Engagement with mathematics:

What does it mean and what does it look like?

What is the difference between engagement and motivation? Are the two constructs linked? What are students' perceptions of engaging mathematics lessons? **CATHERINE ATTARD** explains all this and more (take a look at the Framework for Engagement with Mathematics) in this article.

When discussing issues surrounding mathematics education, the topic of student engagement (or lack of) often dominates conversations. The low levels of engagement with mathematics experienced by students during the middle years have been of some concern to Australian mathematics educators and stakeholders in recent decades (Commonwealth of Australia, 2008; State of Victoria Department of Education and Training, 2004; Sullivan & McDonough, 2007; Sullivan, McDonough & Harrison, 2004). Lowered engagement with mathematics has the potential to affect our communities beyond the need to fill occupations that require the use of high level mathematics. It can also limit one's capacity to understand life experiences through a mathematical perspective (Sullivan, Mousley & Zevenbergen, 2005).

What does the term 'engagement' mean and what does it look like in the primary mathematics classroom? This article will explore the concept of engagement against the backdrop of a recent longitudinal study into the influences on student engagement during the middle years of schooling (Attard, 2009), provide some insight into students' perceptions of engaging mathematics lessons and introduce a *framework for engagement with mathematics* that could be used to inform planning.

Engagement or motivation?

The constructs of engagement and motivation are often used together and are very much connected (see Figure 1). However, they are different. When we use the term 'motivation,' we refer to the ways in which students choose to behave, their self-confidence in their ability, their ability to overcome obstacles and challenges, and their capacity to recover from academic setbacks (Martin, 2003). A student's motivations determine whether or not he or she will engage in a particular pursuit and whether or not those motivations exist as part of one's beliefs about what is important (Eccles & Wigfield, 2002; Martin, 2006; Middleton & Spanias, 1999). Figure 1 is a synthesis of the above literature and highlights how a student's motivation can influence his or her engagement with mathematics.

Engagement has been defined as a multi-faceted construct which operates at three levels: cognitive, affective and behavioural (Fredricks, Blumenfeld & Paris, 2004). Cognitive engagement involves the idea of investment, recognition of the value of learning and a willingness to go beyond the minimum requirements. Affective engagement includes students' reactions to school, teachers, peers and academics, influencing their willingness to become involved in school work. Finally, behavioural engagement encompasses the idea of active participation and involvement in academic and social activities, and is considered crucial for the achievement of positive academic outcomes.

When an individual is engaged with mathematics, he or she has been influenced by motivation, yet on its own this is often not enough to maintain high levels of engagement. If other influences come into play such as poor pedagogy, a lack of confidence, the sometimes negative influence of peers or perhaps the anxiety of an impending transition to secondary school, then motivation can decrease, in turn affecting engagement levels.

When viewed through a mathematical lens, engagement occurs when:

- Mathematics is a subject students enjoy learning;
- students value their mathematics learning and see its relevance in their own lives now and in the future;
- students see connections between the mathematics they learn at school and the mathematics they use outside school.

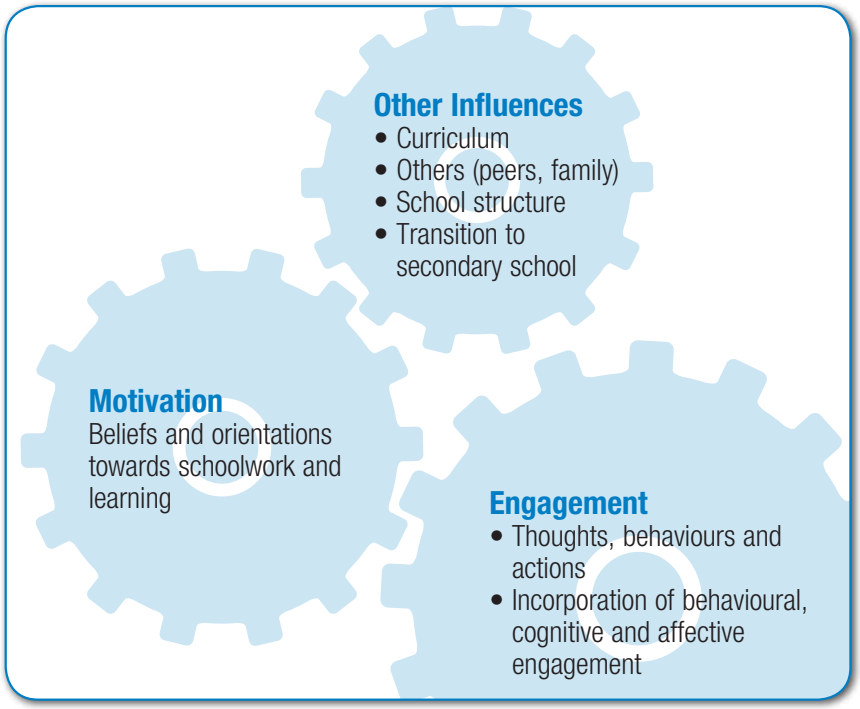

Figure 1. The relationship between motivation and engagement.

Year 6 students' perceptions of engaging mathematics lessons

In the first phase of a three-year longitudinal study, a group of 20 Year 6 students were asked to discuss aspects of what they perceived to be 'good' mathematics lessons. They were able to quickly recall such a lesson and were able to articulate many positive aspects of classroom pedagogy that had positive

influences on their levels of engagement. Most of the 'good' lessons discussed by the students were those that included physical activity, active learning situations involving concrete materials, and/or games.

A particular lesson that was discussed included an activity that required the students to design a floor plan for a dream home. Students were to incorporate perimeters and areas of various rooms so that their understanding of the measurement concepts could be assessed. Nathan commented: "I thought it was really good because you could use your imagination and make up whatever you wanted so you were almost making your own maths tasks."

Aspects of choice and creativity made this lesson a favourite. Students were provided with a task that allowed them to make links to the real world, making the mathematics relevant for them. They felt as though they had some control over their own learning, thus became empowered. The task also allowed for differentiation, as evidenced in the following comment about how they were allowed to change the task and work on the computer rather than on grid paper, with Billy saying: "Me and my friend got to do a special task because the task we were doing was so easy for us."

Within the same task, students were given the choice to work either independently or cooperatively with a peer and were able to extend the task, with two boys incorporating the use of technology using Google Sketchup. All of these aspects of the task correspond with the recommendations of the *Standards for Excellence in Teaching Mathematics in Australian Schools* (Australian Association of Mathematics Teachers (AAMT), 2006). The students were provided with some flexibility within the task to allow for self-directed learning as described in *Domain 3: Professional Practice* of the AAMT Standards: "Excellent teachers of mathematics plan for coherently organised learning experiences that have the flexibility to allow for spontaneous, self-directed learning" (p. 4). Although it is not known how often the students experienced similar 'rich' tasks, this activity reflects many of the features described in the Framework for Engagement.

Other popular lessons incorporated the use of games that allowed the students to interact with other students while practising a learned skill or concept. Andrew said: "If you sit on the carpet and the teacher goes on and on about what we're learning it gets boring and you get restless so that's why I like doing fun games." The inclusion of games in mathematics lessons appeared to be particularly motivating for this group of students, reflecting findings that the social element of learning is critical to students in the middle years (Boaler, 2000; Patrick, Ryan & Kaplan, 2007). Games appeared to engage these particular students in mathematics lessons, although it should be noted that the level of engagement may be related to aspects of the game, such as competition, rather than the mathematics itself. For sustained engagement with games, there needs to be reflection about the mathematics involved and some challenge in terms of mathematical content.

Another aspect of 'good' lessons appears to have been the links made between 'real' life and mathematics. The incorporation of tasks that mirrored life-like situations appears to have been a strong factor in engaging students in mathematics tasks, as were the tasks that required the students to take the mathematics out of the classroom and into the school playground. George recalled a lesson that involved going outside: "We went down to the sand pit and we got some sand and we had to measure. We made these little boxes with an open lid and, like, cubes and rectangles and stuff."

Although all of the lessons described by the students were engaging and memorable to some degree, it is not possible to gauge the learning that occurred as a result of the activities discussed. As reported by Askew, Brown, Rhodes, Wiliam and Johnson (1997), effective teachers focus on students' mathematical learning rather than providing

a 'pleasant' classroom experience. Ideally, students' experiences of mathematics should combine both: a focus on learning and a pleasant classroom experience, and this was evidenced in comments made by two of the participants. Alyssa said, "You're, like, having fun, so you're not getting, like, distracted or restless with other things, so you stick to the thing, so you learn more." Max said, "Because you're having fun while learning, so it's kind of, like, you're not exactly learning but you actually are." These comments indicate that the students valued the learning experience, showing insights into their own learning preferences along with a willingness to persevere with a task that is engaging.

A framework for engagement

A direct result of the above research is the Framework for Engagement with Mathematics which combines current understandings of engagement, literature on 'good' teaching of mathematics, and students' own voices. The framework is split into three sections. First, aspects of an engaging classroom are listed according to behavioural, affective and cognitive elements of engagement. The next two sections see pedagogical relationships and repertoires as two separate yet interdependent aspects of an engaging classroom. Each section includes a set of recommendations that would assist in achieving sustained engagement with mathematics.

It is not suggested that teachers strive to achieve every aspect of the framework in every mathematics lesson. However, the framework can serve as a useful reminder and a starting point from which to plan mathematics teaching and learning experiences that represent student voice and promote affective, behavioural and cognitive engagement with mathematics. The Framework for Engagement with Mathematics and examples of how it can be applied in the primary mathematics classroom will be appearing in a forthcoming issue.

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Framework for Engagement with Mathematics

In the mathematics classroom engaged students are:

- actively participating — group discussions, practical, relevant activities and homework tasks (high behaviour)
- genuinely valuing — "This learning will be useful to me in my life outside the classroom" (high affect)
- reflectively involved in deep understanding of mathematical concepts and applications, and expertise (high cognition)

In an engaging mathematics classroom, positive pedagogical relationships exist where:

- students' backgrounds and pre-existing knowledge are acknowledged and contribute to the learning of others
- interaction amongst students and between teacher and students is continuous
- the teacher models enthusiasm and an enjoyment of mathematics and has a strong pedagogical content knowledge
- the teacher is aware of each student's abilities and learning needs
- feedback to students is constructive, purposeful and timely

Pedagogical repertoires mean:

- there is substantive conversation about mathematical concepts and their applications to life
- tasks are positive, provide opportunities for all students to achieve a level of success, and are challenging for all
- students are provided with an element of choice
- technology is embedded and used to enhance mathematical understanding through a student-centred approach to learning
- the relevance of the mathematics curriculum is explicitly linked to students' lives outside the classroom and empowers students with the capacity to transform and reform their lives
- mathematics lessons regularly include a variety of tasks that cater to the diverse needs of learners

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