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It includes articles about curriculum issues, research in the area of curriculum and informed curriculum practice. Reviews of curriculum related books may also be included.

The Opinion item is contributed by a leading New Zealand educationalist.

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- raise important issues to do with the curriculum
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- provide examples of informed curriculum practice
- review books that have a curriculum focus.

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# Four Māori girls and mathematics: What can we learn from them?

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## Children's views about learning

Pupils' voices can help us better understand their experiences of schools and schooling (McCallum, Hargreaves & Gipps, 2000). The UN Declaration on Human Rights states explicitly that children should be given a voice on matters that affect them (New Zealand Ministry of Foreign Affairs and Trade, 1997). The importance of considering how students experience school mathematics programmes is clearly evident in the work of international researchers in recent years (e.g., Star, Smith & Jansen, 2008).

Children's beliefs about a particular subject are entwined with their perceptions of the teacher involved (Alerby, 2003). Children who come to believe that their role in mathematics classes is to be passive and compliant are not likely to feel compelled to engage in mathematics where meanings could be negotiated with their teacher (Taylor, Hawera, & Young-Loveridge, 2005).

## Children and mathematics education

An enriched, high-quality programme designed to foster dispositions such as motivation, curiosity and perseverance enables children to enjoy and participate fully in mathematics learning (Frigo, 1999; Maxwell, 2001). Problem-solving within mathematics requires perseverance and determination. Some mathematics ideas can be a struggle to comprehend, and risk-taking is expected for understanding to develop (Carpenter, McMurchy-Pilkington & Sutherland, 1999; Pendlington, 2006). These dispositions have been identified in the key competencies outlined *The New Zealand Curriculum* (Ministry of Education, 2007a).

Several mathematics education researchers have written about the importance of establishing norms for learning mathematics in the classroom (eg, Yackel & Cobb, 1996; Franke, Kazemi & Battey, 2007). The discussion of key ideas while learning mathematics is an example of one such norm. Appropriate and expected ways to participate in mathematics discourse must be made explicit and overt (Hunter, 2006). This may not be a familiar process for some children (Lubienski, 2007). Hunter argues that children from minority groups can be encouraged to participate in meaningful mathematics discussion. Hunter's research provides examples of Māori and Pasifika children being scaffolded by their teacher to express their ideas to their classmates. The revised curriculum document (Ministry of Education, 2007a) promotes the ideal of having confident, active learners of mathematics, who are able to communicate with others.

Using material and equipment in mathematics programmes can benefit children's learning and assist them to be inventive, confident and independent learners (Ministry of Education, 1992) and recent initiatives in mathematics education support this idea (Higgins, 2005; Ministry of Education, 2007b). However, opportunities for learning mathematics may be limited for children if they develop the view that apparatus is not helpful in supporting their thinking (Kelly, 2006).

## Māori children and mathematics learning

Traditionally, education for Māori was oral, thematic and holistic (Barton & Fairhall, 1995; Riini & Riini 1993) and learning mathematics was integrated into community practices. In recent times, mathematics learning for Māori children has also been in classroom contexts that are complex and multi-faceted. Macfarlane (2004) suggests that many aspects need to be considered if worthwhile learning for Māori children is to occur. Building face-to-face relationships (whanaungatanga) and interactions with teachers are central to Māori educational achievement (Bishop, 2005; Bishop, Berryman, Tiakiwai, & Richardson, 2003; Macfarlane, 2004). Poor relationships with Māori children can result in teachers having low expectations of them, and placing blame for any lack of educational achievement on students and their families (Bishop, 2005).

Caring relationships for Māori (manākitanga) are built upon

trust and respect (Macfarlane, 2004). These relationships, combined with effective pedagogies, can ensure opportunities become available for alternative ways of thinking about mathematics and mathematical problems, and thus different ways of knowing mathematics become possible (Hackenburg, 2005; Silver & Smith, 1996). The concept of reciprocal learning (ako), where peers and teachers interact and learn from each other, is also considered helpful for Māori children (Macfarlane, 2004).

Research evidence clearly indicates that the affective domain impacts on mathematics learning (Biddulph, 1997; Grootenboer, 2003; Leder & Forgasz, 2007; Hawera, 2004). It is not enough to focus just on the mathematics; it is also necessary to consider networks and systems that support the learning process. Any support system must align with learners' cultural backgrounds (Latu, 2004; Macfarlane, 2004; Perso, 2003). Children from a minority group who have high self-esteem can engage in academic activities that ultimately lead to higher achievement (Burris, Heubert & Levin, 2006). To promote self-esteem in Māori children, it has been suggested that learning experiences emphasise co-operation, and that competitiveness and individualism are minimised (Rubie, Townsend & Moore, 2004).

Mathematics education should be an inclusive enterprise (Perso, 2003; Tate, 1997). Some studies (eg, Christensen, 2004; Hawera, Taylor, Young-Loveridge & Sharma, 2007; Hunter, 2006) have indicated that many Māori children do not fully participate in major discussions of key mathematics ideas. Māori have the right to access high-quality mathematics education. Appropriate institutional and pedagogical commitment is important for their mathematics learning (Rubie et al. 2004).

Recent evidence about patterns of performance in mathematics indicates that Māori and Pasifika children are making gains in their mathematics achievement. For example, Young-Loveridge (2007) reported a comparison of effect sizes for students after participation in the Numeracy Project compared with older students before the project had started, showing a slightly greater effect size for Māori students (0.35) than for European (0.33). When compared with their Pākehā and Asian peers, actual levels of achievement for Māori are lower (Young-Loveridge, 2005; Ministry of Education, 2006). However, it is interesting to note that when assessments are made individually with questions presented orally by the child's own teacher (as in the Numeracy Project) instead of whole-class written tests (as in international comparisons such as TIMSS), the differences favouring Pākehā over Māori are substantially smaller (0.17 cf. 0.69) (see Young-Loveridge, 2006).

Little is known about what Māori children themselves see as significant for their mathematics learning in primary classrooms. Knowing more about their views on this might help to illuminate ways in which disparities between Māori and other ethnic groups might be reduced. As Star et al. (2008) have pointed out, research on the impact of programmes on students' mathematics achievement without considering how the students experience these programmes presents only one side of the story.

This paper is part of a larger study that explores the perspectives of students on their mathematics learning. (see Young-Loveridge, Taylor, & Hawera, 2005; Young-Loveridge, Taylor, Sharma & Hawera, 2006). The focus here is on four case studies of Māori girls, and endeavours to highlight factors that may influence their mathematics learning.

## Method

### Participants

The participants were four Māori girls from three different classrooms in mainstream (English medium) schools. The children were in year 5 classes. Three were from decile 1 schools and the other was from a decile 4 school.

### Procedure

Students were interviewed individually in a quiet place away from the classroom. Students were told that the interviewer was interested in finding out more about "how kids learn maths and how their teachers can help them" and "what kids themselves think about learning maths".

Interviews were transcribed for analysis. These girls' responses were selected for this paper because their transcripts indicated interesting insights into their mathematics learning.

## Results

### Case Study 1: Erana

Erana attended a decile 1 school, the sixth school she had attended in less than five years. Erana was confident about her facility with mathematics. She thought that mathematics could be difficult at times, but it would get better if she worked at it. She said she always tried to make sense of the ideas that were being presented.

> *It [mathematics] can be really frustrating and then you just get along. Like you and maths are friends or something.*

Erana considered that mathematics was her "*favourite task*".

> *I love doing maths. At the start, when I started school I thought it was dumb but when I got to know all the numbers and all, I got used to it.*

She said she liked mathematics because she "*got to play with numbers.*"

Erana felt that she did not need equipment to support her mathematics learning, nor did she want it.

> *I just like making them [answers] out of my head. It's because when you are going on to high school they're going to be asking you some questions and you won't be able to use beads probably, and then you'll have to know how to use your brain properly, control your brain.*

She thought that a calculator was not a useful tool for learning mathematics.

> *They're actually cheating. Because they tell you all the answers.*

In Erana's view, the role of the teacher was to help her with each step of her learning. She considered that it was the teacher's responsibility to give out mathematics sheets with all the times tables and answers on them. Erana said that it was a relieving teacher, not the regular teacher who had given her a sheet, but felt her teacher should have made this resource available.

Erana's view of mathematics also incorporated a point about mathematics being useful beyond school.

> *I'd say that maths was a really complicated thing but when you get used to it you might be able to solve problems and if you want to be a banker you can start counting all the money.*

Erana enjoyed talking to other children about how to do their mathematics tasks. She viewed mathematics lessons as opportunities to interact with others, yet believed it to be her responsibility to develop her own understanding of mathematics. Erana liked to help others with their mathematics tasks. This was not a co-constructive activity but one where she was the "*expert*".

Erana thought that being quick to recall answers from, for example, times-tables, was a goal to strive for. She was aware that there could be more than one way of completing a mathematics problem. She believed it was important to know about mathematics ideas for her future. She wanted to succeed at high school, and thought she would be able to do this if she knew some mathematics "*things automatically*".

If she had homework, Erana said no one at home needed to help her because she felt she was able to be independent and did not need any support.

> *Because I can kind of sort them out myself.*

### Case Study 2: Roimata

Roimata also attended a decile 1 school. When asked if she thought equipment might be useful to help her with mathematics Roimata stated:

> *We're not allowed to use counters. The teacher just says to try and do it in your brain and not use a pencil and paper to do it.*

In Roimata's view, a teacher's role in mathematics classes was to:

> *get everybody down and talk to everybody about it and then after she has done that, she will go over it again just quickly. She will ask everyone to do that individually and then they will all tell her, and she will go "OK now. Go and do the sheet."*

Roimata stated that that if she got something "*wrong*" with her answers, it meant that she just needed a little bit of help.

Roimata did not like to make her thinking public to a class in case her responses were incorrect. She said she sometimes felt "*shy*" about sharing answers with others because hers "*might be wrong*". She preferred to work on her own in class. To her, working with a group of other children indicated that she was not succeeding in mathematics. She explained:

> *Sometimes it is OK to work in a group if you really need help, but for a person who does not need help, it's not a good thing.*

Roimata thought that mathematics could be fun. She thought there was a need to be able to solve teacher-led problems quickly.

> *Because if you have a lot of money and there is someone at the shop and you don't have one of those computer calculator things you have to be able to add it all up fast.*

She felt that she needed to work at mathematics and it was better to do so now.

> *It will be faster if you learn maths when you are young, so that when you grow older you can work it all out…. It is very valuable, because it will help you in the future of things.*

Roimata said her mother was available to help her with mathematics homework, but that she also had books at home that she could consult.

> *Well if I am stuck and mum is there, I will just go to my mum if she is home. I will just go and ask her, but we have a bookshelf and I have got a lot of maths books on our shelf in alphabetical order, so it is very easy to find what we need, just get what we want.*

Roimata indicated that she used to hate mathematics and now she liked it. When asked why she had changed her view, Roimata confided:

> *I don't know, but some of the teachers hate maths. They really hate it.*

### Case Study 3: Kiri

Kiri attended a decile 4 school. She stated that she was in the "*highest group*" for mathematics in her class and that the teacher made decisions about where to put students as the result of what seemed to her to be "*endless*" testing. She found that the tests could be confusing.

Kiri felt confident about her mathematics knowledge and learning, but thought that the previous year's experiences had been better for her.

> *Because if we didn't get them right, she would always go on to the next one, and then she would go back.*

Kiri thought that mathematics was a social endeavour. She thought it was appropriate to give other students "*clues*" to help them answer mathematics tasks.

> *Well, somebody might not know an answer and you can help them out by just helping them a little bit. You don't tell them the answer but you set an example for them.*

She also considered it was not beneficial for anyone who just wanted a solution "*because they're not figuring it out their self*".

Kiri realised that there were different degrees of knowing.

> *Some people might need more helping out and some people know more things than others.*

Kiri thought it was appropriate to share her strategies for solving mathematics problems, but she did not need to learn other ways. She stated that she had already acquired ways that she understood.

Kiri considered that an incorrect answer to a problem was an opportunity to learn.

> *If you get the answer wrong it's quite good because you can really learn that equation.*

### Case Study 4: Maria

Maria attended a decile 1 school. She preferred to do things on her own because she professed a strong sentiment that each individual needs to understand their own mathematics work. She considered that it was necessary for her to make sense of the mathematics she was involved with.

She stated that each person needed to be responsible for their mathematics work, and noted that others in the class were not always doing that, in her view.

> *When we've had the instruction from our teacher, but when you miss, [the instructions] I can get on with maths really quickly and quietly by myself.*

She was comfortable about helping others only after she had completed her own tasks.

> *Because you can help. I can help different people with maths problems. Like my friend helped me with my maths, so if they get stuck on a maths question and I've finished my maths I can help them.*

Maria felt it was the teacher's role to give her instructions about what to do. She thought it important to listen to instructions because those on paper were not always clear.

> *When she photocopies for us like paperwork, the printer can't come out properly. We've got a spare book in our class which has answers but we can't check those until we have finished.*

Maria stated that mathematics was something that had to be taken on board rapidly.

> *You've just got to learn quickly, very quickly.*

Getting an answer correct was not important for Maria. For tasks that she was unsure about, she felt it was important to "*give them a go.*" For Maria, knowing how to "*do*" mathematics gave her an element of control over different activities in her life. She cited shopping and pocket money as contexts where she used mathematics. Learning mathematics could help her keep track of her pocket money, how much she should have, and how much change she should be getting from a shop. Maria said that "*maths is really useful*".

Maria felt that she did not need help at home with her mathematics.

## Discussion

The case studies of these four Māori girls emerged from a wide range of possible candidates within the wider study. They each had interesting things to say and offered insights into the ways that they perceived mathematics and their mathematics learning.

All of the girls enjoyed the mathematics programmes they were involved with. They felt confident and strong about themselves as learners of mathematics. Their self-identities as mathematicians were centred on the way they could complete set tasks. There was a pervasive perception that to be good at mathematics had more to do with being quick rather than having the persistence to solve a problem (Maxwell, 2001; Ministry of Education, 2006). Being able to rapidly finish work bolstered each girl's self-confidence and served as an achievement indicator to them. However, the use of more demanding mathematics tasks might have encouraged greater persistence and reflection about their mathematics ideas.

According to the previous curriculum document (Ministry of Education, 1992, p. 11) "students need frequent opportunities to work with open-ended problems." Holt (2001) argues that an investigative approach to mathematics learning will encourage "problem solving, communication, active participation and social interaction that will benefit all learners" (p. 24). Mathematics investigations presented in meaningful contexts can help children to make links between school mathematics and their world, where open-ended mathematics problems occur naturally. Traditionally, such problem-solving has resonated well with Māori learners (Hemara, 2000). This highlights the need for school experiences to help children make the links between school and community life (Presmeg, 2002).

These Māori girls thought that learning mathematics was a personal responsibility and, in the main, needed to be an individualistic enterprise. They felt they were required to be self-reliant once they understood the instructions. Recent developments in mathematics education portray mathematics learning as a social enterprise where interactions contribute to the learning process (Franke, Kazemi & Battey, 2007). Research suggests that access to opportunities for collaboration could enhance Māori children's learning (Bishop, 2005; Macfarlane, 2004). On the other hand, the girls' preferences for working at mathematics on their own could be seen as countering the common stereotype that Māori "like to work in groups" (McKinley, Stewart & Richards, 2004). It is important to provide opportunities for students to work in a range of classroom situations so that they learn to work with others as well as on their own.

To these Māori girls, finishing set tasks quickly meant that they had time to support others with their mathematics learning. They enjoyed this interaction with their peers although they did not consider that this offered them any advantages for their own learning. The benefits of mathematics discourse may need to be made more overt and explicit to Māori children in order to help them appreciate and value opportunities for learning with others (Hunter, 2006).

Three of the girls viewed mathematics as a useful tool for their own lives. One appreciated its usefulness in keeping track of her pocket money and two thought about needing to understand mathematics ideas for success in any future situations, such as high school or being a banker. This utilitarian view of mathematics is consistent with research by Masingila (2002) and Young-Loveridge, Taylor, Sharma and Hawera (2006), and supports the notion of the relevance of learning mathematics (Biddulph, 1997).

Each of the girls had a distinct view of the role their teacher played in their mathematics learning. They thought of their teachers as managers of the classroom environment (Taylor, Hawera & Young-Loveridge, 2005), rather than as people who assisted with the co-construction of mathematical ideas (Ernest, 1994). There was no indication from the girls that their contributions regarding mathematics ideas were either expected or valued by their teachers. Teaching approaches can include dialogue with students (Kinchin, 2004), thereby incorporating their perspectives. This would also provide opportunities for reciprocal learning (ako) to occur (Macfarlane, 2004).

Three of the girls considered that using equipment and calculators was neither useful nor acceptable for their mathematics learning. Calculators were regarded as a form of "*cheating*" rather than a tool to actively explore, develop, model or explain number ideas (Huinker, 2002). Equipment was viewed as a prop needed by those thought to be less able, not as an alternative way of exploring mathematics ideas (Kelly, 2006; Moyer, 2001; Owens, 1994). The potential for considering mathematics ideas in alternative ways could be minimised if learners believe that equipment is appropriate for "weaker" students only. If equipment is used instrumentally as a means of carrying out procedures rather than for the development of conceptual understanding (Higgins, 2005), it may be difficult for children to appreciate the value of using apparatus in alternative ways.

These girls did not think that they required help to complete mathematics homework, but believed that out-of-school assistance was readily available should they need it. This is consistent with Biddulph, Biddulph and Biddulph (2003) who state that most families are prepared to help their children as well as resources permit. While these girls felt confident that they could complete mathematics tasks without recourse to any support at home, more might be made of such whānau involvement.

One of the girls had attended at least six different schools. Perhaps surprisingly, she related that, mathematics was a "*friend*" albeit a "*difficult*" one at times. The number of schools she had attended did not seem to have had a detrimental effect on her confidence as a mathematician. The patterns of participation and discourse she had developed in previous mathematics classes enabled her to make the transition from one school to another (Silver & Smith, 1996). This challenges assumptions that are sometimes made about transient children and their mathematics learning.

## Conclusion and possible implications

From the case studies it is clear that these four Māori girls have developed strong, positive views about their mathematics learning. They have offered particular insights about their experiences that give us much to consider. Their stories provide some "good news" to counter the many negative images of Māori that are disseminated in the media.

Although this paper presents data from just four students, making it difficult to generalize to other students, some tentative recommendations emerged from the study. These include:

1. encouraging Māori children to co-construct mathematics ideas with their teacher and peers;
2. providing more opportunities for Māori children to participate in collaborative tasks as well as independent mathematics investigations;
3. helping Māori children to appreciate and explore links between school mathematics and their world outside of school;
4. encouraging Māori children to appreciate the value of using equipment to support and extend their ideas;
5. exploring the possibilities of including whānau involvement in Māori children's mathematics learning; and
6. carrying out further research with other Māori children to explore in more depth their views about learning mathematics.

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