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Teacher perspectives on adoption of student-made screencasts as a peer learning approach in secondary school mathematics

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ABSTRACT

A secondary school in Melbourne, Australia piloted an innovative programme in Year 10 Advanced Mathematics, in which the students recorded screencasts as a method of student-led peer learning. The four mathematics teachers who piloted the programme were interviewed to gain their perspectives on their experience and the outcomes of the initiative. Thematic analysis revealed the teachers did not recognize a need to adapt their pedagogy to integrate the technology effectively into their teaching. Three of the teachers were also focused on the quality of the screencast product rather than scaffolding the lessons to enable impactful student-led learning. One teacher who did scaffold his lessons felt unable to lead the other teachers in a consistent approach to the project. The study underscores the need for teacher professional development in pedagogical methods for student-centred, technology-enabled learning if the integration of digital technologies in twenty-first century secondary school classrooms is to be successful.

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Digital technologies; secondary education; mathematics teaching; student-centred pedagogy; peer learning

1. Introduction

Teachers in secondary education, including mathematics teachers, have been considering the question of how education and pedagogy need to evolve and adapt to best prepare today's students for navigating and succeeding in the twenty-first century. Rapid changes in society, economics, technology and the workplace have meant pedagogies and classroom subjects need to keep pace with these changes to ensure young people can be prepared for further education and their careers in the future (Hunter, 2017; Kivunja, 2015; Rotellar & Cain, 2016). Two developments in the evolving twenty-first century classroom have been the integration of information and communication technologies (ICT) into teaching practice and peer learning (Keane et al., 2016).

This paper is the second report of a study that investigated student and teacher views on a pilot to incorporate student-created screencasts into a Year 10 Advanced Mathematics

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class. The paper aims to assist with expanding research evidence in the areas of secondary mathematics pedagogy and technology, as well as peer learning approaches in secondary schools. The paper also aims to offer guidance to others who are interested in developing similar projects for their own classes or across departments.

2. Literature review

This paper conceptually draws on several ideas and approaches in the pedagogical literature. The pilot incorporates the following ideas: the role of digital technology in teaching in general and specifically in the teaching of mathematics, the suitability of screencasts as a mathematics teaching resource, elements of flipped classroom approaches (use of video tutorials and students learning content at home before attending the classroom), and peer led learning. A review of the relevance of these concepts is below.

2.1. Digital technology in the classroom

Digital and mobile information and communication technologies are a key central part of modern life and will continue growing in the future. Today's students are considered digital natives in their personal use of technology (Prensky, 2001), although some researchers have questioned if youth are as digitally savvy as they are assumed to be or have the right digital skills to prepare them for success in further education and workplaces of the future (Selwyn, 2016). To ensure students are prepared and competitive, some secondary schools are mandating student use of technology in the classroom, providing access through school provision of personal laptops and tablets or expectations that parents purchase these personal devices for their children (Keane & Keane, 2017, 2018). However, adapting pedagogy to appropriately harness effective use of technologies in teaching has lagged behind the provision of devices and software (Admiraal et al., 2017; Calder & Larkin, 2018; Galligan & Hobohm, 2018).

2.2. Digital technology, screencasts and mathematics teaching

Using technology to teach mathematics enables students to kinaesthetically engage with mathematical concepts, enhancing their mathematical thinking skills (Calder & Larkin, 2018; Galligan & Hobohm, 2018). Screencasts are one such technology suited for teaching mathematics. A screencast is a video recording of a live digital screen, usually accompanied with audio narration and/or subtitle text describing the action happening on the screen (Croft et al., 2013). Screencasts are ideal for explaining and demonstrating mathematical concepts and processes, with students able to pause, and re-watch parts of the video to aid in their comprehension. Screencasts can be made available online, with students able to access remotely for self-study or revision at home. If they have been absent from class, screencasts can aid the student to stay on top of the lessons being taught.

2.3. Flipped learning

Screencasts are often used in flipped classroom or flipped learning approaches (Bergmann & Sams, 2012; de Araujo et al., 2017). In flipped approaches, students familiarize themselves with new material outside of the classroom, both before and after class. In-class time with the teacher is used to reinforce concepts, practice activities and receive more tailored instruction from the teacher. Videos and screencasts are useful for students to watch before attending class to grasp a topic and this form of instruction often replaces the more routine classroom instruction in a traditional approach. Usually these videos are created by the teachers (Bergmann & Sams, 2012; de Araujo et al., 2017; Muir, 2019). One of the novel aspects of the pilot was that the responsibility of creating the videos shifted to the students, while capitalizing on the opportunity to make it a student led peer learning exercise at the same time. This was a unique approach and had not been previously explored in a combined manner at the school.

2.4. Peer leaning

There is growing interest and nascent research into student-created screencasts, especially for peer to peer teaching/learning (Croft et al., 2013; Galligan & Hobohm, 2018; Loch & Lamborn, 2016 Zhang et al., 2016). Students making their own screencasts can contribute to deep learning through the sensory experience of writing mathematics, the need to understand a concept in order to be able to explain it clearly, and the performance of explanation in the screencast (Galligan & Hobohm, 2018). Student-created screencasts suit constructivist, student-centred learning, and can unlock creativity, empowering students in their learning (Zhang et al., 2016). Through the video capture of the student working through problems, the screencast can reveal to the teacher how the student is conceptualizing and processing mathematics (Galligan & Hobohm, 2018).

2.5. Applications to secondary schools

Student led approaches have been mostly researched in tertiary education settings and often under the framework of 'students as partners' that values students as capable and collaborative partners in learning (Matthews, 2016). This approach is yet to enter the secondary level with a lack of research on the success or otherwise of students learning from resources produced by other students. We argue that there is a space for this in secondary education, where the teacher's role is to scaffold the learning experience for students who are producing videos, and later on to scaffold the learning experience for students learning from these student-produced videos. There is a need for more research on this topic. This research study examines secondary school teachers' perspectives on a pilot with Year 10 Advanced Mathematics students in student-created screencasts. In the absence of existing research on how teachers perceive the loss of control when they give students the task to produce screencasts for their peers, we are comparing in the discussion section our results to the findings in the literature on the flipped classroom and the difficulties teachers face in changing their pedagogical approaches. This paper follows on from an earlier paper reporting the students' responses to the pilot (Keane & Loch 2017).

3. Project approach

The pilot project took place within an all-boys Catholic secondary school in Melbourne, Victoria, Australia. The school was known as an early adopter and leader in providing one-to-one mobile technology to students for use in their learning. When the school issued touch screen pen-enabled tablet PCs to all teachers and students in Year 10, the researchers approached the school to propose the school experiment with having students make screencasts instead of the teachers to see what perceived impact it would have on both students and teachers in their attitudes towards technology use in learning and teaching. The school valued the chance to use the pilot as an opportunity to engage students and staff in greater uptake and expanded use of technology in learning and teaching.

Four Year 10 Advanced Mathematics teachers and their combined 100 students participated in the project. The broad concept of the pilot was codesigned between the researchers and the Learning Enhancement Co-ordinator (Brian) while the specific implementation in the classroom was designed by each teacher. In the classroom design, the four teachers created example screencasts to demonstrate their classes what the intended final product should be. The teachers introduced the topic of expanding and factorizing to their classes in a 20-minute overview. Students in each class were then divided into pairs to work for two weeks on creating a screencast of a subtopic; including expanding three factors, expanding the difference between two squares, and factorizing quadratic trinomials. The pairs were allowed to pick their own subtopic from a list, and some topics were picked more than once by the students. Teachers were available to assist and clarify topics in class, with a large portion of the student work done outside the classroom. After the assignment was completed, screencasts were presented in class for the students to view each other's work and to learn from the screencasts.

The researchers conducted interviews with the teachers and a survey with the students to gauge students and teacher perceptions of the experience. For the schools, the overall intention of the screencast pilot was to allow students to take ownership of their learning and to be self-directed whilst using technology in a meaningful way. The project was student driven, as the students taught themselves sub-topics of expanding and factorizing and then produced a screencast to demonstrate their understanding. The researchers' roles were to document and understand what this experience meant for students and teachers, and what implications this may have had for scaling the pilot into an ongoing programme of pedagogy.

3.1. Brief background on the teachers

The four teachers involved in the pilot were highly accomplished teachers, with at least 15 years of teaching experience each. David was the Head of Mathematics at the school and was close to retirement. He was away on sabbatical for part of the term during the project. Craig was the Deputy Principal in Learning and Teaching. Brian was the Learning Enhancement Co-ordinator and the youngest in the group. He was the coordinator of the pilot for the four teachers. Andrew worked part time and held no leadership position in the school.

None of the teachers had previous professional development in using ICT or screencasts in their Mathematics classrooms. Each teacher self-identified different levels of experience and comfort with using technology in their personal lives and in teaching. Brian was the most enthusiastic adopter of technology use in the classroom and was the leader of the project. David and Craig expressed comfort with using technology, such as creating videos, while Andrew expressed comfort with basic technology uses such as sending emails.

4. Research method

This research takes a case study approach using both a descriptive and exploratory focus to investigate the reflections of the students and teachers on their experiences in the pilot. A case study is appropriate here as the benefit 'is in the process rather than outcomes, in context rather than a specific variable, in discovery rather than confirmation' (Merriam, 1998). A survey was designed and administered to the students and is reported in a previous publication (Keane & Loch 2017). For this part of the study, a qualitative narrative framework was used to capture the teachers' experiences and reflections. The four teachers who taught the subject were interviewed separately by the researchers once screencast production had concluded, using a semi-structured interview guide. The teachers also showed and discussed some of the student screencasts with the researchers during the interviews. Their responses were analysed thematically, coded and categorized to answer the following three research questions:

- What were the teachers' perceptions of quality, usability and likely student uptake of the final screencasts for mathematics peer learning?
- What were the teachers' perceptions of the impact production of screencasts had on student learning and skill development?
- What were the teachers' attitudes towards student-led screencast production and how did they reflect on the process?

This method captures the teachers' journeys and voices through direct quotes, as well as providing a thematic summary of their perceptions and experiences (Boyatzis (1998); Bogdan and Biklen (2003)). Due to the small sample size, pseudonyms have been used and all teachers have been identified as the same gender to reduce risk of identification.

The researchers were observers and not directly involved in the project beyond initial discussions before its commencement. The researchers' roles in this study were to evaluate the project after screencasts had been created. The project received ethics clearance from Swinburne University of Technology under SUHREC Project 2012/106.

5. Results

5.1. What were the teachers' perceptions of quality, usability and likely student uptake of the final screencasts for mathematics peer learning?

Most of the teachers saw the technical side of the task easy for themselves and the students. They attributed it to the school having a history of using technology and having made professional development for using technology in the classroom available. The teachers stated the students were used to using mobile technology and adapted to the technology with ease. David, Craig and Brian described themselves as self-taught with technology and as having previously made screencasts or videos. Andrew stated he was less digitally sophisticated compared to his colleagues. He had previous experience sending digital photos and links on emails to students but had not made his own screencasts.

All the teachers stated that the students easily used the tablets and screencast software. The teachers hypothesized on potential technical issues such as mechanical/digital failing, having possible audio or video issues, and limitations around file size and video length.

Craig mentioned a student had lost his work when his computer failed and needed repair, but the other students did not encounter technical issues in the project.

According to the teachers, there was varied quality of the final resources. Some were described as excellent; others were described as mediocre. However, all the teachers felt the final resources were valuable for revision, or to catch up if a student was absent from class. The teachers also reported varied interest from students to watch them again, commenting that those that did watch them again or watched screencasts from other classes found them useful for revision and seemed to do better on their exams. The teachers also had varied interest to retain the screencasts for future use. David said he would not keep them, the other teachers said they would keep a few of the best ones. Andrew commented the students did not trust the screencasts unless made by a teacher:

> One student said, "No, I'm not going to use them. I'm not going to use them unless they're done by a teacher." But that wasn't the point. I would be thinking that if we had a bank of these, future students would use them because they're past year students. But they didn't trust their own peer group for some reason ... Did not trust it even though we went over it as a class and we looked at it and I said, "You just need to make a correction there and that's fine." And so we reviewed it but they still didn't trust it.

This remark echoes feedback from the students who completed a questionnaire on their experience (Author and Author). The teachers all spoke of the need for the resources to be mathematically accurate and of high watchable quality. This includes features of good audio, the screencast being no longer than two to three minutes, and the explanation or demonstration being clear and easy to follow.

5.2. What were the teachers' perceptions of the impact production of screencasts had on student learning and skill development?

All four teachers spoke of the value of students needing to understand a mathematical concept on their own before they could describe it to someone else. David reasoned that mathematics is a sequential process, as is planning and creating the screencasts. He suggested the experience of sequencing the steps to make the screencast could assist with the sequential thinking one needs for solving mathematical equations:

> I think that helps in the learning process because maths is a sequential subject, you can't just not do this here and all of a sudden expect them to know it. So, if they've worked out there's a particular set of steps that they need to do, they need to get those steps in order, and I think this process helps that ordering mechanism.

Andrew also reiterated mathematics was sequential, but in contrast to David, he felt the creation of screencasts in his mathematics classes was additional workload and a disruption to the sequence of learning mathematics from the teacher:

> I think in maths it's difficult because it's so sequential. And if you interrupt it, then they can't get to the next step. And so, you can't ask them to do a screencast at the start of the topic when they haven't done it.

Andrew also cited numerous circumstantial factors, such as school holidays, and a heavy content load on the curriculum, asserting these impacted the students' ability to do the project well. He admitted he was unsure how much to teach about the mathematical concepts to the students before leaving them to self-direct their learning on the topic. Andrew thought students couldn't explain what they didn't yet know, but he was also concerned if he taught all of the concept, he would be defeating the point of letting them self-learn. Andrew was of the belief they could not learn the topic on their own.

The teachers commented that the students who took to the assignment with the most enthusiasm got the most out of it. Two teachers spoke of students in their classes whom they regarded as disorganized in general and were likewise disorganized with this assignment. Brian, the pilot coordinator who had the most structured approach, reported his students did well on the exam, while Andrew, who seemed most challenged by the project, stated he did not think his students did as well on the exam.

David was surprised at the achievement of some of his students in screencast creation. He remarked the screencasts revealed abilities of some students he had underestimated, and that the assignment gave them a chance to shine in new light. Craig was pleased at the creativity and digital skills some students demonstrated, such as editing and splicing their screencast, or creating two parts to ensure they could cover all the content within the video time limitations. Brian spoke of an adaptation of the approach with students in a lower year level, using screencasts to create similar videos of examples on fractions and then watching them in class. The screencasts in the lower level were repetitive, but the repetition seemed to help the students understand the material and improve their test scores.

In descriptions of how the assignment unfolded in their classes, the teachers each also described incidental student behaviours and outcomes that could be named as collateral learning of transferrable skills. Collateral learning is unintended learning of other knowledge in addition to the intended knowledge of the lesson (Dewey, 1938, cited in Abramovich, 2012).

For example, Craig mentioned some of this collateral learning indirectly without specifically citing it as a learning benefit of the project:

> I think the planning is important, the sequencing of information, the actual, I guess comradery or the team work that goes into it and I guess as, you know a bit of sort of leadership skills and time management and all those things come into it because they've got a definite time zone, they've got to work with all those parameters. They also have to do some job selection of who's your best for what, so there's quite a number of different decisions that the students, even though it sounds like something simple.

5.3. What were the teachers' attitudes towards student-led screencast production and how did they reflect on the process?

The school pilot project had dual objectives. The first was to use a student-centred learning approach to engage students in deep, self-directed and peer-assisted learning by having to research and understand a mathematical topic in pairs, and then record themselves explaining and demonstrating that topic. The second objective was for the screencast to become a reusable learning resource for other students to access at some stage in the future.

The emphasis on creating a bank of learning resources seemed to overshadow the potential the project had to enable student-led learning, with opportunity for the teachers to gain insight into how their students learn and understand mathematics. While all the teachers spoke of the value of a student needing to understand a concept to be able to explain it to others, only Brian planned, communicated, and supported his students in a way that enabled the potential of this process to be realized. The other three teachers did little to no preparation for scaffolding instruction and guiding students through the project. As previously mentioned, they stated they did not want to interfere with the students' self-directed learning, lest it defeat the purpose of the project as they understood it. David stated he did not know how the process with his students was going until the screencasts were completed and uploaded.

The attitude of each teacher seems to transfer to their class and their students' attitudes towards the process and the final products. Brian, who was enthusiastic and valued the process, reported his students also were enthusiastic, valued the experience and performed well on a subsequent exam on the topic. In contrast, Andrew, who was negative about the experience, reported his students were also negative about it and did not perform well on the exam.

The teachers held different conceptions of the assignment which seemed to impact the way in which they introduced it to their students, how they directed them, and their overall attitude towards the project and final products. Brian and Andrew in particular had differing methodologies to teaching mathematics, with each approaching the project differently.

Andrew had a very teacher-centred approach towards teaching mathematics and did not believe his students were capable of researching and learning about new, advanced-mathematics concepts on their own. He positioned himself as the expert, stating he had to teach the concept to the students first before they could explain it. He stated the project, 'distracted me from how I taught'. While reviewing a student's screencast with the researchers, he remarked on his own behaviour: 'That's me letting go … ' suggesting that letting go of control of the teaching is not something that comes easily to him.

While Andrew said he understood the aim of the project, his commentary through the interview and overall negative view of the output and impact on his students suggested he saw the project as a distraction and additional on top of mathematics teaching work that needed to be completed in class:

> I personally don't want to do [student-created screencasts]. Don't want to do it because there's so much content to cover. I don't want to spend time doing this unless they could do it outside – some of them were quite good. They managed to be quite efficient at it. And I said, "If you've got a spare bit of time, head out to a quiet area and do it and then come back into class." And they did very well. And others were really disorganised with it. If you said to me, I have to do this in every topic, I would get angry.

However, his strongest reactions were over not being in control of how the concepts were taught/learned by the students, suggesting that it was not the technical side of making screencasts that challenged him. Rather it was his distrust that his students were capable of the task:

> It's not a level of maths that would naturally occur to you as a teenager. Do you know what I mean? That's what I say to people when they say you've got to explore it and stuff like that. We don't have the time and it is not maths that is going to naturally ping into your head if you're an average person. And it was developed over hundreds of years so how could you expect a teenager to all of a sudden go, "I think if I do this and I do that, I'm going to be able to factorise that another way. In fact, I'm going to call this completing the square. And now I think I'm going to derive the quadratic formula." Not many teenagers are going to be able to do that.

Andrew also seemed uncomfortable relinquishing a teacher-centric method to allow students to explore and make mistakes. He reported his students were not very positive about the experience, which leaves room to speculate if his own views from the outset on the project influenced how the students came to feel about it.

Brian's experience was very different when compared to Andrew's. He had a lot of enthusiasm for the project and confidence his students could do the work:

> Expanding and factorising in its most part is taught in Year 9 maths in advanced maths, so most kids would have had experience, except for probably complete the square method – in terms of all the rest, difference of two squares, perfect square rule, cross method, most of the elements they would have had some experience with their – with previous years.

Brian enthusiastically shared in detail with the researchers how he planned the management of the project in his class. He explained the purpose and dual objectives of the project to his students, showed them an example of how the final product should look, especially technical specifications such as video length, and went through the overarching mathematical concept with them. He then assigned subtopics to the students and gave them guidance about how to go about teaching themselves the subtopic. He was available to answer questions, work through problems with them or check their work. He then used their final products interactively in class. He asked students to take notes as they watched the products. He paused the screencasts to discuss with the students, correct mistakes, highlight or expand concepts, have students ask questions, and allow them time to write notes. He reported the students really enjoyed the activity and performed well on their exams on the topic. It should be noted Brian shared this information with the researchers freely without prompting, whereas the other three teachers were not as detailed in their description of how they worked with the students on the project.

Brian stated that students must be prepared and supported though a self-learning activity and not just let loose on their own without guidance. He also had belief his students had capability to learn the concepts on their own. Brian summarized his approach as:

> Technology is just another way to facilitate understanding learning outcomes, and I employ that in my teaching anyway.

These two teachers exemplified two different attitudes and approaches to their roles as teachers and the purpose of the project.

David and Craig seemed to be placed between these two approaches. Both acknowledged the value the screencasts as resources could have to the students, especially for revisions. David, who was away for part of the project, commented that students needed a lot of guidance with creating screencasts and it was too much effort for them. He also seemed to underestimate the capabilities of some of his students, remarking on the fresh insight he got into some students who did the project well when he did not think they would.

Craig saw value in the assignment for student learning but wished he had given more structure and promoted aspects of the assignment to his students better, such as watching screencasts from other classes to see concepts explained by someone else. He seemed to take a hands-off approach to the project. Likewise, David also took a hands-off approach in his class to let his students find their way through the assignment, stating he did not know at one stage what they were producing until he saw the final screencasts.

Collectively, the four interviews with the teachers provided an interesting insight into how this team worked together. They did not collaborate on a lesson plan or strategy to implement and facilitate the screencast project. The teachers did not seem to have a shared understanding of the objectives of the project. The main shared communication was around a brief introduction to the use of the tablet, software and the idea to have a repository of reusable screencasts made by students. After that, teachers shared ideas in terms of what each was doing in their class, but there was no collaboration or brainstorming about a joint approach to the project or collaborative troubleshooting during the assignment.

Brian, the project leader, had very structured, considered methods for introducing the project to his students, and facilitating and supporting them through the assignment. The other three teachers described giving overviews of the mathematical concept at the start of the project and then being available to answer questions, but largely leaving the students on their own to figure out the mathematics and create their screencasts. Brian expressed wanting more upfront collaboration between the teachers and to get more consistency between them on how the screencast project was taught and used in class. The absence of David for a term and the part-time status of Andrew created challenges in setting times for when all four could meet face-to-face to collaborate. As Brian stated:

> I would probably like to have more collaborative spaces with my teaching staff, but if they're not available they're not available. I'd like to have more consistency in delivery of the project with my teaching staff, but I'm just a person and I can't make everyone be and do exactly how I envisage it, and that could be in part my fault, or it could be in part theirs or a bit of both, but I think it's really important for staff consistency and if you believe in something it's much easier to get the kids onboard and using it, and doing what you're asking them to do in class, as opposed to, if they can sense there's an attitude there that they're not totally onboard with it, well then it's very difficult to convince the kids to jump onboard as well.

The other teachers did not seem to feel they needed to meet or collaborate on the project. Craig commented they were all experienced and did not need to collaborate much. Both David and Craig stated they felt it was easy to do and did not need much instruction or set up, while Andrew seemed to feel the project was imposed on him. He indicated that not much assistance was available to help him with the technology, so he left it to the students to figure out.

The four teachers seemed to have distinctive teaching styles and approaches. It is possible the attitude towards collaboration and communication among the four teachers was not specifically unique to the screencast project but rather indicative of the culture within this particular team.

6. Discussion

The key contribution of the current study is investigating teacher experiences and perceptions of the development and potential future use of student-produced screencasts. The analysis focuses on the emergent theme of impact on teacher identity and teaching practice in secondary education. We reiterate the three research questions guiding the analysis and discussion:

- What were the teachers' perceptions of quality, usability and likely student uptake of the final screencasts for mathematics peer learning?
- What were the teachers' perceptions of the impact production of screencasts had on student learning and skill development?

- What were the teachers' attitudes towards student-led screencast production and how did they reflect on the process?

Pettersson (2017) observes that schools have become more complex environments as a result of the modern digital world, while Howard and Thompson (2015) write that technology integration in secondary schools is a 'complex and dynamic social practice which is part of a larger social system of education' (p. 1877). Schools have endeavoured to equip their classrooms with the latest technology both in response to the students of today who have only known and expect a digital world (Bennett et al., 2008, Howard & Thompson, 2015; Prensky, 2001), as well as to prepare them with essential digital knowledge and skills for their adult lives. Flipped classroom approaches are also seeing growth in secondary schools in response to the need for schools to modernise and future proof their pedagogy to reach a cohort for which traditional didactic teaching methods are ineffective and outdated (Rotellar & Cain, 2016). This may be particularly challenging for teachers since digital technology is a key component in flipped approaches, given its flexibility for developing and delivering content in various formats, and being able to be accessed anywhere, anytime (Muir & Geiger, 2016; Pierce & Ball, 2009; Sargent & Casey, 2019).

The Standards for Excellence in Teaching Mathematics in Australian Schools published by the Australian Association of Mathematics Teachers (2006) stated that 'Excellent teachers of mathematics plan for coherently organised learning experiences that have the flexibility to allow for spontaneous, self-directed learning' and 'A variety of appropriate teaching strategies is incorporated in their intended learning experiences, enhanced by available technologies and other resources' (p. 4). The pilot project at the school was an opportunity to realize both of these standards.

The teachers were mixed in their views if the students making screencasts was academically beneficial to the students. It is unknown if the project actually enhanced student mathematical learning. Muir (2019) argued that due to a range of variables, it is hard to evaluate student performance solely against the teaching approach, noting that most studies of flipped classroom approaches are based on student perceptions of their own learning. Muir also stated most studies of flipped classroom approaches have been conducted with university students, in which student independent study is expected, whilst there is less research with secondary students.

However, it seemed the project did have benefits for students in learning and practicing collateral skills. To complete the assignment, students engaged in activities and behaviours such as cooperating with a partner, planning and coordination of tasks, delegating responsibilities, managing their time, making decisions of what is important information to convey, understanding the target audience and tailoring appropriate communications, communicating clearly, plus learning and using technical skills required to operate the device, the software and upload the final product to the online repository. These skills are essential for students to manage their studies, future work and adult life (Geiger et al., 2015 Pellegrino & Hilton, 2012).

None of the teachers specifically identified these behaviours as 'collateral learning', 'transferable skills', or named them as beneficial student outcomes. This could be due to the teachers having an understanding that this kind of learning is present in all forms of education, taking it for granted and thus not warranting comment in the interviews. It could be due to the way the project and interview were framed that the teachers' responses focused on the mathematical skills benefits of the project only. Alternately, it could be that it had not occurred to the teachers the project had collateral learning benefits. Considering teachers who suggested the project took away from core work of the curriculum, it would be interesting to understand more broadly how they regard collateral learning of non-mathematics specific but still critical life and work skills in the mathematics classroom.

For three teachers, the project seemed to challenge a teacher-centric pedagogical method, which Hunter (2017) suggested is the common teaching approach in Australian secondary schools. Muir and Geiger (2016) state 'In a traditional teacher-centred model, the teacher is the primary source of information; within a flipped classroom, however, a shift in learning culture occurs, as there is a deliberate shift from a teacher-centred to a student-centred approach' (p. 153). The student-led nature of the project appeared to threaten one teacher's views on his practice and purpose in the classroom in particular. Andrew was a traditional teacher in that he practiced a teacher-centric pedagogy. His reflective comment on 'letting go' when reviewing screencasts with the researchers is interesting as teaching with technology requires 'letting go' in a constructivist approach. The teacher has to allow students to build on their own knowledge through self-discovery (Iversen et al., 2015).

Another two seemed to interpret 'student-led' to mean to leave the students to their own ways to figure out how to complete the task without scaffolded and structured guidance. Commentary from the teachers focused mostly on the practical aspects of creating the screencasts, i.e. how to operate the software, time required in and outside of class for the students to complete the assignment, and quality of the final products. There were limited remarks on pedagogical impacts or adaptations. They did not seem to recognize a need for professional development in regard to their pedagogy. When asked directly about professional development, the teachers responded in respect to using the devices or software, without recognition that technology integration in teaching requires a change in teaching approach.

The integration of both digital technologies as teaching tools as well as flipped approaches in the classroom requires equal integration of appropriate pedagogy. Meaningful integration of technology into mathematics classrooms requires teachers to know how best to incorporate the technology into a new pedagogical way suited to the content (Handal et al., 2013). Equally, flipped approaches require 'a major reconceptualization practice for many teachers' (Muir & Geiger, 2016, p. 153), as students set the learning pace, and in a truly flipped classroom, achieve mastery of concepts before moving to the next lesson.

The teachers in this study stated they did not undertake nor require professional development to execute the screencast project. However, this overlooks the need for teachers to develop their pedagogy to harness effective use of technology. Only one teacher, the coordinator of the project, seemed to be adept at both the technology and a pedagogical approach that effectively integrated the content, the technology and the approach, while the other three did not seem willing or able to adapt their pedagogy.

The presence of technology itself does not automatically improve classroom teaching. Nor do technology-enabled projects, like screencast development, guarantee students' successful use and integration of technology effectively in their studies. The teacher's use of technology must be based on sound pedagogy (Ruggiero & Mong, 2015). Research with secondary mathematics teachers in Australia (Goos & Bennison, 2008; Handal et al., 2013) found that teachers wanted targeted professional development in pedagogy that would allow meaningful and relevant integration of technology with content. Mishra and Koehler (2006) theorized the Technological Pedagogical Content Knowledge (TPCK) model to explain effective implementation of technology in educational settings. In mathematics education, it has provided value in developing professional development models.

Personal teacher traits and beliefs about technology in the classroom has been showed to influence the likelihood of uptake of technology in their teaching (Ruggiero & Mong, 2015) and successful use appropriate to the content (Ertmer et al., 2012). Pierce and Ball (2009) note this may be particularly challenging for Australian mathematics teachers, since their profession has traditionally been 'dominated by working with pen and paper' (p. 300).

Likewise, teacher attitudes, beliefs and confidence can also influence their uptake of the flipped classroom, as flipped methods can challenge teachers' familiarity and experience with teacher-centred practice or be viewed suspiciously as a faddish trend (Wang, 2017). Howard et al. (2015) found there are differences between teachers in different disciplines regarding technology integration. In a small, self-selected study, they found secondary mathematics teachers reported having less confidence in teaching with information and communication technology (ICT) and more negative views towards ICT as supporting learning compared to science and English teachers.

Teachers are the key stakeholder in successful implementation of new approaches. Research has found teachers who are student-centric in their pedagogies are more successful with ICT use and flipped classroom approaches (Ertmer et al., 2012; Ruggiero & Mong, 2015), a finding reflected in Brian's statement that his teaching approach already encompassed a student-centric focus.

Professional development to support pedagogical change for flipped approaches integrating ICT needs to address teachers' attitudes and beliefs towards these changes (Pierce & Ball, 2009). Teachers who come to understand the merits of the approach and integrating technology will be more likely to embrace new methods (Howard et al., 2015). This development needs to directly relate to teachers' actual practices and enable teachers to reflect on their own practice and how they can shift and integrate new approaches and tools (Wang, 2017).

Professional development in pedagogical approaches to flipped classrooms is emerging (Sargent & Casey, 2019). Muir (2019) observes that while flipped approaches may help address challenges in mathematical classrooms, such as increased curriculum demands and disengaged students, constraints to adoption of the approach in secondary schools may include student and parent resistance due to the method being unfamiliar compared to traditional teaching methods. Teachers may also resist flipped classroom approaches due to their own attitudes, beliefs and experiences in mathematics teaching (Wang, 2017). This resistance was illustrated in this study through Andrew's story. Adopting flipped methods requires pedagogical professional development, ICT integration training and support, capacity building and professional development (Dennen & Spector, 2016).

Teacher collaboration can aid this integration and professional development. According to Hunter (2017), 'If secondary school teachers co-plan lessons or units of work with a head teacher who acts as a type of 'instructional coach' in the school context, then more technology integration occurs' (p. 569). Brian coordinated the project and was the most prepared with his pedagogy, but he was not the head teacher of Mathematics. He desired more collaboration with his colleagues on a unified approach, but lacked the positional authority to lead. Research on teacher leadership in schools has showed that teacher leaders are sometimes informal, emergent roles that can influence the professional development of other teachers and improve overall school performance (Wenner & Campbell, 2017). Peer mentorship among teachers can in particular assist in developing flipped approaches in schools (Wang, 2017). However, teachers showing leadership qualities or actions may be reluctant to identify themselves as leaders, fearing how it may affect their relationship with other teachers (Fairman & Mackenzie, 2015). Teacher leadership can also be inhibited by the culture of the school or the attitude of other teachers (Wenner & Campbell, 2017). In this project, Brian appeared to be supported in introducing the project to the other teachers, but unsupported in leading them, as well as uncomfortable in assuming a more direct leadership role in the project.

7. Conclusions

This paper drew on teacher perceptions of a pilot programme than incorporated many elements which challenge traditional pedagogical methods: the use of technology, peer-led learning, creation and use of video tutorials, and students learning the content outside of the classroom. The opportunity presented to the school in trialling a student-led screencasting programme could have been an opportunity to move away from teacher-centric pedagogies to student-centred learning. The introduction of screencast creation on tablet computers with touch screens as another method of teaching without accompanying pedagogical professional development may draw focus to the operation and function of the technology itself, overshadowing or even obscuring the opportunity it presents to teach and learn in a different way. Secondary teachers and students may not be familiar with this technology for educational purposes in educational settings, and require preparation and support. Without clear objectives and student-led learning not being well understood and shared by the teacher and students, the experience may be confusing, disorganized, frustrating and not of benefit to either purpose for both students and teachers. Negative experiences may lead to further resistance to the uptake of new technologies and technology-enabled teaching methods.

The literature is strong on recommendations for teacher professional development for successful implementation of student-centred ICT integration. While these methods have been more widely explored in university settings, there is reason to believe they would be effective in secondary school settings as well.

Secondary schools need to ensure the reduction or elimination of external barriers to shifting to integrating technology. Aside from assuring access to contemporary hardware and software, considerations need to be given to the time required to introduce change, planning for new methods, and provision of ongoing technical, pedagogical and emotional support for teachers from the whole of the school community (Dennen & Spector, 2016; Wang, 2017).

Formal professional development for teachers should start by exploring teacher attitudes and beliefs about ICT and flipped classroom approaches. Teacher fears and discomforts should be taken seriously by school administrators. Schools need to understand the basis for their resistance, and support them on a journey though change This in turn should inform conversations about how ICT approaches are relevant to their teaching experience and classroom practice (Ruggiero & Mong, 2015; Wang, 2017).

Professional development needs to be regular, ongoing and evolve with the teachers as their needs, students' needs, and the technology changes (Wang, 2017). Professional development should be offered using the same technologies and flipped approaches as the teachers are expected to use with students (Ertmer et al., 2012), and involve opportunities for self and group reflection on teaching practice.

Teacher champions of ICT approaches should be supported to lead other teachers, and mentor peers (Wenner & Campbell, 2017). Close collaborations should occur between teachers, building communities of practice, observing each other's classes, and discussing ideas.

Finally, schools need to recognize change takes time, as well as preparation and guidance. Just as the students in the project required preparation, guidance and support to successfully create screencasts, teachers would also benefit from the same approach when introducing new teaching approaches and integrating technology.

Disclosure statement

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