

Sticking With It or Doing It Quickly: What Performances Do We Encourage in Our Mathematics Learners?

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What types of performance do we encourage in our mathematics students? How do these performances reflect students' identity constructions? This paper uses a performance metaphor for identity to analyse interviews with teachers and students in their first year of secondary school. *Perseverance* is valued by teachers, yet many mathematics classrooms appear not to provide the opportunities to persevere and students do not perform identities of perseverance. Rather, *quickness* and *just knowing* the answer are considered part of a successful mathematics identity.

Students around the world increasingly opt out of mathematics learning at higher levels (Black, Mendick, & Solomon, 2009). Although they may be successful in this subject, many do not form positive relationships with mathematics and reject the subject, finding it difficult to merge it with their sense of self (Boaler & Greeno, 2000).

Researchers within mathematics education are increasingly turning to the concept of identity to understand the relationships learners form with mathematics and to explain why so many drop this subject. Mathematical identity refers to the way someone sees themselves as a learner and doer of mathematics. It incorporates views of the nature of mathematics, ways of learning, self concept and perceptions of the personal relevance of mathematics (See for e.g., Boaler & Greeno, 2000; Esmonde, 2009; George, 2009; Hodgen & Marks, 2009). Identity can be understood using a metaphor of performance (Butler, 1988). We perform our various identities in different places and to different audiences. As such, identities are very context specific. How people act as learners of mathematics depends on the context they are in.

After transition to secondary school, students find themselves in a very different mathematics learning context. There are many changes in how mathematics is portrayed to students and in the delivery of teaching (Bicknell, Burgess, & Hunter, 2009). This change in context affects the students' constructions of mathematical identities and leads to sometimes very different types of mathematical identity performance.

In this paper I will explore these questions: What mathematics identity performances do we encourage in our students as they begin secondary school? How might these performances impact on students' understandings of what it means to learn mathematics?

Theoretical Framework

This study draws from socio-cultural perspectives on learning. Mathematics learning, in this view, happens through participation in a social ecology and through the processes of identity development and communication (Esmonde, 2009). This perspective foregrounds the interactions between the individual, culture and society (Grootenboer, Smith, & Lowrie, 2006). Notions of identity here are derived from psychology and anthropology (Holland, Skinner, Lachicotte, & Cain, 1998; Wenger, 1998) and have been widely taken up in mathematics education (Black, et al., 2009).

A contrasting view on identity is that it is constructed discursively (e.g. Lerman, 2009). The stories we tell, the words we use, the conversations we engage in, all speak to our

identity. For some authors a discourse view of identity sees narrative not as a mere window to identity but as the identity itself (Sfard & Prusak, 2005). In other words, we are what we say. For others, stories are the way people make sense of their experiences of being in the world (Boylan & Povey, 2009).

While socio-cultural theories of identity foreground the social context, a discursive understanding of identity focuses on the stories people tell and how these stories fit within wider societal discourses. However not much is written from these perspectives about what a positive learner identity would actually look like, or how it might be recognised.

I adopt a performative view of identity. This is derived from Butler's (1988) work on gender identity and has been taken up by writers within mathematics education such as Chronaki (2011) and Hogan (2008). This view looks at identity using the metaphor of a performance. It is similar to discourse views of identity (e.g., Gee, 2000) in that it attends to what is said and how and why it is said and yet it also fits within a socio-cultural frame in that it considers the influence of culture and society on an individual's performance.

The way someone acts in any given place and at any given time is an expression of their identity. It encompasses what they say and how they say it, what they do and how they interact with other actors on the stage. A mathematical identity is performed in any mathematics context, and the performance is part of that context. Performances are also reflexive. One's identity produces particular performances and these performances work to shape one's identity. Students may perform their mathematical identity through persevering with a problem, putting up their hand to offer an answer or by asking probing questions in mathematics. Conversely they may give up without trying or work silently and individually during class. In these ways students are enacting very different mathematics identities which may highlight different understandings of the nature and learning of mathematics.

The mathematics classroom is the main context within which students perform their mathematical identities. Upon this stage the teacher is a director, co-performer, critic, audience and stage-hand. The teacher has a strong influence on the types of performance students engage in. Yet teachers are in turn constrained by outside influences such as departmental, school and government agendas. All these things shape the stage upon which students perform, and in turn frame students' mathematical identity performances.

Research Design

Late in 2011 I recruited two teachers from two different intermediate schools in a New Zealand city and asked for volunteers amongst their Year 8¹ students to participate in a longitudinal study. I gained 11 students from each class, a total of 22. In November I observed the students during mathematics lessons and interviewed them, asking about their experiences and thoughts on mathematics and expectations for secondary school next year. The interviews were semi-structured and lasted between 15 and 30 minutes. I also interviewed their teachers to gain their perspectives on the participants as learners.

In 2012 the students moved to nine different secondary schools throughout the city, and into 17 different mathematics classes. Early in the school year I observed them in each of these classes and interviewed them about the transition to secondary and their thoughts on learning mathematics in this new context. Halfway through the school year, in term three, I repeated this process, this time also interviewing their Year 9 mathematics teachers. Sixteen of the Year 9 teachers agreed to be interviewed. The study will conclude

¹ Year 8 is the last year of primary/intermediate schooling. The students were aged 12-13.

early in 2013 when I complete one last interview with, and observation of, each student in Year 10.

At each phase of the study I audio-recorded and transcribed the interviews and entered these, along with observation notes, into nVivo. Here I conducted a thematic analysis (Braun & Clarke, 2006) on each section (the different participants and time periods) of the data and compared and contrasted the themes within and between each section.

Results and Discussion

Three key themes emerged from the thematic analysis of the interviews with Year 9 mathematics teachers. These were perseverance, confidence and asking questions. These themes were drawn not in response to one particular question, but at different places in the interview. Questions such as: “What do Year 9 students need to do to be successful in maths?”, “What advice would you give to a Year 8 teacher of mathematics?”, “Describe for me the perfect lesson”, “What is the most important thing for a Year 9 student to learn?” elicited various responses relating to the teachers’ impressions of what made a successful mathematics learner. Of the 16 teachers interviewed, 14 mentioned the importance of asking questions, 12 talked about confidence as being an important quality in a learner of mathematics and 10 of the teachers talked about qualities that I have grouped together as ‘perseverance’ in learning mathematics. For the purpose of this paper, I will discuss perseverance, as it not only contrasts with the students’ comments but it also contrasts with the nature of the experiences offered to students in most of the classes.

What the Teachers Said

The teachers spoke in different ways about perseverance and used different terms to refer to this idea. This indicates that the notion of perseverance is not deeply embedded in teachers’ vernacular in the same way as that of confidence or asking questions. However, all of these teachers spoke about it as something very desirable (and ultimately somewhat lacking) in learners of mathematics.

Many teachers spoke about wanting their students to firstly make an attempt at the mathematics and to not give up. For example:

“...I think they need --- to engage with it ... not just say, oh, I can’t do something...” (Teacher D)

“See for me it’s – they can’t give up ... that’s what I find really frustrating – kids that, you know, --- before we get down to even trying, they’ve given up.” (Teacher I)

“... I think mainly [the most important thing is] um, resilience, you know, not giving up”
“... and with that, of course is, is perseverance as like, well actually I can’t do that so I’ll have another go at it, I’m going to keep going until I sort it out.” (Teacher J)

Linked to this is the impression that if students find the work too hard, then they will not attempt it:

“They think, ‘oh it’s too hard, I can’t do it,’ and they don’t start.” (Teacher L)

“They just assume that because ‘I don’t know it straight away, I don’t know it,’ and they don’t give themselves a chance to actually think through it to process it and find a way to understand it” (Teacher O)

“... when she finds something difficult, she doesn’t know what to do, she doesn’t know what path to take.” (Teacher B)

Other teachers talked about wanting students not to be afraid of making mistakes and to use them as a learning experience:

“[The most important thing is] that they can make mistakes and learn from their mistakes. It’s ok to make mistakes. Yeah, I think that’s very important - and to learn from them” (Teacher C)

“So if [students] have an appropriate response to failure, they're more likely to learn. Whereas if they beat themselves up every time they get something wrong then they don't learn and they become afraid to ask questions, and afraid to try because they might get it wrong.” [Teacher G]

“[The most important thing for a Year 9 student to learn in maths is] it’s ok to make mistakes. Yeah. Um, and it's ok if you don't get it the first time” (Teacher O)

In summary, the teachers spoke about wanting students to give it a go, to try, not think it is going to be too hard and not be afraid of making mistakes. It suggests they interpret these behaviours as being part of a successful mathematics learning performance.

Yet interwoven in the teachers’ discourse is the implication that many students do not persevere. Other research has found children as young as Grade 3 (Thom & Pirie, 2002) and in Year 8 (Sullivan, Tobias, & McDonough, 2006) to be willing and able to persevere with long difficult problems given the right situation. This begs the question, why do these teachers think their Year 9 students do not (or cannot) persevere? A possible answer to this question comes from the observational data: many lessons do not provide the sort of mathematics in which perseverance is required.

What Happened in Class

My observations of the Year 9 mathematics lessons did not, on the whole, reflect the valuing of perseverance in mathematical problem solving. The majority of teachers delivered mathematics content in small bite size pieces. Explanations were made through step by step procedures and problems given seemed to emphasise quantity over quality.

To promote perseverance students need to be given a problem that they can actually persevere with. For example Boaler’s research at Railside school found students developed a willingness to persist when faced with challenging problems (Brodie, Shahan, & Boaler, 2004). I observed 34 Year 9 mathematics lessons and in only four of these lessons were the students given a problem to solve that took up the entire lesson. All the other lessons consisted of numerous short answer problems.

To illustrate, a typical lesson begins with a “Do now” problem that students are expected to complete as soon as they enter the classroom. After a short time period the “Do now” is marked and the lesson proper begins. The teacher gives a short explanation and demonstration of the new skill or concept to be learned and this is followed with the students completing a large number of similar questions from a worksheet or textbook. Students raise their hand if they have questions and the teacher roams the room giving assistance where required. I observed this lesson format in most of the classes and students described this format to me when I asked what mathematics lessons were usually like. In order to be successful students are required to complete a large number of short answer questions quickly. Similarly Schoenfeld (2010), in a survey of 12 high school mathematics classes, found students considered an average of 2.2 minutes to be a reasonable amount of time to work on a mathematics problem. The message given by their mathematics learning experiences was that if a problem cannot be solved in a few minutes, they should give up.

If teachers value perseverance as much as the interview data would suggest, why is this not usually reflected in their pedagogy? The exam culture may be in part responsible for this. Teachers face pressure to get through a huge amount of content, despite the first national assessments not occurring for another two years in Year 11: “... we've still got to cover the same content to prepare them for Year 11, so it's kind of like, you don't get that time to really enforce that understanding that they kind of need.” (Teacher O).

Another possible reason for the disparity in teachers' talk versus enactment may stem from a belief that their students arrive in Year 9 with negative feelings about mathematics:

"I mean at the beginning they have a lot of fear of um, math." – (Teacher A); "... at the start of the year he was very afraid to --- get it wrong I suppose." – (Teacher L); "... maybe he has got a fear, -- - maybe from his past experience." – (Teacher E); "... he's not as ... not as frightened as he was at the beginning of the year." – (Teacher F);

"... when they come to Year 9 --- a lot of them already have a dislike of maths." - (Teacher C); "... so they get this um, hatred of it from a very young age." - (Teacher I)

However, the perception of fearing or disliking mathematics conflicts with the National Education Monitoring Project findings that mathematics was the third favourite subject surveyed, chosen by 30 percent of Year 8 students (Crooks, Smith, & Flockton, 2009). Despite such findings, it is the teachers' own perceptions that appear to be influential on their practice:

"I don't want to make it too hard so they'll stop liking it and think they're not good at it." (Teacher N)

"[They say:] Oh I hate maths, I'm not good at maths, I don't like maths. As teachers we have to change that thinking, everyone can do maths, honestly, everyone can do maths." – (Teacher B)

"And they look at the too hard thing and they won't even try the stuff they can do, they go, oh, it's too hard! You know, so you try and avoid frightening them I s'pose". – (Teacher D)

These comments hint at the ways in which teachers may adapt their pedagogy in order to alleviate the fear and loathing they perceive in their students. The step by step approach to teaching, and giving students short answer problems, may be a way of avoiding "frightening" the students and helping them to realise that "everyone can do maths." During interviews, however, and supporting the NEMP findings, the majority of the students did not perform negative mathematics identities of fear or hatred; they were generally quite positive about the subject. Perhaps this perception of the teachers comes from wider societal discourses about mathematics.

What the Students Said

What understandings then do students have regarding learning mathematics at secondary? No student in any of the first two interviews talked about how they might learn from their mistakes in mathematics or of the importance of persevering in mathematics. In the third phase of interviews I asked the students directly: "When you come across something in maths that you don't know how to do, what do you do?" Just four of the 22 students said they would try again themselves to work it out; everyone else said they would either ask the teacher or ask a friend for help. This does not mean, of course, that most never tried to work it out themselves, rather the answers suggest that even if the teachers are trying to promote perseverance, the students do not seem to consider this performance an important part of being a successful mathematics learner.

What the students did more commonly say about successful mathematics learning was related to speed and just knowing the answer:

"Yeah, he's so, he's so good at maths, I don't actually see him do his maths but he's always finished before everyone else and stuff. He's quite quiet but he's so fast." (Student 1); "[He is the best at maths] 'Cause [he] gets through it really fast." (Student 13); "Pretty much as soon as the question's up they take about ten seconds to figure it out and they can do it in their heads." (Student 5);

"And they, um, they just always seem to know the right answer." (Student 2); "...she always, like, knows what the answer is." (Student 3)

These comments and others suggest students interpret speed and knowing the answer as indicators of ability in mathematics. The valuing of speed in mathematics is not unique and has been found by other researchers such as Solomon (2007). At no point did students answer the question: “How do you know he/she is good at maths” with a response crediting the classmate’s perseverance. The impact of this may be that if students are not fast or if they do not ‘just know it’ then they construct for themselves a negative mathematics identity. The performance constructs the identity as much as it reflects it.

Such talk also reflects students’ understandings of mathematics. This was evident in their dichotomising of mathematics as easy or hard. Students often referred to the mathematics tasks as either being easy or hard but not much in between. In one observation I watched a student repeatedly comment on how easy the problems were as she applied her knowledge of multiplication facts to simple area problems. As soon as a compound area problem was given she loudly stated that it was too hard and did not participate in the rest of the lesson. This suggests a belief that mathematics is something you either know or do not know, as opposed to a view of mathematics as being something you need to work at, to make different attempts upon, and to problem solve.

Equating the idea of a quick performance with being successful, works against a performance of perseverance. One teacher reflected similarly:

“Because everyone thinks at different speeds. And I think what happens a lot of the time is their neighbour will catch it straight away and so they’ll give up and think, ‘oh, I’m not going to get this’. Whereas they probably would get there and they would get to that same level, they just need a little bit more time.” (Teacher O)

Conclusion and Implications

Many teachers in this study commented on the importance of perseverance in a successful learner of mathematics. However perseverance is not nearly so evident in the students’ identity performances and it does not appear to be promoted by common classroom experiences. There are many things affecting the stage of the classroom upon which students perform. Possibly the exam culture of secondary school forces teachers to ‘cover’ a huge amount of content and leaving no time to give students to persevere on problems. Some students may arrive with a fear or loathing of mathematics and teachers may feel the need to alleviate this. We need to look at wider societal discourses of mathematics, discourses that value speed and knowing the answer. We also need to pay further attention to the ways in which students dichotomise mathematics into easy versus hard, leading to a belief that either you know it and can do it – or you do not know it and cannot: mathematics is done quickly or it is just impossible.

However, we must still consider the implications of these findings at a classroom level. Perhaps teachers need to embrace the idea of mathematics as slow and, whilst difficult at times, still possible. Mathematics from the earliest levels could perhaps include long convoluted problems and teachers could highlight for students the complexities of doing mathematics at all levels. For example Devlin (2010) discusses Pascal’s letter to Fermat regarding the difficulties Pascal was facing in solving the Unfinished Game problem. He argues for using this correspondence in the classroom to show students how even professional and famous mathematicians do not necessarily get it right the first time and that the secret is to just keep trying and learn from your mistakes. He concludes by noting that:

The Pascal-Fermat correspondence is an excellent teaching resource. It shows students that mathematics does not come easily, even to the world’s best mathematicians; that it can take time and

effort even to understand a problem, let alone solve it; that the experts make mistakes; and that the principal requirement for doing mathematics is perseverance (p582).

As discussed, research has found that even young children can persevere in the right situation (Sullivan, et al., 2006; Thom & Pirie, 2002), but further research is required into whether we can generate more perseverance in mathematics students by either intentionally teaching students how to persevere, or providing more opportunities to encourage it.

Finally when considering the ways in which we can ensure our pedagogy reflects our beliefs about perseverance, we should also pause to consider other desirable mathematics behaviours. As well as confidence and asking questions, what else do we value in our mathematics students? Consider for example argumentation, justification and creativity. Most important, however, is the question: do we enable our students to enact these performances which we purport to value?

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