Teacher Practices: How they Promote or Hinder Student Engagement in Mathematics

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With persistent concerns about student engagement, interest and participation in mathematics, this research investigated the range of practices 31 Year 7 mathematics teachers reported using and how they perceived these practices influenced student engagement in mathematics. In-depth interviews revealed similarities in teachers' perceptions of student engagement but differences in what teachers did to address engagement through their practices. This paper reports on teacher practices identified as promoting and hindering student engagement in mathematics.

This paper reports on research that emanates from concerns about declines in student participation, interest and achievement in mathematics in the middle years of school. A key aim was to identify effective pedagogy that teachers perceived supported and shaped student engagement in mathematics in early secondary school. Increasingly, educational research is taking note of student engagement and how motivational factors influence student learning (Hardré, Sullivan, & Crowson, 2009) and achievement outcomes (Boaler, 2000; Brown, Brown, & Bibby, 2008; Forgasz, 2006; Fredricks, Blumenfeld, & Paris, 2004; McLeod, 1992; Nardi & Steward, 2003; Sullivan & McDonough, 2007) as well as attitudes, interests and beliefs (Lomas, Grootenboer, & Attard, 2012). Additionally, the significance of students' emotions (Linnenbrink-Garcia & Pekrun, 2011), their cognitive functioning (Hannula, 2006), and interpersonal relationships with teachers and peers within the mathematics classroom are central to student engagement (Martin, 2007; Zan, Brown, Evans, & Hannula, 2006). Seeking clarity about how teacher practices for teaching mathematics, including their perceptions of cognitive and emotional aspects, are crucial for addressing student engagement as it is unlikely that improvements in levels of engagement and participation will occur of their own accord.

Student Engagement

The comprehensive review of engagement carried out by Fredricks et al. (2004) has been pivotal in establishing a framework to delineate the distinctions between 'types' of engagement underpinned by influencing factors and the multidimensional ways in which they operate. For example, students who are behaviourally engaged (actively participating, persisting, asking questions) and emotionally engaged (demonstrating interest and enjoyment) in mathematics classes may not necessarily be cognitively engaged (effectively planning, managing and regulating their learning).

Although linked, motivation and engagement are viewed as distinct because motivation encompasses internal, private and unobservable aspects that are manifested in the outer, public and observable engagement. However, because engagement reflects an individual's interaction within contexts, it is more obvious in the learning environment (Fredricks & McColskey, 2012; Fredricks et al., 2004). Engagement is also influenced by factors internal to the classroom such as interactions with peers and teachers in learning contexts, and by

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external influences such as parents and school cultures (Reschly & Christenson, 2012: Skinner & Pitzer, 2012). Therefore oscillations in engagement are to be expected and the changeable nature of engagement also implies that it is malleable (Fredricks et al., 2004). This suggests that the planning and implementation of intervention programs and instructional practices can address persistent factors of engagement, achievement, intentions and future aspirations in mathematics (Hardré & Sullivan, 2008) offering a way forward for attending to student engagement needs.

Teacher Practices for Promoting Engagement in Mathematics

Contributions from the field of mathematics education propose effective mathematics practices for engaging students in mathematics that include dynamic and active instruction involving interactions between the teacher and their students to "shape what gets taught and learned" (Hill, 2011, p. 30). Importantly, distinctions between the quality of the mathematics during teaching and pedagogical approaches for the quality teaching of mathematics are made. Various frameworks propose important features of mathematics (high quality tasks, connecting key mathematical points, providing clear explanations and developing reasoning skills) alongside elements of quality practices that are viewed as effective for enhancing student learning. For example, Sullivan (2011) advocates six key principles for the effective teaching of mathematics that draws on research from several models of recommended practice including 'Productive Pedagogies' (Education Queensland, 2010), Hattie's (2009) synthesis of teaching approaches and influenced by the work of Clarke and Clarke (2004). Further, Anthony and Walshaw (2008) isolated effective practices that they believe teachers should convey to students in order to develop student competency and identity with mathematics. Each of these approaches illuminates links between teacher practices for developing mathematical thinking and strategy use in conjunction with promoting active participation and interest thereby directly and indirectly integrating cognitive and emotional perspectives of student engagement in mathematics.

Recognising the importance of the relationship between motivational factors and types of engagement, research in the field of academic motivation offers significant contributions for a deeper understanding of factors intertwined with and influencing student thinking in mathematics. Stipek et al. (1998) identified practices that positively affected student motivation and conceptual learning in mathematics. Stipek et al. (1998) cite specific supporting instructional practices including: (a) encouraging readiness to take on challenging tasks; (b) cultivating understanding, evidenced by mastering concepts; (c) promoting active student engagement and autonomy, fostering feelings of control and greater enjoyment; and (d) cultivating feelings of competency for tasks that provide personal meaning and offer variety. Similarly, Schweinle, Meyer and Turner (2006) observed that particular teacher practices such as feedback and clarification, support for autonomy, cooperation, and emphasis on learning for its own sake are related to student motivation in mathematics classrooms. Elements such as belongingness, competency, relevance, and valuing are also consistent with literature that identifies motivating instruction effective for engaging middle year students (Dinham & Rowe, 2007). This is relevant to the present study because concerns about student engagement and achievement in mathematics during early secondary years highlight sensitivities to the cognitive demands and emotional challenges that influence student participation and interest in mathematics study.

Hardré (2011) specifically sought to identify the types of motivating strategies that teachers explicitly used in mathematics classrooms. A number of strategies were identified including those that focused on the relevance of content, the value of learning and the application of mathematics. It was also reported that the majority of teachers focused on strategies external to students' needs, telling students what they "should do … rather than striving to support students' own internal desires and interests" (p. 227). Further, teachers tendered to focus on short-term behavioural factors with few teachers describing long-term efforts to influence individual or whole class motivation. It was concluded that the small set of strategies that teachers used did not meet the varying needs for competency and self-efficacy that students reported and therefore teachers were lacking the means to motivate students internally and in the longer term. Similarly, Raphael, Pressley, & Mohen (2008) found that highly engaging teachers used a wide variety of instructional practices to initiate and maintain student engagement with academic content, covering more information in greater depth, increasing positive affect and resulting in students who were more behaviourally and cognitively engaged.

Drawing together literature of effective practices for engaging students in mathematics from educational and motivational sources revealed that teachers who use motivating approaches in instruction also tend to promote constructive learning environments, demonstrate positive affect through their interest in and respect for students, reveal their enjoyment and value of mathematics, care about student engagement and provide support for students' learning through promoting metacognitive and self-regulative strategies. This style of instruction conveys expectations that students are able to learn, that effort for explaining their thinking is required, and that despite confusion or setbacks, students should persist.

Method

The overarching design for this inquiry was qualitative in nature, predominantly employing interview approaches. The study focused on understanding individual, classroom, pedagogical and school level factors that influence engagement and achievement through in-depth interviews with teachers. The research question asked: How do teachers perceive students' levels of engagement and motivation in mathematics and how is this reflected in their teaching practices? With this focus, teachers were asked how they identified student engagement, their views on the importance of engagement for mathematics, and how they promoted engagement in mathematics lessons.

The participants comprised 31 mathematics teachers drawn from 10 secondary schools (coded A-J) within a large school system in a metropolitan region of Australia. All of the schools were comprehensive schools of mixed ability and represent a range of social and economic levels. There were 4 female–only schools, 3 male–only schools and 3 mixed–gender schools. The interviews occurred at the start of Term 4, the final term of the school year and therefore it was expected that teachers would be able to reflect on their experiences in mathematics classes throughout the year.

The interviews took place at the relevant schools using a semi-structured interview format allowing for flexibility with question order according to interviewees' responses. Each interview took between 40 and 60 minutes, depending on the length and depth of responses. The interviews were audio-recorded and later transcribed. Field notes recorded biographical information such as teachers' qualifications, years of service, years of teaching Year 7 mathematics, as well as noting aspects of demeanour.

A deductive approach to analysis of data was used that drew upon Fredricks et al. (2004) types of engagement framework and the frameworks of effective teacher practices for engaging students in mathematics. Teacher interview transcripts were read several times to gain an understanding of the key themes present before the commencement of coding. The qualitative analysis software programme, NVivo (QSR-International, 2008) assisted in organising the interview data throughout the coding process. In keeping with the research question the focus was on responses relating to teachers' perceptions of their practices for engaging students in mathematics. Guided by the selected theoretical frameworks, provisional codes for practices that promoted and hindered student engagement were established as each transcript was attended to, refining like codes as required until saturation was reached and specific categories were developed. The analysis of teacher interviews focused on determining the types of practices teachers reported using and how they were perceived as engaging students in mathematics learning.

Findings

From the teachers' reports, practices were categorised as promoting or hindering student engagement. Practices seen as promoting engagement are reported first and include those that attended to adaptive motivational factors. However, not all teachers used strategies to support learning and engagement and although teachers did not report that they intentionally set out to hinder or undermine student engagement, unintended negative practices were identified and reported as hindering engagement in mathematics. Additional practices such as occasionally attending to engagement, uncertainty about how to engage and controlling teacher styles were included in this category.

Practices Promoting Student Engagement

Practices emphasising the relevance and future value of mathematics. Most teachers attempted to address questions about relevance and future value of mathematics in positive ways, and talked to students about "all the different things they can do with maths or things that could be helpful to know when they get out in the real world" (D1). Other teachers stressed learning current mathematics content as building knowledge for complex mathematics work reporting:

> The stuff we are learning now is just a building block to using high levels maths in jobs when you leave school. I usually say there is not a job you will do that uses maths exactly like this but if you cannot do this easy stuff you will not be able to do the more complex stuff in engineering, medicine etc. (A3)

Practices emphasising mathematics applications and connections. The majority of teachers drew on the practical application of mathematics for engaging their students because "mathematics has a place in life, in the simple things that you do … that ratio of how you want your drink or how you are going to make a cake" (H1). One teacher sourced relevant internet sites that connected specific aspects of mathematics (e.g., ratio and scale drawings) and "how mathematics is used in different situations", believing the students found this "interesting, motivational and relevant" (H2). Some teachers revealed their awareness that students felt a lack of connection with mathematics explaining:

> I think [the students] see [mathematics] as being isolated and non-connected and hence comments … "Why do we have to do this?" I tell them it is a way of increasing their ability to reason and to be logical and whilst it may not have a direct application outside of school the skills that they learn and by following a process are useful skills outside of mathematics (A4)

Practices to enhance autonomy support and empowerment. 'Autonomous teaching styles' are described as "interpersonal sentiment and behaviours teachers provide to identify, nurture and develop students' inner motivational resources" (Reeve, 2009, p. 159) and are associated with positive classroom functioning and increased educational outcomes. Several teachers demonstrated an autonomous teaching approach, welcoming students' questions, acknowledged their frustrations and encouraging independent investigations. For example: "Oh we can explore that with me doing the guiding ... and see if we can come up with some solutions" (E2). Another teacher was keen for students to take control of their learning by seeking solutions for themselves:

> Maths needs to be centred on the students … it should be about the kids themselves taking control of what they are doing, owning what they are doing, so it is not just me giving them the answers, they are actually finding the answers themselves … (C2)

Practices emphasising student interests. Teachers reported using practices sensitive to students' personal interests and desires. For instance, one teacher noticed a student's capability and interest in mathematics and nurtured this by allowing her "to create the warm-up for the class", reporting "she got a buzz out of doing that, like owning it" (C2). Other teachers maintained interest by varying ways of working, by veering away from the textbooks and making maths a "little bit more meaningful and a little bit more practical ... looking at a clip on 'You Tube' based on [content]" (H2). Capturing students' interest and intrigue by starting lessons "with puzzles and things to get their brains ticking" (F1) and sparking interest in the progression of mathematics learning by "deliberately leaving notes from previous classes on the board" (C3) were seen as positive engagement practices.

Practices emphasising interpersonal relationships. Teachers believed that developing interpersonal relationships and making a personal connection with their students was important for engagement: "If you have a rapport then I think you are going to get a lot more out of any student" (J2). One teacher reported her sensitivity to students' feelings and perceived that establishing relationships mattered for "building trust that you are not going to make fun of them or make them embarrassed" (I1). Teachers perceived that students needed to feel confident of asking for help:

> I figure if the kid is too scared to ask you a question then what is the point of being a teacher. They are supposed to want to ask you so you can help them. I like to think one of my strong points is my rapport with the kids because I try and relate to them as much as possible (E3)

Practices Hindering Student Engagement

Practices that were deemed to hinder student engagement included those that did not support adaptive motivations such as persistence, self-regulation, planning, control self-efficacy and autonomy. Practices where engagement was attended to occasionally or viewed separately to teaching mathematics content were also reported.

Unintended negative engagement practices. Several teachers expressed low expectations of students to persevere with learning. For example, one teacher reported that for an upcoming test she suspected that most students' revision would include a simple "look through their books" which she did not perceive would "make a difference to them" (A4). Rather than support students or provide specific revision strategies, she continued the same practice, which was to put a "few revision questions on the board". Another teacher decided that it was best to start Year 7 mathematical work at a very basic level because some students had low mathematical skills. He reported that "you can't even pitch to the

middle as some miss out, that's why it has to be pitched to the bottom, even though, yes, some kids have done it before … revision can't hurt" (A3).

Engagement as an occasional practice. Several teachers perceived engagement as something to be attended to occasionally or separate to the teaching of mathematics content. Several teachers perceived that teaching mathematics content and completing curriculum requirements was their main responsibility, even when they were aware that student understanding and engagement would be compromised. Comments about needing to cover course work were made by several teachers, who felt that "even if you have some great ideas that could engage, there is just not the time for it" (A3). The same teacher perceived that practical lessons were "a time waster" and used to alleviate boredom with mathematics rather than potentially engaging students.

Other teachers perceived that engaging lessons included those where students did not think they were working, such as "practical lessons like they have to do measurements so they measure their limbs, go out in the playground they can talk … they don't mind, they get engaged" (F3). From these reports, it appears that some teachers perceived that a one-off different type of activity satisfied students' need for engagement. Many of the comments suggested that when teachers selected an activity to 'interest' students, the value of the task was not carefully considered—the expectation that students would complete tasks was low and the monitoring and scaffolding of class work was limited. It was therefore unlikely that these strategies motivated students internally or long term.

Uncertainty about how to engage students. Uncertainty about how to engage students in mathematics was reported by several teachers, with one believing that there were many factors outside his control that influenced students' engagement, and although wanting his students to "enjoy the experience of maths", they did not and he did not know how to influence that (F3). Several teachers also considered that students' lack of engagement was caused by poor primary school preparation, curriculum demands, other non-engaged students and parents who voiced their own dislike of mathematics. Teachers perceived these external factors as obstacles that would be difficult to overcome and this appeared to lower their expectations that they could successfully engage students in mathematics and consequently limited the efforts they made to promote sustained engagement.

Degrees of teacher control. Separate to practices that hindered engagement, the negative influence of controlling teaching styles has also been identified as a factor in student engagement (Reeve, 2009). Controlling styles result in students lacking motivation for personal interest, value, task involvement, positive feelings, self-initiative, perseverance, creativity and preferences for challenge (Reeve, 2009). Consequently, teaching styles with a high degree of control tend to influence aspects of behavioural engagement such as on-task attention and effort, however are not supportive of emotional and cognitive aspects of engagement. Some teachers imposed controlling teaching styles in their classrooms, despite thinking they did not. For example, one teacher reported that he liked to have "a low-stress classroom" and gave students "a bit of responsibility" (B2) but also emphasised sanctions for off-task behaviours and used practices that pressured students into completing their work during class time by imposing penalties if not completed. Another teacher reported using a system of increasing penalties in order to have her students "co-operate, listen and focus" in the classroom (A4).

In summary, although believing promoting engagement was important, not all teachers reported using practices that were effective for promoting engagement. Practices that emphasised relevance, future value, and application of mathematics tended to focus on

placating students' immediate queries about the purpose of learning mathematics, but did not necessarily satisfy students' internal motivational needs and therefore were not as effective as they might be expected. Practices that emphasised student interests, interpersonal relationships and supported student autonomy were more closely aligned to students' needs by addressing student competency and self-efficacy and more likely to influence persistence and achievement success.

A few teachers reported using either sustained or wide-ranging motivational practices in their classrooms. Some reported using practices that addressed engagement occasionally or separately to mathematics learning, whilst others did not know how best to engage students. This reiterates Hardré and Sullivan's (2008) findings where teachers reported low knowledge and efficacy for motivating students who were "seriously or chronically unmotivated" (p. 2069) in mathematics. The findings highlight that understanding students' motivational needs is the first step for addressing student engagement in mathematics, and secondly, developing a wide repertoire of practices that tap into students' internal needs is crucial for promoting long-term emotional and cognitive engagement in mathematics.

Conclusion

The findings are significant for several reasons. First, the range of practices for engaging students in mathematics is clarified and draws attention to the potential effectiveness of specific practices including those that teachers can draw upon to promote engagement. Second, by making links between motivational factors and types of engagement the physiological processes that involve emotions and cognitions that influence mathematical learning processes are emphasised. Finally, teachers have choices about the practices used in their classrooms that influence engagement. Apart from establishing positive classroom climates, developing inter-personal relationships with students, attending to student needs for understanding mathematical concepts, the present study identified that teachers who believed in the importance of engaging students in mathematics regularly used practices that promoted student engagement by meeting students' motivational needs for competency and self-efficacy. This is important because practices that meet students' internal needs are more likely to sustain emotional and cognitive types of engagement in the longer term, in contrast to practices directed to external sources that tended to only address immediate behavioural engagement.

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