Children Talk About Their Mathematics Lives

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In their own words, ten children whose mathematics careers were tracked from the beginning of their third year at school, to the end of their fifth, describe their experiences of learning of mathematics within the social world of the classroom. Their statements contain both cognitive and affective dimensions. A model linking these two domains, demonstrates impacts of everyday mathematics routines. Suggestions are made for changes in teaching practice to more effectively meet children's social and cognitive needs in learning mathematics.

For many decades, there has been interest in, and debate about, the relationship between affect and achievement in children's learning of mathematics. (Aitken, 1970; Antonnen, 1969; Dutton, 1954; McDonough & Clarke, 1994; Ma, 1997; Mandler, 1989; Renga & Dallas, 1993.) It appears that this interest arose from a perception that those children who most enjoyed mathematics were also the ones who were most successful. This perception was given some credence in the report of the New Zealand results of the Third International Mathematics and Science Study on the performance of Year 4 and Year 5 students (Garden, 1997) where it was reported that:

> While a majority of students have positive attitudes to learning mathematics … it appears that from a fairly young age there is an increasing proportion of students having lost interest in the subject, with a concomitant decline in their achievement. This effect is considerably greater for girls than for boys (p.252).

This statement became the focus of the research upon which this paper is based. Clearly there was a need to investigate the link between 'losing interest' and 'decline in achievement' and to map this phenomenon by studying case histories of individual children, in order to better understand when and how it might happen. Ten children were randomly selected from a range of schools in Wellington, New Zealand. Through classroom observation and interviews, their thoughts and feelings about mathematics were tracked from the beginning of their third to the end of their fifth years at school.

Introduction

Individual children learn mathematics within a social context. From the time they start school, children enter into a social world of routines and patterns that come to define for them, not only the meaning and purpose of that world, but who they are themselves. Through their longitudinal case-study research, Pollard and Filer (1999) have described the social world of *pupil career* by compiling biographies of individual children as they negotiated their way through the social world of school. They showed how individual children struggle to create an identity, to maintain self-esteem, and to gain kudos even when the routines and rituals of their social world undermined them. They show how children create for themselves a *meaning framework* that allows them to navigate their way through the everyday patterns of the school community. They demonstrate that children adopt *strategic* behaviour so that they may be seen to be part of the class, not to be out of the ordinary, and successful in the eyes of peers and teachers.

Mathematics teaching and learning is part of this social world. Children negotiate meanings for themselves through interaction with others in the everyday rituals and routines of mathematics lessons. Children's meanings include beliefs about what mathematics is and why we learn it, and beliefs about themselves, their perceived competence and causal attribution for personal success or failure.

Examples of rituals observed in the majority of the thirty-five study classrooms visited during the research, were: standard expectations for setting out of exercise; teacher emphasis on neatness; speedy production of answers to questions supplied by an authority such as the teacher; test paper or textbook; answers judged as either right or wrong; marking of children's 'work' with ticks or crosses.

Mathematics lessons often followed a regular routine such as starting with a whole-class Quick Ten, followed by small ability-group lessons with the teacher, moving on to individual written exercises, marking of work on completion, and then a whole-class basic facts game to finish.

The children in the study group responded in varying ways to these rituals and routines as they constructed meaning and negotiated identity. Georgina, Fleur, Jessica, Liam, Jared, Peter and Mitchell talked about loss of confidence and were at varying times quite negative about aspects of mathematics during the three years of the study. Rochelle, Dominic, and Toby remained confident and positive for most of that time.

Georgina's case will be examined in some depth. Her own words will be used to illustrate important connections between how she felt about mathematics, the nature of the rituals and routines of the social world of mathematics in her classrooms, and learning.

Georgina

"I hate maths because I only get three or four because it's really hard."

These were the first words heard by the researcher from seven-year-old Georgina. She was talking about the Quick Ten, an everyday event in mathematics lessons in her classroom. For her, this daily ritual became the single most important gauge by which she measured her enjoyment of mathematics and her competence in the subject. Over the three years of the study, Georgina attended two different schools. Every one of her teachers routinely began their lessons in this way, with slight variations. The Quick Ten consisted of ten arithmetic calculations that were to be recalled or performed mentally with written recording of answers. Sometimes the questions were posed in rapid succession by the teacher, sometimes written on the whiteboard, and at other times provided for children on printed test papers. In each case, the questions were to be answered within a given time. No discussion between children or use of concrete materials was permitted. Georgina appeared very anxious at these times. She was observed deploying a range of strategic actions during the Quick Ten. These included counting ineffectively on her fingers, attempting to read answers from the times table chart on the classroom wall or from someone else's work and being told off, shrugging and just writing any answer, finishing quickly to appear more competent, and giving false information when the teacher asked children to share their scores. Although this was a daily ritual, the regular testing did **not** appear to help Georgina to memorise the basic mathematics 'facts' or develop efficient strategies to derive answers. Her exercise books tells the story – usually less than 50% day after day.

As Georgina spoke about her experiences of learning mathematics, the significance of such everyday routines on her beliefs about mathematics and her feelings towards it,

emerged. This history can be traced through Georgina's comments collected during nine separate interviews over the three-year period.

Year Three (aged seven – eight years):

> Mr T claps his hands and says, 'Get out your maths books and set up one to ten'; I hate maths because I only get three or four because it's really hard; I really want to win (maths Lotto game) and be the first one out to lunch. I've never won; I'm not very good at taking away 'cause I haven't got enough fingers to count; Only me and Hannah, she always gets it wrong and has to catch up and copy me (in response to question about who is not good at maths in the class); I've learned to do, like, one plus one, two plus two. And it's just hard to get some other maths things like sixteen plus sixteen. That's hard!; I don't like maths much 'cause we do hard things and we have to do it. I just look at the paper and go 'Hmmm' (she sighs deeply) and I get told off. I don't like getting told off.

Year Four (aged eight – nine years)

> Ugh! We have to do this twenty or ten question thing and Mrs Cayo calls out the questions and you have to write the answer and she goes really fast now and I can't do it; I never get my basic facts right; It (maths) just gets annoying, and stuff, like some stuff's really hard for me and I can't do most of my times tables; I just try to learn them but I keep forgetting them; I feel dumb; (in response to how she feels about not knowing); Sometimes I get them wrong and the teacher shouts at me; I missed some out but I got the rest right, but I thought that if I bring it up to the teacher I would get told off so I don't do that; When I draw on the board (in front of the group) I can't sometimes … can't remember and I get it wrong; I liked it when we used this thing with three stalks and these miniature rings (three-bar abacus); I liked doing these scoops of water out of the bucket and finding out how many.

Year Five (aged nine - ten) years:

> On Mondays we have to do this thing. It's got eighty questions and it's got, like, eight times nine and stuff like that. And you have to start doing that and you have to do it under seven minutes. We've got this grid (multiplication array) and it's got, like, seven times seven equals forty-nine, that's the only one I know; We start maths by doing ten or twenty questions down here. But I don't like maths tests 'cause I mostly get like sixteen out of twenty. Lots of other kids get twenty; I think I'm going to get most of them wrong; I don't like stuff that's really, really hard and I don't like it when I have to stay on the mat and the other kids can go off; You only do that (play maths games) if you finish early. That never happens for me; I'm not that good at it (maths) because some things I don't know, like I have to go up to the teacher all the time because I don't get what it's saying (textbook); Well when we were doing fractions it was really hard for me and I didn't get it and they (other children) were going , 'Oh yeah I know that one,' and they got it straight away and they were correct. I had to, like, lie and say …like, there was this one person, there's this girl Carina, she sits next to me and she gets it right all the time and …yeah, 'cause when she goes, like, 'Seven', I just put up my hand and say, 'Seven', 'cause otherwise I'll be just sitting there and I don't know and the teacher will go, 'Georgina', and I'll just sit there going 'Oh, um… .' When I work by myself I get really bored, 'cause, like, I don't really get it … I ask them (other children) the question; The problem solving (done on Fridays) I don't get them, 'cause they're really hard; We need to have more time, like we have half an hour on maths time and we don't hardly have time to do it.

There are significant recurring themes in Georgina's statements: 'not getting it', the 'hardness' of the tasks, anxiety about getting answers wrong, feelings of humiliation (getting told off, feeling dumb) and exclusion (having to ask others, never winning, being left on the mat) when unable to complete tasks or understand concepts as easily as other children.

When Georgina changed schools at the beginning of her fifth school year, her attitude to the Quick Ten became more positive when she was allowed the support of a multiplication array. This removed some of her anxiety and stress by allowing her access to answers but did not address the cognitive barriers that had been the major hurdle for her all along. She still did not understand the mathematics

Appropriateness, Accessibility and Affect

The everyday mathematics routines in Georgina's classrooms, such as the regular activities for the start of the lessons and for certain days of the week, had shaped for her the belief that mathematics was primarily about working alone, knowing facts and producing correct answers. Georgina was excluded from success in these activities because of the difficulty of the tasks for her. Georgina attributed her lack of success to the 'hardness' of the tasks rather than her own lack of ability. For three years, Georgina had frequently said, "I don't get it", because for her there was all too often a mismatch between the degree of mathematical skill and knowledge required of tasks and her Zone of Proximal Development (Vygotsky, 1962). The key issue here is one of cognitive accessibility.

Because 'getting them right' was reinforced daily, Georgina had become fearful that she would 'get them all wrong' on account of the difficulty of the questions, and in so doing 'get told off' by the teacher or suffer public humiliation in front of her peers. She had developed strategies to reduce or conceal her failure in order to protect herself from further emotional damage. During mathematics lessons, therefore, Georgina experienced considerable pressure to maintain self-esteem.

The activities she mentioned as having particularly liked were practical, either using equipment such as the three bar abacus to model three-digit numbers and a bucket of water measured in scoops, or involving some kind of drawing or visual representation such as bar graphs, symmetry and coordinates. Because these were not a regular part of the everyday program, they appeared to her more as special highlights rather than real maths.

Georgina's statements carry important clues about her response to the mathematics rituals of her classroom. They tell us about her degree of comfort or enjoyment, (affect) and also about how well she is able to understand the mathematics being taught(cognition) and there are significant links between the two. The following model (Table 1) has been devised to demonstrate these links.

The table divides mathematics activities into those that are *socially appropriate* and those that are *socially inappropriate*. A socially appropriate (SA) mathematics activity is defined as one that, for a particular individual, is both enjoyable and emotionally safe. Enjoyment may be derived from the degree of meaning and purpose the activity holds for that individual and from the style of the activity itself, such as use of equipment. Emotional safety may be derived from working with trusted peers, receiving appropriate support and engaging in tasks that are within the individual's capabilities and comfort zone. The term 'socially appropriate' has been chosen to describe activities that are well-matched to the interests and dispositions of individuals within the social setting of the classroom and as members of the classroom community. When considering the needs of an individual, it is also necessary to take account of that individual as member of other communities outside the school such as whanau[1] groupings or religious organisations. A combination of these

[1] Whanau is the traditional New Zealand Maori term for family, often meaning extended family

factors contribute to the social appropriateness of any given activity for a particular individual.

The table also categorisies mathematics activities by accessibility, dividing them into those that are within a child's cognitive reach, and those that are not. The table demonstrates that a child's affective responses are a product of the interplay between *cognitive accessibility* and social appropriateness.

Table 1
Social appropriateness and cognitive accessibility of mathematics activity types, and student affect

Mathematics Activities	Cognitively Accessible (CA)	Cognitively Inaccessible (CI)
Socially Appropriate (SA)	Strongly Positive affect (enjoys the task, and understands the mathematics) Example: The abacus activity for Georgina.	Positive affect (enjoys the task, but does not understand the mathematics) Example: The Quick Ten with array support for Georgina.
Socially Inappropriate (SI)	Negative affect (does not enjoy the task but understands the mathematics) Example: Having to stay on the mat with the bottom group while the other children go off and do different work, for Georgina.	Strongly Negative affect (does not enjoy the task and does not understand the mathematics) Example: Quick Ten without support for Georgina.

It must be noted that these activity types are identified by the feelings they produce for a particular child. An activity that is SA/CA for one child may be SI/CI for another.

A SA/CA activity is one that is non-threatening and comfortable for the child. The child might say that the activity is interesting, fun, easy or challenging. The activity is engaging and has extensive meaning and purpose for the child. The mathematics is within reach of the child even though it may be challenging. Support and encouragement is provided. There is the expectation that the child will understand. The child feels happy and successful. The child does not create difficulties for the teacher. Mathematical learning takes place.

SA/CI activities are non-threatening and comfortable for the child but it may or may not have meaning and purpose. The child might say that the activity is fun. The activity is made possible for the child by the provision of crutches such as peer helpers, calculators or answer sheets. The mathematics is beyond the child, and there is no expectation that the child will understand. The child feels temporarily safe because there are no negative repercussions for lack of understanding. The child may keep a low profile. Little mathematical learning takes place.

The SI/CA activity feels uncomfortable, perhaps even threatening for the child. It may also be lacking in interest. The child might say that the activity is boring, or too easy, and might complain of being left out or separated from friends. Although the mathematics is

within reach of the child, and support or even extension maybe provided, the child feels 'different'. There is the expectation that the child will understand. The child feels bored, inadequate or excluded. The child develops strategic behaviour to cope. Little mathematical learning takes place.

The SI/CI activity feels extremely threatening and uncomfortable for the child. The child may complain of worry, nervousness, boredom, not 'getting it', feeling dumb or hating maths. The mathematics is beyond the child even though there may be the unrealistic expectation that the child should understand. There is inadequate support or encouragement for the child. The child feels a sense of failure. The child feels angry and/or sad. The child develops strategic actions to cope. No mathematical learning takes place.

In Georgina's case, Quick Ten was an SI activity because it made her feel anxious, inadequate, and desperate to avoid public exposure. It was also CI because, given the time constraints, absence of concrete materials, and her lack of understanding of some of the questions, she was unable to produce the answers. On the other hand, activities where she was using real things to do maths and working in groups she found non-threatening, interesting and enjoyable. (SA). When the activities were SA/CA for her, the positive affect was maximised. However, when she was singled out to do special work with the teacher, the task was made accessible, but she was unhappy at being treated differently to the others so the approach was socially inappropriate for her (SI/CA).

The research revealed that Georgina spent a significant proportion of the daily routines and rituals of her mathematics lessons engaged in activities that were, for her, SI/CI. So not only is the type of activity important, but also the frequency of the activity and the value it appears to have for the child.

It is hardly surprising that mathematics had become one of Georgina's least favourite subjects. By the end of her fifth year at school, she said that she doubted whether she would enjoy mathematics at secondary school or ever pursue a career requiring mathematics.

The Other Children

When Fleur talked about mathematics, she too reveals the negative affect associated with a daily diet of SI/CI activities. As with Georgina, these made up the greatest proportion of her everyday learning experiences.

> Fleur: I feel nervous.(written tests); There's, like, two seconds to know them. (Quick 20) It's terrible; I think, 'I'm going to get all these wrong' "(written tests); Ugh! Maths is hard. It's just too hard. I find it really hard; I'm a bit of a slow learner. They're quick. (Other children) I'm quite a bit slower. Because I struggle. They know a bit more and what they're doing. They get the point of it all; Well usually there's a few of us who don't understand, so, we, um, so some of us get up the courage and put our hand up, and sometimes she can be nice, sometimes she can be mean. She goes, 'Well you shoulda listened!' We don't see where we've gone wrong. She's not patient with us; I usually need help from the teacher; We had to do a whole lot of maths questions, there was piles of everything and the questions – 'How much would it cost for three hot dogs if they were two forty cents each?' It's boring; If it was easier and not as tricky, not too easy but not too hard, like I can still do it. But when it's too hard you've got to think and think.' (SI/CI). I like coordinates, graphs and money because they're easy and fun. (SA/CA).

After a year of SI/CI activities, Jessica went to a school where the children were cross-grouped for mathematics. While the mathematics content was now accessible because she was put into one of the 'lower groups, she was not happy.

Jessica: I don't really enjoy it (maths) that much; Maths is pretty boring; Well, we get split up from our friends. I like being with my friends. I'd like it if we did it together. I think it'd be quicker and easier. (SI/CA).

Most of the time, Rochelle experienced SA/CA mathematics activities and therefore felt comfortable and confident with the everyday mathematics of the classroom,

Rochelle: We did this maths test and I got it all right; We start off with Daily Twenties. I like that because you get to answer questions; It's pretty easy. (SA/CA).

Although Rochelle was able to learn by rote, memorise and follow rules, it was observed that she had trouble solving even quite simple non-routine problems. Cognitive demand was usually limited to rule-following, so too was her learning of mathematics. The strongly positive affect associated with SA/CA activities does not guarantee the development of understanding of mathematics. If Rochelle were suddenly confronted with mathematics activities requiring understanding and flexible thinking, they would almost certainly prove SI/CI for her and her confidence could plummet.

Toby and Dominic were very confident with mathematics. They enjoyed the routines and rituals of mathematics sessions, and understood the mathematical content. The activities were mostly type SA/CA for them.

Toby: I feel quite good because maths is fun. We do fun things; I feel pretty good about it. I like being ahead of other people; I like it because I usually get like most of them right; Speed maths – that's my favourite part; (SA/CA). I'd like it if we got more time for tests. (SI/CI).

Dominic: I feel good, really; the easy parts are the Quick Test or the Daily Drill; Maths is challenging; (reason for success) I try and try and don't give up; (SA/CA). Some bits are boring, where we have to make sentences and copy stuff. (SI/CA).

Liam was positive to begin with, but lost confidence.

Liam: It's a competitive thing and I like to compete; (SA/CA). Sometimes I get really nervous when we're having basic facts tests. 'Cause I might get a real bad score. I feel like my legs would shake. Kids might say, 'That sucks,' and, 'you should have got higher than that'; I'm not the best. They get higher scores than me. (SI/CI).

Peter was reasonably confident but endured rather than enjoyed mathematics.

Peter: Maths is OK, it's fun; I'd like to have more time to learn my times tables; (SA/CI). I'd like more maths games and more drawing things; I don't like the extension group. (SI/CA).

Jared struggled in a SI/CI classroom environment but thrived on SA/CA activities when he was grouped for ability with his Year Five teacher.

Jared: (Year Three): Maths is OK.; it's hard; I hate it (Beat the Clock game); (SI/CI). (Year Five): Maths is fun; I'm really good at it; There's one person in the class who's the same as me. We both know all the answers. (SA/CA).

Mitchell, a child with special learning needs, experienced some SA/CI activities, but most of the time, he was painfully aware of the difference between himself and the others.

Mitchell: Bad. I always lose. Cause other kids know and I don't; Sad. I'm supposed to do my times tables and I don't know them; Maths is dumb; (I need) 'Help – from the teacher. (SI/CI).

Conclusion

Student affect in learning mathematics cannot be either discounted as unimportant, sidelined as too complex, or discredited as political. Fennema (1989) stated that, 'we need to know and understand how affective variables relate to and influence important

educational outcomes'. The children in this study provide compelling evidence of the powerful links between learning and affect. Based on their evidence, there can be no justification for mathematics teaching rituals and routines that subject children to emotional distress, or boredom through social inappropriateness or cognitive inaccessibility. When mathematics activities are routinely SI/CA, SI/CI or SA/CI for an individual child, little learning will result for that child. The resulting negative affect may become entrenched and even cause long-term negative impacts. Equally, SA/CA activities that do not stretch the child, will result in limited learning. Teachers need to change traditional rituals and routines when teaching mathematics. They need to: (a) correctly identify each child's cognitive needs and regularly monitor each child's learning; (b) find out how each child feels about mathematics and what works best for them; (c) based on a and b above, provide each child with a regular program of mathematics learning experiences that are both cognitively accessible, sufficiently challenging, and socially appropriate; (d) provide each child with sufficient and appropriate learning support and feedback. Classroom planning needs to be flexible and focused on learners' diverse needs.

This is not easily done. Teachers' resistance to change is vividly illustrated by Fleur's teacher (a young teacher in her second year of teaching) who reflected:

> Normally we start off the day, there's ten questions on the board. I went on a maths course where the lady said, 'Don't do it. Don't put questions on the board because if they don't know it, they're going to feel like they're failing, and if they do know it, they don't need to practise it.' And I thought, 'Oh, that might be a really good point,' and I came back and thought about it and then I thought, 'But often it's reminding them of things we've done.'

Until teachers understand the links between the routines of the mathematics classroom, the cognitive and social suitability of the activities, pupil affect, and learning, children like Georgina will continue to say 'I don't get it,' lose heart, and fail to achieve.

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