Student and Parent Perspectives on Fipping the Mathematics Classroom

Tracey Muir
University of Tasmania
<Tracey.Muir@utas.edu.au>

Traditionally, the domain of higher education, the 'flipped classroom' is gaining in popularity in secondary school settings. In the flipped classroom, digital technologies are used to shift direct instruction from the classroom to the home, providing students with increased autonomy over their learning. While advocates of the approach believe it is more engaging and effective than traditional instruction, there is little empirical research into the benefits of this approach, particularly in relation to mathematics instruction. This paper adds to the limited research by reporting on students and parents' experiences with a flipped classroom in a senior mathematics class. The results indicated that there were five main components that influenced students' motivation to engage with the flipped classroom approach. The study has particular implications for students and secondary mathematics teachers who have limited time to make the curriculum comprehensible for students and to prepare them for external assessment tasks.

In the flipped classroom, teachers typically record and narrate screenshots of work they do on their computer screens, create videos of themselves teaching or curate video lessons from internet sites such as TED-Ed and Khan Academy (Hamdan, McKnight, McKnight, & Arfstrom, 2013). Benefits of the approach include differentiated teaching for a range of student abilities, greater student motivation and increased student-teacher interaction (Bergman & Sams, 2012). Despite its growing popularity, there is little empirical research on the flipped classroom outside of higher education settings, with Abeysekera and Dawson (2015) labelling the area as under-evaluated and under-theorised. This paper adds to the limited research in the field by investigating senior secondary students' and parents' experiences with flipping the mathematics classroom. It adds to a previous study by Muir and Chick (2014) through targeting a different cohort of students and documentation of parental perspectives. Specifically, this paper aims to answer the following research question: What are student and parent perspectives of the benefits or otherwise of adopting a flipped classroom approach in the teaching of senior secondary mathematics?

The study is important because it documents an alternative approach to traditional mathematics instruction. There is continued concern in Australia, and internationally, over the lowering levels of engagement with mathematics (Attard, 2010), and research has shown that there is a definite decline in school mathematics engagement of many young adolescents compared with their primary school counterparts (NSW Department of Education & Training, 2005). As noted by the Department of Education and Early Childhood Development (2009), there is a persistent and progressive decline in middle school students' attitudes towards, and interest, in science and mathematics. This is of concern as disengagement with mathematics can lead to exclusion from courses requiring specific levels of mathematics and generally limits one's capacity to understand life experiences through a mathematical perspective (Sullivan, Mousley, & Zevenbergen, 2005). According to Attard, the pedagogical relationship between students and teachers appeared to have a significant effect on students' engagement in mathematics, and that students were highly engaged when working on computers. The flipped classroom caters

2015. In M. Marshman, V. Geiger, & A. Bennison (Eds.). *Mathematics education in the margins* (Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia), pp. 445–452. Sunshine Coast: MERGA.

for students' propensity to be online, and is consistent with MCEETYA's (2003, p. 4) statement that "students will use online curriculum content to expand and deepen their understanding at a pace, in a place and with an educational purpose that suits them". The pedagogy, however, must transform learning, engage students in ways not previously possible (MCEETYA, 2005), and give them greater control over how, where and when they learn (ACARA, 2014).

The flipped classroom also reconceptualises the paradigm of traditional mathematics homework. It is common practice in Australian secondary classrooms to allocate regular homework, often involving the use of the classroom textbook, and requiring the completion of a number of exercises. In the home environment, completion of homework tasks can be problematic, particularly as students move into higher grades, and the mathematics becomes more challenging. Mathematics homework often becomes a source of tension between parents and children (Civil, 2006) and many parents feel largely uninformed about contemporary mathematics teaching methods (Muir, 2009). In the flipped classroom, traditional homework tasks are completed in class where the teacher can provide targeted assistance as students work through activities designed to help them master the material.

Theoretical Framework

Regarded as the pioneers of flipped learning, Bergman and Sams (2012) reported that flipping their classroom led to greater student interaction in class, and more targeted individual instruction. A range of benefits associated with flipping the classroom have been identified for students, including differentiation of teaching, allowing the "pausing and rewinding' of teachers in recorded presentations, informed parents, a more transparent classroom, greater student motivation and interest, and improved classroom management (Bergman & Sams, 2012).

A key feature of the flipped classroom is the shifting of direct instruction to outside of the group learning space, and maximising one-on-one interactions in the classroom that more actively involve students in the learning process (Hamdan et al., 2013). The reduction of in-class time spent on teacher presentations and explanations allows the teacher to target their teaching to specific areas which may be particularly challenging and provide for greater monitoring of individual student progress. Instructional benefits of the flipped classroom approach include active learning, increased one-to-one interaction, priming, reduction in cognitive load and catering for diverse learners (Hamdan et al., 2013).

A theoretical model proposed by Abeysekera and Dawson (2015) provides an appropriate lens for investigating the flipped classroom approach. Although developed in a higher education setting, it contains a number of elements that would be relevant in a secondary school setting. The model, which is depicted in Figure 1, shows five components of the flipped approach that have the potential to cater for motivation and cognitive load. These components are: sense of competence, sense of relatedness, sense of autonomy, tailoring to expertise and self-pacing.

Motivation, which is closely linked to engagement, can be defined as 'the willingness to attend and learn material in a development program' (Cole, Field & Harris, 2004, p. 67). According to Pintrich and De Groot (1990), motivation is linked strongly with self-regulated learning and contains three components: an expectancy component, which includes students' beliefs about their ability to perform a task, a value component, which

includes students' goals and beliefs about the importance and interest of the task, and an affective component which includes students' emotional reactions to the task. In essence, students' motivation is related to their beliefs about whether or not they can perform the task and that they are responsible for their own performance (Pintrich & De Groot, 1990). This is consistent with Xu and Wu's (2013) research on self-regulated learning in relation to homework management. They suggested that the use of self-regulatory strategies are influenced by goal orientation (purpose for engaging in a task), task value (the importance and utility of a task), and task interest (the appeal of a task or an activity).

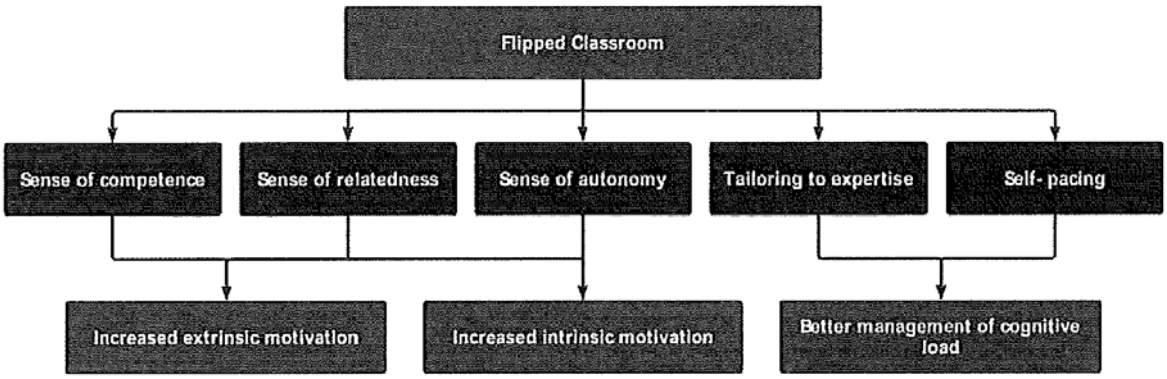

Figure 1. Theoretical model for the flipped classroom (Abeysekera & Dawson, 2015, p. 10)

As homework is primarily an individual task, undertaken outside of a scholarly environment, with the goals typically set by others, it requires students to be motivated in order to complete it. As mentioned earlier, homework is often seen as a source of tension between students and parents (Civil, 2006) and students complain about homework tasks being frequently boring, too easy or too hard, or irrelevant to their lives (Xu & Wu, 2013). As depicted in Figure 1, intrinsic and extrinsic motivation is closely linked with characteristics such as competence, relatedness and autonomy, which in turn all relate to self-regulated learning. Students develop a sense of competency through a belief that they can perform a task, are motivated to perform the task if they can relate to it as being importance and interesting, and are more likely to complete the task if they have a sense of autonomy or belief that they are responsible for their own performance. They are also more likely to manage the cognitive demands associated with a task if the instruction is tailored to their expertise, and there is provision for self-pacing, such as manipulating the pace of video tutorials. These aspects are particularly applicable to students' engagement with homework tasks, including those set within the context of a flipped classroom approach.

Methodology

The study employed a mixed-methods approach (Creswell, 2003) to investigate students' and parents' perceptions of their experiences of a flipped mathematics classroom. Within this methodology, the researcher used sequential procedures (Creswell, 2003) where data collected from the surveys were used to inform the interview schedule, allowing more detailed exploration with a few cases or individuals. The study was undertaken with a senior secondary mathematics class from a large metropolitan secondary

school in Tasmania. Mathematics Methods is a senior secondary pre-tertiary course which covers topics such as functions, calculus and statistics. The teacher, Mr Smith, (pseudonym) was a fully qualified mathematics teacher, with over 20 years' teaching experience and had been teaching the course for several years. He had trialled the use of videos in 2013 (see Muir & Chick, 2014), but 2014 was the first year in which he used a fully flipped approach to teach his class. The student participants were in Grades 11 or 12 (approximately 16-17 years of age); there were 24 students in the class, all of whom completed the online survey (15 male and nine female), and 10 participated in the student interviews (seven male and three female). Six parents participated in the parent interviews.

The procedure involved the completion of an online survey using Qualtrics and for some students, participation in a follow-up interview. The survey contained 24 items, two of which required responses in a Likert format (see Table 1 for example items). There was also the provision for open-ended responses. The survey took approximately 15 minutes to complete. Semi-structured interviews were conducted with students after the completion of the survey. The interviews were audio-recorded and transcribed, and took approximately 15 minutes. Students were given the option of individual or focus group interviews, and with one exception, ('Rose') they all participated in focus group interviews. Parent interviews were conducted early in 2015 after students had finished the course and received their results. These were conducted individually, either in person or over the phone and varied from between 15-40 minutes duration. The teacher was also interviewed.

Quantitative data from the survey were analysed using Qualtrics, with responses to the Likert scale items expressed in percentages for ease of comparison. 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 contained in Figure 1 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. Initially 11 codes were ascribed to the data, and these were able to be further classified into the five components in Figure 1. For example, references to 'convenience' or 'easily accessible' were included in 'sense of autonomy' and 'targeted work' in 'tailoring to expertise'. The results section has been organised to report against the themes identified in the student data, supplemented by teacher and parent interview data.

Results and Discussion

Survey data showed that 100% of students had a computer and internet access at home and that 88% of students had accessed Mr Smith's pre-prepared online tutorials that year. Items from the student surveys that are relevant to this paper are presented in Table 1. Qualitative data from the survey were drawn primarily from three main open-ended questions which asked students to identify the advantages of the online resources as compared to the text book and the teacher, and whether or not they would recommend the practice to others.

Sense of Competence

Responses in this category included references to being helpful in terms of understanding the mathematical content and/or achieving success, thereby establishing a 'sense of competence' in the user. Table 1 shows that 96% of students agreed that online

tutorials helped with their learning and helped them to learn a concept. Furthermore, 92% indicated that they found the tutorial helpful and 88% indicated that watching the tutorial contributed to success in both tests and class work. Qualitative comments from students included "Online resources are good for clarification of understanding" and "I liked Mr Smith's videos because they are easy to understand and they're more based on the questions we're answering". Jess, in a focus interview, indicated that "It helped because he was actually like teaching how to do everything and [it was] easier than looking in the book and trying to figure it out for yourself".

Mr Smith explained that:

> the flipped classroom enabled me to do the easier examples, set the scene, bit of drill and practice, you know what's differentiation of trig functions about - do these examples, so that when we got to class, they were ready to go [In class]. I was able to do a more sophisticated example so I didn't waste 20 minutes starting from scratch so that the homework, instead of doing lots of problems which I could have got them to do if I wanted to, was to just get the topic consolidated, the knowledge consolidated, the easier questions done, the rule, whatever it was, so that they were ready to go when we got in there

Parents were ambivalent in their perceptions of whether or not the flipped classroom approach impacted upon their child's success with the subject and with their overall grades. Donna, for example, believed it definitely benefited her daughter and "definitely helped her in terms of her results". Sue, however, felt that her son, Andrew, "thought that by watching these videos, I'm going to understand this maths and then when they ask questions I'm going to be able to do it … but he didn't – had no idea". Sue's comments show that, while not the intention, her son tended to passively watch the videos, which was in contrast with other students who generally indicated that they regularly paused and rewound the videos, and took notes throughout. Other parents, perhaps not surprisingly, were reluctant to attribute their child's success or otherwise in the subject to the flipped classroom approach, due to extraneous variables and no opportunity to compare with other approaches.

Sense of Relatedness

Table 1 shows that 88% of students accessed Mr Smith's online resources, compared with 25% who accessed other online resources. Reasons for this included relevance, with many students' comments showing that they particularly connected with, or related to, Mr Smith. Illustrative survey comments included, "I preferred Mr Smith's videos [over other online tutorials] because they were explained well and easy to understand". They were also impressed with Mr Smith's commitment to helping them learn:

> [In class] he'd get everyone involved and like the amount of effort he put into these videos – like he'd spend his periods where he was free, recording like he was talking to himself on his iPad and just the amount of effort he put in was really good. [Jack, focus interview]

> I like Mr Smith – he's really good and I understand him, but if it was like [Mr T, another mathematics teacher], I have no idea about half the stuff he's saying, so I probably wouldn't understand his videos, but I understand Mr Smith's. [Ella, focus interview]

The parents also communicated a sense of relatedness to Mr Smith. Sue, for example, acknowledged that it was "almost like having your teacher coming into your home environment and you don't feel so isolated". Interestingly, only 33% of students agreed that they used the tutorial to explore mathematics of their own, despite finding them engaging. This is perhaps not surprising as the emphasis was on the prescribed work that

needed to be covered in the course, and exam preparation, indicating that students were extrinsically motivated to access them.

Table 1
Student Responses to Selected Likert Scale Items (n=24)

Statement	SA/A	Undecided	D/SD
I use online resources to help me with my learning	96%	4%	0%
I have used online resources (not prepared by my teacher) to help me with my mathematics this year	25%	25%	50%
I have used online resources prepared by my teacher to help me with my mathematics this year	88%	0%	12%
The tutorial helped me to understand a concept	96%	0%	4%
The tutorial was about the right length	71%	16%	13%
I watched all of the tutorial from beginning to end	71%	8%	21%
I found the tutorial helpful	92%	4%	4%
I found the tutorial boring	25%	42%	33%
I think I did better in the test because I watched the tutorial	88%	8%	4%
I think I understood the work better in class because I watched the tutorial	88%	8%	4%
I used the tutorial to explore mathematics of my own	33%	42%	25%
I used the tutorial to explore ideas about mathematics begun in class	58%	38%	4%

Sense of Autonomy

In order for students to be motivated through integrated regulation, the need for autonomy needs to be satisfied (Abeysekera & Dawson, 2015). Students' survey and interview data showed several references to this aspect of the framework. Rose, for example, in her interview, recommended the use of videos and stated:

> If you're doing your homework at home on a Saturday night, and you don't understand something, then rather than waiting for next maths lesson, you could just go online and access the video straight away

Elsa's comment, "I always watch them because I don't want to get behind", demonstrates that she sees herself as in control of her own learning, and also indicates that she is extrinsically motivated by wanting to maintain her grades.

In terms of identifying advantages over asking the teacher or using a text-book, six student responses included references to the capacity to view the clips multiple times and pause and rewind them. Five student responses also mentioned accessibility (e.g., "You can work on the topic at home").

Parents also appreciated their children taking control over their own learning, particularly as they felt unable to assist with this level of mathematics homework. Trudy, for example, stated that:

> I think it's really good that she's had the videos to watch because before, and in other years, she might have been working from a textbook and get stuck, and I couldn't help her, whereas with this

> way, if she's stuck, she can watch the video and she can write down questions and she can either email her teacher or she can ask him the next day, and it just seems to take all the stress out of the homework that used to happen before when she couldn't do things.

Tailoring to Expertise and Self-pacing

In the framework, these components lead to better management of cognitive load. Students typically referred to these aspects when discussing the affordances of the medium, such as "You can go back and revise it whenever you need it", "It [Mr Smith's tutorial] was more specific to what we were studying", "You can pause and rewind the video" and "You can choose what part to watch and what you need help with".

The ability to differentiate the learning and allow students to monitor their own progress was what led Mr Smith to trial the flipped classroom approach, particularly as it gave him added capacity to cover all the material required. He also stated:

> It had spin offs that I didn't expect, so I had [names student] was [overseas] for a couple of weeks, and he was basically learning, he had his text book with him, he was watching my videos, he was doing the problems I set, and his mother was quite appreciative of the fact that he could do that.

Conclusions and Implications

The results indicate that Abeysekera and Dawson's (2015) framework was useful for interpreting perceptions of the flipped classroom approach. Although originally developed for use in higher education settings, the senior secondary mathematics students in this study referred consistently to the five components in the framework when talking about their experiences with the flipped classroom. Reference was also made to these components by the classroom teacher and parents of the students in the class. The results showed that students had a purpose for engaging in the task (Xu & Wu, 2013) in that they were motivated to succeed in the subject and felt that watching the video tutorials helped them understand the work better and perform successfully in assessment tasks. The tutorials helped them with developing a *sense of competency* and a *sense of autonomy* in that they could use the video tutorials to consolidate and extend their learning when and where it suited them. Creating *a sense of autonomy* particularly resonated with parents, who felt unable to assist with mathematics homework at this level.

It appeared that Mr Smith was particularly influential in developing *a sense of relatedness* in his students. The results showed that students and parents were appreciative of the time and effort involved in producing the videos, and they recognised that he could select examples and provide directed teaching when necessary to capitalise on the flipped classroom approach. Class time previously spent working through examples on the board became more targeted towards specific instruction. In this way Mr Smith was *tailoring to students' expertise* and providing students with opportunities to *self-pace* their learning.

Overall, the study shows that the flipped classroom approach has merits in terms of creating an environment where students can be intrinsically and extrinsically motivated to achieve learning goals. While it could be argued that the students in this study were already motivated to succeed as they chose to study the course, it is evident through the data that they could identify factors that influenced their engagement with the course. With the exception of Sue, who raised concerns about the passivity of the approach, students and parents favoured it over traditional mathematics homework practices. The study, therefore, has implications for teachers, parents and policy-makers who may need to re-consider

traditional approaches to senior secondary teaching and homework practices in light of these findings.

References

Abeyseker, 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.

ACARA (2014). *Information and Communication Technology (ICT) capability*. Available from: http://www.australiancurriculum.edu.au/GeneralCapabilities/Pdf/ICT

Attard, C. (2010). Students' experiences of mathematics during the transition from primary to secondary school. In L. Sparrow, B. Kissane & C. Hurst (Eds.), *Shaping the future of mathematics education* (Proceedings of the 33rd annual conference of the Mathematics Education Research Group of Australasia, pp. 53-60). Fremantle, WA: MERGA.

Bergman, J., & Sams, A. (2012). *Flip your classroom: Reach every student in every class everyday.* Washington, DC: International Society for Technology in Education.

Civil, M. (2006). Working towards equity in mathematics education: A focus on learners, teachers, and parents. In S.Alatorre, J.L. Cortina, M. Sáiz, & A. Méndez (Eds.), *Proceedings of the Twenty Eighth Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (Vol. 1, 30-50). Mérida, Mexico: Universidad Pedagógica Nacional.

Cole, M., Field, H., & Harris, S. (2004). Student learning motivation and psychological hardiness: Interactive effects on students' reactions to a management class. *Academy of Management Learning and Education, 3*(1), 64-85.

Creswell, J.W. (2003). *Research design: Qualitative, quantitative, and mixed methods approaches* (2nd ed.). Thousand Oaks, CA: Sage Publications, Inc.

Department of Education and Early Childhood Development (2009). *Energising science and mathematics education in Victoria*. Melbourne: Education Policy & Research Division Office.

Hamdan, N., McKnight, P., McKnight, K., & Arfstrom, K. (2013). *A review of flipped learning.* Available: http://flippedlearning.org/cms/lib07/VA01923112/Centricity/Domain/41/LitReview_FlippedLearning.pdf

MCEETYA. (2005). Pedagogy strategy: Learning in an online world. Available: http://www.curriculum.edu.au/verve/_resources/ICT_LearningOnlineWorld-PedagogyStrategy.pdf

MCEETYA. (2003). Contemporary learning: Learning in an online world. Available: http://www.curriculum.edu.au/verve/_resources/Contemp_Learning_Final.pdf

Muir, T. (2009). At home with numeracy At home with numeracy: Empowering parents to be active participants in their child's numeracy development. In R. Hunter, B. Bicknell, & T. Burgess (Eds.) *Crossing divides* (Proceedings of the 32nd annual conference of the Mathematics Education Research Group of Australasia, pp. 395-402). Wellington, NZ: MERGA.

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.

NSW Department of Education and Training. (2005). Students - middle years. Available from http://www.dec.nsw.gov.au/about-us/statistics-and-research/public-reviews-and-enquiries/

Pintrich, P. R., & De Groot, E. V. (1990). Motivational and self-regulated learning components of classroom academic performance. *Journal of Educational Psychology 82*(1), 33-40.

Sullivan, P.A., Mousley, J., & Zevenbergen, R.L. (2005). Increasing access to mathematical thinking. *Gazette of the Australian Mathematical Society*, *32*(2), 105-109.

Srivastava, P. (2009). A practical iterative framework for qualitative data analysis. *International Journal of Qualitative Methods, 8*(1), 76-84.

Xu, J., & Wu, H. (2013). Self-regulation of homework behaviour: Homework management at the secondary school level. *The Journal of Educational Research*, *106*, 1-13.