An in-depth look at students' experiences of, and thoughts about, 'flipped classrooms' in mathematics

Marie Joubert, Dominic Oakes, Sofya Lyakhova

Swansea University

In response to teachers' complaints about an overcrowded curriculum, FMSP in Wales initiated a research project into the Flipped Classroom Approach in two phases. This presentation relates to Phase 1, which aimed to research the responses of teachers and students to the use of 'flipped classrooms' for mathematics. In a previous paper (Oakes, Davies, Joubert, & Lyakhova, 2018), we reported on mainly teachers' views. This paper provides a more detailed look at the students' views.

Flipped classroom, resources, pedagogy, depth, connection

Outline of the problem

In 2015, the Welsh examination board (WJEC) introduced new specifications for A-level mathematics and Further Mathematics. The Further Mathematics Support Programme in Wales (FMSPW) worked with a group of teachers in North Wales to construct a scheme of work to support understanding of the new specifications. The idea behind this scheme of work was that it would help teachers to teach mathematics rather than teaching how to pass the examination, focusing on building connections and developing deep conceptual knowledge. However, many teachers suggested that, although they would like to teach in this way, there was not enough time to do so.
In response, the FMSPW suggested they might try a new teaching approach in which students are introduced to the content, or the 'chalk and talk' part of the lesson via video at home, which would mean that there would be more class time for teaching in a connected and deep way. This approach is usually referred to as the 'flipped classroom approach'.

We are interested in whether and how this approach of freeing up time does in fact lead to the sort of teaching described above, but to begin we wanted to evaluate how well the flipped approach worked for both teachers and students. The student perspective is the question addressed in this paper.

Flipped classroom research

The 'flipped' approach involves introducing students to content before the face to face lesson takes place and in recent years, using video has become a popular way to share the content.

Our previous paper for the BSRLM proceedings (Oakes et al., 2018) reviewed relevant literature in this context, suggesting that there are some challenges associated with the use of technologies, such as video, when using the flipped classroom approach. Firstly, it requires teachers to get materials ready in good time, although, as found by Adams and Dove (2016) and as reported in our paper, teachers become better at this once they master the technological difficulties.

As we previously reported, there appears to be some agreement in the literature on the benefits of using a flipped approach; for example it provides time for more mathematical discussion in class and better peer learning (E Silva, 2014; Jungic, Kaur, Mulholland, & Xin, 2105; Lo, Hew, & Chen, 2017); students can use the videos at any time, and they can be used not only to prepare for class but also for revision (Grypp & Luebeck, 2015; Kraut, 2015; Ziegelmeier & Topaz, 2015).

What we did

In a professional development meeting held in North Wales in March 2018, we introduced the idea of using the flipped classroom approach (FCA). A number of schools in the area expressed an interest, and, following this, six teachers participated in initial research meetings in July 2018 and September 2018. Four teachers eventually took part in the research.

The data-gathering for the project began in October 2018 and is ongoing. Data consisted of lesson observations and interviews with teachers and students. We also asked all students in two of the classes (40 students) to complete a seven-question questionnaire similar to two found in the literature (Johnson, 2013; Long, Logan, & Waugh, 2016), in which we asked students to rate their experiences of the FCA and provide a comment.

For this paper, the data was analysed to answer questions about the students' experience of using the FCA and the approach adopted was a thematic approach informed by the literature.

Findings

This section reports on the findings from the research in three parts: findings showing the student perspective of what happens during an FCA, findings describing student views of advantages and disadvantages and a student survey. These findings follow the first round of observations and interviews.

We considered the student perspective of 'what happens' under three categories: student understanding of the FCA in terms of how it works and why it is used; how students work with the videos; what happens in lessons. These categories are used to structure the discussion below.

The students were asked how they would explain what the FCA is to someone who has no knowledge of this approach. We found that generally students had a clear understanding of the practicalities of the FCA, explaining that they are expected to prepare for lessons by using (mostly) video and that they should make their own notes in advance of the lesson based on the video, as demonstrated by S2's comment:

> The FCA is where a student watches a video or is given notes in which they are meant to read/watch. Then in class you complete questions based on the video/notes where the teacher is able to help you with the questions. (AB, S2)

The students appeared to understand the teachers' motivation for using the FCA. Essentially they saw this as being better prepared for lessons and saving precious class time, as S3 explained:

> It is where we watch a video, made by our teacher before going into the lesson so we have a better insight into what we are going to be learning. It saves time at the start of a lesson. (AB, S3)

Interestingly, whereas some students saw the videos as a preparation for learning, rather than the learning itself, others saw the videos as the 'basic' learning, allowing 'harder' work to be tackled in class, with the aid of the teacher.

> Learning the whole thing at home, or out of the classroom and then when you go into the classroom you do the harder stuff. (HH, S1)

Students generally appeared to use the videos as intended. All of the students interviewed explained that they realised it was vital to watch the videos before the lesson, and all also mentioned making notes and pausing the videos where necessary to facilitate this. One student reported using the videos both before and after a lesson as well as for revision purposes, saying that she thought she would not be able to remember the mathematics later so she watched the video again to reinforce it.

> I'll watch it through, try and make notes where I can and I'll go back, pause it where I need to and carry on making the notes (AD, S4)

> At the end we have a big summative assessment which is what gets sent home so your parents can see your progress – I always use the videos to revise for those. (CB, S1)

Students from all four research classes described similar patterns in their mathematics lessons. All of them spoke of some sort of quiz or quick questions, which they appeared to see as a checking process to ensure that they had watched and understood the video. Following that, they said, they moved onto questions, usually taken from examination papers. Some of them reported that, if the video had not been widely understood, the teacher would go over the video content in class. Students noted the time saving aspect of videos where this did not need to happen.

> We usually have a look at what we did first at home, so we'll have a look at the questions we did then we'll move on to the advanced stuff on that topic. (HH, S4)

> The ones that are more complicated, the teacher would usually go through it as well so you know exactly what to do, but the stuff that's more simple … those you can just go into some questions. Makes it easier, saves time as well. (CB, S2)

When tackling new questions in class students generally mentioned a process of trying it on their own, then on their table and only then involving the teacher.

> Well we just try them ourselves at first and obviously if we don't get them we'll ask each other and if we still don't get it we'll just ask Sir. [Interviewer: Does he have more time to explain things?] Yes definitely. (AD, S1)

> We'll discuss on our table, especially if we don't get the question, we'll kind of see where people get it so we can help each other but if the whole class is struggling, Sir will stop us and go through it on the board. (AD, S4)

Students mentioned time being saved in comparison to other classes. They also referred to the structured nature of their lessons with videos covering a topic bit by bit.

> I'd say it's different. It's a lot faster pace in this class, because, like the lessons we just go through the work so much quicker and we get the topics done in a shorter amount of time – I feel like it's very structured like that. (AD, S1)

> We have the videos and then we come into class, we do a recap sheet and then we go onto past paper questions. Whereas with Miss [other mathematics teacher] it's kind of like we get all the information all at once in a lesson and we've just got to sort of process it all at once. (AD, S1)

Coming now to students' views of advantages and disadvantages, some of these are included in the 'what happens' section above. In terms of advantages.

students particularly mentioned the advantage of having the teacher to help with more difficult questions. They also mentioned being better prepared for lessons as well as advantages in note-taking from videos.

> (The videos) are not too long so it's manageable and it's easier than going home with a difficult homework which you can't do rather than having a difficult question in class which you can ask the teacher to help you with it. (GS, S1)

> For me it means that I get more time in class to do more exam questions so it preps me, because if we didn't have them then I'd come into class not knowing what we were going to do in the class and we'd spend the majority of the lesson learning about the basics of it and then we'd get the exam questions for homework. If I'm at home with the questions and I don't understand them then I can't get Sir to help me. (AD, S2)

> You get straight into it… it's like practising while you're learning. So, like, you'll be doing it and you'll get it wrong but because you're in the classroom it doesn't matter because you can always go back to her and you can be, like, I got to this bit and now I'm stuck. So I just think it's a lot more, like, productive during lesson time. (HH, S3)

One student had two weeks away from school in a sailing competition. He found the flipped videos useful towards catching up:

> It helped me quite a bit, just getting used to what they were doing back at school. I didn't miss so much stuff, kind of thing, so I didn't miss the fundamental basic parts. So then catching up didn't take half as long as it would have before. (GS, S2)

In terms of disadvantages, connectivity was a particular problem for students in a very rural school. This was mentioned by nine of the 22 students in the comments in our student survey for that school. A minority of students struggled with the videos, though they often found solutions.

> Sometimes there was a bit of a struggle with the size of the videos and connectivity issues. (GS, S1)

The questionnaire results were similar to (though slightly less positive than) those from the similar surveys in the literature, as mentioned above. The comments mirrored the student interview responses.

Table 1, below, provides a summary of the responses. The mean is calculated taking 'Strongly disagree' as one point and 'Strongly agree' as five points.

	Number	Frequency (%)					Descriptive	
		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	Mean	S.D.
1. I like the Flipped Classroom Approach (FCA)	40	0.0	7.5	5.0	50.0	37.5	4.2	0.84
2. I like learning from the FCA videos	40	2.5	2.5	17.5	45.0	32.5	4.0	0.92
3. I spend the right amount of time on homework	40	2.5	12.5	22.5	50.0	12.5	3.6	0.96
4. If I find the maths in the video difficult, I can sort out the difficulties in class	40	0.0	2.5	22.5	42.5	32.5	4.1	0.81
5. I get more help during lessons with the FCA than in my other maths lessons	40	0.0	15.0	27.5	40.0	17.5	3.6	0.96
6. I am able to discuss maths with classmates more with the FCA than in my other maths lessons	40	0.0	7.5	42.5	27.5	22.5	3.7	0.92
7. I am satisfied with my progress this term	40	5.0	7.5	10.0	65.0	12.5	3.7	0.96

Table 1: Results of the survey

Figure 1 below provides a graphical representation of the mean values.

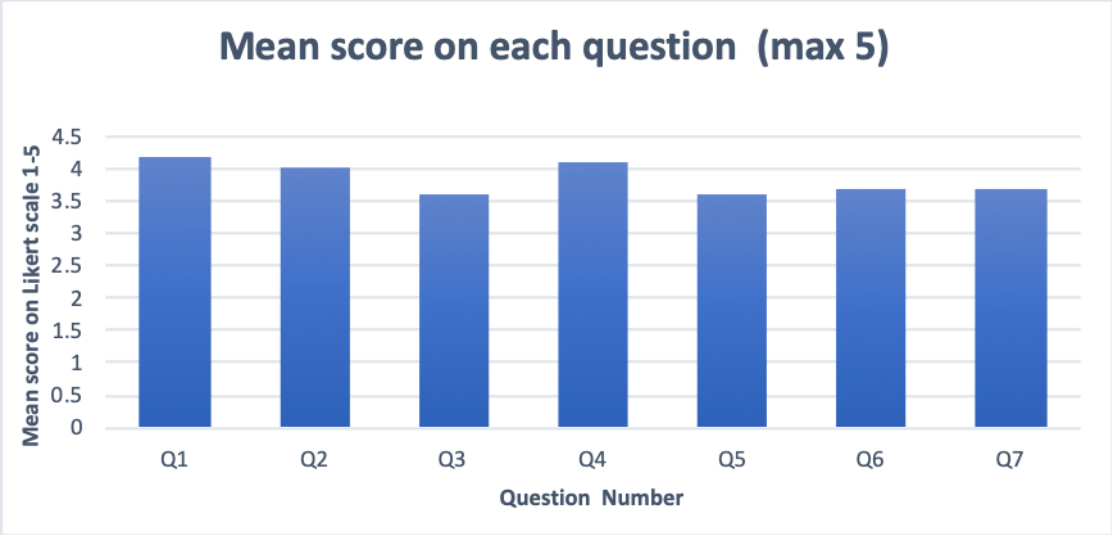

Figure 2: Results of the survey

Conclusion

Our research suggests that overall the students understood the process of, and rationale for, the FCA. A large majority liked the flipped approach (87.5% agreeing with this in our survey), for a variety of reasons. In particular they cited the following reasons for liking the FCA: feeling more prepared when they arrived in the classroom; having more time to take notes; and time being saved that allowed their teacher to give more time to help with their difficulties. A minority of students, however, appeared to prefer more traditional approaches and others reported that, while they liked the flipped approach for mathematics, they would not like it in other subject areas.

Overall then, students expressed a positive view of the FCA. However there are issues which one would need to be aware of if planning to introduce the FCA in particular ensuring that all students are able to access videos. There is evidence that the issue of 'not enough time for depth and understanding' (or 'better teaching') has been partly addressed in that time is released by the FCA. We therefore feel it is reasonable at this stage to conclude that the teacher and student responses taken together indicate that the FCA should be introduced to teachers as a possible approach for them to use.

To this end, Phase 2 of the research is ongoing and focuses on the teaching and learning of mathematics, looking at how teachers are using the time gained. Ultimately, it is intended to develop good practice guidance in this area (both in terms of flipped resources and classroom pedagogy).

References

Adams, C., & Dove, A. (2016). Flipping calculus: The potential influence, and the lessons learned. *Electronic Journal of Mathematics & Technology*, *10*(3), 154–164.

E Silva, J. C. (2014). What international studies say about the importance and limitations of using computers to teach mathematics in secondary schools. *Lecture Notes in Computer Science (Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, *8543 LNAI*, 1–11.

Grypp, L., & Luebeck, J. (2015). Rotating solids and flipping instruction. *Mathematics Teacher*, *109*(3), 186–193.

Johnson, G. B. (2013). *Student Perceptions of the Flipped Classroom*. University of British Columbia.

Jungic, V., Kaur, H., Mulholland, J., & Xin, C. (2105). On flipping the classroom in large first year calculus courses. *International Journal of Mathematical Education in Science and Technology*, *46*(4), 508–520.

Kraut, G. L. (2015). Inverting an introductory statistics classroom. *PRIMUS*, *25*(8), 683–693.

Lo, C. K., Hew, K. F., & Chen, G. (2017). Toward a set of design principles for mathematics flipped classrooms : A synthesis of research in mathematics education. *Educational Research Review*, *22*, 50–73.

Long, T., Logan, J., & Waugh, M. (2016). Students' perceptions of the value of using videos as a pre-class learning experience in the flipped classroom. *TechTrends*, *60*(3), 245–252.

Oakes, D., Davies, A., Joubert, M., & Lyakhova, S. (2018). Exploring teachers' and students' responses to the use of a Flipped Classroom teaching approach in mathematics. In F. Curtis (Ed.), *BSRLM Proceedings, King's College, London 38(3)*. London: BSRLM.

Ziegelmeier, L. B., & Topaz, C. M. (2015). Flipped calculus: A study of student performance and perceptions. *PRIMUS*, *25*(9), 847–860.