Motivation in Mathematics: Perceived Control, Engagement and Achievement in the Mathematics Classroom

Sue Fullarton
Monash University

This study examined the effects of perceived control on engagement and achievement in mathematics. Year ten students were asked to indicate their level of agreement with statements about strategies for achieving success and avoiding failure in mathematics and to what extent they felt they personally had the capacity to employ of these strategies. Students were also surveyed about the level of control they had over success and failure, and the level of cognitive and emotional engagement that they felt in mathematics. Their teachers were asked separately for their perceptions of each studentís level of cognitive and emotional engagement. Engagement, confidence and achievement were found to be promoted by high control beliefs, and by high strategy and capacity beliefs in ability. In contrast, engagement was found to be undermined by low capacity beliefs about ability, powerful others and luck.

Introduction

The focus of this study was an investigation of the motivational processes that affect success with cognitive tasks in mathematics and in particular the psychological factors that determine how effectively a student acquires and uses mathematical skills. It appears that, given the same achievement outcomes, some students are confident of future success while others view their successes as a matter of luck and are fearful of future failures. In mathematics, students need to be actively engaged with the task and persist in the face of failure in order to achieve high level success.

Some characteristics of mathematics, compared to language areas, may act against those students with low confidence or other motivational problems. Dweck (1986) explained that secondary school mathematics tends to involve new skills or even entirely new conceptual frameworks (for example algebra and calculus) and that these new skills are often not only different but more difficult than has been dealt with in the past. In language areas, once the basic skills of reading and writing have been mastered, there are typically no ìleaps to qualitatively different tasksî (p. 1044). Increments in difficulty often appear instead to be more gradual, and students are more often asked to apply existing skills to new material. It is therefore essential for the student to be motivated to persist, and it is as essential that teachers have a clear understanding of the affective aspects of childrenís learning.

Vito & Connell (1988, cited in Skinner, 1991) found that, relative to a random control group, children labelled as academically ìat riskî reported knowing less about the causes for school successes and failures, endorsed ability, powerful others and luck as playing a major role in school performance and viewed themselves as not possessing the capacity to enact these causes. This is precisely the combination of beliefs that Skinner, Wellborn & Connell (1990) claim is most likely to undermine engagement and actual performance in school.

However, it is not only the low achieving or ìat riskî students who may exhibit motivational patterns that lead to learning problems. Studies carried out by Licht & Dweck (1984) found a negative correlation between girlsí actual ability and these motivational patterns. For girls, especially bright girls, the knowledge that one is a high achiever and has done well in the past does not appear to always translate into high confidence when faced with challenges or difficulties. Fullarton (1993) found that boys were consistently more confident of their abilities than girls, even when the girls outperformed the boys academically.

Meta-analysis of the attribution literature (Hyde, Fennema, Ryan, Frost & Hopp, 1990) concluded that males were more likely to attribute success to ability and females more likely to attribute failure to (lack of) ability. Further, studies on learned helplessness in students provide evidence that boys stress the role of lack of effort for their failures to a greater extent than girls (Dweck & Repucci, 1973). Therefore, even if girls believe themselves to be hard workers they might be less likely than boys to believe that success in mathematics is actually achievable through hard work.

The theoretical context on which this present study is based emphasises not only the importance of investigating studentsí beliefs about ìwhat it takes for me to do well in mathematicsî or strategy beliefs, but also their beliefs about ìwhether Iíve got what it takesî, capacity beliefs.

Skinner (1991) described how the beliefs that students hold about the level of control they have over outcomes influences the development of the student. ìWhen individuals believe they can influence desired outcomes, they engage in sustained, focused efforts; they cope more actively with challenges; and they are more likely to re-engage following setbacks or failures. Active engagement ... is posited by many theories to lead to the development of competence and understandingî (p. 175).

Motivation

Motivation has been found to play an important role in the cognitive development of students. For example, Skinner & Belmont (1993) claimed that ìhighly motivated students are enthusiastic, interested, involved and curious. These students try hard and persist, and they actively cope with challenges and setbacks. These are the students who are most likely to stay in school longer, learn more, feel better about themselves and continue their education past secondary schoolî (p. 571). If learning consequently is an active process that requires a conscious and deliberate effort on the part of the learner, the learner must be motivated to engage in the educational tasks that are set.

Perceived Control

Perceived control describes studentsí perceptions of the causes of success or failure, the amount of control they have over success and failure, and the personal resources they believe they can access in attaining success. A body of research has investigated perceived control and found that it acts to predict aspects of motivational, cognitive and emotional functioning (Bandura, 1977; Findley & Cooper, 1983; Seligman, 1975; Weiner, 1979, 1985).

Students who believe that they can exert control over their learning in mathematics are more likely to engage successfully with a task, to redirect their efforts when they meet with hindrances and to learn more effectively. These students will achieve more cognitive success and in turn this reinforces their beliefs about school performance being controllable by themselves. In contrast, students who perceive themselves as having little control over academic outcomes will exhibit disaffected patterns of behaviour and will generate performances that serve to confirm their beliefs (Seligman, 1975; Skinner, 1991; Skinner et al., 1990).

Model of Motivation

A motivational model developed by Connell and Wellborn (1991) presents a global representation of how attitudes may have an indirect effect on achievement in the classroom through the construct of engagement. This model is shown in figure 1.

The model describes a set of basic psychological needs for students;

needs for relatedness, competence and autonomy. Each of these in turn is influenced by aspects of the school environment; involvement, structure and autonomy support respectively.

Each of these will be described in greater detail presently. Connell & Wellborn (1991) suggest that student engagement is optimised when the social context fulfils studentís basic psychological needs, and that high engagement in turn optimises academic and behavioural performance.

CONTEXT SELF ACTIONS OUTCOMES

Involvement Relatedness Academic
Performance

Engagement
Structure Competence vs
Disaffection Behavioural
Performance

Autonomy Autonomy
Support

Figure 1. A motivational model of the effects of childrenís psychological needs on their engagement (Connell & Wellborn, 1991, p. 51).

Relatedness

Relatedness refers to the needs of the student to feel a secure involvement with teacher and peers and to experience a sense of worth. The latter aspect of relatedness can be thought of as a need for high self-esteem. Connell & Wellborn (1991) tested emotional security with parents, teachers and peers for an elementary school sample and found significant correlations with teacher reports of engagement but no significant correlations with academic performance. Subsequent results from path analysis, however, show that emotional security with parents predicted emotional security with teachers and peers. This security then uniquely predicted engaged patterns of action that, in turn, predicted school performance. Relatedness is supported or undermined in the school setting by involvement. Involvement refers to the communication of interest in the person through the allocation of physical and psychological resources, so that students feel that they are respected and considered worthy by their teachers and peers. Lack of involvement can lead to feelings of isolation and neglect in students.

Competence

The seminal paper published by White (1959) presented evidence that an innate characteristic of humans is an intrinsic ëneedí to feel competent, and that behaviours such as exploration and mastery attempts are best explained by this innate motivational force. Studentsí needs for competence are satisfied if they feel they can achieve positive and avoid negative outcomes. Figure 1 indicates that competence is affected by structure. 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 ìclearly 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 childî (p. 572). Lack of structure can be viewed as inconsistency or overly difficult work requirements. Skinner et al. (1990) found that combinations of competence-related beliefs were particularly relevant for undermining or promoting engagement in school.

Autonomy

Autonomy refers to self-regulation processes, involving the ìinitiation, inhibition, maintenance and redirection of activityî (Connell, 1990, p. 64). Patrick, Skinner & Connell (1993) described autonomy as

> the connection between volition and action; ... the extent to which a person feels free to show the behaviours of his choice. Non-autonomous behaviours include both compliance and defiance, which

have in common that they are reactions to othersí agendas and not freely chosen. (p. 782)

Although it sounds contradictory, studentsí need for autonomy in learning is promoted when they experience autonomy support, that is ìthe amount of freedom a child is given to determine his or her own behaviourî (Skinner & Belmont, 1993, p. 573). Students need to feel that they have choices in what they do, and that they are supported in making decisions connected to their own personal goals or values. Lack of autonomy support could be interpreted by the student as being controlled or pressured.

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).

Engagement

Cambourne (1994) claimed that while learners are exposed to thousands of demonstrations during their lives, many of these demonstrations are ignored by students, and therefore learning cannot occur. He proposed that demonstrations can only result in learning if the student engages with them.

Skinner et al. (1990) found that students who are highly 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 highly engaged are positive emotionally and show sustained behavioural involvement. ìThey 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 interestî (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.

Summary

There is evidence from the literature that students have three fundamental psychological needs; for competence, autonomy and relatedness. Fulfilment or non-fulfilment of these needs in the classroom can be translated into patterns of engaged or disaffected behaviour and thus to cognitive achievement or behavioural outcomes. The present study sought to examine the relationships between engagement, achievement and perceived control in a Year 10 mathematics classroom. In particular, the following research questions were among those addressed:

what do these students see as the most important strategies for success in mathematics?

which of the capacity beliefs do students feel are the easiest to access?

is there a relationship between confidence and control beliefs, and if so what?

are there different patterns of beliefs exhibited by high, medium and low achieving students?

The Study

Instruments

Three instruments were used. The first was designed primarily to provide an overview of each studentís confidence for the forthcoming test. It asked the student to indicate the approximate mark they believed they would get on the test, how good they believed themselves to be at mathematics, how hard mathematics was for them and a judgement about how they would fare on the test compared to their classmates.

The second instrument was given to teachers to assess each studentís emotional and cognitive engagement or disaffection, and was derived from the Rochester Assessment Package for Schools (RAPS) - Teacher instrument. This instrument asked teachers to act as expert raters to assess the cognitive and emotional engagement for each child in their class. This was carried out by asking teachers to report about the extent to which each particular student actively participated in class and the studentís emotional involvement while in class.

The third instrument was based on the RAPS - Student questionnaire, modified to reflect the language used by Australian students and to specifically refer to mathematics. It measured perceived control by asking students to respond to questions pertaining to three constructs using four point rating scales (from not at all true to very true).

Strategy beliefs were measured by asking students to endorse five potential causes for success and failure in mathematics : (a) effort (e.g. ìtrying hard is the best way for me to do well in mathematicsî), (b) ability (e.g. ìwhen I do badly on a mathematics test itís because Iím no good at mathematicsî), (c) powerful others (e.g. ìwhen I get good marks for a mathematics test itís because I get on well with the teacherî), (d) luck (e.g. ìI have to be lucky to do well in mathematicsî), and (e) unknown factors (e.g. ìI donít know how to do well in mathematicsî).

Capacity beliefs were measured by asking students to what extent they believed they could employ each the four ìknownî strategies: (a) effort (e.g. ìI try as hard as I can in mathematicsî), ability (e.g. ìI am smart at mathematicsî), powerful others (e.g. ìI can get my teachers to like meî), and (d) luck (e.g. ìIím usually lucky in mathematicsî).

Control beliefs were assessed using items in which students indicated the extent to which they are able to produce positive and prevent negative outcomes in mathematics (e.g. ìI can get good marks in mathematics if I want toî; ìI canít help making mistakes in mathsî).

The confidence subscale devised by Fennema & Sherman (1976) was also included in this instrument, and students were asked to indicate the mark they had obtained for the achievement test.

Participants

The participants in this study were a complete year cohort of 141 students enrolled in Year 10 at a large Government Secondary College in the outer eastern suburbs of Melbourne. The school caters for students from diverse backgrounds and socio-economic levels.

The students presented an interesting cross section of cognitive ability. Of the 141 students, 15 were enrolled in a terminal ëbusiness mathematicsí class. These are students who are, in general, unable or unwilling to cope with a mainstream mathematics class. There was also a group of 37 students who were participants in the schoolís acceleration program. These students had been taught mathematics separately from their age cohort through years 7, 8 and 9. At Year 10 level all students were re-integrated, with the accelerated students completing the yearís work at the end of Semester 1 followed by enrichment topics leading into the Victorian Certificate of Education (VCE). Analysis of data was carried out on the entire cohort and then separately on the three groups: business, mainstream and accelerated students.

Procedure

All instruments were administered in regular class time while the students were in Year 10. Instrument 1 was administered immediately prior to a scheduled class test, and Instrument 3 to the same students after they had received their tests back and looked at the marks, but before there had been any class discussion about the test.

Results

Descriptive Statistics

The means and standard deviations for all the dimensions of perceived control, engagement, confidence, and marks on the classroom test are presented in Table 1. The scores for perceived control and confidence ranged from 1 (not at all true) to 4 (very true); the scores for teacher and student related engagement ranged from -3 (disaffected) to +3 (engaged); and achievement test scores from 0 to 100.

Pairwise comparisons using t-tests for dependent samples showed that effort and powerful others were perceived by these students as the most important strategies for success in mathematics. An example of this would be students endorsing statements of the type ìI have to work hard to do well in mathematicsî or ìI need the teacher to help me if I want to do well in mathematicsî. Ability was seen as the next most important strategy (powerful others v ability, $t = 2.0$, $p < .05$), followed by luck (ability v luck, $t = 4.0$, $p < .001$) and unknown (luck v unknown, $t = 5.3$, $p < .001$) of less importance.

For capacity beliefs, students believed that effort and powerful others were the easiest causes to enact. This means that the students generally endorsed items such as ì I work really hard on all my mathematics workî or ìMy teachers try hard to make sure that I really understand what they are explainingî. Ability (powerful others v ability, $t = 2.9$, $p< .05$) and luck (ability v luck, $t = 11.0$, $p < .001$)

were considered to be less accessible to them.

Table 1
Means and Standard Deviations of Perceived Control, Engagement, Achievement and Confidence for the Entire Cohort (N=142)
VariableMeanSDPerceived controlControl beliefs3.150.62Strategy beliefs Effort2.900.42 Ability2.760.71 Powerful others2.860.43 Luck2.520.26 Unknown2.310.35Capacity beliefs Effort2.740.70 Ability2.460.86 Powerful others2.710.60 Luck1.650.60Student rated Engagement0.280.86Teacher rated Engagement0.561.35Pre-test Confidence3.040.88Post-test Confidence2.810.78Mark on test (%)49.3929.19

Studentís control beliefs were high, 3.15 on a scale of one to four. This indicates a response of ìMostly trueî to items such as ìI can do well in mathematics if I want toî. Teacher rated engagement was low; 0.56 on a continuous scale of -3 to +3, but it was higher than the average student rating of engagement of 0.28. Average confidence was 2.8, indicating a response of ìSometimes trueî or ìMostly trueî to items such as ìI have a lot of self-confidence when it comes to mathematicsî. The average mark scored on the test was 49%, but the scores ranged from 0 to 100%.
Subsequent analysis using t-tests for independent samples found no significant gender differences on any of the variables tested.

Correlations
Table 2 shows the correlations among strategy and capacity beliefs for this sample. It can be seen that the intercorrelation between capacity and strategy beliefs for each cause is significant, indicating that those who believe in the efficacy of a strategy also generally believe in their ability to enact that strategy.

Table 2
Intercorrelations of the Aspects of Perceived Control
StrategyCapacityBeliefsBeliefsEffortAbility OthersLuckEffort 0.49**-0.04 0.06-0.04Ability 0.27* 0.84**0.080.20*Powerful

Others-0.24*-0.29**0.49**-0.24*Luck0.060.24*0.050.33**Unknown- 0.26*-0.31**-0.08-0.19** p < 0.05 ** p < 0.001

Students who believe that they have the capacity for effort ìI work really hard on all my mathematics workî believe in ability as a strategy, but do not believe the help or liking of the teacher is necessary to achieve success or avoid failure in mathematics. These students are also fairly confident that they know the causes for success and failure in mathematics.
Capacity for ability was significantly positively related only to luck, negatively to powerful others and unknown strategies. Luck strategy was significantly positively correlated with strategy ability, but

negatively with powerful others and unknown strategies.

Consequences of Perceived Control

In order to examine the relationships between perceived control and its consequences, the set of control-related beliefs were correlated with engagement, confidence and achievement. The results of this analysis are presented in Table 3.

Table 3
Correlations Between Perceived Control, Engagement, Confidence And Achievement (N=135)

Perceived Control	Engagement	Confidence	Achievement
Control Beliefs	0.58**	.80**	0.46**
Strategy Beliefs			
Effort	-0.00	-0.05	0.04
Ability	0.35**	0.84**	0.47**
Powerful others	0.16	-0.15	0.12
Luck	-0.00	0.20*	0.05
Unknown	-0.08	-0.36**	-0.11
Capacity Beliefs			
Effort	0.25*	0.23*	0.11
Ability	0.31**	0.80**	0.39**
Powerful Others	0.34**	0.21*	0.22*
Luck	0.06	0.13	0.05

*p<0.05 **p<0.001

Engagement

Teacher reports of student engagement were found to be positively correlated with control beliefs ($r = 0.58$, $p < 0.001$), the belief in ability as a strategy ($r = .35$, $p < .001$) and capacity beliefs for effort ($r = .25$, $p < .05$), ability ($r = .31$, $p < .001$) and powerful others ($r = .34$, $p < .001$). Those students whom teachers perceived as being the most engaged were most likely to have a strong sense of themselves being in control of their learning, and believe that ability is the most effective strategy for succeeding in mathematics. They also believed that they have the ability necessary, as well as the capacity to work hard and to enlist the help of teachers when it was needed.

There were no significant negative correlations with engagement, however strategies for effort, luck and unknown were slightly negatively correlated with engagement.

Confidence

Confidence was very strongly positively correlated with control beliefs ($r = .80$, $p < .001$), strategy and capacity beliefs for ability ($r = .84$, $p < .001$, $r = .80$, $p < .001$ respectively), moderately positively correlated with strategy luck ($r = .20$, $p <.05$), capacity effort ($r = .23$, $p < .05$), and capacity powerful others ($r = .21$, $p < .05$), and negatively for unknown strategies ($r = -.36$, $p < .001$).

The confident students believed strongly in their ability to control their learning, and believed both that ability is necessary to do well in mathematics and that they personally have the ability to succeed. It should be noted that these correlations are the strongest found amongst any of the variables tested. Confident students also believed that a certain amount of luck is needed to do well at mathematics, and believed that they are able to produce effort and obtain the help of teachers when they need it. The strong negative correlation with unknown strategies indicates that the more confident student is sure about the causes for success and failure in school, or conversely that

itís difficult to be confident about succeeding at school when you are unsure of how to succeed.

Achievement

Achievement, measured by a regular classroom test, was strongly positively correlated again with control beliefs ($r = .46$, $p < .001$), and with strategy and capacity beliefs for ability ($r = .47$, $p < .001$, $r = .39$, $p < .001$ respectively). It was also moderately positively correlated with studentsí beliefs that they were able to get teachers to help them if they needed this help ($r = .22$, $p < 0.05$).

Correlations between the three proposed consequences of perceived control are shown in Table 4. It can be seen that the strongest correlations were between teacher rated engagement and achievement on the class test, although all correlations were highly significant.

Table 4
Correlations Between the Proposed Consequences of Perceived Control

	Student rated engagement	Teacher rated engagement	Achievement
Confidence	0.52**	0.41**	0.47**
Student rated Engagement		0.36**	0.24*
Teacher rated engagement			0.64**

* $p < 0.05$
** $p < 0.001$

Contributions of Elements of Perceived Control to Student Engagement

Multiple regression techniques were used to examine which of the four known strategy beliefs and which of the four capacity beliefs showed unique contributions to engagement. Firstly, teacher rated student engagement was regressed on to the strategy belief variables. The overall equation was highly significant ($R2 = .173$, $p < .0001$). The significant unique predictors of engagement were found to be ability ((= .44, $p < .0001$) and powerful others ((= .28, $p < .001$). Engagement was then regressed on to the four capacity variables. This regression equation was also found to be significant overall ($R2 = .194$, $p < .0001$). Effort, ability and powerful others capacities were significant unique predictors of engagement for this sample (effort; (= .18, $p < .001$, ability; (= .23, $p < .01$, powerful others; (= .31, $p < .001$).

To examine the unique effects of strategy and capacity beliefs for the same cause on engagement, the strategy and capacity belief for each cause was entered into the regression equation with engagement as the dependent variable.

The regression equation for effort was significant overall ($R2 = .062$, $p < .01$) and showed that only capacity beliefs predicted engagement ((=.32, $p < .005$). For ability ($R2 = .108$, $p < .001$), strategy beliefs predicted engagement ((=.30, $p < .05$), for powerful others capacity beliefs predicted engagement ($R2 = .10$, $p < .001$, (= .34, p <

.001), while for luck the regression equation was not significant and neither strategy or capacity beliefs predicted engagement. These results are contrary to those found by Skinner et al. (1990), and may represent a fundamental difference in the thinking of students about school in general as compared to mathematics in particular. It is the perception of many students (and teachers and parents) that ability is the strongest predictor of achievement in mathematics.

Summary of differences found between the three groups

One Way Analyses of Variance (ANOVAs) were carried out to test differences between the three groups (accelerated, mainstream and business) on all aspects of perceived control, engagement and confidence. Post hoc testing using the ScheffÈ test was used to ascertain between which groups possible significant differences lay.

Significant differences were found for the following variables:

pre-test confidence $F(2,136) = 10.56$, $p < .0001$. The differences were found between the accelerated and business groups ($p < .001$) and the accelerated and mainstream groups ($p < .001$).

teacher rated student engagement $F(2,138) = 6.08$, $p < .003$. Differences were between the accelerated and mainstream groups ($p < .003$). It is of interest to note that the business group was not seen as significantly different from either of the other groups.

control $F(2,138) = 15.21$, $p < .0001$. Differences were between the accelerated and business groups ($p < .0001$), the accelerated and mainstream groups ($p < .002$) and the business and mainstream groups ($p < .006$).

strategy ability $F(2,138) = 21.55$, $p < .0001$. The differences were found to be between the accelerated and business groups ($p < .0001$) and the accelerated and mainstream groups ($p < .0001$).

capacity ability $F(2,138) = 16.01$, $p < .0001$. Again the differences were between the accelerated and business groups ($p < .0001$) and the accelerated and mainstream group ($p < .0001$).

strategy unknown $F(2,138) = 6.05$, $p < .004$. The differences lay between the accelerated and business group ($p < .006$) and the business and mainstream groups ($p < .006$).

student rated engagement $F(2,138) = 4.87$, $p < .01$. Once again the difference could be seen between accelerated and business groups ($p < 0.05$) and accelerated and mainstream students ($p < .05$).

confidence $F(2,138) = 30.00$, $p < .0001$. There were differences between all groups; accelerated vs business, $p < .0001$, accelerated vs mainstream, $p < .0001$ and business vs mainstream ($p < .05$).

Summary

Examination of the entire cohort indicated that students believe that to do well in mathematics, effort is the best strategy. This belief, coupled with the belief that they are generally able to exert the required effort, are claimed by Skinner et al. (1990) to promote strong control beliefs.

It was found that confidence was very strongly positively correlated with strategy and capacity beliefs for ability. Highly confident students endorse statement such as ìYou need to have a talent for mathematics to do well in itî ìI am good at mathematicsî. Confident students believe they are able to work hard, and that they are able to get the teachers to help them. These results also indicate that perhaps itís very difficult for a student to be confident about succeeding at mathematics when they are unsure of how to succeed.

The analyses suggest that the accelerated students believe strongly that ability is necessary to achieve success in mathematics, and that they have that ability; they feel more engaged (although this engagement is still not high), appear more engaged to the teachers and are confident of their ability to succeed.

Business students, however, are more reliant on the influence of powerful others to succeed in mathematics; being liked by the teacher and having a teacher who explains well. Overall these students have moderately high strategy beliefs but low capacity beliefs for unknown strategy, effort, powerful others and luck. The business students feel slightly disaffected in mathematics and were less confident both before and after the test than their counterparts in other classes. Control beliefs indicate that these students feel they have little control over their learning.

Students in the mainstream group perceive effort as being the most effective strategy, followed by powerful others. These are also seen as the easiest strategies for this group of students to enact. They are confident that they know what strategies cause success in mathematics and feel slightly engaged with their work. While still less confident than the students in the accelerated group, they felt reasonably confident of their abilities both before and after the test.

Discussion

The results of this study illustrate the multiple dimensions that may combine to influence or be influenced by studentsí beliefs about learning. The model used in this study describes a system of actions and beliefs that is assumed to interact dynamically within the social context, whether this be the classroom, the school, or the wider community. Motivational problems with students in the age group looked at in this study become apparent because the students are capable of ìregulating their own actions to a standstillî (Skinner, 1991, p. 203). Owing to the increasing differentiation apparent in their belief systems, it also becomes more difficult for teachers and parents to promote engagement. Skinner (1991) argued that ìinterventions would need to be more powerful and more subtle as children reach adolescence ... [which] underscores the need for early detection and treatment of motivational problemsî (p. 210).

A variety of motivational problems may be one set of reasons that students discontinue their studies in mathematics. By alerting teachers to the possibilities of these problems occurring, providing the means of assessing the problems and suggesting ways to intervene and remediate the problems, research can have a strong positive effect in the classroom. Cognitive engagement of each student is an ideal to be aimed for, since ìcognitively engaged students use thinking, metacognitive, and self-regulatory strategies to approach learning thoughtfullyî (Blumenfeld, Mergendoller & Puro, 1992, p. 207).

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