Self-Efficacy in Mathematics: Affective, Cognitive, and Conative Domains of Functioning

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Self-efficacy has the potential to facilitate or hinder our mathematics learner's motivation, use of knowledge, and disposition to learn. This paper examines the use of a questionnaire and classroom discussions to access the self efficacy of 64, year four to six students. The questionnaire and classroom discussions gathered data on the students affective, cognitive, and conative psychological domains of functioning. The findings from the questionnaire and classroom discussions are presented and discussed in regard to their relationships with the students' self-efficacy.

Self-efficacy is the judgements we make about our potential to learn successfully and the belief in our own capabilities. The choices we make, the effort we put forth, and how long we persist are influenced by self-efficacy (Bandura, 1997; Schunk, 1996).

Perceptions of self-efficacy come from personal accomplishments, vicarious learning experiences, verbal persuasions, and physiological states (Bandura, 1986; Ingvarson, Meiers, & Beavis 2005; Tanner & Jones, 2003). Self-efficacy impacts on a learner's potential to succeed (Bandura, 1977). An insight into the self-efficacy of their learners is a valuable tool for mathematics educators.

> It is important for educators to know how their learners feel, think, and act, about, within, and toward mathematics. The influence of attitudes, values and personality characteristics on achievement outcomes and later participation in the learning of mathematics are important considerations for mathematics educators. (Yates, 2002, p. 4)

One way to gain insight into how their learners feel, think, and act, about and toward mathematics is to examine their psychological domains of functioning: the affective, the cognitive, and the conative (Huitt, 1996; Tallon, 1997). It is important to examine each domain as a student may feel efficacious within the affective domain but less confident within the cognitive domain.

Affect is a student's internal belief system (Fennema, 1989). The affective domain includes students' "beliefs about themselves and their capacity to learn mathematics; their self esteem and their perceived status as learners; their beliefs about the nature of mathematical understanding; and their potential to succeed in the subject" (Tanner & Jones, 2003, p. 277).

The cognitive domain considers students' awareness of their own mathematical knowledge: their strengths and weaknesses; their abstraction and reification of processes; and their development of links between aspects of the subject (Tanner & Jones, 2000). Cognition refers to the process of coming to know and understand; the process of storing, processing, and retrieving information. The cognitive factor describes thinking processes and the use of knowledge, such as, associating, reasoning, or evaluating.

Conation refers to the act of striving, of focusing attention and energy, and purposeful actions. Conation is about staying power, and survival. The conative domain includes students' intentions and dispositions to learn, their approach to monitoring their own learning and to self-assessment. Conation includes students' dispositions to strive to learn and the strategies they employ in support of their learning. It includes their inclination to plan, monitor, and evaluate their work and their predilection to mindfulness and reflection.

This research examined the self-efficacy of 64 year 4 to 8 students (aged 8 to 11) towards their mathematics learning by analysing their responses to affective, cognitive, and conative statements.

Methodology

The teacher participants in this research were selected because of their existing relationship with the researcher. Within this relationship each teacher had discussed their concerns regarding the impact of their student's self-efficacy on their potential to succeed. The following tables outline the teachers' demographic data and their students' year levels.

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Participants

Table 1

Teachers

	Students ($N = 64$)	Years Teaching	Current Teaching Level	Years at Current Teaching Level	Highest Qualification
Teacher One	17	31	Year 3/4	3	B.Ed
Teacher Two	26	20	Year 5/6	7	B.Ed
Teacher Three	21	25	Year 6	4	B.Ed

Table 2

Students

Name	Year 4 ($n = 17$)	Year 5 ($n = 15$)	Year 6 ($n = 32$)	Total
Teacher One	17			17
Teacher Two		15	11	26
Teacher Three			21	21
Total	17	15	32	64

Method

Each student ($N = 64$) was given a questionnaire (adapted from Tanner & Jones, 2003) containing twenty statements sorted into three domains: affirmative, cognitive, and conative. The students responded to each statement by selecting either: I agree, I do not know, or I disagree. The findings from the questionnaire were collated and graphed by the researcher. The participating teachers met with the researcher to discuss the findings from the self-efficacy questionnaire and formulated six questions for each teacher to ask their class. The researcher recorded the discussion and noted the students who contributed.

Materials

The self-efficacy questionnaire asked the students to respond to the following statements.

Affective Domain Statements

Statement 1: Working hard leads to success in mathematics.

Statement 2: Some people just cannot do mathematics.

Statement 3: Some people are naturally good at mathematics.

Statement 4: You cannot change how good you are at mathematics.

Statement 5: There is no point in me trying in mathematics.

Statement 6: I know when I have got a mathematics question wrong.

Statement 7: I often get a mathematics question wrong but I do not understand why.

Statement 8: I know if I am going to get a mathematics question right.

Cognitive Domain Statements

Statement 9: If I do well in mathematics it is because the questions are easy.

Statement 10: If I do well in mathematics it is because I work hard.

Statement 11: If I do badly in mathematics it is because my memory let me down.

Statement 12: If I do badly in mathematics it is because I have no natural ability.

Statement 13: I know which parts of mathematics I do not understand.

Statement 14: Mathematics does not make sense to me.

Statement 15: I like finding bits of mathematics which go together.

Conative Domain Statements

Statement 16: Mathematics is about working together with others to solve problems.

Statement 17: When I am stuck it is useful to talk to others.

Statement 18: I could do better in mathematics if I worked with others.

Statement 19: If I make a mistake I try to find out where I went wrong.

Statement 20: I make sure that I understand mistakes that I have made.

Findings

The first set of findings discussed are from the self-efficacy questionnaire that each student (*N* = 64) completed and the second set are the findings from the questions posed by each teacher (*n* = 3) to their class.

Affective Domain Questionnaire

The affective statements asked the students to consider what they believed and examined their perceived status as a learner. Figure 1 shows the percentile results of the students' responses to statements 1 to 8.

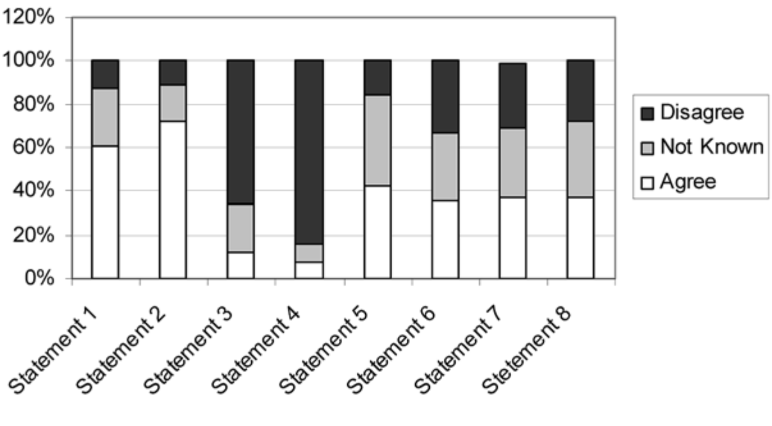

Figure 1. Student (N = 64) affective domain questionnaire results.

As a group the students agreed that hard work led to success in mathematics (S1 61%). The students disagreed that some people are naturally good at mathematics (S3 66%) and disagreed that you cannot change how good you are at mathematics (S4 84%). From these three findings it would appear that the students believe that maths is not something you are born good at, that anyone could get better, and that success could be attributed to hard work. However, as with the findings of Tanner and Jones (2003), a "worryingly hard core" (p. 280) 72% of the participants agreed with statement 2 some people just cannot do Maths.

Forty-two percent of the students either agreed or were unsure if there was any point in them trying in mathematics (S5). This finding correlated with the students lack of certainty in their responses to statements 6, 7 and 8 which were about knowing if you have a mathematics question wrong and why, and knowing if you have a mathematics question right. Each option of agree, do not know, and disagree was in the 30% range for each statement. This would imply that the students were less sure about knowing if they were right or wrong (Tanner & Jones, 2003) and that some students lacked confidence in self-regulating.

Cognitive Domain Questionnaire

The cognitive domain is the students' awareness of their mathematical knowledge, their strengths and weaknesses, and their ability to make connections with, and within the curriculum. Figure 2 shows the percentile results of the students' responses to statements 9 to 15.

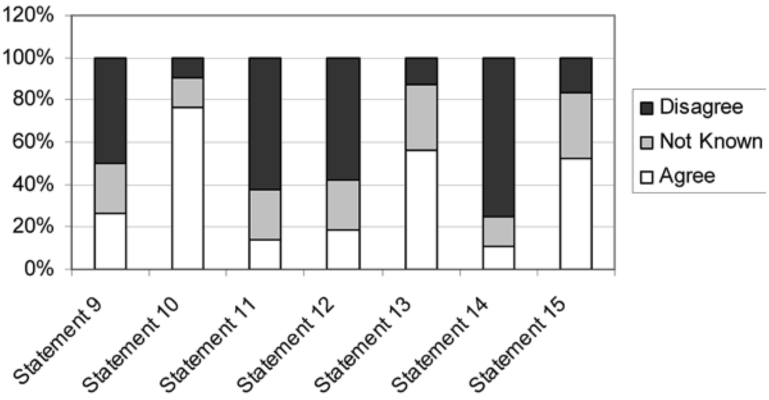

Figure 2. Student ($N = 64$) cognitive domain questionnaire results.

The students reiterated their affective belief that success and failure in mathematics related to working hard. Seventy-seven percent of the students agreed with statement 10 if I do well in mathematics it is because I work hard. The students agreed that they knew which parts of maths they didn't understand (S13) and they liked finding bits of mathematics which went together. This was endorsed by the students' disagreement with statements 9, 11, 12, and 14 which included reasons for doing badly in mathematics such as easy questions, no memory, or natural ability, and mathematics not making sense. The students were not attributing their successes to uncontrollable factors such as easy questions or a good memory and appear to have a detailed knowledge of their strengths and weaknesses. This is a positive finding as students who attribute their success or failure in mathematics to uncontrollable factors are unlikely to apply effective learning strategies (Tanner & Jones, 2003)

Conative Domain Questionnaire

The conative domain includes students' dispositions to learn, their approach to monitoring their own learning and to self-assessment. Figure Three shows the percentile results of the students' ($N = 64$) responses to statements 16 to 20.

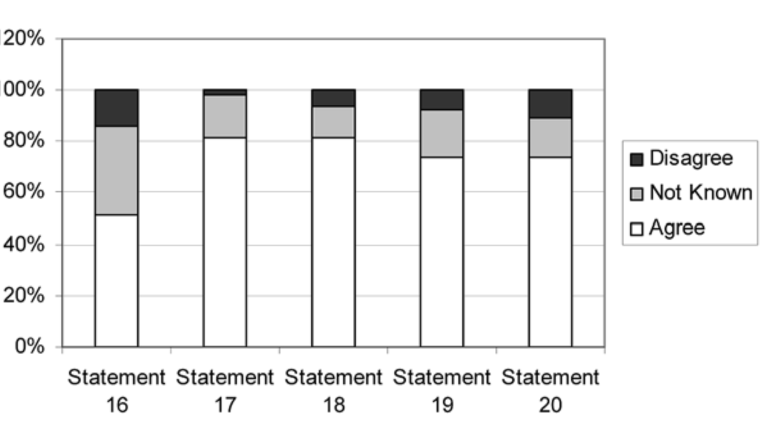

Figure 3. Student (N = 64) conative domain questionnaire results.

As a group the students were in stronger agreement in their responses to four of the five conative domain statements. There was a strong sense that it was useful to talk with others if they got stuck (S17 81%) and that they could improve by working with others (S18 81%). The students agreed that it was important to find out where you went wrong if you made a mistake and to try and understand your mistake (S19 74% & S20 74%). Statement 16, related to working with others to solve problems, did not engender as strong a response with 52% agreeing, 30% being unsure, and 18% disagreeing. This could suggest that talking to and working with others could be useful but that mathematics tasks were more of an individual pursuit than a team pursuit.

Discussion Findings

Following the analysis and discussion of the self-efficacy questionnaire the teachers decided to ask their classes the following questions:

1. Why do you believe that some people just cannot do maths?
2. What are the causes for some people not being able to do maths?
3. Why do you think some students have difficulty in knowing if they are right or wrong?
4. What helps you to do well in mathematics?
5. Why is it good to work with others?
6. In what ways is working with others valuable to you?

Affective Domain Discussion. When asked why some people just can't do maths the students discussed how mathematical ability was related to mathematical interest. It seemed that those who were not interested in mathematics were the basis for the group who just can't do maths. The students believed that you are good at what you like and you like what you are good at. So whilst some people were not naturally good at maths and you could change how good you were for those who did not like mathematics failure was both expected and accepted.

> It's not an interest and so they choose not to do it. And if you don't do it then you won't get better at it. (Student Year 4, Teacher 1)

> If maths isn't one of your favourites [subjects] then you aren't going to be very good at it, like if art was a favourite [subject] you would be good at that. (Student Year 6, Teacher 2)

> For some people mathematics is just not their subject–and they don't like mathematics because it's boring and they don't try and they don't do well. What you like is kind of what you are good at and if you like something you are more likely to be good at it. (Student Year 6, Teacher 3)

The students believed that for some failure was a self-fulfilling prophecy. They described how some students may have doubts about their mathematical abilities and the doubt could lead to a lack of commitment, stress, and eventually failure.

> Some people don't believe in themselves and they think they are not good at it and so they don't try. They might have not got anything right for a long time and they get frustrated and give up. (Student Year 6, Teacher 3)

> They might get all worried when they make mistakes and then that means they make more mistakes and so they stop trying. (Student Year 6, Teacher 3)

Cognitive domain discussion. The difficulty in knowing if you had a question right or wrong was discussed in terms of time pressure. The pressure to be finished on time was discussed as well as how the potential for errors was increased through rushing to finish. The students identified the need to be finished as more important than the need to be right. Speed was valued over accuracy and it would appear that these students thought it was better to write something down and be thought a fool than to have a blank page and remove all doubt.

> You haven't finished and you don't want to look dumb so sometimes you just speed up and hope it's right. (Student Year 6, Teacher 3)

> Getting finished means that you gave it a go, not finishing means not trying, finished means trying your best. If you haven't finished then you haven't achieved your goal. (Student Year 4, Teacher 1)

One Year Four student disagreed and described a success leads to success philosophy.

> But getting more right and less finished shows you tried your best. So if you go slower and get it right the first time you would have more chance of getting it right the next time. (Student Year 4, Teacher 3,)

The students agreed that working hard and having knowledge was important as well as having the ability to strategise when the answer was not immediately accessible.

> Mathematics is about working hard but you also need to know your stuff so that you have something to work hard with. (Student Year 4, Teacher 1)

> Mathematics is about knowing how to do it but not about knowing all the answers straight away. Strategies help you get the answer if you can't get there straight away. (Student Year 5, Teacher 2)

Conative domain discussion. The students responses to the questions posed at this point were not as clear cut as their responses to the conative statements. Whilst the majority of the students agreed that working with others was valuable, they did have some qualifiers. Working with others was valuable if those working together were in agreement, otherwise it was seen as a waste of time.

> It's good to work with others if you all agree but it takes a lot of time if you have to work with others and you don't agree. (Student Year 4, Teacher 1)

> It's not good working with others if they don't agree with you because you can waste a lot of time. (Student Year 5, Teacher 2)

Discussion and Implications

Bandura (1977) believed that the development of life-long learners of mathematics depended on the interaction of three linked psychological domains of functioning: the affective, the cognitive, and the conative.

The students' responses and comments to the affective domain questions showed a strong correlation between enjoyment, motivation, and success. The students saw liking or not liking as the beginning of a cycle of success or failure. The responses imply that the students sought external confirmation of their answers being right or wrong and suggest that some students are unsure of their own capabilities and capacity where mathematics is concerned. Nearly half of the students looked to someone else, possibly the teacher, for positive affirmations. This could impact negatively on the students in the future as they do not appear to know how to effectively monitor or regulate their responses. "Monitoring is the hub of self-regulated task engagement and the internal feed-back it generates is critical in shaping the evolving pattern of a learners' engagement with a task" (McDonald & Boud, 2003, p.210).

Analysis of the cognitive domain questionnaire and classroom discussions showed that the students related mathematical success to hard work, and recognised the need to have knowledge and strategies to bring to their mathematics learning. The findings from the conative domain questionnaire showed that the students saw the value of talking with others and the potential value of working with others. However analysis from the classroom discussion showed that the students believed that the potential for working successfully with others was conditional on being able to quickly reach agreement. It was only useful to talk with others if everybody agreed; differences and disagreements were not seen as valuable.

The students in this research are efficacious within the cognitive domain. They are confident about what they can do mathematically, but less sure about what they know and can achieve. This signifies a need for mathematics that is accessible and enjoyable for all learners and increased use and expectation of students regulating and monitoring their own learning.

Students' self-efficacy for mathematics may be defined as their judgements about their potential to learn the subject successfully. Students with higher levels of self-efficacy set higher goals, apply more effort, persist longer in the face of difficulty and are more likely to use self-regulated learning strategies (Wolters and Rosenthal, 2000, p.276).

References

Bandura, A. (1977). Self-Efficacy: Towards a unifying theory of behavioural change. *Psychology Review, 84,* 191 – 215.

Bandura, A. (1986). *Social foundations of thought & action: A social cognitive theory.* Englewood Cliffs, NJ: Prentice-Hall.

Bandura, A. (1997). *Self-efficacy: The exercise of self-control*. New York: W. H. Freeman and Company.

Fennema, E. (1989). The study of affect and mathematics: A proposed generic model for research. In D. B. McLeod & V. M. Adams (Eds.), *Affect and mathematical problem solving: A new perspective*. (pp. 207-219). London: Springer-Verlag.

Huitt, W. (1996). The mind. *Educational Psychology Interactive*. Valdosta, GA: Valdosta State University. Retrieved December, 2007, from http://chiron.valdosta.edu/whuitt/champion/mind.html

Ingvarson, L., Meiers, M., & Beavis, A. (2005). Factors affecting the impact of professional development programs on teachers' knowledge, practice, student outcomes and efficacy. *Education Policy Analysis Archives. 10*(13) 1- 26.

McDonald, B. & Boud, D. (2003). The impact of self-assessment on achievement: the effects of self-assessment training on performance in external examinations. *Assessment in Education, 10*(2), 209-220.

Schunk, D. H. (1996). Self-efficacy for learning and performance. *Paper presented at the annual conference of the American Educational Research Association*, New York.

Tallon, A. (1997). *Head and heart: Affection, cognition, volition as triune consciousness*. New York: Fordham University.

Tanner, H. & Jones, S. (2000) *Becoming a successful teacher of mathematics*. London: Routledge/Falmer.

Tanner, H. & Jones, S. (2003). Self-efficacy in mathematics and students' use of self-regulated learning strategies during assessment events. In N.A. Pateman, B.J. Dougherty, & J.T. Zilliox, *Proceedings of the 27th Conference of the International Group for the Psychology of Mathematics Education* (PME27), pp. 275-82. Honolulu, HI.

Wolters, C. A. & Rosenthal, H. (2000). The relation between students' motivational beliefs and their use of motivational regulation strategies. *International Journal of Education Research, 33*(7-8), 801-820.

Yates, S. M. (2002). The influence of optimism and pessimism on student achievement in mathematics. *Mathematics Education Research Journal 14*(1), 4-15.