Eliciting Positive Student Motivation for Learning Mathematics

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Responding to an instrument we developed to give insights into students' orientation to, and motivation for, learning mathematics, Year 8 students showed more confidence in their ability to learn mathematics and in their persistence than observations of their classes would indicate is warranted. They identified a negative influence of peers for some classmates but less for themselves, and had modest career aspirations. We believe teachers can assist students by becoming aware of their orientations to learning, their perceptions of the value of schooling, and their further vocational aspirations, and by finding ways to overcome factors inhibiting their engagement in school.

Introduction

The under-participation of students in learning in the middle years in Australia (students aged 10 to 14) is both widely reported and persistent (e.g., Hill, Holmes-Smith, & Rowe, 1993; Russell, Mackay, & Jane, 2003). This under-participation, in the case of learning mathematics, may be a product of some students: lacking confidence and giving up readily (e.g., Dweck, 2000); not connecting current learning opportunities with their future goals (e.g., Sfard & Prusak, 2005); and experiencing discontinuities between the curriculum, the pedagogy, assessment regimes, and their own culture and family influenced expectations (e.g., Delpit, 1988).

Ideally, to promote student engagement in learning, two sets of factors must align. The first set of factors include that the students have the requisite prior knowledge, the curriculum is relevant to them, the classroom tasks interest them, and the pedagogies and assessment regimes match their expectations. The second set of factors relate to their goals for learning, their willingness to persist, and the extent to which they see participation in schooling as creating opportunities. The focus of this paper is on assisting teachers to address the second set of factors, even though the challenge for teachers of middle years classes, in particular, is to address both sets of factors, more or less simultaneously.

In an earlier study, we investigated individual students' perceptions of the extent to which their own efforts contribute to success in mathematics (Sullivan, Tobias, & McDonough, 2006) and English (Sullivan, McDonough, & Prain, 2005) through two separate interviews where Year 8 students encountered increasingly difficult tasks. The intention was that eventually nearly all students would confront the challenge of a task that was difficult for them. The students were asked how they felt about the challenge they experienced, and the type of support they needed to solve the problem. The survey included items adapted from three instruments proposed by Dweck (2000), and asked students to rate their self confidence and achievement, their persistence, their perception of the value of schooling, and what constitutes successful learning.

We found that the students were surprisingly confident in their own ability, they perceived effort as important and themselves as trying hard, and saw these as linked. The students seemed to have short term goals, aiming to please the teacher by getting questions correct and scoring well on tests. We further found that a significant minority of responses

referred to the negative influence of classmates. In such cases, a lack of observable effort could be a result of a desire to be popular or a fear of censure by peers. The present study extends this to examine ways that teachers might be able to support students to overcome inappropriate orientations and negative influences.

The Orientation of Students to Learning

Both the previous work and the current study draw on the work of Ames (1992) and Dweck (2000) who categorized students' orientation to learning in terms of whether they hold either *mastery* goals or *performance* goals. Students with *mastery* goals seek to understand the content, and evaluate their success by whether they feel they can use and transfer their knowledge. They tend to have a resilient response to failure, they remain focused on mastering skills and knowledge even when challenged, they do not see failure as an indictment on themselves, and they believe that effort leads to success. Students with *performance* goals are interested predominantly in whether they can perform assigned tasks correctly, as defined by the endorsement of the teacher. Such students seek success but mainly on tasks with which they are familiar, they avoid or give up quickly on challenging tasks, they derive their perception of ability from their capacity to attract recognition, and they feel threats to self worth when effort does not lead to recognition.

Dweck (2000) connected these goals with two perspectives on intelligence: a fixed perspective termed *entity* theory that refers to students who believe that their intelligence is genetically predetermined and remains fixed through life; and an *incremental* perspective in which students believe that they can change their intelligence and/or achievement by manipulating factors over which they have some control. Students with *incremental* perspectives tend to hold *mastery* goals, whereas an *entity* view can result in *performance* goals.

Of course, most students hold a mix of these types of goals, and there is considerable complexity within each type. For example, performance goals to please a teacher can motivate students to complete tasks satisfactorily as long as the teacher's endorsement is forthcoming (Elliot, 1999). Such goals can also lead to performance avoidance in which students choose not to engage in tasks for fear of failure and the risk of teacher censure.

More recently researchers have recognised the complexity of factors influencing students' orientations to learning. Watt (2004), for example, argued that course choices and achievement are related to students' self-perceptions, including their rating of their ability, and their expectations of success, the value they attribute to the particular content, such as its intrinsic value and its usefulness, and their evaluations of a particular task, such as its difficulty and the amount of effort required to complete it. Similarly, Martin and Marsh (2006) described adaptive or helpful characteristics of students' orientation to learning as the extent to which they feel they can succeed at a task, their valuing of school, mastery orientation, persistence, planning, and self management.

Drawing on these approaches, this research examines students' self perceptions of confidence and effort, aspects aligned with Watt's rating of ability, expectations of success, and effort to complete the tasks, and to Martin and Marsh's self efficacy and persistence, as well as Dweck's (2000) entity/incremental distinction, which is connected to Martin and Marsh's (2006) mastery orientation.

We are also interested in examining external influences on effort. For this we draw on Hannula (2004) who explained that potentially negative influences on effort are derived from adolescents' need for identity, autonomy, and social connectedness that are often

enacted in negative ways, such as by challenging the authority of the teacher, and by conforming to peer pressure to under-perform.

Further, we see potentially positive influences as including the extent to which students connect current schooling with future opportunities or their *possible selves,* which is "the future-oriented component of self-concept" (Oyserman, Terry, & Bybee, 2002, p. 313).

Research Context and Data Collection

As a first step, we used a questionnaire to seek students' responses to items addressing such issues, with the intention of subsequently using their collective responses as a prompt for discussion with their class on the implications of trends in the results.

The questionnaire used in the earlier study was based on items proposed by Dweck (2000), predominantly seeking to discriminate between students who had *incremental* or *entity* views on intelligence, and *mastery* or *performance* goals. For this current study, we chose the items from the earlier questionnaire that discriminated between the responses of the students, and added open response items on students' job aspirations, their perception of the effort of others in their class, and their ideas about causes of other students' lack of effort. We removed most negatively worded statements, since we found that these were difficult for weaker readers to interpret. Overall, our intention was for the instrument to be brief, clear, unambiguous, individually completed, easily analysed, and completed in under 15 minutes requiring minimal assistance or explanation. The new instrument was piloted with similar students to the target population, one on one, with the students talking aloud as they responded, and resultant changes were made to clarify wording. In this piloting we found that the items were clear for students who were fluent readers, although we were surprised with some wordings that proved difficult (e.g., suburb) for weaker readers. We adjusted the protocol for administering the tool to allow explanations of words that were not clear. Subsequent interviews with a selection of students, including weak readers, indicated that those students comprehended the questions.

Responses to the final instrument were sought from students in year 8 (age 13) in three government secondary schools, and one Catholic school, in a regional city in Australia. There were a total of 205 responses, 101 male and 104 female, with 15, 41, and 39 respectively from the government schools and 110 from the Catholic school. The schools served predominantly lower socio-economic families. The regional city is prosperous, overall community infrastructure is good, and there are ample further education and employment possibilities for school leavers.

In each school, we interviewed three students in each class following the completion of the questionnaire: one student identified by the teachers as a high achiever, one as a low achiever, and the other in between. Generally the students interviewed endorsed their responses on the questionnaire, and it seems that the instrument does give insights into most students' thinking.

We also conducted a class discussion with one group of students who responded to the questionnaire in which we presented their results in the form of a "research seminar" and sought their responses. The rationale was that if students become more aware of their respective individual responses in comparison with the group responses overall, and if they consider possible implications of their responses, this might allow more active decisions on the connections between their current effort, their learning and future opportunities. Bar graphs were presented to the class, the interpretation of the graphs was clarified, the

students discussed the graphs in groups, the groups reported to the whole class, and these reports were recorded, and transcribed.

Results

The results presented here are from items addressing the students' confidence and perceptions of their own effort, their reported commitment to an incremental perspective on intelligence, the influences on their effort including the negative influence of their peers, and their future career aspirations. We also present data on the students' suggestions of what can be done to address the issues raised, and including responses from a particular "research seminar" style intervention.

The tables present the frequency of each of the six response options (strongly agree, agree, mostly agree, etc.). There was no attempt to quantify confidence in the instrument overall, such as using Cronbach Alpha, since the items were addressing quite different constructs, and the items and responses can be taken on face value.

Students' Confidence and Effort

Table 1 presents responses of students to the item relating to confidence. Nearly all of the students report confidence in their ability to learn mathematics.

Table 1
Self Perceptions of Confidence (n=205)

	Strongly agree	Agree	Mostly agree	Mostly disagree	Disagree	Strongly disagree
I feel confident I can learn most things in maths	56	87	50	10	1	1

Table 2 presents the items seeking their self-perception of how they felt their effort would be reported by friends. The stems were phrased in this way to create a sense of distance for the students, and perhaps get more accurate responses. In the previous study, the students' responses to more direct items seemed unrealistic.

Table 2
Perceptions of How Effort would be Seen by Friends (n=205)

	Strongly agree	Agree	Mostly agree	Mostly disagree	Disagree	Strongly disagree
My friends would say that I keep trying when our maths work gets hard	24	60	69	28	15	9
My friends probably think I give up quickly when maths gets hard	9	16	24	34	76	46

These items were designed to get two perspectives on the same variable. Even though the distribution of responses seems similar (with one reversed), the responses were not significantly correlated. The majority of the students report that they consider that their friends would think they try hard, although there is a substantial minority who do not think so. Overall we can infer that most students are satisfied with their level of effort.

It is interesting to contrast these responses with the comments by their teachers who report low levels of persistence and significant difficulties in engaging students in learning

mathematics. Based on our observations in mathematics classes, the students overall seem neither confident in their learning nor do they try hard. This is discussed further below.

Entity vs Incremental Views of Mathematics Ability

We were also interested in students' responses to items seeking their views on the nature of ability for mathematics learning. The items are presented in Table 3.

Table 3
Commitment to Incremental or Entity Perspectives of Ability (n=205)

	Strongly agree	Agree	Mostly agree	Mostly disagree	Disagree	Strongly disagree
Anyone can be good at maths if they put their mind to it	81	70	42	10	2	0
People are either good at maths or not. They cannot get better by trying	7	12	16	23	62	85

The responses to the two items are significantly correlated ($r = -0.2$, $p < .05$), and the distributions are similar. Across each of the schools, the responses of these students indicate a strong commitment to an *incremental* view of intelligence.

Influences on Effort

Part of the rationale for the questionnaire is to offer teachers prompts that they can discuss with their students. One key focus could be the effort of the class and the influences on that effort. The following presents some questionnaire responses and some responses of students during an intervention with one class. Table 4 summarises the responses to the prompt "Tick the statement that best describes your maths class".

Table 4
Student Perceptions of the Effort of their Maths Class (n=205)

	Frequency
All try their best	18
Most try their hardest, a few could try harder	108
A few try their hardest, most could try harder	55
All students could try much harder	24

Over half of the students report that most in their class try hard. Overall the students report a positive orientation to effort for their class, although a significant minority think that students could try harder.

There was an open response item, "If there are any students who do not try their hardest in maths, why do you think this is?" The responses were categorized to simplify reporting. The more frequently cited categories, using our words, can be summarized as: lack of motivation or laziness; dislike of mathematics; boredom; difficulties with understanding of the mathematics; desire to be popular; and lack of sense of future. These categories could perhaps have been anticipated, nevertheless the responses give teachers some indication of ways that they might address the engagement of their students.

In the earlier study, the responses to open items and interview questions suggested that there was a significant minority of students whose effort and participation were negatively influenced by peers. Since this was an important and unanticipated result, we included a

number of further items that sought responses related to influence of the class on the effort of others or themselves, the results of which are in Table 5. The first item in the table seeks a response about other students, and the others refer to the influences of the class on themselves as individuals.

Table 5
Influences of Other Students on Effort (n=205)

	Strongly agree	Agree	Mostly agree	Mostly disagree	Disagree	Strongly disagree
In my maths class, some students don't try hard because they are afraid of what other students might think of them	35	52	44	39	24	10
I would try much harder in a different maths class. This class holds me back	8	11	28	44	76	38
I am able to try my hardest in maths. The rest of the class doesn't make any difference to me	54	68	57	16	7	3
In maths, I try my hardest in maths no matter what the other students think	51	78	56	13	4	3

The negatively worded items were retained because they seem to offer an additional perspective, and it also seemed that weak readers could interpret them. The trend is clear across the items, and the responses to each are significantly correlated with the others. Most affirm their own effort irrespective of other class members, and they deny that the other class members have a negative influence on their own effort. There is a minority who acknowledge a negative influence of peers.

An intervention seeking to explore this further consisted of presenting these tabulated results to students as column graphs, clarifying that they could interpret the graphs, inviting them to discuss, in groups, the reasons for the responses of the classes as portrayed in the graphs, and then facilitating reporting back by the groups with some whole class discussion. The following are representative extracts from two groups of students reporting on their discussion in response to the first item in Table 5.

> Most people try their hardest because they don't want bad marks, but some people didn't try because they didn't want to look like nerds, and some people are sitting next to smart people so they felt like being smart and doing it, but sometimes there's a dumb group and they don't want to look like a nerd in front of everyone.

> We just talked about how people try to get good marks but some people don't try to become nerds and stuff, to get kicked out of social groups and things like that.

In other words, the students are reflecting the results in Table 5 with a recognition that most students try hard, but there are some who are negatively influenced by others. Another group more explicitly connected effort with criticism.

> Because if you try hard in maths, people think you're a nerd and then you get teased. Because if you're smart usually no one likes you, as in they don't not like you but they just call you names because you're smart, and when you're not smart they just…

This illustrates the subtlety of the effect. It appears there is not a direct correlation between not being liked and effort, although effort is likely to draw comment. In a similar way, another of the groups noted:

> There are loser nerds that are losers, and if they're nerds, they are…if you're popular and you are a nerd you're going to still have all your friends around you, and if you're a loser you're going to have no friends around you and no one defending you.

As did the class teacher, this group noted that some students who try hard, even if considered "nerds", are still popular, and so presumably willing to try and achieve despite any criticism whereas the "loser nerd" seems vulnerable. These are issues on which teachers could build further discussion. Again the comments confirm the tabulated results and suggest that the influence of others is indeed an issue that classes could productively discuss.

Future Aspirations

It is assumed that students who have future career aspirations that might include tertiary education would be more orientated to positive participation in school. To explore this, the following open question was posed "What type of job do you want to do after you leave school?" Not all students responded to this item.

We categorised 68 responses as "professional": medicine/health (20), ICT (9), veterinarian (14), lawyer (7), science (2), small business (5), architect (6), and teacher (5).

Eighty-two responses, described as "non professional", included entertainment (13), beauty (16), sports (11), and military/police (9). The 13 responses that indicated they did not know what career they would pursue were included as "non professional" in that it is assumed that lack of a specific career aspiration would not be a positive motivating influence. Likewise, the 20 students who indicated a particular trade were included. Even though trades require post-school study, an aspiration to be a plumber, for example, is not usually associated with greater attention to learning mathematics. The item from the questionnaire that addressed career aspirations is presented in Table 6.

Table 6
Effort and Job Opportunities (n=205)

	Strongly agree	Agree	Mostly agree	Mostly disagree	Disagree	Strongly disagree
Trying hard in maths will give me more future job opportunities	120	66	12	5	1	1

There were no significant differences between the responses of the students from different schools. The majority of the students connected effort with increased job opportunities. It is interesting to compare this with Beavis, Curtis, and Curtis (2005) who reported that students were more likely to have not planned post-school education if they had below average levels of achievement, and if they had educational aspirations, these were more likely to be apprenticeships for trades.

To investigate this further, we cross tabulated the responses of the 30 students who strongly agreed with the proposition, "I feel confident I can learn most things in maths" with whether their aspirations were professional, as described above, or not. We found that it was more likely that students with professional aspirations would be part of this "more confident" group than those without professional aspirations. We also cross tabulated the career responses with those who strongly agreed with the statement, "My friends would say that I keep trying when our maths work gets hard", but students with professional aspirations were not more likely to choose the "strongly agree" category than the others.

In the class discussion, a question was posed contrasting their responses to the questionnaire item that effort in mathematics class is connected to job opportunities with the earlier discussion of influences on effort. Two of the groups responded as follows.

> Because we don't think that it's important. We're not like really thinking of what we want to be right now, and we're not thinking of how failing a subject … is going to affect our jobs and stuff.

Another group responded:

> If you're at school and you sit down and you have to do maths or something, you're not really thinking…like, if someone asks you a question, "Will maths affect what job you get when you're older", you can like sit down and think about it, you go, of course it's going to affect it. But when you sit down in maths, to do your maths after recess or lunch or whatever, you don't really think what I do right now is going to affect what I'm doing in 15 or 20 years.

Yet another group compared the influence of friends and consideration of the future:

> When you're in school, you don't really think about, like, that work is important, you only think that your friends are important and what you do at recess and lunch and not in classes and that.

It seemed that the students took the point, and that they are also both reflective and honest in their assessment. Such responses would provide an opportunity for teachers to pursue the issue further with the students, and perhaps find ways to connect current efforts with future opportunities more explicitly.

Discussion and Conclusion

The limited number of responses is due to stringent procedures for seeking parental approval, and this process may have biased the sample. Nevertheless this potential bias would make the results more severe. In other words, the students who did return the ethics approval forms were presumably those more positively oriented to schooling.

One of the results of interest is the positive self ratings of the students' confidence that they can learn mathematics. It is possible that the students' self perceptions are accurate, and there are other factors constraining their participation in learning. It is also possible that the items do not allow students to communicate their actual confidence and self perception of effort. It is also possible that the students' self perceptions may be inaccurate, in which case some attention to these unrealistic perceptions is necessary. This explanation is favoured by Dweck (2000) who argues that some teachers give students unrealistic positive evaluations of their achievement, and even conspire to reduce challenge to produce success. In other words, it seems important that assessments of students' performance are realistic, and that teachers should be encouraged to affirm effort more than achievement.

Another result relates to the influence of peers. Most students acknowledged this negative influence of peers on some others, but denied that it influenced them. The instrument and the results also raise the possibility that there is a significant minority of students for whom this factor is a negative influence. Recently the first author was teaching a year 8 class. The class was asked to work out what percentage calculations expressed in the form "50% of 200" they could work out in their head. The intent of the task was that the children would realise that it is possible to calculate some percentage calculations in your head, and then make generalisations about what type of percentages are straightforward and can be calculated mentally and for which types it is more appropriate to use a calculating device. After a group discussion, a spokesperson for one of the groups of students in reporting back said, "Well you can get half of anything, and quarter of …" at which stage there was a chorus of derision from some other students about the nature of

this response. The students from the group that had formulated the response then refused to articulate their answer further even though it was clear that they were satisfying part of the task by seeking to form generalisations. Because some other class members were critical of students who were either seen to be trying hard or seeking to intellectualise their engagement with the task, these students then not only stopped working, but could not be encouraged to re-engage with the task. In other words, it seems that this negative influence of peers would be particularly detrimental if the teacher is hoping to promote argumentation as a pedagogical tool.

The third result relates to the career aspirations of these students, in that only one third of the students listed a career aspiration that would be associated with success in mathematics at school. Even though the students discounted the motivational impact of their future aspirations, it seems that helping students to become aware that a decision not to work in order to please the peer group, or for some other reason, does have longer term consequences. It seems that teachers could assist students by making this connection between current effort and future opportunities more explicit.

For each of these aspects of learning it is important that teachers are aware of the responses that their students would give. We conclude that a simple instrument similar to the one used in this case can provide a prompt for discussion and consideration of these potentially important issues. The hypothesis is that if teachers are aware of the orientations of their students they can intervene positively. Dweck (2000), for example, argued that teachers can teach self regulatory behaviours such as decoding tasks, perseverance, seeing difficulties as opportunities, and learning from mistakes. This capacity is evident in quite separate research strands on self fulfilling prophecy (e.g., Brophy, 1983), and motivation (e.g., Middleton, 1995).

We suspect that, concurrent with considering ways of overcoming any difficulties their students may be experiencing with learning, teachers could well develop awareness of connections between study and career opportunities, encourage students to keep future options open (by studying), make tasks relevant to their lives, illustrate utility of learning mathematics to all, especially to those who do not aspire to continue with further study, and develop greater awareness of effort expended and required, and ways of overcoming negative influence of peers.

A Possible Continuation of the Class Discussion

To illustrate the way that the instrument and the ensuing discussion of results might be used, the following suggests some ways that teachers build on the students' comments.

With this class, there were a number of occasions that the students made responses wise for their age. For example, one group, in discussing the influence of peers, said:

> It's good to be smart because then you know stuff, and if you're dumb just so your friends like you then it's really bad. Obviously they're not your friends if they make you be dumb to be their friend.

This response could be used by the teacher as the basis of further discussion on the potential for peers to be both a positive and a negative influence, and on ways that students could respond to negative peer pressure. For example, the teacher could: create a story scenario using photographs or drawing and invite the students to work out the sequence of the events; invite the students to write story about a time that they underperformed for fear of censure by their friends; have the students create a role play of a scenario; or ask them what how they might encourage a friend who was not trying.

In the same discussion, another student made a similarly interesting comment using a sporting perspective.

> …if you're playing and you mess up or something and you have a kick and it falls short or it goes out of bounds on the full where it shouldn't, if you have someone on your team that says, 'You'll get the next one,' you're more confident to keep playing, but if someone is like, 'What are you doing?'

Even though students probably see sport and school as different, this response would also serve as a useful prompt for further discussion on ways that peers have the potential to be both supportive and critical, and on the positive influence that peers can have on effort and achievement. For example, the teacher might follow up by asking:

- How might "you'll get the next one" help?
- What would "you'll get the next one" look like in a mathematics class?

Responses of Year 8 students in the present study reveal awareness that perhaps is not expected of students who are less engaged in learning mathematics than would be desirable. We have argued that the insights provided by students can be a powerful starting point for addressing under-participation of students in middle years learning.

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