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What Secondary Teachers Think and Do About Student Engagement in Mathematics

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1. Introduction

In this paper we focus on secondary mathematics teachers' perceptions of student engagement in mathematics—reflecting their knowledge and beliefs about the different types and intensities of engagement that they perceive in their students during their first year of secondary school. We also analyse the practices that teachers report using in response to their perceptions and as part of their efforts to promote student engagement in mathematics. Despite widespread acknowledgement of its importance to educational success (Reschly and Christenson 2012, p. 4) and the influential role played by teachers in the promotion of student engagement, there are few studies that have examined teachers' beliefs about the nature and extent of student engagement (Harris 2011) and fewer still on how teacher beliefs about engagement influence their instructional practices (Zyngier 2007).

As students advance through school, the role of teachers and classroom environments for supporting engagement become increasingly important. Consequently, teacher awareness and perceptions of student engagement during instruction is essential knowledge, but equally important are teacher self-efficacy beliefs about how effectively they can engage students in learning (Hardré et al. 2008). Teachers regularly use information about student engagement to adjust their instructional strategies (Hardré 2011; Hardré et al. 2008). To effectively respond to student engagement, it is essential that teachers are not only able to accurately infer how engaged their students are, but that they also possess the prerequisite knowledge and skills to implement supportive instructional strategies to promote student engagement (Lee and Reeve 2012).

Much of the research exploring teacher inferences about student engagement has utilised questionnaires, requiring teachers to rate individual students via Likert-type scales indicating the degree to which they agree or disagree with statements of engagement (Furrer and Skinner 2003; Givvin et al. 2001; Lee and Reeve 2012). However, engagement is a complex construct and it is insufficient to simply describe a student as 'engaged' or 'not engaged' without exploring accompanying academic circumstances and classroom environments. The research reported here used in-depth interviews to investigate the signals of student engagement that secondary mathematics teachers perceive and explores how these perceptions influence their instructional practices.

Teacher practices and their links to teachers' perceptions of student engagement are by no means clear. Hence, this study aimed to add clarity to these links by investigating the range–or 'spectrum'–of student engagement in mathematics from the perspective of their teachers. It also aimed to explore *how* teachers constructively respond to student engagement in mathematics, and as suggested by Lee and Reeve (2012), determine whether they possess the prerequisite knowledge and skills to respond appropriately.

2. Review of Research and Theory

2.1 Student engagement in mathematics

The comprehensive review of engagement by Fredricks et al. (2004) has been pivotal in establishing a framework that distinguishes between three types of engagement (behavioural, cognitive and emotional) and the multidimensional ways in which they operate. Referring to engagement as a metaconstruct, Fredricks et al. (2004) infer that it is more than simply a collection of separate constructs, but rather, brings "together many previously separate lines

of research" (Reschly and Christenson 2012, p.11) relating components relevant to how students behave, feel and think during learning processes (including motivational and affective factors) (Wigfield et al. 2015).

Behavioural engagement is concerned with levels of participation and involvement in academic, social or extra-curricular activities associated with school (Fredricks et al. 2004). Emotional engagement is concerned with students' positive and negative affective reactions to teachers, schoolwork, peers and school. Although emotions have been characterised as relatively unstable and short lived (McLeod 1992), there is increasing interest in the long-term effect of emotions and their influence on motivation and achievement (Pekrun and Linnenbrink-Garcia 2014) and specifically to mathematics education (Goldin 2014; Brown et al. 2008). Definitions of cognitive engagement often refer to the psychological investment students apply to their learning, including "being thoughtful, strategic and willing to exert the necessary effort for comprehension of complex ideas or mastery of difficult skills" (Fredricks and McColskey 2012, p.764). Therefore, cognitive engagement involves the extent to which students seek deep meaning and understanding as well as the cognitive strategies students use to self-regulate their learning.

Characteristics of the engagement metaconstruct include consideration of duration, intensity and changeability. Engagement is seen as dynamic and ongoing; therefore, its duration may be specific to particular tasks but also reflect a "pattern of involvement in a variety of activities" (Smith et al. 2005, p. 87). Intensity of engagement reflects the degree of investment or commitment to engage and can fluctuate between types of engagement. For example, in relation to behavioural engagement, a student may complete work as required (low investment) or take a proactive role such as asking questions and independently seeking further information (high investment). Regarding cognitive engagement, a student may read over notes as test preparation (low investment) or use sophisticated learning strategies,

identifying difficult material and preparing summaries of notes, to develop their understanding and mastery (high investment).

Student engagement can also fluctuate (Martin et al. 2015). For example, students who on one day display high levels of interest (emotional engagement) and ask a range of questions for clarification (behavioural and cognitive engagement) when introduced to a new mathematics concept, may subsequently display much reduced interest and participation when a related concept is presented — possibly due to gaining mastery rather than an indicator of reduced engagement. Further, engagement has been found to be volatile as students' previous experiences of encountering difficulties with mathematics or falling grades in early secondary school can negatively effect their emotional engagement and can have lasting negative effects for subsequent mathematics study (Lewis 2013). Therefore, patterns of engagement for individual students are likely to be changeable (Martin et al. 2015) or idiosyncratic in nature (Williams and Ivey, 2001) with students exhibiting different types of engagement at varying levels of intensity depending on the activities at hand, past experiences or any number of other contextual factors.

The reasons for fluctuations in student engagement are difficult to determine. A key to understanding why and how student engagement fluctuates is to explore motivational and contextual factors that influence how students feel, think and behave. Motivation is concerned with the psychological processes that underlie visible engagement characteristics (Skinner and Pitzer 2012). Therefore, although linked, motivation and engagement are distinct. Motivation encompasses the internal, private and unobservable factors of the outer, public and observable engagement. Certain features are shared between engagement and motivation, for example, persistence (adaptive motivation) may be observed as time spent on tasks and asking questions, which are also characteristics of behavioural engagement.

However, because student interactions in the classroom are more obviously linked to learning environments (Fredricks and McColskey 2012; Fredricks et al. 2004), it is often difficult for teachers to determine underlying motivational processes that may influence the ways students engage in mathematics. Since it is difficult to access student motivations, feelings and thinking about mathematics, teachers may come to rely on student behaviour as a sign of their engagement. Therefore it is important to know what teachers 'notice' or perceive about their students' engagement and what they interpret as 'signs' of engagement extending beyond behaviours and overt emotions to how students are thinking about their mathematics learning. A major aim of the study reported here, is to advance our understanding of teachers' perceptions of student engagement in mathematics. Importantly, these perceptions influence teachers' beliefs and drive the instructional choices and efforts they make to promote student engagement in mathematics (Author et al. 2015; Hardré et al. 2008; Hardré 2011).

2.2 Teacher perceptions and beliefs about student engagement

Beliefs and perceptions are intricately intertwined. Beliefs are considered to be "psychologically held understandings, premises, or propositions about the world that are felt to be true" (Philipp 2007, p. 259) so are subjective and vary according to the bearer of the beliefs. Philipp (2007) suggests that an individual's beliefs filter their perceptions because they serve as a model or theory, affecting what one notices, that is, what one perceives. In turn, what one perceives influences how one constructs his or her beliefs of (knowledge) and beliefs in (values) phenomena (Philipp 2007), therefore there is an implicit circularity about the relationship between one's perceptions and beliefs. The current study adopts the stance that a teacher's beliefs and perceptions mediate his or her "practices and moderates what is attended to" (Mason 2008, p. 303).

Apart from beliefs about teaching and learning, increasing attention is being paid to teacher self-efficacy in school contexts. From a social cognition perspective, Bandura (1977) defines self-efficacy as "beliefs in one's capacities to organise and execute the courses of action required to produce given attainments" (p. 3). In the school context, this reflects a teachers' belief that they have the "capacity to bring about a desired outcome" (Draper 2013, p. 71). Bandura (1977) suggests that self-efficacy varies in strength so that some teachers may be more efficacious than others and this may have important implications for teacher behaviour, including how they shape learning opportunities through their approaches to instruction. For example, teachers with high self-efficacy beliefs tend to show more enthusiasm, spend effort planning lessons, persist longer when facing challenges, are willing to try new strategies, have more confidence in managing classroom behaviours, expend effort to reach their own goals, have high expectations of their students capabilities and goals and promote self-regulatory approaches (Draper 2013; Chatzistamatiou et al. 2014).

The extent to which teachers believe that they can engage students is important because it influences the types of strategies teachers use and the efforts they make in their classrooms (Author et al. 2015; Hardré et al. 2008; Hardré 2011). In a mixed-method study designed to measure 202 secondary teachers' self efficacies for identifying student motivation and for intervening to motivate students in their disciplines, Hardré (2011) found that teacher efficacy for identifying and addressing students' motivational needs were lower in mathematics compared to that of teachers of other disciplines. When teachers reported their efforts to motivate students, some recounted success in changing the academic motivation of individual students. However, most teachers did not invest long-term efforts for change, seeing this as futile and reporting that they lacked the strategic knowledge for addressing the motivational needs of their students (Hardré, 2011). It is not clear from these and other research findings to date, if teachers are unsure about instructional approaches for engaging

students or whether engaging students in mathematics is perceived as being particularly problematic.

2.3 Teacher practices for promoting student engagement in mathematics

Stipek et al. (1998) found that instructional practices associated with building understanding and conceptual learning in students positively influence student approaches towards mathematics. Specific supportive practices identified include: (a) encouraging readiness to take on challenging tasks; (b) cultivating understanding, evidenced by mastering concepts; (c) promoting active student engagement, autonomy, feelings of control and enjoyment; and (d) developing feelings of competency.

Similarly, teacher practices such as providing feedback and clarification, emphasis and support for mastery learning, pressing for understanding, providing formative feedback, nurturing students' interest and needs, and fostering collaboration, are related to student engagement in mathematics classrooms (Schweinele et al. 2006; Turner et al. 2011). Reeve (2009) also advocates promoting student autonomy, as he identified that controlling teaching styles have negative influences on student engagement. Controlling styles result in students lacking motivation in terms of their personal interest, value, task involvement, positive feelings, self-initiative, perseverance, and creativity. Consequently, controlling styles influence aspects of behavioural engagement such as on-task attention and effort, but are not supportive of emotional and cognitive aspects of engagement (Reeve 2009).

Despite the identification of a range of effective strategies for promoting student engagement, Hardré (2011) found that teacher practices were often intuitive responses to student behaviours. She noted the prevalence of practices that emphasised the relevance of mathematics to students, particularly the practical application of mathematics and the use of learning mathematics for future careers. Such practices were categorised as ones that

provided reasons that were external rather than internal to meeting students' needs and interests for learning mathematics. Although the practices noted by Hardré (2011) are viewed as being intuitive and easily understood by teachers, they rarely included practices that were explicit about students' competency and efficacy and therefore were less likely to intrinsically motivate students—and consequently less likely to have positive consequences on student engagement in the longer-term.

Further, a study that considered the effectiveness of teacher practices, found that teachers who used a wide range of research-based practices to encourage engagement in academic content covered more information in greater depth, demanded greater concentration from their students, reported higher levels of positive affect resulting in strong levels of student engagement (at least 90% of the time) (Raphael et al. 2008). Importantly, these researchers also identified teaching practices that undermined student engagement, and included: practices with low levels of task value; low expectancy to complete tasks; ineffective rewards; poor monitoring and scaffolding; negative classroom atmosphere; and negative disciplining styles. An aim of the current study was to investigate teachers' beliefs and perceptions about student engagement and explore how these beliefs and perceptions influence their practices for promoting engagement in mathematics. For example, do teachers who perceive multiple types of engagement and believe in its importance report using different practices for promoting engagement than those who have a limited view of engagement?

3. Methodology

This study was part of a larger project investigating student engagement and achievement in mathematics (see Author et al. 2012 for details about the larger project). A qualitative study running parallel to the one reported in this paper, included interviews with 37 grade 7

students (first year of secondary school, 12-13 years of age) (Author 2014). The current investigation complements the findings of the larger project by interviewing the 31 teachers of these grade 7 mathematics students. Its aim was to investigate teachers' perceptions and beliefs about student engagement in mathematics and explore how these perceptions influence their instructional practices. The research questions were:

1. What perceptions and beliefs do secondary teachers hold about student engagement in mathematics?
2. How are teachers' practices influenced by their perceptions of and beliefs about student engagement?

3.1 Participants

The participants comprised 31 mathematics teachers drawn from ten secondary schools within a large school system in a metropolitan region of Australia. Teachers were invited to participate in the study because one or more of their grade 7 students were involved in a related study that investigated students' perceptions of their engagement and achievement in mathematics.

All of the schools (coded A-J) were secondary schools of mixed ability, representing a range of social and economic levels. There were four female–only schools, three male–only schools and three mixed–gender schools. Participating teachers were assigned a code that included the letter representing the school and a number representing each teacher at that school. For example, at school A, five teachers were interviewed and coded thus: A1, A2, A3, A4 and A5. Teacher background information is presented in Table 1. Three teachers had not undertaken initial teacher education in mathematics—one trained as a geography teacher and

two others trained in computer science. Each of these teachers had undertaken professional development in mathematics teaching and had been teaching mathematics for more than ten years.

Table 1: *Details of Teacher Participants*

	Years Teaching Mathematics				Highest Teaching Qualification			
Teacher Gender	0-10	11-20	21-30	30+	Diploma/ Certificate	Bachelor Degree	Masters Degree	Unknown
Female (n=17)	4	8	4	1	1	14	0	2
Male (n=14)	5	5	2	2	1	8	1	4

3.2 Data collection

The interviews occurred at the start of Term 4, the final term of the school year. 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 in private meeting rooms and lasted between 40 and 60 minutes. Audio-recordings of interviews were transcribed to assist analysis. Field notes recorded biographical information such as teachers' qualifications, years of service and years teaching grade 7 mathematics. Apart from contacting participants to arrange an interview, the researcher had no prior contact with any of the teachers.

A semi-structured approach to interviewing was adopted, as recommended by Zazkis and Hazzan (1999). It was considered that such an approach would allow the interviewer to ask probing questions to elicit rich information about teacher perceptions and their practices. To address the first research question, teachers were asked: "Which students in your class at the moment are/not particularly engaged in the mathematics you are teaching them?" and "How

do you know these students are engaged or not engaged? Other questions aimed at eliciting further information about how teachers derived their judgements about students' engagement levels included, "What 'signs' of engagement and disengagement do you notice?" and "Are there particular aspects of mathematics that seem to engagement students more and why do you think this is this the case?" To address the second research question, teachers were questioned about instructional strategies they used to promote student engagement in mathematics. For example, teachers were asked, "What strategies do you use to engage/facilitate student engagement?" and "How do you know these strategies engage students?" Teachers were asked about the resources they chose for engaging students, their use of technology in mathematics lessons, how they provided feedback to students, and the importance they placed on making personal connections with students.

3.3 Data analysis

The approach to analysing the interview data was deductive in the sense that it drew on literature that discussed (a) teachers' beliefs and perceptions of student engagement and disengagement; and (b) teachers' practices linked to the promotion of student engagement and achievement in mathematics. The qualitative analysis software programme, NVivo (QSR- International 2008), assisted in the coding of teacher interview transcripts.

The analysis of teacher perceptions about student engagement drew on teacher responses to interview questions that asked them to describe engaged and disengaged students in their Year 7 mathematics classes. Additional probing questions by the researcher clarified details about their perceptions of student engagement or disengagement. In the first instance all of the participants' comments were coded from the transcripts using the NVivo software (QRS –

International, 2008). Then, drawing from engagement literature, keywords and phrases were identified and recorded manually. Any words or phrases repeated or deemed very similar in meaning, were noted by the researchers, resulting in a summarised final list. Subsequent analysis of the final list of key words and phrases was conducted in two stages. In the first stage we considered teachers' reports of engagement by drawing on the definitions of types of engagement provided by Fredricks et al. (2003). We identified specific types of engagement that were consistent with conceptions of engagement in the existing literature. Subsequently, for behavioural aspects of engagement, attention was paid to teachers' reports of student actions, participation and involvement. For example, descriptions of students "refusing to talk to the teacher" or "fiddling and chatting with friends" were considered to reflect behavioural engagement, albeit at different 'levels'. For emotional engagement, expressions of feelings, attitudes, values and interest were noted. Examples from teacher reports that indicated their awareness of student emotional engagement included statements such as: "she kind of panics and is unsure of herself" and "He tells me he likes maths". Cognitive engagement indicators relate to students' thinking, planning, self-regulation and strategy use. Teachers reported such things as: "they are self motivated…stay behind and clarify points" and " they are trying to get their heads around it, asking for help".

The varying levels of intensity that teachers perceived for the different types of behavioural, emotional and cognitive engagement were considered during the second stage of analysis. For instance, the example given in the previous paragraph—"refusing to talk to the teacher"—was considered to infer a severe lack of participation and subsequently deemed as *disengaging behaviour*. This is in contrast to "fiddling and chatting with friends", which the teacher explained as switching from on-task to off-task behaviours, and was deemed as *variable engagement*. This is contrasted with statements describing students as "hands up and

frequent participation", which was considered to reflect high levels of involvement, and subsequently labelled as *substantial engagement*. These three levels of engagement (disengaging, variably engaged and substantial engagement) were applied across each of the three types of engagement, resulting in a two-dimensional analysis framework that was representative of the full range, or 'spectrum', of engagement reported by teachers. The development of the framework was done in consultation with two other researchers involved in the study and included discussions about the appropriateness of placing of key words and phrases in particular categories and category headings. The resultant framework (referred to as the 'Engagement Spectrum') (Table 2) is an empirically derived framework for describing, organising and analysing a wide range of teacher perceptions of student engagement in mathematics classrooms. It is used here to report the results of the teacher interviews regarding their perceptions and beliefs about student engagement in mathematics. The Engagement Spectrum highlights two dimensions of engagement. First, reading down each column, signs for each type of engagement are listed—behavioural, emotional and cognitive—ranging from the most negative to positive responses. Secondly, looking across each row, profiles of engagement for students who are *disengaged, variably engaged* and/or *substantially engaged* are revealed.

Table 2. The Engagement Spectrum

<insert Table 2 about here, The Engagement Spectrum-separate file >

The second focus of the interviews was to explore the practices teachers reported using to engage students in mathematics to help determine how such practices were linked to their perceptions of engagement. The process of analysis drew upon existing literature that examined teacher beliefs, perceptions and practices associated with engagement and

disengagement with mathematics (Hardré, 2011; Raphael et al., 2008; Schweinle et al., 2006; Stipek et al., 1998). Initial categories of teaching practices derived from this body of literature and considered to promote all types of engagement included: emphasising the relevance and future value of mathematics; enhancing student autonomy and empowerment; emphasising student interests; and, emphasising interpersonal relationships. New categories also emerged from the data, including teachers' uncertainty about practices that might promote student engagement. The new categories were incorporated into the coding process and subsequently the teacher reports were coded using the range of categories outlined.

Reliability for coding interviews was addressed by establishing high levels of inter-rater reliability using a method recommended by Krippendorf (2004). A second researcher undertook random coding of 13% of the teacher interviews. The coding reliability overall ranged from 87% to 93%, representing a high level of reliability and satisfying the recommendations suggested by Krippendorf (2004).

4. Results

We begin by summarising teachers' perceptions of student engagement in mathematics by types and then levels as detailed in the Engagement Spectrum (see Table 2). The Engagement Spectrum reports behavioural, emotional and cognitive types of engagement identified in the teacher interview data that was subsequently categorised at each of three levels: *disengaged*, *variably engaged*, and *substantially engaged*. Following this is a presentation of the practices teachers reported using to engage their students in mathematics.

4.1 Teachers' beliefs and perceptions of student engagement

For the purposes of this study, teachers' beliefs and perceptions of student engagement were analysed to identify specific indicators of behavioural, emotional and cognitive engagement and were categorised according to our assessment of 'best fit' in line with the definitions used by Fredricks et al. (2004).

For a significant number of teachers, their perceptions of student engagement tended to focus on student participation, interest and enjoyment. The results summarised in Table 2 indicate that teachers predominantly perceived behavioural aspects and overt emotions as signs of engagement. Behavioural signs that were reported by three or more teachers included: students were off-task and being distracting (n=5), on-task and paying attention (n=4), hands up and frequent participation (n=8), asking and answering questions (n=8), and students wanting to 'get on' with work (n=6). Signs perceived to be indicative of emotional engagement (positive and negative) reported by three or more teachers included: students appearing not interested (n=3); anxious (n=3); interested and keen (n=4); enjoying and liking mathematics (n=6). Teachers' reports emphasised the perception that on-task behaviour was due to enjoyment, participation and variation in activities.

Teacher reports of cognitive engagement occurred less often than behavioural engagement with only 18 of the 31 teachers reporting signs that reflected cognitive engagement. Signs of cognitive engagement that were referred to by three or more teachers included: lack of organisation and poor quality book work (n=3); listening to each other and increased communication (n=4); interest in discussing the use of mathematics (n=4); keen to explore different thinking (n=4); raising questions in class and staying behind to clarify understanding (n=3); and, wanting to work ahead, completing homework and bookwork (n=5). Teachers who referred to cognitive engagement described students as "keen to learn",

"confident explaining mathematics", able to devise a "methodology that is a little bit different to others" or "ask if they could show another solution that had not been considered by the teacher" (E2). One teacher reported multiple signs of cognitive engagement indicated by a student's "level of interest, level of concentration…whether they are on task…and a lot of them [students] want to work ahead" (G1). Additionally it was reported that certain students are "self-motivated …their bookwork is always thorough and complete…they do their homework and come with questions. They are the students who after class will stay behind and clarify points" (G3). These comments reflect aspects indicative of intrinsic motivation and the use of strategic approaches for mathematics learning.

4.1.1 Disengaged students

When asked about student disengagement, teachers generally referred to off-task behavioural indicators before emotional and cognitive ones. For example, teachers referred to disengaged students as actively disruptive by "distracting others ... talking and whispering" (A3), "avoiding eye contact" (H2) and not participating in class tasks. As presented in Table 2, teachers reported that disengaged students generally displayed a lack of effort during mathematics lessons, distracted others, did not complete homework or maintain tidy notes for revision and failed to bring all the necessary equipment to mathematics classes on a regular basis.

Teachers also referred to affective aspects of disengaged students, including their emotions, attitudes and interests towards learning mathematics. One teacher reported that some students openly stated that they "don't like maths" (I3) and reflected intense negative emotions such as "hate", "anger" and "frustration" towards the subject. Other teachers reported their awareness of less intense emotions present in students, describing disengaged students as simply "not being interested" in learning mathematics (F1 and E4) or "caring" about their

work (H1). Teachers commented that some students were perceived to be disengaged in mathematics had immediate negative responses to new work, stating that the work was too difficult even before attempting it (A4). They considered that the majority of disengaged students possessed strong beliefs about their potential to achieve (or not achieve) including prior to starting class tests (A4). These students were also perceived to lack organisational skills in and outside of the mathematics classroom. For example, teachers considered that these students often did not attempt homework and study for tests rarely occurred (A4 and J2).

4.1.2 Variably engaged students

Teachers' descriptions of students perceived to be neither totally disengaged nor substantially engaged in mathematics were grouped under the category of 'variable engagement' in Table 2. Teachers considered that variably engaged students generally displayed behaviour that complied with the teachers' requests in class to complete work, but often avoided active and sustained involvement in the mathematics classroom.

One teacher described variably engaged students as those who were "quiet, and seated", appearing to listen but they had "switched off" (J2) and another as "those who avoided work by wasting time or procrastinating by spending too long on menial tasks, and asking 'lesson stopper' questions such as 'Why do we have to do this?'" (F2). Teachers noted that some students' levels of engagement fluctuated when their ability to concentrate waned and they needed explicit encouragement to maintain their participation. Teachers reported that these students would "still have a go, at least for part of the lesson" (J3), or they "would contribute occasionally" (A4) to class discussions.

While some teachers construed students' lack of participation in mathematics lessons as a lack of interest, others reported that it was sometimes difficult to determine if lower levels of involvement were due to other personal characteristics, such as shyness (E1). Moreover, teachers thought that some students might know the answer to a question but were often "scared to explore in front of the peer group" (C2) or "panicked" and disliked attention if asked a question in class (E1). Teachers also considered that uncertainty and anxiety were factors influencing this group of students' reluctance to participate, particularly "getting things wrong in front of the other students" (D1). Teachers indicated that they were very aware of students' concerns about looking "like an absolute idiot" in the classroom, so suggested that these were reasons why they would discreetly offer help to students at the end of the lesson rather than expect students to ask them questions in class (H2).

In contrast, some teachers believed that certain students did not want "to be seen as smart, to be seen as capable of doing it. I think he is happy …not being pushed or confronted" (E1). Although such students were not active participators in mathematics classes, the teachers considered these students to be reasonably competent at mathematics but were at times under-achieving because they "don't want to be seen as nerds" (J1). One teacher explained the variable engagement of high achieving students being possibly due to boredom when repeating procedures and going over more examples.

On the other hand, variably engaged lower-achieving students were thought to lose focus because they had difficulties understanding mathematics content or had poor retention abilities, but this did not necessarily mean that teachers considered that these students were disengaged:

> I think she is just passive. At times you see her staring at the ceiling when you are trying to explain something because it's gone beyond her. But she does do the work when asked and if I ask her for an answer she'll give it to me after a struggle…but I don't think she is disengaged. I just think she finds the content a bit difficult. (E1)

To date, variable engagement has received little attention in the field. These findings suggest that the space between substantial engagement and disengagement is important to explore because the reasons for variability are unique to individual students. Significantly teachers' suggestions about why students in this category were choosing to take less active roles in mathematics confirms the need to understanding underlying factors that may be inhibiting students (be they anxiety, uncertainty, shyness, fear of failure and the like), rather than make judgements about a student's engagement level based solely on their behaviours.

4.1.3 Substantially engaged students

When discussing students whom they considered substantially engaged, teachers' statements routinely referred to high levels of student "interest, their level of concentration…talking to their friends about the work… on task…and the questions that they fire," (J1). Drawing on examples provided in Table 2, teachers considered that students demonstrated their engagement in mathematics classes when "their hands are always up… are willing to give an answer. They want to come up to the board to show the answer…You see smiles and 'I get it, I get it'" (E1). Further, teachers noted that students considered substantially engaged always seemed "attentive and co-operative" (A2). A regularly cited characteristic of students perceived to be substantially engaged was their high level of interest in understanding the mathematics rather than just completing tasks or following procedures. For instance, one teacher stated that 'engaged' means:

> On task, interested in not only finishing the task but finishing it to the best of their ability, to a high standard, and wanting to know what they don't know, wanting to go that step further, rather than ticking and crossing, actually finding out why. (J3)

Teachers were cognisant of the amount of effort that lower-attaining students considered to be substantially engaged, needed to apply in mathematics. They acknowledged the importance of small achievements in the lives of these students to help ensure their persistence with mathematics and to maintain their positive perspective on the subject. For one low achieving student, his teacher commented that his perseverance was his " number one strength and his:

> Desire to do as well as he can regardless of what it is and just to even improve by three marks he gets excited and happy. He really struggles with maths, but it doesn't stop him trying. (J2)

Teachers generally perceived that they positively contributed to the achievement and engagement levels of these students through their willingness to support their learning. This was particularly so when teachers perceived that the students were "focused", "listening" and "want[ing] to learn … asking for help" (H1). Even when low achieving engaged students were frustrated or unable to initially complete a task, teachers perceived that these students did not let this "get in the way" of their learning (F1). Instead, they were considered to "persist" by seeking help from the teacher after the lesson or via other means (F1).

Teachers reported that substantially engaged students displayed greater levels of respect for learning and sharing knowledge with others. They described engaged students, whether they be low or high achieving, as those who concentrate, are self-motivated and strategic by maintaining bookwork, do their homework and stay behind to clarify questions (G3). One teacher reported a heightened level of "communication" in the classroom, where students'

interests and learning coincided and resulted in learning experiences being enhanced by satisfaction and absorption in their mathematics learning (J3). Substantially engaged students were also perceived to be more proactive about mathematics work outside the classroom and show an interest in knowing where "it will be used and how it will be used" (D1) not only to satisfy their immediate needs but for future application.

4.2 Practices for engaging students in mathematics

This section first reports a range of practices and approaches used by teachers that support student engagement in mathematics. The majority of the these practices came from a third of the teachers who reported signs for all types of engagement but significantly reported at least the same or more signs of cognitive engagement than behavioural or emotional. Secondly, it reports some teacher approaches that were seen to limit student engagement. The majority of these reports came from a third of the teachers who reported a small number of practices (three or less) and which comprised mainly behavioural signs of engagement.

4.2.1 Practices emphasising the relevance and future value of mathematics

About a third of teachers reported instances of providing students with examples of how mathematics was relevant to the students' world, believing that mathematics "needs to be connected to their life in some way" (C2). 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 work situations", believing the students found this "interesting, motivational and relevant" (H2). Teachers revealed their awareness that students felt a lack of relevance between mathematics and their everyday lives.

More than half of the teachers reported drawing upon practical applications of mathematics with the intention of engaging their students. The use of mathematics in 'real life' was often cited as a reason for studying mathematics because "mathematics has a place in life, in the simple things that you do" (H1). Most teachers attempted to address questions about the future value of mathematics as being "helpful to know when they get out in the real world…and relevance is really important" (D1). For example, as part of a lesson on trigonometry and bearings the teacher used a PowerPoint presentation including an animation of a boat, reporting: "I think some kids are stimulated visually…with animations you do not have to rub our or draw a circle around important information…the kids to tend to refer to it because I try and link to real life things" E1.

However, not all teachers perceived students' needs for understanding the relevance of the mathematics work they were doing. For example, one teacher commented, "at 13 and 14 years of age … we are doing it because we are doing it. I don't think you are going to come up with a satisfactory story for a 13 year old so sometimes I just think, 'what is the point?'" (F2). The teacher continued to explain that he would ignore questions from students asking for reasons why they were learning particular topics or avoid students who he thought might ask such questions.

4.2.2 Enhancing student autonomy and empowerment

Several teachers explained how they encouraged student autonomy in their learning of mathematics and altering their teaching approach to suit the range of student achievement

levels in their classrooms. They welcomed students' questions, acknowledged their frustrations and encouraged independent student investigations.

One teacher who advocated student autonomy believed that "Maths needs to be centred on the student… it should be about the kids themselves taking control of what they're doing… so it's not just me giving the answers, they're actually finding the answers themselves" (C2). The teacher then reported examples of his practice that supported student active involvement in their learning:

> I invite students to come up…and immediately when they answer one question they become teachers. So if a student puts their hand up I don't answer, I make a thing of that I don't answer, but another student answers the question. So that's one way I try and get the kids engaged every single lesson.
>
> And further:
>
> I actually give them the framework of what exactly we're doing in every single class. The warm-up, then the theory then the practice and then the homework…when they come to the class they already know about what we're learning and I find that's engaged them tremendously. (C2)

Another teacher, believed that students who were "not very strong in mathematics do not tend to volunteer to answer questions in class" (E2). Therefore, this teacher "differentiated and framed" his questions so that they "were more accessible" to the students to ensure that they could all participate in class discussions and also responded positively to students who offered alternative ways of finding solutions to problems, saying "that's a thoughtful way of doing it, I had not thought of it that way" (E2).

4.2.3 Practices emphasising student interest

Teachers reported using practices that were sensitive to students' personal interests and desires, as they believed this was important for encouraging them to continue learning. These practices were viewed as distinct from practices with the main purpose of doing something 'interesting' to keep students on-task. For example, teacher E1 reported, "I am trying to make it a bit more fun and energetic in class, I think they get that vibe off me that it can be fun even though the work is not easy all the time. I tend to give them quite a bit of homework…I don't want them to go a day without doing any mathematics at all as they forget the next lesson." Another teacher, who noticed a student's capability and interest in mathematics, nurtured this by allowing her to create the warm-up for the class, reporting that the student "got a buzz out of doing that" (C2). Other teachers captured 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 mathematical working notes from previous classes on the board (C3). Using interactive materials were also reported as maintaining interest, for instance "it was fantastic starting that topic using smart board and visual aids–for algebra we had containers and balls and they had to move them and create an expression" (C1).

In other cases despite students' willingness to listen, work and "understand as best they can", the teacher reported the students have problems retaining information and the subsequent inability to " to apply it to something new" (E3). In response to this the teachers' practice incorporates doing "quick quack quizzes…and start lessons with questions that were done in previous lessons just to keep it fresh". The above mentioned practices were viewed as positive for promoting engagement and were aligned with teachers who believed in and emphasised the importance of maintaining mathematics learning.

4.2.4 Practices emphasising interpersonal relationships

Teachers believed that developing interpersonal relationships and making a personal connection with their students was important for engagement. For example, one teacher said "if you have a rapport then I think you are going to get a lot more out of any student" (J2) and another, "I try and make maths in simple terms, the way they would explain it if they could…I think they like having someone who can talk their language" (E3). 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). Another reported that for students who admit they don't mind maths but know they are not very good at it, they offer advice such as: "It is just something you are learning, don't make that decision about it yet" (A4). It was also seen that developing interpersonal relationship built student confidence and this was important for help seeking:

> 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)

4.3 Practices that limited student engagement

4.3.1 Low expectations and controlling teacher styles

Several teachers expressed low expectations of students to persevere with learning. For example, one teacher reported that she believed most students' revision strategies for an

upcoming test would include a simple "look through their books", which she perceived would not "make a difference to them" (A4). Rather than guiding students to use more effective revision strategies, the teacher continued her practice of putting 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, without offering challenge to those with higher skill levels. This teacher 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). One teacher reported expecting that some students could not be engaged, reporting, "Not engaged students have a negative influence on others. It doesn't send out good signals to everyone else. I think also that some students may never get engaged in maths no matter what you say." (F3)

Some teachers imposed controlling teaching styles in their classrooms, incorporating practices identified by Reeve (2009) as not being supportive of emotional and cognitive aspects of engagement. For example, one teacher reported that although he liked to have "a low-stress classroom" and to give students a "bit of responsibility" (B2) he emphasised sanctions for off-task behaviours and used practices that pressured students into completing their work during class time by imposing penalties (e.g. demerits) if not completed. Another teacher, after finding that students did not contribute in class discussion or complete tasks, implemented a system of sanctions for students who did not "co-operate, listen and focus" in the classroom (A4). Each of these teachers considered their actions as helpful for increasing student participation. They seemed unaware how these controlling practices might impede students' desires to engage with mathematics learning independently.

4.3.2 Occasional and uncertain—the absence of effective practices

Several teachers considered engagement as something that only needed occasional attention. They considered engagement issues to be separate from issues that concerned mathematics content—equating student engagement with 'on-task' behaviour. These teachers considered teaching mathematics content and completing curriculum requirements to be 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 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 expressed the view that practical lessons were "a time waster", alleviating boredom with mathematics, rather than potentially engaging students. Other teachers considered that engaging lessons included those where students were not aware that they were doing mathematics, such as when students were kept physically active such as visiting the computer lab once a term.

Several teachers reported their uncertainty about how to engage students, feeling powerless in their attempts to engage them. One teacher considered that there were many factors outside his control influencing student engagement and although he wanted his students to "enjoy the experience of maths"—they did not (F3). Other teachers shared this sense of helplessness about their abilities to successfully engage students in mathematics and actually reported reducing the efforts they made to engage students in mathematics lessons. For example, one teacher commented that: "You walk out of some classes and think I may as well have just shown a movie because what did we achieve?" (F2). Although he knew he should be supportive of his students regardless of whether their results were "good or bad", he also believed that the students did not have the "ability" to get higher grades. The teacher reported

that he was not aware of any teaching practices that would help engage his students. Similarly, another teacher reported her "dilemma as a teacher, I don't know what to do with one or two boys…I have tried a few different things and I just don't know how I can get them to want to do it." (E1).

5. Discussion

In this study, teachers' beliefs and perceptions about grade 7 students' engagement in mathematics, along with the teaching practices they used to promote engagement, were investigated. This study expands previous research on student engagement described by Fredricks et al. (2004), by reporting teachers' detailed descriptions of student engagement by type specific to mathematics. While teacher practices for promoting engagement have been discussed in prior research (Hardré 2011; Raphael et al. 2008), this study links more directly teacher perceptions about engagement to the practices they report using. In particular, it highlights that not all teachers use effective teacher practices or consider that they know how to promote student engagement in mathematics.

5.1 Teacher perceptions about student engagement in mathematics

The findings of this study advance thinking about student engagement from the teachers' perspective by revealing in detail what they perceive as signifiers of student engagement in their mathematics classrooms and incorporate them into a single framework—the Engagement Spectrum. Particular interest was paid to student engagement that was variable and operating between substantial engagement and disengagement, adding depth and clarity to students who have previously been described as 'quietly disaffected' with mathematics (Nardi and Steward 2003). The focus on variable engagement draws attention to differences in signs for this intermediate area raising opportunities to both promote engagement and

arrest declines in disengagement. The teachers' perceptions for variably engaged students were accompanied by reasons for fluctuations in engagement, including feelings of competency about mathematics, past mathematical experiences, beliefs and attitudes. Variably engaged students were perceived as compliant but in need of regular encouragement to complete class tasks and homework.

The findings also revealed that teacher reports of cognitive engagement were fewer in number and scope than for behavioural and overt emotional engagement. This could be because signs of behavioural and obvious emotional engagement displayed by students were more readily noticeable to teachers and possibly demand more immediate teacher attention. Further, because only some teachers reported perceiving aspects of cognitive engagement, and the fact that their descriptions varied, suggests that awareness and recognition of the importance of students' cognitive engagement is not widespread. However, the results of this study indicate that it is the teachers who are capable of identifying, and believe in the importance of, cognitive engagement are the ones likely to use the most effective practices for promoting student engagement in mathematics.

5.2 Teacher practices for student engagement in mathematics

The second focus of this paper was on the practices that teachers reported using to promote student engagement. Practices included, framing questions in ways where all students can participate in class discussions, purposeful pairing of students to support each other's learning, and being available to help students who are perceived as making extra efforts to improve their learning. Teachers who invested in such practices promoted effort and mastery, encouraged students to take risks and complete challenging tasks, fostered students' interests in the subject of mathematics itself, developed interpersonal connections between the themselves and their students and promoted feelings of competency and autonomy for

managing mathematics learning (Turner et al. 2011). Similar to findings by Raphael et al. (2008), about a third of teachers in the present study used multiple practices that promoted cognitive engagement and encouraged academic learning. These teachers believed that mathematics needed to be centred on the students as they sought answers for themselves.

The investigation of teacher practices also unveiled the use of some practices that were viewed as ineffective for promoting student engagement. Teachers who displayed low expectations of students' learning did not promote persistence, student self-regulation, control, self-efficacy or autonomy. Further, some teachers believed that preparing an occasional 'interesting' but cognitively non-demanding activity was sufficient for attending to student engagement. These teachers viewed student engagement as something to be dealt with separately to teaching mathematics content, rather than integral to the learning process. Attention to engaging students was mainly at the behavioural level rather than encompassing practices that promoted emotional and cognitive engagement.

5.3 Teacher efficacy for engaging students in mathematics

A major theme to emerge from the teachers' reports was their concerns about not feeling confident about engaging their students in mathematics. Similar to findings reported in another study, teachers who perceived obstacles for engaging students as too difficult to overcome, reported the lowest levels of self-efficacy (Hardré 2011). Teachers' perceptions of being powerless to engage their students resulted in many limiting their efforts to attempt some form of intervention—thus highlighting the importance of teacher perceptions about engagement, and their beliefs in their own abilities to effect change in their students via their teaching practices.

In contrast, teachers who used multiple practices to promote engagement believed that they were competent at supporting their students' engagement (Schweinele et al. 2006; Stipek et

al. 1998). The practices of such teachers are in accordance with those who have high levels of self-efficacy, that is, noticing and attempting to alleviate students' negative affect by understanding and continuing to support students as they struggle to master content rather than overlook their learning needs.

Clearly there could be many reasons why some teachers find it difficult to engage students in ways that will promote long-term mathematical learning. Addressing this situation will, at the very least, require teachers to invest time or effort to understand and build their knowledge about engagement to develop a repertoire of strategies for engaging their students. It is important to understand teacher perceptions about and efficacy for student engagement because these drive the instructional choices and efforts teachers make to promote student engagement in mathematics (Author et al. 2015; Hardré et al. 2008; Hardré 2011). Knowing how to engage students requires clearer ideas about the types of and intensities of engagement combined with specific practices to promote engagement of students. The present study highlights a need to increase teacher engagement knowledge, particularly the importance of cognitive engagement in mathematics. It also highlights the need for strategies to build teacher self-efficacy regarding student engagement in mathematics. This might involve strategies that increase teacher knowledge about student engagement and of effective engagement-supporting teaching practices.

5.4 Limitations

Although this study reported engagement at three levels of intensity, it is acknowledged that this does not adequately represent the multiple levels of engagement and their possible fluctuations. However, the framework emerging from analysis of teacher perceptions was beneficial for teasing apart, organising and understanding teacher perceptions of this complex

construct. In terms of teacher self-reports about their practices, it is possible that additional practices to promote types of engagement were used by teachers, but these may not have been represented or clearly articulated during the interviews. The inclusion of observations would be desirable alongside interviews to help verify teacher reports of their practices. Combining information from students about their engagement in mathematics classrooms would offer an opportunity to further compare and triangulate data. Additionally, teacher participants in this study belonged to one school sector (the Catholic school sector), and although large and somewhat diverse, a certain school culture prevailed. To appreciate the full scope of teacher beliefs and perceptions and their abilities to respond with appropriate strategies, it would be beneficial to include teachers from a much broader range of school systems and grade levels in future research.

6. Conclusion

The results of this study connect teacher perceptions of student engagement to their beliefs and subsequent practices for promoting engagement in mathematics. In this study we explored teachers' perceptions of student engagement in mathematics and organised these perceptions according to types and levels. The resultant Engagement Spectrum helped organise teacher perceptions of and the ways in which they distinguish between various types and intensities of engagement. The intensity of engagement perceived by teachers—from substantial engagement to disengagement—was explored in depth, exposing the expected fluctuations and variations for engagement and confirming its idiosyncratic nature. Importantly, the findings emphasise the limitations of teacher judgements concerning students' engagement levels being solely based on behavioural indicators and relatively overt emotions. This emphasises the personal and individualistic nature of engagement (Fredricks

et al. 2004) and highlights the importance of teachers deliberately planning for engagement as carefully and thoughtfully as any other aspect of their instruction.

A second key finding of this study highlighted that while some teachers use a range of practices to promote student engagement in mathematics, others used practices that were ineffective, some used different practices as a diversion from 'normal' mathematics lessons and some did not know what practices to use to engage their students at all. Teachers who tend to employ practices that addressed short-term interest and behaviour are unlikely to promote deep engagement in mathematics over the long term. It is for this reason that teachers who believed they could support students' engagement used practices that met students' motivational needs, promoted competency and helped students gain a sense of autonomy for mathematics learning. However, not all teachers in this study reported using robust practices to promote student engagement and this drew attention to a third key finding, that is, that teacher efficacy plays a vital role in empowering teachers to notice and respond to students' low engagement. It is therefore important for teachers to assess their personal beliefs about student engagement and consider how their practices in mathematics classrooms may or may not be supportive of students' mathematical engagement and learning. We believe that raising teacher awareness of different types of student engagement, and of engagement-supportive practices will develop teacher perceptions and knowledge that will promote longer-term and more substantial levels of student engagement in mathematics.

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Table

Table 2

The Engagement Spectrum

Levels of Engagement	Types of Engagement in Mathematics		
	Behavioural (actions, participation & involvement)	**Emotional** (feelings, attitudes, values & interest)	**Cognitive** (goals, self-regulation & metacognition)
Disengaged	**Will not talk** to the teacher/Respond to questions	Say "**I don't like maths**" and want justification for why they need to learn it and how they will use it	**Lack of organisation/Lack of bookwork**/No attention paid to keep notes tidy
	Refuse to do mathematics work	**Not interested**/Not absorbing (this sometimes only applies to a particular concept)	**Resistance** to homework
	Avoid eye contact /Sit towards the back/In a corner/Keep a low profile	Say "**I'm going to fail**" before tests (anxiety)	**I don't know if they know what 'to study' means** (i.e. how to study effectively)
	Off task or not on task enough/**Distract others** and try and distract the teacher	**Immediate "I can't do it"** or "Miss, this is hard" **negative** response	Not getting anywhere with learning the subject of mathematics (i.e. **lack of progress**)
	Regularly **do not bring equipment** such as pens, rulers, calculators and books to lessons	**No desire to better themselves** in maths/**lack initiative** and drive	
Variably Engaged	**Use diversion tactics** -'lesson stopper questions'	**Low interest /Disenchanted**/Low support for mathematics at home	More able students are **happy to be average**
	Procrastinate/Find reasons not to complete work/ Chat, fiddle and avoid work	**Disappointed** if do not do well in tests and easily put off	**Lack of discourse** about mathematical themes
	Muck around/Make jokes/Act the class clown	**Anxious** about getting things wrong/Asking questions in front of other students	**Variable concentration**/Unable to focus for long periods
	Wait and let others answer the questions/**Reluctant contributors** - even when able to	For those that have mastered skills, they do not need or like **repetition and get bored**	**Poor retention** of information
	Rush through work but not thorough/**Low effort**	**Compare themselves** to more successful siblings	**Focus on good marks** rather than understanding
Substantially Engaged	**On Task**/Pay attention/Sit at the front	**Interested/Keen/Switched on/Enthusiastic/Positive** attitude	**Listening** to one another/**Increased communication** between students and teacher
	Hands are up/**Frequent Participation**/Wants to contribute/Keen to get involved	**Enjoy maths/Smile/Say they like maths**	Interested in **discussing how the maths will be used and applied**
	Want to **answer questions**/Want to **ask questions**	**Get excited and happy** when they improve/Experience success	Keen to find out **different ways of thinking/ Solving**/Use own methodology
	Want to learn/Gets on with work/Wants to improve/**Desire to do well**	**Confident** in expressing themselves	**Bring questions** to class/Stay behind after class to **clarify concepts**/Talk about homework
	Persevere and do not let frustration get in the way/ Always trying their hardest	**Self-esteem increases** /Thrive on attention and responsibility	**Like to help others** and recognise this **helps their own understandings**
	Interacts in class/Does groups work well/Make lots of suggestions/Wants to **share solutions**	**Self-motivated**/Exceptional motivation	**Like to work ahead**/More examples/Homework complete/Bookwork thorough

(Skilling, 2016)