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Transition from Primary to Secondary School Mathematics: Students' Perceptions

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During a longitudinal case study on engagement in Australian middle school years mathematics, 20 students in their first year of secondary school in Western Sydney, New South Wales, were asked about their experiences of the transition to secondary school in relation to their experiences of mathematics teaching and learning. Changes and disruptions in teacher-student relationships were a major cause of concern. This was due to fewer opportunities for teacher-student interactions and a heavy usage of computer-based mathematics lessons during the first months of secondary school. Findings indicate that a strong pedagogical relationship is a critical foundation for sustained engagement in mathematics during the middle years.

Keywords: transition, primary school mathematics, secondary school mathematics, teaching and learning

Students experience significant change in the structure, delivery and expectations of school during the transition from primary to secondary education. In an Australian setting, transition to secondary school occurs at a time when students are experiencing physiological, psychological and social changes associated with adolescence (Downs, 2003). Literature suggests difficult transitions can result in lowered levels of engagement, negative attitudes towards school and learning, and reduced self-confidence and motivation, particularly in relation to mathematics education (McGee, Ward, Gibbons, & Harlow, 2003). Lowered engagement with mathematics can potentially result in limiting the range of higher education courses available to students and can limit the capacity of students to understand and interpret life experiences through a mathematical perspective (Sullivan, Mousley, & Zevenbergen, 2005).

During a qualitative longitudinal case study on engagement with mathematics during the middle years (Years 5 to 8 in New South Wales (NSW)), a group of 20 Year 6 students from one school were asked to asked about their perspectives of mathematics teaching and learning. Data was collected through individual interviews, focus group discussions and classroom observations. In the second phase of the study, during their first year of secondary schooling the students 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 relating to the differences in mathematics teaching and learning encountered by the students following their transition to secondary school.

Transition and Middle Years Mathematics

There are factors from within the mathematics classroom, the school, and outside the school that have the potential to influence students' engagement with mathematics. Although transition to secondary school can play a major role in influencing engagement, there are other factors specific to the teaching and learning of mathematics that play a critical role. Such factors are curriculum, pedagogy, assessment strategies, social interactions and students' interpersonal relationships. Together with issues relating to transition, the potentially negative impacts of these factors are cause for concern. It is beyond the scope of this paper to explore current literature concerning all of these issues, so the following is a brief account of current literature pertaining to key issues of transition and mathematics.

During the last two decades research has overwhelming documented an increasingly smaller percentage of students pursuing the study of mathematics beyond the compulsory years. Low academic performance and students' negative attitudes towards mathematics can seriously influence the choice not to pursue mathematics. This choice is also shaped by school mathematical experiences and the teaching practices students experience while at school (Nardi & Steward, 2003). Although arguably attitudes can change throughout the school years, once formed, negative attitudes are difficult to change and often persist into adulthood (Newstead, 1998). If positive engagement can be maintained during the middle years of education, students may be more inclined to continue the study of mathematics.

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

During their transition to secondary school students must deal with changes at social, organisational and academic levels. When preparing to transition from primary to secondary schooling, students often have preconceived ideas and high expectations of the challenges presented by secondary schools. Many students in their final year of primary education expect the work in secondary school to be harder than the work in primary school, 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 similar, and in some cases easier than their final primary year, yet they still experienced difficulty adjusting to the different academic environment. Although there may be a lack of academic challenge, the transition to secondary often results in some level of achievement loss, a phenomenon not limited to students in Australian schools (McGee et al., 2003).

Along with the academic issues outlined above, students are faced with substantial social changes as they transition to secondary school. Many must learn to cope in a significantly larger school environment where, relative to Australian primary schools, secondary schools are characterised by a greater emphasis on control, less personal student-teacher relationships and a greater likelihood of public evaluations of students (Hardy, Bukowski, & Sippola, 2002). Most secondary schools in Australia require students to move from classroom to classroom, often changing peer groups and teachers throughout the day.

While substantial literature maintains social interaction within the classroom is an important contributor to positive learning outcomes (see, for example, O'Toole & Plummer, 2004; Ricks, 2009), it appears mathematics classrooms are sometimes regarded as an exception to this. The often individualistic nature of mathematics lessons seems extremely unusual when compared to other subject areas, 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). 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" (Boaler, 2000, p.394).

Emotional wellbeing is crucial for adolescents to function well at school and within society. Along with peer relationships, relationships with teachers have a substantial influence on student learning of mathematics. One of the most obvious differences between primary and secondary schools in Australia is the amount of time students spend with their teachers forming pedagogical 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 wellbeing. For adolescents to function positively at school and within society, emotional wellbeing is crucial.

While 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 current research with a lack of longitudinal studies set within an Australian context. Another gap is a lack of using 'student voice' to explore students' perspectives on mathematics teaching and learning during this time of transition. The goal of this study is to address these current gaps in research and to explore students' perceptions of teaching and learning in mathematics, identifying pedagogies that help sustain engagement during the transition to secondary schooling, fostering continued study and enjoyment of mathematics.

Methodology

It was a commitment in this study to take a positive perspective rather than a deficit approach towards current classroom practices, focussing on identifying what was perceived by the participants to be working well or taught well in the mathematics classrooms involved. A second commitment was to give the participants a voice; something lacking in current research on student engagement.

The initial phase of the study took place during the students' final year of primary school in a western Sydney systemic Catholic school (although Catholic the school accepts students from all religions). The school had been selected as an appropriate site for the study because it had been 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 nation-wide numeracy test). 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 made sense, then, that students who experience positive academic self-concept in mathematics are more likely to be engaged, and therefore was an appropriate starting point from which to explore students' engagement levels as they made the transition to secondary school.

In the second phase of data collection the students attended the second site, a systemic 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 'ground-breaking' learning community in which an interdisciplinary approach to learning via an integrated curriculum was delivered. Students embarked on Programs of Study that ranged

from five to 10 weeks in length, making connections between and across two or more key learning areas. Each student at the school was required to purchase a laptop computer and teachers were referred to as 'learning advisors'. Co-teaching occurred in large, purpose-built learning spaces with each learning advisor taking a role in the facilitation of the group. The school population was derived from a low to mid socio-economic range with students drawn from a wide range of both catholic and local government schools.

For the purpose of identifying prospective participants, the Year 6 cohort of 55 students were administered the Motivation and Engagement Scale (High School), a 44 item Likert scale requiring students to rate themselves on a scale of 1 Strongly Disagree to 7 Strongly Agree (Martin, 2008). The instrument was adapted to be specific to mathematics. Twenty students, all of whom identified themselves through the Motivation and Engagement Scale as having strong levels of engagement with mathematics and also intending on transitioning to the same high school, were invited and became participants. The participants' academic ability was not a consideration. The participants came from a variety of cultural backgrounds including Filipino, South African, Chinese, Italian, Sudanese and Irish. Almost all of the students 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. The participants placed themselves into one of three groups: all female; all male; and mixed gender. The interviews and focus group discussions were based on the following set of discussion points or questions: (a) Tell me about school; (b) Let's talk about maths; (c) Tell me about a fun maths lesson that you remember well; (d) When it was fun, what was the teacher doing? and (e) What do people you know say about maths? Other data were collected through series of classroom observations and teacher interviews.

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

Pedagogical Differences

The different pedagogies experienced by the participants will be discussed in terms of mathematics content, teaching practices, student workload, assessment practices, integration, and the use of Information and Computer Technologies (ICTs). It will be seen that during their first year at secondary 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)

While the content did not present as a challenge, the students did find the teaching of the content and the volume of work (at school and at home) expected of them was.

> 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 start of Year 7 the students noticed a significant change in the pace of the mathematics lessons when compared to primary school. During their primary school experience, lessons were paced according to the students' needs and there was room in the timetable to re-visit topics that students were experiencing difficulty with. This fast pace continued during the second term (the school year is divided into four, 10 week terms), as the students felt pressure to complete work within a limited time frame. Although the participants claimed they were familiar with the mathematics content, the fast pace of lessons appeared to have a negative effect on their engagement with 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 boy, Term 2)

As the first year of secondary school progressed the participants became less concerned over the workload and more concerned over the number of assessment tasks 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)

During their years at primary school, the participants had experienced a range of formative and summative assessment strategies that included few traditional pen and paper tests. 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 evolved as the year progressed, so that by Term 4 the students were beginning to be exposed to a slightly wider variety of assessments in which they appeared to be much more engaged. One assessment task that the students particularly enjoyed incorporated the use of computers to create a movie. The assessment required students to produce a 'How to Do It' movie on geometrical constructions. The students were to film themselves, using their laptops, constructing a range of different angles. While completing their constructions they were to explain the procedures. Students were provided with a portion of time during mathematics classes to work on their assessments.

> 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 practical, 'hands-on' approach that students found engaging in the above assessment task was one aspect of primary school teaching and learning that appeared to be lacking from their secondary school mathematics classrooms. Although the students commented on how they enjoyed being more independent, it appears they still desired the use of concrete materials and 'hands-on' practical activities in their mathematics lessons.

In contrast to their primary school experiences where no text books were used and students regularly participated in interactive, cooperative learning tasks, during the first term of secondary school 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 (provided in CD-ROM format), 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 the

students were initially engaged with the computer activities it can be argued that this was likely due to the novelty of having brand new laptops and a degree of freedom to work at their own pace. During the first months of secondary schooling the dependence on the on-line program for full, 100-minute mathematics lessons and a lack of other pedagogies 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)

It seems a lack of interaction between teachers and students and amongst students, minimal explicit teaching, and an overuse or misuse of computer technology initially had an impact on the students' overall 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 on-line mathematics program and the computers were beginning to be used in a more flexible manner. In addition, some lessons involved hands-on activities.

> I'm enjoying maths… we can use computers in this program called Sketch-up 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 appear to be those that were derived from the interdisciplinary Programs of Study. The integration of mathematics with other subject areas was found to engage the students yet some felt they still needed mathematics lessons that were focussed on the mathematics content.

Overall, the different pedagogies experienced by the students during transition 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 with other students proved to be a stronger influence on engagement in mathematics.

Relationships

As they made the transition to secondary school the relationships the participants experienced within the mathematics classroom changed dramatically. Coming from a school where they were expected to work within cooperative groups, the students were initially faced with working on an individual basis. The students' reactions are consistent with the

findings of Boaler (2000), who found 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)

During their first year of secondary school the students continued to complete most of their mathematics work on an individual basis and they appeared to become accustomed to this. However, they did express some concerns over the lack of interaction between the students and their teachers. It should be noted at this point that along with coming to terms with having different teachers for different subjects, the participants were faced with a rotation of teachers during their mathematics lessons as well. That is, four teachers taught the Year 7 cohort on a rotation basis so students did not see the same teacher for two consecutive lessons. This seemed to have had a negative effect on the participants as none of the teachers were trained mathematics specialists and as such, did not have a strong pedagogical content knowledge and were unable to cater to the learning needs of all of 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, during focus group meetings 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 who came from a middle years training background and had previously taught in primary schools, appeared to have formed positive relationships with the students. Amongst the positive 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 participants 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

While the nature of the sample precludes the construction of generalisations, the findings do add to the body of knowledge regarding engagement of students with mathematics, It is important to note that there were many positive aspects of the participants' experiences that should be focussed upon even though the students reported dips in their engagement due to the differences in their mathematics teaching and learning experiences between primary and secondary schooling. 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.

In the very early part of their secondary experience the students were highly engaged when working on computers each day. These levels of engagement were not maintained due to the way the computers were used. Had they been used differently and in a more flexible manner, as was beginning to occur as the year progressed, the computers may have had the potential to enhance and sustain engagement with mathematics in combination with stronger teacher-student relationships. Further studies into the use of computer technology in the mathematics classrooms 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 does not always occur. The lack of qualified mathematics teachers could indirectly be a result of students' disengagement with mathematics and it seems there is a cycle occurring that needs to be addressed sooner rather than later.

The use of more a more interactive approach to teaching and learning with hands-on activities and concrete materials is something that must 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 a challenge for teachers, incorporation of such pedagogies would be of benefit during the middle years. Liaison and networking opportunities with primary school teachers and a sharing of teaching and learning ideas would assist with this.

Above all, the difficulties in establishing pedagogical relationships between students and teachers appear to have had a vast effect on this group of students' engagement levels. 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 teachers coupled with fewer opportunities for interaction with other students. 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 and unless such a relationship exists, other factors such as pedagogy and content knowledge will not sustain engagement with 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 will be of interest to different student groups. Repetition of the study in different contexts and further investigation of factors affecting engagement during the transition from primary to secondary school would be of benefit in maintaining student engagement with mathematics during the secondary years and beyond.

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