Engagement with Mathematics: The Influence of Teachers

Catherine Attard
<*c.attard@uws.edu.au*>
University of Western Sydney

Recent decades have seen growing concern over the lowering levels of engagement with mathematics in Australia and internationally. This paper reports on a longitudinal study on engagement with mathematics and explores the influences of teachers on the students' engagement with mathematics. Findings reveal that the development of positive pedagogical relationships between students and their teachers forms a critical foundation from which positive engagement can be promoted.

Introduction

In recent years there has been growing concern over the lowering levels of engagement with mathematics in Australia (Commonwealth of Australia, 2008; State of Victoria Department of Education and Training, 2004; Sullivan & McDonough, 2007; Sullivan, McDonough, & Harrison, 2004) and internationally (Boaler, 2009; Douglas Willms, Friesen, & Milton, 2009; McGee, Ward, Gibbons, & Harlow, 2003). The issue of lowered engagement levels in mathematics during the middle years of schooling (Years 5 to 8 in NSW) has the potential to cause wide-reaching consequences beyond the obvious need to fill occupations that require the use of mathematics. Lowered engagement with mathematics can lead to reducing the range of higher education courses available to students through exclusion from courses that require specific levels of mathematics. Students who discontinue studying mathematics can potentially limit their capacity to understand life experiences through a mathematical perspective (Sullivan, Mousley, & Zevenbergen, 2005).

One of the most significant influences impacting on engagement in mathematics is the teacher and teaching practices, or pedagogy (Hayes, Mills, Christie, & Lingard, 2006; NSW Department of Education and Training, 2003). This paper is derived from a longitudinal case study on engagement with mathematics during the middle years of schooling. In this study a group of 20 students experienced a range of mathematics teachers and pedagogical practices in their final year of primary school and the first two years of secondary school. Data was collected from the group across the three school years through individual interviews and focus group discussions.

This paper is an investigation of the influences of teachers and their practices on the participants' engagement with mathematics. The theoretical framework underpinning this paper is based on current theories and definitions of engagement, and literature defining 'good' teaching of mathematics. A brief overview of the literature is now provided.

Engagement

Seminal Australian research into student engagement, the Fair Go Project (Fair Go Team, NSW Department of Education and Training, 2006) focussed on understanding engagement "as a deeper student relationship with classroom work" (p. 9). The Fair Go Team found students need to become 'insiders' within their classroom, feeling they have a place and a say in the operation of their classroom and the learning they are involved with. Students have a need to identify themselves as 'insiders' as well as to be identified as 'insiders' by their teachers, students and all stakeholders.

There are other definitions of engagement that should also be considered. Some view engagement only at a behavioural level (Hickey, 2003), where others view it as a multidimensional construct (Fredricks, Blumenfeld, & Paris, 2004). Fredricks et al. (2004), define engagement as multi-faceted and operating at operative, affective, and cognitive levels. Operative engagement involves the idea of active participation and involvement in academic and social activities, and is considered vital for the achievement of positive academic outcomes. Affective engagement includes students' reactions to school, teachers, peers and academics, influencing willingness to become involved in school work. Cognitive engagement includes the idea of investment, recognition of the value of learning and a willingness to go beyond the minimum requirements. In terms of engagement with mathematics, engagement occurs when students are procedurally engaged within the classroom, participating in tasks and 'doing' the mathematics, and hold the view that learning mathematics is worthwhile, valuable and useful both within and beyond the classroom.

In an investigation into the reasons students are choosing not to pursue higher-level mathematics courses, McPhan, Moroney, Pegg, Cooksey and Lynch (2008), claim "curriculum and teaching strategies in the early years which engage students in investigative activities and which provide them with a sense of competence are central to increasing participation rates in mathematics" (p. 22), yet attempts to investigate the lack of engagement with mathematics have failed to find good reasons for students' difficulties. It is claimed students who are engaged with school are more likely to learn, find the experience rewarding and continue with higher education (Marks, 2000).

‘Good’ Teaching and Mathematics

The teaching practices employed within mathematics classrooms cover a wide spectrum ranging from ‘traditional’, text book based lessons, to contemporary or ‘reform’ approaches of problem solving and investigation based lessons, or a combination of both. When recalling a typical mathematics lesson, many students cite a traditional, teacher-centred approach in which a routine of teacher demonstration, student practice using multiple examples from a text book and then further multiple, text book generated questions are provided for homework (Even & Tirosh, 2008; Goos, 2004; Ricks, 2009).

An alternate approach to teaching mathematics reflects a constructivist perspective where students are given opportunities to construct their own knowledge with a focus on conceptual understanding rather than instrumental understanding. Such an approach promotes problem solving and reasoning and is consistent with Australian frameworks for quality teaching (Newmann, Marks, & Gamoran, 1996; NSW Department of Education and Training, 2003).

Although there are arguments for using either or both approaches, there is strong support for an investigational, contemporary approach to teaching and learning mathematics (Anthony & Walshaw, 2009; Boaler, 2009; Clarke, 2003; Lovitt, 2000). Open-ended, rich tasks transform students’ beliefs about problem solving and alter the culture of mathematical engagement. Evidence suggests that providing students with engaging mathematical tasks supported by appropriate teaching strategies leads to sustained improvement in learning outcomes (Callingham, 2003).

Much research has been conducted on effective teaching of numeracy and mathematics, with a particular emphasis on the pedagogical content knowledge (PCK) required for effective teaching of mathematics (Askew, Brown, Rhodes, Johnson, & Wiliam, 1997a; Delaney, Ball, Hill, Schilling, & Zopf, 2008; Hill, Ball, & Schilling, 2008; Schulman, 1986). In support of the need for strong PCK it can be argued that teachers with higher mathematical qualifications do not necessarily produce strong learning outcomes in their students as a result of weak understandings of how students learn and the pedagogies that are appropriate for particular mathematics content (Askew, Brown, Rhodes, Wiliam, & Johnson, 1997b).

In recent years the national mathematics teaching professional association, the Australian Association of Mathematics Teachers (AAMT) (2006), developed a set of standards that reflects current literature on effective teaching of mathematics and represents national agreement of teachers and stakeholders on the required knowledge, skills and attribute of quality teachers of mathematics. Data informing this paper were analysed against the backdrop of the above literature on engagement, effective teaching and current teaching standards. The following is a brief description of the methodology used in the study.

Methodology

The participants in this case study were originated from a Year 6 (the final year of primary schooling in New South Wales) cohort in a western Sydney catholic primary school. The students were identified through Martin's Motivation and Engagement Scale (High School) (2008), as having strong levels of engagement with mathematics. The instrument consisted of a 44 item Likert scale requiring students to rate themselves on a scale of 1 (Strongly Disagree) to 7 (Strongly Agree) and was adapted to be specific to mathematics. All students in the group of 20 made the transition together to the local catholic secondary college which had been in operation for only two years prior to the group's arrival. The participants had a diverse range of mathematical abilities and came from a range of cultural backgrounds, and most came from families with two working parents.

During the study the students participated in individual interviews during Year 6 and again in Year 8, and a series of focus group discussions at five points across the duration of the study. Teachers identified by the students as 'good' mathematics teachers were interviewed and observed during several mathematics lessons. The students formed three focus groups, a boys group, girls group and mixed gender group. Each interview and focus group discussion was based on the following set of discussion points/questions: (a) Tell me about school; (b) Let's talk about maths; (c) Tell me about a fun maths lesson that you remember well; (d) When it was fun, what was the teacher doing?; and (e) What do people you know say about maths?

The data gathered were transcribed and coded into themes. In terms of the students' perceptions of mathematics teaching, two major themes emerged as being influential on their engagement with mathematics: teachers' pedagogical practices, those day-to-day routines that teachers implement in their teaching of mathematics, and the pedagogical relationships formed between teachers and students.

Results and Discussion

During Year 6 the participants experienced pedagogies that included an emphasis on cooperative learning. The opportunities for interaction and discussion that this provided had a positive impact on the students' engagement with mathematics, with one student saying: "You've got like more options to choose from rather than if you're by yourself" and another: "working with partners is fun because you could find different strategies and you have fun and it's easier." It can be argued that the classroom practice of cooperative learning has positive results in terms of providing a safe environment in which the students are able to learn within a positive classroom culture. The ability to associate learning in mathematics with fun appeared to be a powerful influence on engagement, and the following quote

summarised the collective feeling of most of the participants: “The group can work it out together to try and solve the problem and you’ve like learned something new or how to work out something.”

One Year 6 teacher, Mrs. L, who was identified by the students as the ‘best’ mathematics teacher, was described by several students as someone who enjoyed teaching and had a passion for mathematics. Alison believed this quality to increasing her own engagement: “She just puts a lot of enthusiasm in maths and makes it really fun for us. She gets all these different maths activities. She just makes it really fun for us and I quite enjoy maths now because of that.”

It appeared the Mrs. L’s enthusiasm for mathematics promoted positive attitudes and excitement towards mathematics, reflecting the findings from research (Askew et al., 1997b) and recommendations by the AAMT (2006). In addition to her passion for mathematics, the students witnessed Mrs. L. as appearing to have fun teaching. Tenille said: “It’s fun when the teacher, like, while you’re doing the work she also has fun teaching the maths as well.”

When the students moved on to their first year of secondary school, Year 7, they experienced a new set of pedagogies and a new group of mathematics teachers. In contrast to the teaching approaches used during their primary years, the students were expected to work on an individual basis, using computer-based interactive tutorials and mathematics textbooks. This caused a reduction in classroom interaction and discussion, and rather than having a single mathematics teacher, the students were provided with a rotation of four different teachers.

Although the provision of computer technology provided the opportunity for teachers to deliver a new and relevant way of teaching and learning (Collins & Halverson, 2009), they instead appeared to be used as replacements for teachers. Alison commented on this emerging idea among the students:

> … it's probably not the best way of learning because last year at least if you missed the day that they taught you, you still had groups so your group could tell you what was happening. Where now, we’ve got the computers and it’s alright because there is, um, left side of the screen does give you examples and stuff, um, but if you don’t understand it, it’s really, hard to understand.

It is reasonable to suggest that the website and textbook were not necessarily inferior resources. However, the data was showing that it was the way they were used in isolation from other resources that meant the students began to disengage from mathematics. During Term 2 of Year 7 the students were provided with the opportunity to participate in tasks that were more interactive and hands-on, consistent with recommendations from research (Boaler, 2002; Callingham, 2003; Lowrie, 2004). Several of the students commented on this change, with Fred saying: “It’s more interesting”. The students found the incorporation of concrete materials made their mathematics lessons more interesting, and the opportunity to work in groups during one particular activity made those lessons memorable, with Rhiannon giving

this reason: “because we got to create the shape by using straws, in groups. Not by ourselves.” In addition to the benefits of being able to work collaboratively, George felt he and his group made more of an effort than usual: “it was good because we could make it ourselves and we could like put effort into it.”

When the students reached their second year of secondary school, Year 8, the school’s structure had been reviewed and during Term 2, the students were allocated one regular mathematics teacher per group. The newly formed mathematics classes appeared to increase the students’ engagement, allowing stronger teacher/student and peer relationships to develop. In terms of the resources that were used in the Year 8 lessons, there was less reliance on the students’ laptops and more emphasis on using text books. Kristie described a typical routine:

> Well, we just got our text book and the laptops don’t come out in maths as much or at all, unless you’ve forgotten your text book or something like that. And, um, maths is good, we separated into groups and the teacher’s out the front and he’ll tell us what to do and you pretty much put your hand up if you need help, and he’ll help you and then you have the text book out and you answer the questions in your maths book.

Although it has been found that a traditional approach to teaching mathematics may have a negative influence on student engagement, in this particular case the students saw it as an improvement on previous pedagogies and appeared to experience higher levels of engagement. One aspect of the teachers’ pedagogies that had a positive effect on the students’ engagement was the students’ perceptions of an improvement in teacher explanations. George made this comment which reflected the feelings of many of the students: “I think maths has improved because the teachers go through it with you more, whereas last year they would just set you a task and leave you with it.” Billy, a student who had difficulty maintaining his engagement with mathematics added: “Sir just writes stuff on the board and then he explains it really good and we learn about stem and leaf graphs. He teaches it really good and other teachers just write it down and say ‘go do that’.”

During the final focus group discussions, Alison made a comment that was reflective of the group’s feelings once they were assigned their regular teachers and were able to begin building positive pedagogical relationships: “The teachers know where we’re coming from and what we need to learn and they learn, not what the group needs, but what we need.” The data shows that the students appeared have begun to re-engage with mathematics because they felt the teachers knew them in terms of their mathematics learning needs. The opportunity to establish positive pedagogical relationships with teachers appeared to provide students with a sense of belonging, an important aspect of an effective mathematics classroom (Boaler, 2009).

Implications and Conclusion

The biggest influence on engagement with mathematics for these students appeared to be that of their teachers. This influence can be viewed at two interconnected levels. The first level includes the pedagogical practices employed by the teacher, and the second, the pedagogical relationships that occur between the teachers and students. That is, the connections made between the teachers and students, and the teachers' recognition of and response to the learning needs of his or her students. Although this study has limitations in terms of the selective nature of the sample, it is suggested that the development of positive pedagogical relationships forms a critical foundation from which positive engagement can be promoted and this may be applicable to a wider student population.

The findings discussed in this paper imply many students in the lower secondary years of schooling are still dependent on high levels of interaction within the mathematics classroom. Repetition of the current study within different school contexts would be of benefit in further exploring the concept of engagement with mathematics. Further studies on engagement with mathematics during the later years of schooling and beyond into tertiary education would be beneficial in terms of investigating whether pedagogical relationships remain as important for older students. Although student achievement and its relationship to engagement levels was not a focus of this study, such an exploration would also be worthwhile for future research.

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