Perceived Competence in the Transition to Secondary School Mathematics

Sue Fullarton
Faculty of Education
Monash University

Transition to secondary school mathematics often poses problems for particular students. This paper reports on the initial stage of a larger longitudinal study that examines students' beliefs about strategies for success in mathematics and whether they are personally capable of succeeding. The aim is to identify students in grade 6 who are at risk of failure in secondary school mathematics. Students will be followed from grade 6 into year 7 to see what effect transition has on their belief systems.

Introduction

Many secondary schools have set up transition networks and specific transition programs for students entering from primary school. The change from primary to secondary systems is frequently seen by teachers, students and parents as problematic, as the primary system is perceived to be close and nurturing while the secondary system requires a great deal more independence of the student and is more often characterised as impersonal and subject oriented. Clarke (1989) argued "if transition creates problems in a student's mathematics education it seems equally true that mathematics contributes significantly to the difficulties of the student in transition" (p. 1).

Students may transfer to secondary school with many others from their own school, in small groups, or alone. Each situation poses a different transition problem. Cockcroft (1982), in a report on mathematics education in Great Britain, suggested that "the greatest problems exist in the transfer to secondary or upper school" (p.125). In the popular press too, the problems of transition have also been highlighted. For example;

> Peter, now 14, enjoyed primary school because he knew the teacher and felt he belonged. At high school, he found the classwork hard and the environment bewildering. The only way to get a teacher's attention, it seemed, was to act up.
>
> The Sunday Age, 5.2.95, p. 4

Some children certainly make the transition to secondary school successfully and happily. Ellerton & Clements (1988) found that many of the students they surveyed coped well with secondary school, some seeing it as an opportunity to "start again".

This research has been prompted by the following concerns: Do transition programs target the problems that can cause students to disengage from the learning process in mathematics? Are there indicators in late primary school that may point to students at risk of failure in the early years of mathematics at secondary school?

This study will focus on the development of motivational behaviours across the transition from primary to secondary school, considering whether aspects such as students' beliefs about their own ability level and perceived competence in mathematics effect the individual's engagement and performance. Data will be collected while students are in grade six and year seven. Entire cohorts have been surveyed at grade six level, and as many students as possible will be followed into year seven and surveyed again.

Description of constructs used in this study

Conceptual Framework

The research questions are to be explored using a model based on that developed by Connell and Wellborn (1991), who presented a global representation of how attitudes have an indirect effect on achievement in the classroom through the construct of engagement. This model suggests that student engagement is optimised when the social

context fulfils student's basic psychological requirements. These include relatedness, which refers to a need to have some involvement on a personal level with other people, a need to feel competence in the context in question, and a need to feel autonomous (Connell & Wellborn, 1991). This paper will report on the issue of perceived competence and autonomy at the grade six level.

Perceived Competence

White (1959) presented evidence that an innate characteristic of humans is an intrinsic 'need' to feel competent, and that behaviours such as exploration and mastery attempts are best explained by this innate motivational force. Students' needs for competence are satisfied if they feel they can achieve their desired ends and if they have the required amount of structure in their environment. Structure refers to the amount of information available within the classroom about how to effectively achieve desired outcomes. Skinner and Belmont (1993) explained that teachers provide structure by "clearly communicating their expectations, by responding consistently, predictably, and contingently, by offering instrumental support and help, and by adjusting teaching strategies to the level of the child" (p. 572).

The scale that assessed students' perceptions of competence in this study measured the degree to which students feel they are in control of their learning, the extent to which they believe that outcomes in mathematics are due to effort, ability, powerful others, luck, or unknown causes (*strategies*), and the extent to which they feel they are able to enact these causes (*capacities*). Examples of items are: *"Trying hard is the best way for me to do well in maths"* (effort strategy), and *"I can work really hard in maths"* (effort capacity).

Engagement

Cambourne (1994) claimed that while learners are exposed to thousands of demonstrations of techniques, methods and other learning practices during their lives, many of these are ignored by students, and therefore learning does not occur. He argued that teaching can only result in learning if the student is engaged with the learning process. Skinner, Wellborn & Connell (1990) carried out a study on 220 students in grades three to six, measuring, among other things, engagement, grades and achievement test scores. They found that students who are more engaged earn higher grades, score better on standardised tests of achievement, and show better personal adjustment to school.

Skinner & Belmont (1993) contended that children who are engaged are positive emotionally and show sustained behavioural involvement. "They select tasks at the border of their competencies, initiate action when given the opportunity, and exert intense effort and concentration in the implementation of learning tasks; they show ... enthusiasm, optimism, curiosity and interest" (p. 572). Disaffected students, however, can be bored, anxious, depressed or even angry about their presence in the classroom, they can withdraw from learning opportunities or be rebellious towards teachers and their peers.

The engagement questionnaire assessed teachers' perceptions of students' cognitive engagement (ie. flexible vs rigid problem solving, independent vs dependent work styles), behavioural engagement (i.e. class participation vs uninvolvement, on task vs off task behaviour) and emotional engagement (i.e. nervousness, happiness, excitement). Cronbach alpha for this scale was found to be .93.

Skinner, Wellborn & Connell (1990) found that particular combinations of competence-related beliefs were particularly relevant for undermining or promoting engagement in school. They found that engagement was undermined by beliefs in nonaction strategies (ability, powerful others and luck) and particularly by not knowing what strategies are effective. Highest levels of engagement were found for students who held high strategy and capacity beliefs for effort, while the lowest levels of engagement were found among those students who reported high strategy and low capacity for ability, powerful others and luck.

Autonomy

Autonomy is described by Deci & Ryan (1991) as "referring to a sense of endorsement and initiation with regard to one's behaviour" (p. 272), while Patrick, Skinner & Connell (1993) described autonomy as "the extent to which a person feels free to show the behaviours of his choice" (p. 782). Deci & Ryan (1991) further claim that "contexts in which others are both autonomy supportive and involved allow satisfaction of the individual's basic needs and are thus optimal for development" (p. 273). Research has indicated that when the classroom climate is experienced as autonomy supportive rather than controlling, it has been associated with greater intrinsic motivation, trust, self-worth and satisfaction (Deci, Schwartz, Sheinman & Ryan, 1981).

A manifestation of autonomy can be found in the reasons that students engage in various activities, such as mathematics. The least autonomous reasons are *external* reasons, such as expectations of punishment or reward, followed by *introjected*, which are more internal but still pressured. Next along the continuum lies *identified* reasons, which are freely chosen but not quite intrinsic, and lastly *intrinsic* reasons, which focus on learning for it's own sake rather than for particular outcomes. In this study, autonomy was measured by nine items that tapped into the reasons for students participating in mathematics (ie *Why do I work in maths classes?*). These reasons could include: external (*because I'll get into trouble if I don't*, $\alpha = .69$), introjected (*because I'll feel bad about myself if I don't*, $\alpha = .60$), identified (*because I want to learn new things*, $\alpha = .71$) and intrinsic (*because it's fun*, $\alpha = .82$).

Method

November December 1995- Grade 6 students

In November and December 1995 ten schools were visited, and the entire cohort of grade 6 students present on the day were asked to complete the questionnaire. Only about 30 students overall refused to participate, and so data from a total sample of 510 students, 231 females and 279 males, were collected. The researcher administered each of the instruments, and the questionnaire was read to the students to obviate any particular reading problems. In general, the teachers completed the engagement questionnaires on each student, while the students were finishing these tasks.

Students' Questionnaire

This instrument consisted of eleven questions about students' general attitudes towards maths, 116 questions about perceived involvement, autonomy support, structure, relatedness, competence, engagement, coping and classroom environment, six questions about perceived ability and perceptions about others' beliefs, and six open ended questions. Unless otherwise stated, students rated their responses to statements on a four point Likert-type scale ranging from *not at all true* to *very true*. All of the items discussed in this paper were adapted from the Rochester Assessment Package for Schools (RAPS, Wellborn & Connell, 1987).

Teachers' Questionnaire

Teachers were asked to complete a 30 item engagement questionnaire for each student present on the day of testing. Teachers rated the behaviours listed on the questionnaire on a Likert- type scale ranging from *almost never* to *very often*. Scoring of the engagement questionnaire produced a combined score for engagement that could range from -4 to +4, with positive values indicating engagement and negative values reflecting disaffection.

Some preliminary findings

Of major interest in this study are students whose belief structures are optimal for engagement, and those whose belief structures are those most likely to undermine engagement. To this end, three approximately equal groups were formed using the teacher rating of student engagement. The lowest third thus relates to low teacher rated engagement, the middle third to average rated engagement, and the upper third to high levels of rated engagement. Table 1 shows the number of male and female students from each of the schools in each group. The percentage shown in brackets in the "Totals" row is the percentage of that gender in the particular category. Twenty engagement questionnaires were not completed by teachers, which causes the slight discrepancy in the data. From these data it can be seen that more males (36%) than females (28%) are rated by their teachers as having low engagement, while more females (36%) than males (29%) are seen as being highly engaged.

Table 1
Number of male and female students from each level of engagement group in each of the primary schools

School (n= Females, Males)	Low engagement (n=166)		Average engagement (n=160)		High engagement (n=164)	
	F	M	F	M	F	M
1 (n=32,33)	6	11	12	10	10	10
2 (n=8,13)	2	5	2	6	4	2
3 (n=48,38)	13	11	14	15	18	11
4 (n=7,13)	2	7	2	3	3	3
5 (n=17,14)	2	5	7	3	8	6
6 (n=16,41)	7	17	5	12	2	10
7 (n=10,27)	1	7	4	13	5	7
8 (n=24,27)	11	8	3	6	10	13
9 (n=46,52)	17	25	15	15	12	12
10 (n=23,21)	4	5	5	8	10	8
Totals (F=231, M=279)	65 (28%)	101 (36%)	69 (30%)	91 (33%)	82 (36%)	82 (29%)

Perceived Competence

Table 2 shows the means and standard deviations for all perceived competence constructs for each of the three groups defined by teacher rated student engagement, F values and significance levels obtained from one way analysis of variance. It can be seen from this table that perceived control and all capacity beliefs are highest for those students in the high engagement group, lowest for those students in the low engagement group. Strategy beliefs in general follow the opposite pattern, with particular strategies becoming less important as engagement increases. Strategy effort beliefs show a slightly different pattern. The trend is increasing from low engagement to high engagement, except for a slight downturn in the average engagement group. Thus for lower engaged students, effort is not as important a strategy as it is for highly engaged students, but both feel it more important than the average engagement group.

Table 2

Means and standard deviations for perceived competence variables for the three engagement groups

	Low engagement		Average engagement		High engagement		F	p
	Mean	SD	Mean	SD	Mean	SD		
Control Strategy	3.07	.78	3.44	.63	3.71	.50	40.31	***
Ability	2.38	.85	2.12	.79	1.91	.71	14.98	***
Effort	3.34	.59	3.26	.63	3.47	.51	5.33	**
Luck	2.60	.81	2.30	.66	2.02	.67	27.01	***
Unknown	2.21	.82	1.88	.76	1.52	.56	38.43	***
Powerful others	1.81	.91	1.57	.70	1.47	.67	8.56	***
Capacity								
Ability	2.55	.86	3.00	.76	3.42	.63	55.30	***
Effort	3.32	.66	3.56	.53	3.72	.50	20.36	***
Luck	2.64	.70	2.90	.58	3.10	.60	21.95	***
Powerful others	2.89	.80	2.92	.74	2.97	.73	.42	
Teacher rating of student ability	2.42	.74	3.10	.65	3.51	.41	218.33	***
Student rating of their own ability	3.14	.79	3.57	.75	4.05	.70	61.72	***
Student rating of their own engagement	3.14	.51	3.32	.43	4.04	.74	26.98	***

** $p < .01$ *** $p < .001$ $df = 2, 487$

The data were analysed for differences using one way analysis of variance followed by the Tukey HSD test to discover where any differences lay. All but three variables, strategy effort, strategy powerful others and capacity powerful others, showed highly significant differences between all three groups of students. Strategy powerful others only showed differences between the lowest engagement group and the other two groups, with no differences between the average and high engagement groups. There were significant differences in the importance placed on effort as a strategy only between the average and high engagement groups, and capacity powerful others showed no differences between any of the groups, indicating that all groups of students felt that the teacher would provide assistance when required.

Effort was perceived to be the most important strategy for success, followed by luck. This latter strategy reflects the endorsement by students of statements such as "I have to be lucky (by getting asked the right questions) to do well in maths". Problems occur with strategy and capacity beliefs when strategy beliefs are high and the corresponding capacity beliefs are low; for example when students believe that it takes luck to do well in maths but that they're not lucky.

The findings from this study confirm those of Skinner et al. (1990). Engagement was undermined by beliefs in nonaction strategies (ability, powerful others and luck) and by not knowing what strategies are effective. Engagement was promoted by students' high strategy and capacity beliefs for effort, while the lowest levels of engagement were found among those students who reported high strategy and low capacity for ability,

powerful others and luck. Teachers' ratings of student ability indicate that the highly engaged students are those most likely to be rated as the most able.

Although the low engaged students believe that luck and ability are important strategies, it is apparent from Table 2 that their capacity beliefs are lowest for these particular causes, "Ability is important in maths and I'm not very smart". For the highly engaged group, ability is rated as a fairly unimportant strategy, however the students feel that they are smart at maths "Ability isn't important, but I am smart". Some students aren't sure what it takes to achieve success and avoid failure in maths. These students endorse those statements "I don't know what it takes to do well in maths". It is much more common for students in the low engagement group to endorse these statements than it is for those students in the high engagement group.

Autonomy

Table 3 shows the means and standard deviations for the autonomy constructs for each of the three engagement groups, F values and significance levels from one way analysis of variance (ANOVA). Most students work for identified reasons; "Because I think it's important", while Tukey's HSD test found that external motivation for engagement in learning was found to be significantly higher among students in the low engagement group.

Table 3
Means and Standard Deviations for Autonomy Constructs

	Low engagement		Average engagement		High engagement		F	p
Self-regulation	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**		
External	2.41	.94	2.13	.90	1.97	.89	9.87	***
Introjected	2.06	.89	2.13	.90	2.08	.94	.32	
Identified	3.45	.69	3.60	.58	3.75	.45	11.07	***
Intrinsic	2.65	.81	2.83	.76	3.11	.77	14.60	***

*** $p < .001$ $df = 2, 487$

Identified and intrinsic reasons for working increased significantly from low to high engagement levels. Tukey's HSD test found significant differences between the low engagement group and the average and high engagement groups for identified reasons, with no significant differences between the average and high groups, and between the high engagement group and the average and low engagement groups for intrinsic reasons, with no significant differences between the average and low groups. Introjected reasons for working were the lowest for all groups, and showed no significant differences between groups.

Discussion

The long-term aim of this study is to identify functional and dysfunctional patterns of beliefs about learning mathematics. It is clear from the results discussed that the instruments described serve this aim well. Students were able to be categorised using the engagement questionnaire into low, average and high engagement groups. Subsequent analysis based on these groups found that students who hold beliefs deemed to promote engagement feel more in control, understand more about strategies for learning, feel more capable of succeeding and are more intrinsically motivated. Students at the other end of the spectrum, in the low engagement group, have the lowest levels of control beliefs, believe that luck and ability are important strategies for succeeding in mathematics but they aren't particularly lucky or smart, and have higher levels of external motivation.

The next phase of this study follows many of the students in the transition to secondary school. Students will be surveyed in terms two and four of year seven, and analysis of data pertaining to the particular engagement groups described in this paper will

be carried out to investigate patterns of change over transition. There are also different patterns of transition; students moving on with a large group of peers, with a few peers only, and on their own. Some investigation towards effect of type of transition is also being planned.

The students involved in the study have already foreshadowed some of the problems they anticipate with secondary school mathematics. For example, when asked whether maths classes would be different in secondary school, some answers were: *"Definitely. [We do] algebra, the really, really, really, really, really hard maths"*, *"Much harder maths. I think I will fale* (sic)*"*, *"Yes they will be harder. The teachers will not help me"*. It remains to be seen what effect these perceptions will have on students' engagement and on subsequent learning in mathematics.

References

Cambourne, B. (1994). Breaking the lore: An alternative view of learning. In J. Turbill, A. Butler, B. Cambourne & G. Langton (Eds.), *Theory of others: Frameworks* (pp. 17-29). University of Wollongong: Illawarra Technology Corporation.

Clarke, D. J. (1989). *Mathematical behaviour and the transition from primary to secondary school.* Unpublished PhD Thesis, Faculty of Education, Monash University.

Cockcroft, W. H. (1982). *Mathematics counts.* London: HMSO.

Connell, J. P., & Wellborn, J. G. (1991). Competence, autonomy and relatedness: A motivational analysis of self- system processes. In M. R. Gunnar & L. A. Sroufe (Eds.), *Minnesota symposium on child psychology* (Vol. 23, pp 43 - 77). Chicago: University of Chicago Press.

Deci, E. L., & Ryan, R. M. (1991). A motivational approach to self: Integration in Personality. In R. Dienstbier (Ed.), *Nebraska Symposium on Motivation, 1990* (pp. 237 - 288). Lincoln: University of Nebraska Press.

Deci, E. L., Schwartz, A. J., Sheinman, L., & Ryan, R. M. (1981). An instrument to assess adults' orientations toward control versus autonomy with children: Reflections on intrinsic motivation and perceived competence. *Journal of Educational Psychology, 73,* 642 - 650.

Ellerton, N. F., & Clements, M. A. (1988). The transition from year 6 to year 7: A problem or an opportunity? In D. Firth (Ed.), *Maths Counts: who cares?* (pp. 134 - 140). Parkville, Victoria: Mathematical Association of Victoria.

Patrick, B. C., Skinner, E. A., & Connell, J. P. (1993). What motivates children's behaviour and emotion? Joint effects of perceived control and autonomy in the academic domain. *Journal of Personality and Social Psychology, 65*(4), 781 - 791.

Skinner, E. A., & Belmont, M. J. (1993). Motivation in the classroom: Reciprocal effects of teacher behaviour and student engagement across the school year. *Journal of Educational Psychology, 85* (4), 571-581.

Skinner, E. A., Wellborn, J. G., & Connell, J. P. (1990). What it takes to do well in school and whether I've got it: The role of perceived control in children's engagement and school achievement. *Journal of Educational Psychology, 82,* 22 - 32.

Wellborn, J. G., & Connell, J. P. (1987). *Manual for the Rochester Assessment Package for Schools.* Rochester, NY: University of Rochester.

White, R. W. (1959). Motivation reconsidered: The concept of competence. *Psychological Review, 66,* 297 - 333.