Students' Experiences of Mathematics During the Transition from Primary to Secondary School.

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As part of a longitudinal case study on engagement in middle years mathematics, 20 students attending their first year of secondary school in Western Sydney were asked to provide views on their experiences of the transition to secondary school in relation to mathematics teaching and learning. Differences in teacher-student relationships caused the most concern due to the decrease in teacher-student interactions and a reliance on computer-generated mathematics lessons. Findings indicate that a strong pedagogical relationship forms the foundation for sustained engagement in mathematics during the middle years.

During the transition from primary to secondary schooling many students experience significant changes in the physical structure, teaching and learning practices, and expectations of school. In an Australian setting, transition to high school occurs when students are aged between 11 and 12, a time when they are experiencing physiological, psychological and social changes associated with adolescence (Downs, 2003; Moroney & Stocks, 2005). Literature suggests difficult transitions can lead to disengagement, negative attitudes towards school, reduced self-confidence, and reduced levels of motivation, particularly in the area of mathematics education (McGee, Ward, Gibbons, & Harlow, 2003). Disengagement in mathematics can lead to reducing the range of higher education courses available to students and can limit their capacity to understand life experiences through a mathematical perspective (Sullivan, Mousley, & Zevenbergen, 2005).

As part of a qualitative longitudinal case study on engagement in mathematics during the middle years (Years 5 to 8 in NSW), a group of 20 Year 6 students from one school were asked to provide their views on mathematics teaching and learning through individual interviews and focus group discussions. When the group began high school, they participated in a sequence of three focus group discussions over the course of the year. This paper is a report of some of the findings of this study. It focuses on the changes encountered by the students in terms of their experiences within the secondary mathematics classroom.

Middle Years, Mathematics and Transition

Factors that have the potential to influence students' engagement in mathematics occur both outside and within the school, and outside and within the mathematics classroom. Although transition to high school can play a major role in influencing engagement, there are additional factors specific to the learning and teaching of mathematics itself that play a critical role. Such factors are curriculum, pedagogy, assessment strategies, social interactions and students' relationships with others. Together with transition, the sometimes negative impacts of these factors are cause for concern. The following is a brief account of current literature pertaining to key issues of transition and mathematics.

Over the last 20 years, research has overwhelmingly documented an increasingly smaller percentage of students pursuing the study of mathematics at upper secondary level and beyond. The choice not to pursue mathematics has been seriously influenced by

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students' attitudes towards and performance in mathematics, in turn deeply shaped by school mathematical experiences and the teaching they experienced in school (Nardi & Steward, 2003). Although arguably attitudes change throughout the school years, once formed, negative attitudes towards mathematics are difficult to change and can persist into adult life (Newstead, 1998). Maintaining engagement in mathematics during the middle years may promote more positive attitudes, in turn making the study of mathematics more attractive.

There is a definite decline in school mathematics engagement of many young adolescents when compared with their engagement in primary school (NSW Department of Education and Training, 2005). In addition, increased truancy, greater incidence of disruptive behaviour, alienation and isolation increase in early adolescence (Sullivan, McDonough, & Harrison, 2004). Hill, Holmes-Smith and Rowe (1993) noted that in the middle years, there is a noticeable arrest in the progression of learning observed, with those in the lower decile seeming not to progress academically beyond Year 4 level. Disinterest in mathematics generated by certain pedagogical approaches seems strongly linked with underachievement (Boaler, 1997).

During transition to high school students encounter changes at social, organisational and academic levels. Students preparing to transition from primary school often have preconceived ideas and high expectations of the challenges presented by secondary schools. Many Year 6 students expect the work in Year 7 to be harder, presenting a challenge to some, and anxiety and concern for others (Howard & Johnson, 2004). In an Australian study of students' perceptions of the transition to secondary school by Kirkpatrick (1992), students found the academic work during their first year of secondary school was no harder, or was easier than their final primary year, yet they still had difficulty adjusting to the new academic environment. Although there may be a lack of challenge, the transition to secondary often results in some level of achievement loss, a phenomena not limited to students in Australian schools (McGee et al., 2003).

In addition to the academic issues outlined above, students are faced with significant social changes as they transition to high school. Many students must learn to cope in a much larger school environment where, relative to primary schools, secondary schools are characterised by a greater emphasis on control, more impersonal student/teacher relationships and a greater likelihood of public evaluations of students (Hardy, Bukowski, & Sippola, 2002).

With substantial literature stating social interaction within the classroom is an important contributor to positive learning outcomes it appears mathematics classrooms are sometimes regarded as an exception. The often individualistic nature of mathematics lessons seems extremely unusual, causing some students to view mathematics classrooms as 'other-worldly', with no relationship to their own lives and perhaps no connection to other academic areas (Boaler, 2000). The traditional practices of individualised work in the mathematics classroom discourage meaning, engagement and understanding. "Students within mathematics classrooms regard themselves as a community, whether teachers do or not, and it is antithetical to the notion of any community that it should inhibit communication between participants, and that dominant practices preclude meaning and agency" (p.394).

For adolescents to function positively at school and within society, emotional wellbeing is crucial. Relationships with teachers have a substantial impact on student learning in mathematics in addition to relationships with peers. One of the most obvious differences between primary and secondary school is the amount of time students spend

with their teachers, forming relationships. The *Connecting Through the Middle Years Project* (Henry, Barty, & Tregenza, 2003), found when dealing with students and the 'drop-out' syndrome a link was made with 'connectedness', referring to the sense of belonging which results in a feeling of well-being.

Although there is an abundance of research into middle-years, mathematics and transition from primary to secondary school, there appears to be a gap in the research with a lack of longitudinal studies set within an Australian context. Another gap seems to be a lack of 'student voice' exploring students' perspectives on mathematics teaching and learning during this time of transition. The goal of this study is to address the current gaps in research and explore students' perceptions of teaching and learning in mathematics, identifying pedagogies that help sustain engagement, fostering continued study and enjoyment of mathematics.

The Study

It is common for research relating to engagement and mathematics to take a deficit approach towards current practices in classrooms. It was a commitment in this study to take a positive perspective, focussing on identification of what was seen by the participants to be working well or being taught well in the mathematics classrooms involved. A second commitment was to give the participants a voice – something also lacking in current research on student engagement.

The study was carried out at two sites. The initial phase took place during the students' final year of primary school in a Western Sydney Catholic school. The school had been selected as an appropriate site for the study to begin because it was identified as one in which a large proportion of students gained high achievement levels in the Year 5 Basic Skills Numeracy Test in 2007. A 'high achieving' school was purposely chosen due to repeated studies showing moderate to strong correlations between academic achievement and academic self-concept (Barker, Dowson, & McInerney, 2005). It is reasoned students who experience positive academic self-concept in mathematics are more likely to be engaged, and therefore the school was an appropriate setting from which to explore students' engagement levels as they made the transition to secondary school.

During the second phase of data collection the students attended the second site, a Catholic secondary school, within the same area of Western Sydney. At the time of data collection the school was in its third year of operation and considered itself a 'groundbreaking' learning community in which an interdisciplinary approach to learning via an integrated curriculum is delivered. Each student at the school is required to purchase a laptop computer and teachers are known as 'learning advisors'. Co-teaching occurs in large, purpose-built learning spaces with each learning advisor taking a role in the facilitation of the group. The school population comes from a low to mid socio-economic range with students drawn from a wide range of both catholic and local government schools.

In order to identify prospective participants, the Year 6 cohort of 55 students completed the Motivation and Engagement Scale (High School) with all questions specific to mathematics (Martin, 2008). Twenty students, all of whose results showed strong levels of engagement towards mathematics and intended on attending the same high school, were invited and became participants. The participants represented a diverse range of mathematical abilities, cultural backgrounds, and most came from families with two working parents.

In the first phase of data collection participants took part in individual interviews before taking part in focus group discussions, which took place once during Year 6, and three times during Year 7. The following discussion points/questions were used as a starting point for each meeting: (a) Tell me about school; (b) Let's talk about maths; (c) Tell me about a fun maths lesson that you remember well; (d) When it was fun, what was the teacher doing?; and (e) What do people you know say about maths? Other data were collected through series of classroom observations of two teacher students had identified as 'good' mathematics teachers, and interviews with each of those teachers.

The data gathered were transcribed and analysed using NVivo software as a tool to assist coding into themes. In terms of the most significant changes and issues affecting the students through their transition to secondary school, two broad themes emerged: differences in pedagogy from primary to secondary; and changes in teacher-student relationships. Representative excerpts from the data will be used to illustrate the two themes in the following section.

Results and Discussion

Differences in Pedagogy

The changes in pedagogy experienced by the participants will be discussed in terms of mathematics content, teaching practices, workload, assessment practices, integration, and the use of Information and Computer Technologies (ICTs). Over the course of their first year at high school the students' attitudes towards mathematics and their teachers evolved as they began to settle in to their new school environment.

Consistent with existing literature, the students found most of the content in Year 7 very similar to that in Year 6 (Kirkpatrick, 1992).

> … basically it's just primary work but they're just making it like that step harder. Like, … , we did polygons the other day, we did polygons from primary but then they gave us harder ones. (Year 7 boy, Term 2)

Although the content itself did not present as a challenge, students did find the presentation of the content and the volume of work expected of them was demanding.

> I find it much more up front and demanding this year. And last year, they'd give you time until you understand it. That's what I like about last year. (Year 7 girl, Term 1)

From the beginning of Year 7 the students noticed a change in the pace of the mathematics lessons compared to the pace of primary school. This continued during Term 2, as the students felt pressure to complete work within a limited time frame, and although they claim they were familiar with the content, this appeared to have had a negative effect on their engagement in mathematics.

> … people are complaining about the teachers and when work is due and I think it's ridiculous how fast it's got to be done and stuff. (Year 7 girl, Term 2)

As the students progressed through the year, the students became less concerned over the workload, and more concerned over the amount of assessments they were required to complete. This finding is consistent with literature that states the assessment practices in secondary school are quite different to those in primary, are more competitive and norm-referenced, resulting in lower engagement (Martin, 2006).

> … there's so many assessments. (Year 7 girl, Term 2)

> The only kind of maths we do is assessments… I guess that's what makes maths a bit boring 'cause there's no excitement. (Year 7 girl, Term 4)

At the beginning of Year 7, the main methods of assessment were either traditional pen and paper tests or computer-based tests at the end of each topic. This changed as the year progressed, so that by Term 4 the students were exposed to a slightly wider variety of assessments in which they appeared to be much more engaged. One assessment that the students particularly enjoyed incorporated the use of technology to create a movie. The assessment required students to create a 'How to Do It' movie on geometrical constructions.

> It's pretty good… considering it's a maths assessment task. Usually they're not too fun, and nobody's looking forward to them, but I'm actually pretty excited. (Year 7 boy, Term 4)

When interviewed, the teacher identified by the students as the 'best' mathematics teacher at the school, spoke about this particular assessment.

> It's a move away from very traditional topic tests at the end, it's not logical. We've got to account for lots of different learning styles and different assessment strategies to enable the different types of learners to have a fair chance of showing us what they know. (Year 7 mathematics teacher)

The 'hands on' approach that engaged the students in the 'How to Do It' assessment task was one aspect of primary school teaching and learning they appeared to miss in their high school mathematics lessons. Although the students commented on how much they enjoyed being more independent, they still craved the use of concrete materials and 'hands-on' practical activities in their mathematics lessons. In direct contrast to their primary school experiences, during the first term the students were confronted with a purely computer-based experience as the basis of all their mathematics lessons. In addition to using a traditional textbook, the school provided a subscription to an on-line commercial mathematics site that included a comprehensive program of lessons, worksheets, interactive animations, step-by-step instructions, assessment activities and feedback. Although initially the students were engaged in the computer activities this was likely due to the novelty of having brand new laptops and a degree of freedom to work at their own pace. Unfortunately the dependence on the program for full, 100-minute mathematics lessons, and a lack of other pedagogies during that time saw the students quickly become disengaged with their mathematics learning.

> I think I liked it better when we could do hands-on stuff… with the (commercial site) it's kind of like you can sometimes get the same problem over and over again 'cause it's like the Internet… (Year 7 boy, Term 1)

A lack of interaction with teaching staff and an over-use or mis-use of computer technology initially had a negative impact on the students' engagement in mathematics during the first months of high school. However, things did improve for the students so that by the end of Term 2, lessons were no longer based purely on the computer mathematics program and the computers were being used in a more flexible manner. In addition, some lessons involved hands-on activities. It is not known whether the change in pedagogy was implemented as a result of student feedback.

> I'm enjoying maths… we can use computers in this program called Sketchup to make three dimensional shapes. It's fun. (Year 7 boy, Term 2)

> One of my favourite lessons was when we got all the straws and had to build a 3D shape… (Year 7 boy, Term 2)

The tasks that the students found engaging were those that were derived from the interdisciplinary Programs of Study. The integration of mathematics with other key learning areas was found to engage the students yet some felt they still needed mathematics lessons that were focussed only on the mathematics content.

The different pedagogies experienced by the students during transition to secondary school had some effect on their engagement in mathematics causing their attitudes to fluctuate throughout the year but surprisingly, pedagogy was not the most influential factor effecting the student's engagement. The relationships between teachers and students proved to be a stronger influence on engagement in mathematics.

Teacher-Student Relationships

The relationships students experienced in the mathematics classroom changed dramatically for the participants as they made the transition to secondary school. Coming from a school where they were expected to work cooperatively, the students were initially faced with working on an individual basis. The students' reactions are consistent with the findings of Boaler (2000), who noted that because of the often individualistic nature of mathematics lessons, some students come to view mathematics as 'other-worldly', having little relationship to their own lives.

> I learnt a lot more in maths when we were doing that cooperative learning. Yeah, but it's more individual here. (Year 7 boy, Term 1)

> It's better if you can communicate with people 'cause then you can explain stuff better to each other rather than by yourself. You can sort of get off task. (Year 7 boy, Term 1)

Over the course of the year the students continued most of their mathematics work on an individual basis but they seemed to become accustomed to this. However, they did express some concerns over the amount of interaction between themselves and their teachers. It should be noted at this point that in addition to coming to terms with having different teachers for different subjects, the participants were faced with a rotation of teachers during their mathematics lessons. This seemed to have a negative effect on the students as some of the teachers were not trained in mathematics and found it difficult to explain mathematical concepts to the students. The strong teacher-student relationships the participants had experienced in primary school were vastly different to what they were experiencing in secondary school.

> The thing is at times when we're trying to get help from the teachers they're not sure how to figure it out. (Year 7 boy, Term 1)

> Well, there's no student-teacher connection. He ends up… calling out the answers… he keeps going through so he's not teaching us anything. (Year 7 girl, Term 2)

Despite the experiences causing students to become disengaged in mathematics, the students discussed a teacher whom they considered to be the 'best' mathematics teacher in the school.

> When Mr. S. was teaching us I really understood fractions more than I did before with other teachers because he really can simplify it if you don't get it. (Year 7 girl, Term 4)

> He always walks you through step-by-step on how to do it and he gives you homework but he doesn't overload you with homework and he doesn't make you rush. (Year 7 boy, Term 4)

The particular teacher appeared to have formed positive relationships with the students and attributes discussed by almost all of the students were his ability to explain things well, his sense of humour and his ability to make mathematics lessons interesting.

Unfortunately, due to the structure of the school, the students did not have access to this particular teacher for every mathematics lesson.

During their final focus group meeting in Term 4, the students were asked if their attitudes towards mathematics had changed since leaving primary school. The students' responses were mixed with many of them claiming they still enjoyed mathematics and realised how important mathematics is to their futures at school and beyond.

Implications

Although the students reported changes in their mathematics teaching and learning experiences that resulted in fluctuations to their engagement, it is important to note that there were many positive aspects of their experiences that should be focussed upon. Many of the negative aspects such as the individual work and a lack of hands-on activities have already been documented in literature. It is the positive aspects that should be highlighted if any future improvements are to take place.

Initially the students were highly engaged when working on computers each day. This did not continue because of the limited way the computers were used. As they began to be used differently, students began to re-engage with mathematics. Further studies into the use of computer technology in the mathematics classroom would be beneficial.

The issue of having several mathematics teachers may be limited to this particular school and does not necessarily have to be a cause of disengagement if the teachers work on building relationships with the students. However, a positive pedagogical relationship includes a strong knowledge of how students learn and a strong content knowledge. If teachers are not trained in mathematics, this may not always occur. It can be argued the apparent lack of appropriately qualified mathematics teachers could be a result of students' disengagement in mathematics with fewer students choosing to continue its study, and it seems there is a cycle developing which warrants further investigation.

The data suggest the use of more hands-on activities and concrete materials is something that should continue during the middle years when students are still making the transition from a concrete-manipulative state to abstract thought. Although the structure of secondary school timetables makes the provision of such activities more difficult for teachers, it is probable that incorporation of such pedagogies would be of benefit during the middle years. Liaison with primary school teachers would assist with this.

Above all, the pedagogical relationship between students and teachers appears to have had a vast effect on this group of students' engagement in mathematics. Although some of the pedagogies these students experienced were not considered 'best practice', it appears they were able to overcome this where it was difficult for them to overcome the lack of positive interactions with some teachers.

It is proposed that regardless of the school context, students in the middle years have a need for positive teacher-student and student-student relationships as a foundation for engagement in mathematics. This relationship is built on an understanding of students and their learning needs. Unless such a relationship exists, other factors such as pedagogy and content knowledge may not sustain engagement in mathematics during the middle years.

Although this study is limited by the selective nature of the sample, it can be argued the impacts of transition, pedagogy and teacher-student relationships may have implications for different student groups. Repetition of the study in different contexts and further investigation of factors affecting engagement during the transition years would be of benefit in helping students maintain engagement in mathematics during the secondary years and beyond.

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