HELPING TEACHERS TO ASSESS STUDENTS' READINESS TO LEARN MATHEMATICS

Peter Sullivan
Monash University

Andrea McDonough
Australian Catholic University

To explore barriers to student participation in learning, we developed a survey tool to give teachers insights into aspects of their students' orientation to, and readiness for, learning mathematics. The focus was on how the students saw themselves as learners, how they perceived their own and others' effort, their perceptions of some influences on their effort, and their future aspirations. The tool was informed by previous research that included individual interviews, responses were validated via interviews with some respondents, and there were feedback sessions with classes. In this paper we discuss responses from Year 8 students at three schools and, in light of these responses, make comment on the potential value of the tool. We found that the students seemed to be more confident in their ability to learn mathematics than observations of their classes would indicate is warranted, they identified a negative influence of peers for some classmates but less for themselves, and they had modest career aspirations. We believe that teachers can assist by becoming aware of the students' orientations to learning and finding ways to overcome inhibiting factors. Teachers should also be aware of students' perceptions of the value of schooling, and their further vocational aspirations.

THE ORIENTATION OF STUDENTS TO LEARNING

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:

- having a record of underachievement and diminished expectations that are exacerbated by irrelevant curriculum and tasks that lack interest (e.g., Clarke, 2005);
- 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 expectations (e.g., Delpit, 1988).

In other words, to engage students in learning, ideally the curriculum is relevant, the classroom tasks are interesting, the students have the requisite prior knowledge, the students have expectations that they can learn, they see themselves as willing to persist, they see participation in schooling as creating opportunities, and the pedagogies and assessment regimes match their expectations. Teachers of middle years classes, in particular, need to address all of these issues, more or less simultaneously. The focus of the research reported in this article is on the students' approaches to learning and schooling, and in particular on assisting teachers to find out about the orientations of the students they teach.

Prior to the phase of the project reported here, we investigated individual students' perceptions of the extent to which their own efforts contribute to success in mathematics (see Sullivan,

McDonough, & Prain, 2005). In the previously reported results, 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 found further that a significant minority of responses related 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.

Both the previous work and the current study are based on the work of Ames (1992) and Dweck (2000) who categorized students' approaches in terms of whether they hold either *mastery* goals or *performance* goals.

Students with *mastery* goals tend to have a resilient response to failure, remain focused on mastering skills and knowledge even when challenged, do not see failure as an indictment on themselves, and believe that effort leads to success.

Students with *performance* goals seek success but mainly on tasks with which they are familiar, avoid or give up quickly on challenging tasks, derive their perception of ability from their capacity to attract recognition, and feel threats to self worth when effort does not lead to recognition.

Dweck (2000) distinguished 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, while 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). We also acknowledge that there are additional important influences on students' motivation and orientation (e.g., Mills & Blankenstein, 2000). For example, students' self-goals are informed by their sense of the future which is connected to basic needs such as identity, autonomy and social connectedness (Hannula, 2004), although these can be enacted in negative ways such as by challenging the authority of the teacher, and by conforming to peer pressure to under-perform. Nevertheless the performance/mastery distinction is useful for describing individual students' approach to learning, and can form a useful basis for developing measures of learning goals and self-regulation.

It is also acknowledged that there are various similar theories such as self-efficacy (Bandura, 1997), resilience (Luther, 1993), and motivation (Brophy, 1983). To us, the Dweck (2000) theory is both powerful and simple, and incorporates the key elements of the others.

RESEARCH CONTEXT AND DATA COLLECTION

This study had two foci. First, we sought to explore three unanticipated results from the previous study: specifically, the apparently unrealistic self perceptions of confidence and persistence; the strength and extent of negative peer pressure; and the future aspirations of the students. Second, we

aimed to develop a tool that teachers could use to gain insights into their students' orientation to learning.

A questionnaire used in the earlier study was based on one proposed by Dweck (2000), predominantly seeking to discriminate between students who had *incremental* or *entity* views on intelligence, and *mastery* or *performance* goals. For the tool in the present 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, their suggestions of causes of other students' lack of effort, and suggestions of ways to support such students. We also added negative Likert statements paired with each of the existing items. Overall, our intention was for the tool to be brief, clear, unambiguous, individually completed, easily analysed, and completed in under 15 minutes requiring minimal assistance or explanation. The new tool was piloted with Year 8 students, similar 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, but there were students for whom some negative items were confusing. We were also surprised with some wordings that proved difficult (e.g., suburb). We adjusted the wording of the negative items, and adjusted the protocol for administering the tool to allow explanations of words that were not clear.

Responses to the amended tool were sought from students in year 8 (age 13) in three government secondary schools in a regional city in Australia. There were a total of 95 responses, 54 male and 41 female, with 15, 41 and 39 from the respective schools. The low numbers was due to difficulties in convincing students to return the parental consent forms, and our desire to restrict the overall number of classes involved. The schools served predominantly lower socio-economic families. Although the city is prosperous, the school buildings are dilapidated. Overall community infrastructure is good, and there are ample further education and employment possibilities for school leavers.

Three students from each class were interviewed to verify their responses to the tool, and we conducted sessions with the students, in the form of a research seminar, to show them the results and to hear their reactions.

RESULTS

The results presented here are from items addressing the three interesting results from the earlier study: the students' perceptions of their own effort; the influences on that effort including the negative influence of their peers; and their future career aspirations. In the tables below, the six response options (strongly agree, agree, slightly agree, etc.) have been reduced to four for ease of presentation, preserving the extreme responses. There was no attempt to quantify confidence in the instrument overall, such as using Cronbach Alpha, since the item pairs were addressing quite different constructs. We present correlations between the respective pairs of items and their significance is discussed in the final section.

Students' confidence and effort

Table 1 presents responses of students to the items relating to confidence. In this, and in subsequent tables, the data represent the number of students.

Table 1: Self perceptions of confidence (n=95)

	Strongly agree	Agree	Disagree	Strongly disagree
I feel confident I can learn most things in maths	25	64	5	1
I feel unsure that I can learn new things in maths	4	19	56	15

The items were significantly correlated ($r = -0.28$, $p < 0.05$). These students seem confident in their ability to learn mathematics. This is discussed below.

Table 2 presents the items seeking their self-perception of their effort, and also the items on how they felt their effort would be reported by friends.

Table 2: Perceptions of effort (n=95)

	Strongly agree	Agree	Disagree	Strongly disagree
If the maths work is hard, I don't make much effort to learn it	3	20	58	14
If the maths work is hard, I nearly always put in a lot of effort	20	59	13	2
My friends would say that I keep trying when our maths work gets hard	8	55	25	6
My friends probably think I give up quickly when maths gets hard	8	23	45	18

The first pair was significantly correlated ($r = -0.49$, $p < .05$) but the second pair was not. The majority of the students report that they try hard, but there are some who do not think that their friends would agree. It is worth noting that, on a different item, the students gave a strong commitment to an *incremental* view of intelligence, with 92 students agreeing (with 42 strongly agreeing) with the statement "Anyone can be good at maths if they put their mind to it".

These students' results are similar to the previous study. In this case, we did not seek teacher ratings of these self-perceptions of confidence and effort. Yet, the teachers at these schools report low achievement and significant difficulties in engaging students in learning. 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.

Influences on effort

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 was negatively influenced by their peers. Since this was an important and unanticipated result, we included a number of further items that sought responses on this issue on the present questionnaire. Table 3 summarises the responses to the prompt "Tick the statement that best describes your maths class".

Table 3: Student perceptions of the effort of their class (n=95)

	Frequency
All try their best	9
Most try their hardest, a few could try harder	46
A few try their hardest, most could try harder	26
All students could try much harder	12

Over half of the students report that most of their peers try hard. One school had significantly more responses in the upper categories than the other two schools. Overall the students report a positive orientation to effort for their classmates.

There was an open 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 larger categories and the number of responses can be summarized as:

lack of motivation (22)
dislike of mathematics (17)
boredom (16)
difficulties with understanding of the mathematics (15)
desire to be popular (11)
lack of sense of future (9).

Even though the "desire to be popular" response had a lower frequency than in the previous study, we suspect teachers should be aware of this factor and act to address it.

There were six Likert items that sought responses related to influence of the class on the effort of others or themselves. Table 4 summarises the items and the responses that seek information about other students.

Table 4: Influences on the effort of other students (n=95)

	Strongly agree	Agree	Disagree	Strongly disagree
Generally the students who try hard in maths have a lot of friends	1	20	54	16
In my maths class, some students don't try hard because they are afraid of what other students might think of them	19	45	27	2

The items were not significantly correlated. It seems that these students do not connect effort in mathematics with popularity, and that they feel that there are at least some students who do not try for fear of others' reactions.

Interestingly, the data in Table 5 suggest that most students do not see peer pressure or the class as being influential on themselves.

Table 5: Influences of their own effort (n=95)

	Strongly agree	Agree	Disagree	Strongly disagree
I would try much harder in a different maths class. This class holds me back.	4	17	59	14
I am able to try my hardest in maths. The rest of the class doesn't make any difference to me	19	63	12	1
Sometimes I don't try as hard as I could in maths because I am worried what other students might think of me	3	20	49	23
In maths, I try my hardest no matter what the other students think	22	61	10	2

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.

In open format, the 95 students were asked "What can be done to encourage (the students who don't try hard) to do their best in maths?" The main responses were categorized as (in our words):

making it more enjoyable (40)
giving feedback and assistance (24)
having better classroom discipline (10)
connecting study with the future (7).

This seems like appropriate advice and is considered further below.

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?"

Thirty-two responses were categorized a "professional", including such responses as ICT (7), veterinarian (6), lawyer (4), and small business (4) (none wrote "teacher").

The other 63 responses, described as "non professional", included entertainment (10), beauty (9), sports (5), military/police (5). There were 13 responses that indicated they did not know what career they would pursue. These were included in this category in that it is assumed that lack of a specific career aspiration would not be a positive motivating influence for learning further mathematics. Likewise, the nine students who indicated a particular trade were included in the "non-professional" category. 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.

There were two items in the Likert section of the survey that addressed career aspirations. These are presented in Table 6.

Table 6: Effort and job opportunities (n = 95)

	Strongly agree	Agree	Disagree	Strongly disagree
Trying hard in maths will give me more future job opportunities	52	37	3	1
Whether I try my best or not, it won't make any difference to my job opportunities	4	18	46	23

The responses were significantly correlated ($r = -0.32$, $p<0.05$), and 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 trade apprenticeships for trades.

To investigate this further, we cross tabulated the responses of the 25 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.

We also cross tabulated the career responses with those who strongly agreed with the statements "If the maths work is hard, I nearly always put in a lot of effort", and "In maths I try my hardest no matter what the other students think", but students with professional aspirations were not more likely to choose these than the others.

FURTHER VALIDATION OF THE TOOL

There were two additional aspects to the research that are only briefly summarised here.

First, we interviewed three students in each class: one identified by the teachers as a high achiever, one as a low achiever, and the other in between. The interviews indicated that the low achieving students experienced difficulty in some cases with the negative forms of the items, and gave the opposite response to what they had intended. Generally though the students interviewed endorsed their responses overall, and it seems that the tool did give insights into most students' thinking on these issues.

Second, we met with the classes of the students who responded (even though not all students had done so). The intention was to present the results to the students in the form of a "research seminar" and to seek their responses. We found that some students had difficulty interpreting basic histograms, and that the graphs of the negative items were very difficult to interpret. We explored in particular the items addressing their confidence and the influence of peers. In class discussion the students reaffirmed their confidence that that can learn mathematics, but we were not able to stimulate discussion on the possible negative influence of peers, even with considerable assistance from the class teachers. Both of these responses could have been anticipated.

DISCUSSION

It should be noted that the smallish number of responses is due to stringent procedures for seeking parental approval, and this process may have biased the sample. Nevertheless this potential bias makes the results more critical, in that the students who did return the ethics approvals 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 measure these variables accurately even after the revisions of the wordings. Alternatively, 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.

A second result is the influence of peers. Most students acknowledge a negative influence of peers on others, but deny that it influences them. Nevertheless it seems that there is a substantial minority of students for whom this factor is a negative influence.

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 school. The positive extrinsic motivation that could be derived from career aspirations associated with further study would be applicable in only a minority of cases.

For each of these three aspects of learning it is important that teachers are aware of the responses that their students would give. Indeed one of the goals of the research was to explore whether the tool could assist teachers in gaining insights into their students' self-goals. The hypothesis is that if teachers are aware of the orientations of their students they can intervene positively in some way. 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 for teachers to enhance positive self-regulatory responses 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.

With respect to the tool, one of our goals was the creation of a written response survey that is simple to use and interpret. Based on the above analysis we propose that only positively phrased statements be used. Most of the paired statements were positively correlated, and the negatively worded items did not seem to contribute to the analysis, and may have created ambiguity in the responses of students with reading and/or comprehension difficulties. The positive items overall

seemed to allow insights into students' perspectives, although there is a need for further work on items that explore students' self perceptions of effort and confidence.

REFERENCES

Ames, C. (1992). Classrooms: Goals structures and student motivation. *Journal of Educational Psychology, 84*(3), 261-271.

Bandura, A. (1997). *Self efficacy: The exercise of control*. W. H. Freeman & Co., New York.

Beavis, A., Curtis, D., & Curtis, N. (2005). *What do students think of work? Are they on the right page? Junior secondary school students' perception of the world of work.* Sydney: The Smith Family.

Brophy, J. (1983). Research on the self-fulfilling prophecy and teacher expectations. *Journal of Educational Psychology, 75*(5), 631-661.

Clarke, D. J. (2005). Essential complementarities: Arguing for an integrative approach to research in mathematics classrooms. In P. Clarkson, A. Downton, D. Gronn, M. Horne, A. McDonough, R. Pierce, & A. Roche (Eds.), *Building connections: Research, theory and practice. Proceedings of the 28th annual conference of the Mathematics Education Research Group of Australasia* (pp. 3-17). Melbourne: MERGA.

Delpit, L. (1988). The silenced dialogue: Power and pedagogy in educating other people's children. *Harvard Educational Review, 58*(3), 280–298.

Dweck, C. S. (2000). *Self theories: Their role in motivation, personality, and development*. Philadelphia: Psychology Press.

Elliot, A. J. (1999). Approach and avoidance motivation and achievement goals. *Educational Psychologist, 34* (3), 169-189.

Hannula, M. (2004). *Affect in mathematical thinking and learning*. Turku: Turun Yliopisto.

Hill, P., Holmes-Smith, P., & Rowe, K. (1993). School and Teacher Effectiveness in Victoria: Key Findings from Phase 1 of the Victorian Quality Schools Project. Melbourne: Centre for Applied Educational Research.

Luther, S. S. (1993). Methodological and conceptual issues in research on childhood resilience. *Journal of Child Psychology & Psychiatry, 34*(4), 441-453.

Middleton, J. A. (1995). A study of intrinsic motivation in the mathematics classroom: A personal construct approach. *Journal for Research in Mathematics Education, 26*(3), 254-279.

Mills, J., & Blankenstein, K. (2000). Perfectionism, intrinsic versus extrinsic motivation, and motivated strategies for learning: A multidimensional analysis of university students. *Personality and Individual Differences 29,* 1194-1204.

Russell, V.J., Mackay, T., & Jane, G. (2003). Messages from MYRAD (Middle Years Research and Development) - Improving the middle years of Schooling, IARTV.

Sfard, A., & Prusak, A. (2005). Telling identities: The missing link between culture and learning mathematics. In H. L. Chick & J. L. Vincent (Eds). *Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education* (Vol. 1, pp. 37 - 53), Melbourne: PME.

Sullivan, P., McDonough, A., & Prain, V. (2005). Student engagement in the Middle Years: Describing influences and possible teacher actions. *Proceedings of the Australian Association of Research in Education Annual Conference.* Sydney, November.