

Flipped learning: A mathematics experience for Year 9 boys

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Flipped learning is a pedagogical approach where students are introduced to the learning material before class. Classroom time is then used to deepen student understanding through peer discussion and collaborative tasks. This innovative pedagogical approach was implemented in mathematics lessons for a Year 9 class of all boys at a school in metropolitan Melbourne. Teacher reflections and feedback from students and parents were used to evaluate this approach. Students' engagement and autonomy have increased. Suggestions to improve the flipped learning approach have been identified by the teacher.

INTRODUCTION

Flipped learning is more prevalent due to innovations in educational technologies. Bishop and Verleger (2013) define the flipped classroom approach as one in which teachers design resources to provide direct computer-based individual instruction outside the classroom and interactive group learning tasks inside the classroom. Teachers who use flipped learning prepare and/or source pre-lesson materials such as prescribed readings, videos, online activities and screencasts for students to explore. The use of these pre-classroom resources allows face-to-face lessons to focus mainly on a collaborative working environment.

The flipped learning approach differs from the more traditional approaches through:

- Allocating homework tasks for new content learning, which prepares students for their upcoming mathematics lessons, in contrast to revision tasks.
- Online learning (e.g., visual presentations, readings, quizzes) is favoured over textbooks and worksheets.
- Class time focuses on facilitating learning rather than whole-class instruction.

(Straw, Quinlan, Harland, & Walker, 2015)

Although there is no single pedagogical model to implement flipped learning (Mercieca, 2018), the Flipped Learning Network (FLN, 2014) established by Bergmann and Sams (2012), describe the Four Pillars of FLIP that teachers should incorporate into their practice in order to engage in flipped learning. Table 1 provides a summary of what is involved in each of the four pillars.

Pillar	Characterised by
Flexible Learning Environment	<ul style="list-style-type: none">• Spaces and time frames that permit students to reflect on their learning are established.• Educators are flexible in their expectations of student timelines for learning and in their assessment of student learning.
Learning Culture	<ul style="list-style-type: none">• Instruction focuses on a learner centred approach.• Students are actively involved in knowledge construction as they participate in and evaluate their own learning.
Intentional Content	<ul style="list-style-type: none">• Educators help students develop conceptual understanding and procedural fluency.• Concepts used in direct instruction are prioritised for learners to access on their own.
Professional Educator	<ul style="list-style-type: none">• Teacher is available to provide real time feedback to individuals, small group and class discussion.• Ongoing formative assessment is conducted during class time to inform future instruction.

Table 1. Overview of Four Pillars of FLIP (FLN, 2014).

TECHNOLOGICAL TOOLS FOR FLIPPED LEARNING

An abundant number of technological tools are being used by teachers in flipped learning (e.g., Matific – an online mathematics teaching resource that focuses on improving core skills such as the four processes). Similarly, there are various approaches used such as the provision of direct instruction via the use of a prescribed reading or a video recorded lecture, to those that allow teachers to individualise learning according to student needs (Attard, 2019). The evolution of new technology provides teachers with opportunities to prepare pre-lesson materials via multimedia and shift students from passive learning to active learning.

A CLASSROOM EXPERIENCE OF FLIPPED LEARNING

SETTING THE SCENE

Flipped learning was used (by Liyanage) to re-conceptualise traditional secondary mathematics instruction for Year 9 boys (48 students, 14-15 years old) and provide students with the opportunity to take responsibility for their own learning. When flipped learning was first introduced, many students found self-directed learning challenging. As their mathematics teacher, I explained to the students my rationale for flipping the classroom, my expectations on viewing the videos, taking notes and coming to class with an awareness of the content that we would be discussing and reinforcing in class. I chose to share with the students why I was going to flip the classroom so that students would be cognisant of my significant investment in the process, from filming and recording the videos to purchasing the equipment to produce the content.

EXPERIMENTING WITH RESOURCES

After trialling a number of different programs, the most straightforward method was to screen record using my iPad and then upload the videos to *Edpuzzle*. *Edpuzzle* allows the editing of videos, the incorporation of formative assessment into the videos and it prevents students from skipping the video. I initially uploaded my content to a private YouTube page accessible to the students. However, it became difficult to track which student had actually watched the video. Therefore, I transferred the videos to *Edpuzzle*, which offers teachers useful data and analytics on student progress per video. I have also established a class notebook on OneNote (Figure 1) where students can find set tasks for the lesson, extra material, basic class notes, and the relevant video links.

The screenshot shows a OneNote page with a purple header bar. The page title is "Topic 3.4 - Simplifying algebraic expressions" and the date is "Friday, 14 December 2018 8:14 AM". The page content is organized into sections: "Learning Intention", "Success Criteria", "Resources", and "Questions".

Learning Intention	To be able to simplify algebraic expressions
Success Criteria	<input type="checkbox"/> I can add and subtract like terms in an expression <input type="checkbox"/> I can multiply and divide like terms in an expression
Resources	Simplifying expressions using addition and subtraction https://youtu.be/cPtO19v52u8 Multiplying and dividing algebraic expressions https://youtu.be/bbV8DgG1GE
Questions	Jacaranda Textbook - Topic 3.4 <input type="checkbox"/> Question 2 (a, c, g, l, k, m, s, z) <input type="checkbox"/> Question 3 (all)

The right-hand side of the page shows a sidebar with a list of pages, including "The Language of Topic 3.2 - Using The Language of Topic 3.3 - Algeb Topic 3.3 Answ Topic 3.4 - Simpl Topic 3.5 - Expan Topic 3.8 - The hi REVISION".

Figure 1. A snapshot of my class OneNote.

Implementing the Flipped Classroom

The implementation of a flipped classroom has required me to change the structure of my mathematics lessons. In the first 20 minutes of a lesson, the video content is reviewed and discussed, and a set of class notes is developed (Figure 2). The class notes are derived from the individual notes taken by the students (Figure 3). In the next 20-30 minutes, students work on collaborative tasks, while I work with students individually or in small groups. During double period of mathematics, I meet with students to focus on reviewing a certain concept. This provides me with an opportunity to intervene earlier when a student is experiencing difficulties. My role has somewhat shifted from being a teacher to a mentor. As students are working at their own pace, I am able to scaffold their learning according to their needs.

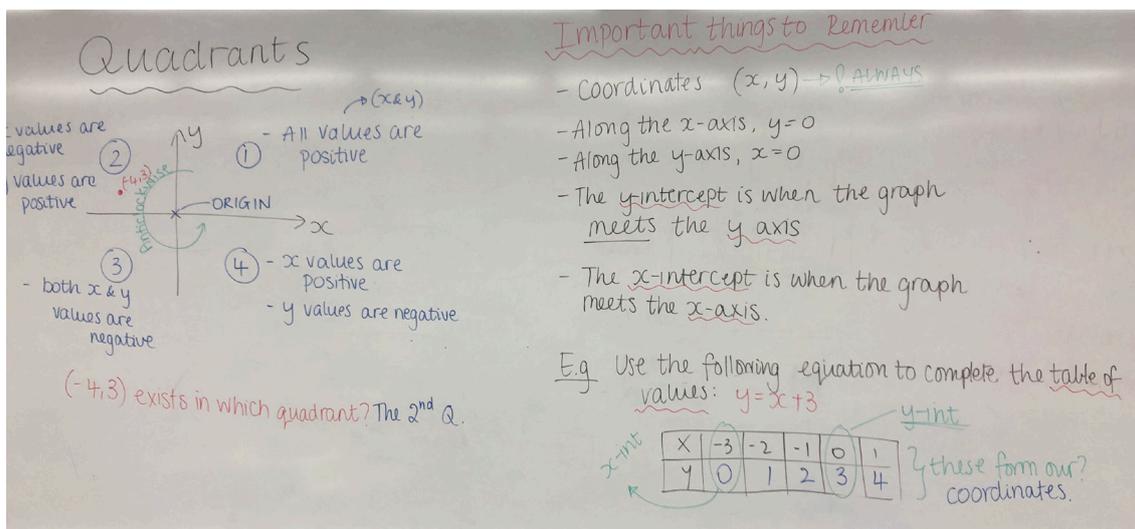


Figure 2. Class notes developed by the students.

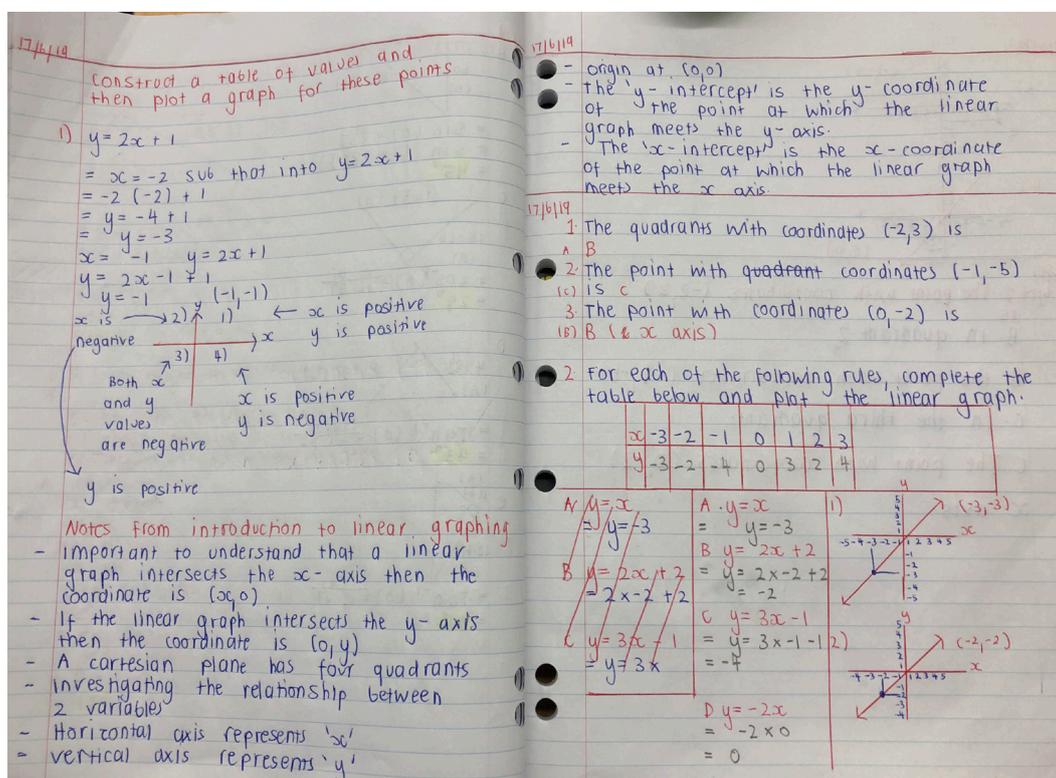


Figure 3. Notes that a student made when he watched the video at home.

RESULTS

The effects of the flipped classroom were evaluated through my own teacher observations and through feedback from students and parents.

TEACHER OBSERVATIONS

Based on my own observations (Liyanage), students who previously lacked the confidence to volunteer in class were now regularly contributing to class discussions and were more receptive to learning. Since implementing a flipped classroom, I have increased collaborative exercises during class time which have promoted group work. Heterogeneous grouping of students allows the more capable students in mathematics to support the students who are finding the content challenging. The cooperative learning that occurs has enabled students to further develop their reasoning strategies and consolidate their understandings. My own teaching philosophy is one where I value rationalism and progress most (Bishop, 1988). Therefore, I design tasks which involve more peer-to-peer interactions so that students are required to rationalise their thought process with others and not just solve the question. I actively encourage students to engage in a growth mindset (Dweck, 2008) and provide opportunities for constructive feedback amongst peers. Classwork becomes challenging when students have not engaged with the pre-class activities. I commonly hear students ask their peers “Did you watch the video? She showed an example of how to work this out”. Ironically, the students are now questioning each other about the completion of homework!

The main disadvantage of flipped learning has been the ‘burnout’ in developing the resources because recording the videos has been a time-consuming process. I have been reluctant to source outside material, choosing rather to create everything myself because the students have explained that my personalisation helps them to connect with what is done in class. Most of my allocated time for planning at school is now dedicated to developing the templates to film and what the students will be viewing at home (de Araujo, Otten, & Birisci, 2017). This has resulted in me doing more preparatory work after hours; for in-class tasks as well as filming the videos. I feel that I would benefit from receiving support in how to better utilise class time, to maximise student learning.

STUDENT FEEDBACK

Upon the completion of a unit on linear graphing, I asked students whether my *Edpuzzle* videos had supported them. Students described the videos as more “engaging” than the usual “confusing and tedious textbook exercises” (Student, 2019). Students believed that they understood the working out of mathematics problems better when they watched the *Edpuzzle* video of me modelling the process. Students have also reported increased satisfaction with the relevancy of materials provided, and greater engagement with, and autonomy over their learning compared with that experienced in the past.

Students have responded favourably to the videos that I have created because it felt like they were receiving one-on-one support. In producing the content, much of my attention is focused on producing quality content that is accessible to all, whilst also planning for educationally rich experiences in class.

PARENT FEEDBACK

Parents were also appreciative of the videos, and my endeavour to make their sons more independent in their learning. One of the students in my Year 9 class has dyslexia and recently, his mother informed me that since implementing flipped learning, she had noticed that her son had become much more independent in his approach to learning mathematics. He would regularly re-watch the videos to understand a new topic and he was less reliant on extra support to complete his coursework. For this student, offering him the opportunity to learn in a different way has reduced his “anxiety that has stemmed from his dyslexia” (Parent, 2019).

DISCUSSION

ADVANTAGES OF FLIPPED LEARNING

The classroom experience described above shows evidence of students actively engaging with their mathematics learning. The increased autonomy that allows students to access their learning resources at their own pace, also promoted a flexible learning environment.

Flipped learning supports students by decreasing the cognitive load required in a typical mathematics lesson. It provides more time for students to process the content of a mathematics lesson through a preview at home. Classroom lessons can then be designed to provide maximised opportunities for students to discuss their mathematical understandings and misconceptions.

Flipped learning is a similar model to the G.R.I.N. (Getting Ready In Numeracy) intervention program that aims to prepare students for their upcoming mathematics lesson through a pre-class tutoring session (Sullivan & Gunningham, 2011). Decreasing the cognitive load through G.R.I.N. has reported similar results to flipped learning in that pre-familiarity with the focus content and associated processes seem to engage students who otherwise may have been disinclined to participate in classroom discussions (Kalogeropoulos, Russo, Sullivan, & Klooger, 2020). Similar to the G.R.I.N. intervention program, the teacher noted that the students in flipped learning came to class with prerequisite knowledge upon which they could build. The teacher perceived this as benefiting students and allowing them to be more active in class. The students' interactions were also greater with one another. Flipped learning has the potential for differentiating the learning for individual students along with enabling them to develop autonomy over their learning, leading to mastery of the content demonstrated through successful completion of the assessment tasks (Muir, 2019).

DISADVANTAGES OF FLIPPED LEARNING

Whilst flipped learning is achieving success in relation to student engagement through access to technology for self-paced learning, it is important that the current challenges are also addressed. de Araujo et al. (2017) suggested that much of the teacher's planning time and attention in preparing for flipped learning is on the at-home activities rather than the in-class activities. Although the teachers' attention to the at-home resources is important because the home context is where the content delivery has shifted, the same attention needs to be given to the planning of the in-class context so that rich communication is fostered within and among students in mathematics. Furthermore, the teacher's role in class is to facilitate student learning in rich tasks that are closely related to the pre-lesson materials. Seeking or designing the appropriate resources are also a challenge in themselves.

Teacher burnout is also a concern due to the demands of creating content, monitoring blogs and other activities planned for flipped learning. Students may not complete the pre-class tasks and this will add more pressure to a teacher who will need to adjust planned lessons accordingly (Attard, 2019). Teachers must keep up to date with evolving technology and be able to filter and choose prepared resources that are appropriate for their students' learning context.

CONCLUDING THOUGHTS

Given the amount of experimentation and time needed to find appropriate resources, teachers would benefit from knowledge and support related to the creation of high-quality video and multimedia resources to promote effective mathematics teaching in flipped learning (de Araujo et al., 2017). Also, teachers could require support in how to better prepare for making effective use of the expanded in-class time. Teachers should consider the tasks they use to support collaboration as well as the quality and purpose of that collaboration (Herbel-Eisenmann, Steele, & Cirillo, 2013).

Flipped learning may shift a teacher's practice if the frequency of increased student self-confidence and engagement in mathematics learning prevails. A teacher can be described as the central force in flipped learning because teachers often initiate the change in practice themselves (de Araujo et al., 2017). How teachers conceive and enact flipped learning reflects their values in mathematics learning. For example, a teacher who values small group interaction with her/his students may aim to front-load the students with instructional content (prior to the lesson) and use class time to conference with students as reported in this case study.

An area for future research is understanding teachers' values for flipped learning so that we can help to align their practise with instructional strategies that literature suggests might help them achieve these goals (de Araujo et al., 2017). For example, if a teacher values classroom experiences such as group discussions and student presentations, they could be directed to specific professional development on how to enact these in maximised classroom time. Lo and Hew (2017) emphasise the importance of carefully scaffolding the transition to flipped learning. This includes explaining the rationale of flipped learning and its potential benefits to both students and parents. Teachers should carefully choose online material for flipped learning to ensure it is appropriate for their students and the context. There appears to be considerable benefit in exploring flipped learning if it is valued by a teacher. This case study reported an increase in student engagement through flipped learning. Using technology has facilitated this pedagogical practice. However, a considerable amount of planning is required to ensure that flipped learning is implemented successfully.

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