begin{bmatrix} 2 & 3 \\ 2 & 3 \end{bmatrix} \quad \text{c } C = \begin{bmatrix} 2 & 4 \\ 2 & 3 \end{bmatrix}$$

Figure 1: Finding the determinant of a matrix (Jones, Evans & Lipson, 2012, p. 726)

Each lesson began with an eight minute 'warm-up' where students worked individually from their textbooks. Ms Brown then facilitated students' oral responses to the problems, then briefly revised some of the content from the video tutorial that most students indicated they had watched. The remainder of the lesson (approximately 40 minutes) was spent on working through allocated questions in the textbook, with Ms Brown individually assisting students who required assistance. Students indicated in the interviews following the lessons that that was typically what happened in their mathematics classes.

At the time of the study Ms Brown had recorded approximately 20 video tutorials, all based upon topics in the textbook and all lasting for about an hour in duration. In her interview, Ms Brown said that she preferred to create a video for each topic and then direct students to watch different parts of it, rather than break it up into shorter

videos. She used Powerpoint with an OfficeMix add on to record her videos, which students accessed through an emailed link. This was provided to students at least three days prior to class. Student survey data showed that 100% of students agreed that the tutorials helped them to understand a concept and that the tutorials were helpful. Just over half (54%) of students indicated that the tutorials were of the right length, with only 38% indicating that they watched all of the tutorials from beginning to end. Interestingly, 77% indicated that they found the tutorials boring, yet 85% of students indicated that they accessed all or most of the video tutorials that were made available. Student interview data provided an insight into how the students accessed the video tutorials at home:

I watch it all, but then if she says something I don't understand, I might go back and watch it all again. [Anna]

She sends [emails] us sheets and questions – like summary pages of the chapters and that's what she goes through on the video so I'll have them with me and be writing down what she said ... and if you don't get it, you can ask her questions [later]. [Helen]

Students were also asked in the interviews how their classes were different this year as compared to previous classes which were not flipped. The following is illustrative of the comments received:

We didn't do questions like this, not all the time, like we used to sit and listen, but now she's doing more questions in class so that gives you more time with her one on one if you have questions, whereas I can remember some other topics, we would just sit and listen, and ... we wouldn't do as many questions like we were doing today. [Hayley]

It's better having the video and watching it at home and being able to come and ask the teacher if I am still unclear about how to do something or a particular concept ... I think it's better than last year where we would go through the book and rather than have lengthy explanation in class, it's better to have an idea before you get to class. [Anna]

Students also identified that the prepared video tutorials were a good source of information, but viewed them as complementary, rather than a replacement, for either the teacher or the textbook, as the following responses indicate:

You can access it easier than a teacher in a class with other students, as well as it being specific to the question you need. [open-ended response, survey]

If you don't understand the book, watching another person explain the concept can help you gain a better grasp of the ideas and skills. [open-ended response, survey]

For me, if the teacher said, watch this video as compared to doing 20 questions in the text book, I would do the video – it's more appealing, [Anna, interview]

## Motivating factors

Data collected from surveys and interviews provided evidence that students' motivational needs for *competence*, *autonomy* and *relatedness* were addressed through this approach. In addition, another strong theme, *relevance*, emerged as being influential in students' motivation to access the video tutorials.

In terms of meeting students' need for *competence*, 92% of students agreed that they performed well in class tests because they watched the tutorials, while there was 100% agreement that the tutorials helped them understand the work undertaken in class. Qualitative comments which referred to this aspect included the following:

Sometimes they [videos] explain it differently so that I may understand better. [open-ended response, survey]

If I don't understand the concepts I can go back afterwards and revisit so it's like Ms Brown teaching me again. [Anna, interview]

Students also recognized that competence varied between individuals, alluding to the individualized nature of the approach, which was also noted by Straw et al. (2015). Brittany, for example, in her interview noted that:

Sometimes with a whole class of say 20, if everyone has a question, then the whole class time is taken up with question time ... but in the video, lots of questions are answered there and even if people do have questions, instead of about 18, there's maybe 2 or 3, so you've got much more time and much more availability to talk to Ms Brown separately.

Comments related to *autonomy* often included reference to self-pacing, accessibility and convenience. Open-ended responses in the survey, for example, included "You can access the videos and information from anywhere", "You can work at your own pace without being pushed ahead or slowed down ..." and "They are a great way to get a head start on the next lesson". In her interview, Helen stated that "You can always go back and view them, not like last year when you had to continuously ask for help".

Students varied in their perceptions as to whether or not it was important that the videos were prepared by Ms Brown. Helen, for example, stated that:

I think the way Ms Brown does it, she does it the easiest way possible so that we can remember it and do it by ourselves ... I feel like Ms Brown does it better than a lot of other teachers would ...

Abigail and Hayley agreed, with Abigail stating that:

You understand it better when it's someone you know ... and they can explain it again in a similar way in class if they have to.

As was found in other studies (e.g., Muir, 2016), having a sense of *relatedness* with the teacher was a strong motivator in its own right. The following comment from Anna was illustrative of students' appreciation of the work involved with the creation of the videos:

You can tell she's really put in the effort so you know it's an easy task in return to her ... so it's no work just to watch it.

Anna, however, also felt that:

I don't think it's really important who does it – whether one teacher does the video or the entire maths faculty ... but what's good about a teacher from school doing it as opposed to Khan Academy is that they know what the curriculum is and know what's important to focus on ... The few times I did that [looked up on Google] it was extremely lengthy and only a few relevant points so it is easier having Ms Brown give us the videos – it's a lot more concise and relevant to what we want.

The above comment indicates that *relevance* is a key motivating factor; this was also endorsed by Brittany who stated that accessing other online resources were “not very helpful ... the language used was a bit formal and not very easy to understand”.

## DISCUSSION AND CONCLUSION

The results indicate that students in Ms Brown's class were engaging with the flipped classroom approach and that her enactment included some of the features associated with flipped learning as identified by the FLN (2014). While classroom observations showed that the lessons were largely dominated by students' completion of textbook problems, there was little whole class demonstration by the teacher which was experienced by these students in the past. While a flexible environment, in terms of spaces and time frames, was not a key feature in this context, Ms Brown did demonstrate that she was intentional about the content she would present to students via the video tutorials and how that would be supplemented with the textbook exercises. Consistent with flipped learning features, Ms Brown determined what needed to be taught and which materials students should explore on their own (FLN, 2014). She also made herself available to all students for individual, small group, and class feedback in real time as required (FLN, 2014). Students perceived their experiences of this approach positively, with the results indicating that it met their needs for competence, autonomy, relatedness (Deci & Ryan, 2008), and relevance. The study has implications for mathematics teachers who may find this approach beneficial in terms of providing students with increased autonomy over their learning, leading to achieving competence with a subject that can be challenging and inaccessible for many.

### Note

<sup>1</sup>pseudonyms used for teacher, school and students throughout

## References

- Abeysekera, L., & Dawson, P. (2015). Motivation and cognitive load in the flipped classroom: definition, rationale and a call for research. *Higher Education Research & Development*, 34(1), 1-14.
- Bergman, J., Overmyer, J., & Wilie, B. (2013). The flipped class: What it is and what it is not. Retrieved from <http://www.thedailyriff.com/articles/the-flipped-class-conversation-689.php>.
- Bergman, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class everyday*. Washington, DC: International Society for Technology in Education.

- Clarke, K.R. (2015). The effects of the flipped model of instruction on student engagement and performance. *Journal of Educators Online*, 12(1), 91-115.
- Creswell, J.W. (2003). Research design: Qualitative, quantitative, and mixed methods approaches (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.
- Deci, E., & Ryan, R. (2008). Self-determination theory: A macrotheory of human motivation, development, and health. *Canadian Psychology*, 49(3), 182-185.
- Flipped Learning Network (FLN). (2014). The four pillars of F-L-I-P. Retrieved from: [www.flippedlearning.org/definition](http://www.flippedlearning.org/definition)
- Fulton, K. (2012). Upside down and inside out: Flip your classroom to improve student learning. *Learning & Leading With Technology* (June/July 2012), 12-17.
- Guskey, T. R. & Gates, S.L. (1986). Synthesis of research on the effects of mastery learning in elementary and secondary classrooms. *Educational Leadership*, 43(8), 73-80.
- Jones, P., Evans, M. & Lipson, K. (2012). *Essential further mathematics*. Port Melbourne, Vic: Cambridge University Press.
- Martin, A. (2007). Examining a multidimensional model of student motivation and engagement using a construct validation approach. *British Journal of Educational Psychology*, 77(2), 413-440.
- Muir, T., & Chick, H. (2014). Flipping the classroom: A case study of a mathematics methods class. In J. Anderson, M. Cavanagh, & A. Prescott (Eds.). *Curriculum in focus: Research guided practice* (Proceedings of the 37th annual conference of the Mathematics Education Research Group of Australasia), pp. 485-492. Sydney: MERGA.
- Muir, T. (2016). No more 'What are we doing in maths today?' Affordances of the flipped classroom approach. In B. White, M. Chinnappan, & S. Trenholm (Eds.). *Opening up mathematics education research* (Proceedings of the 39th annual conference of the Mathematics Education Research Group of Australasia), pp. 485-494. Adelaide, SA: MERGA.
- O'Leary, Z. (2010). *The essential guide to doing your research project*. Thousand Oaks, CA: Sage Publications Inc.
- Skilling, K., Bobis, J., & Martin, A. (2015). The engagement of students with high and low achievement levels on mathematics. In K. Beswick, T. Muir, & J. Wells (Eds.). *Proceedings of the 39th Psychology of Mathematics Education conference*, Vol. 4, pp. 185-192. Hobart, Australia, PME.
- Srivastava, P. (2009). A practical iterative framework for qualitative data analysis. *International Journal of Qualitative Methods* 8 (1), 76-84.
- Straw, S., Quinlan, O., Harland, J., & Walker, M. (2015). *Flipped learning research report*. UK: National Foundation for Educational Research (NFER) and Nesta.
- Strayer, J. F. (2012). How learning in an inverted classroom influences cooperation innovation and task orientation. *Learning Environmental Research*, 15, 171-193.