

# Maori Preservice Primary Teachers' Responses to Mathematics Investigations

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There has been concern for some years about the low mathematics achievement of Maori students in New Zealand. This case study reports on the responses of 18 Maori preservice teachers to an investigative approach to learning mathematics during their compulsory Year 1 mathematics education course, as a possible aid towards helping improve the achievement level of Maori in mathematics.

## Introduction

Carrying out mathematics investigations in primary classrooms has become a focus in New Zealand classrooms especially since the introduction of Mathematics in the New Zealand Curriculum (MINZC, Ministry of Education, 1992). This has meant an increased focus on implementing this approach to mathematics teaching and learning at the preservice primary teachers' level.

Every year the School of Education at the University of Waikato recruits and accepts applications from people who wish to become teachers for Maori immersion (all curricula taught in the Maori language), bilingual and mainstream classrooms. The great majority of this group over the years has been Maori, many of whom have arrived as mathematically anxious students with real concerns about their own mathematics content knowledge (Hawera, 2004; Herewini, 1998). Their mathematics anxiety has been compounded by past mathematical experiences which have involved very little mathematics learning using an investigative approach. This study reports on some of the responses of Maori preservice primary teachers to using this investigative approach for their own mathematics learning as an integral part of their Year One mathematics education programme.

### *Mathematics Investigations and Students' Feelings*

According to MINZC (Ministry of Education, 1992), engaging in a mathematical investigation places greater emphasis on the process of problem solving and the open-endedness of a problem or investigation. As well as dealing with the mathematics content, students often have to pose questions and decide which avenue to follow to move towards a solution or solutions. This active involvement and mathematical thinking is usually over an extended period of time thereby offering students an opportunity to learn to persist and sustain their engagement in a mathematics task (Bastow, Hughes, Kissane & Mortlock, 1984; Colomb & Kennedy, 2005; Maxwell, 2001).

Maxwell (2001) explains that the benefits of being engaged in such an approach encourages persistence, risk-taking and open-mindedness. This can help students develop a positive disposition towards mathematics and enjoy their mathematics learning.

Learning and mathematical "caring" for the student during the mathematical learning process is important (Hackenberg, 2005). Students' feelings about engaging in investigations may well be part of the subtle emotional balance that exists between students and their teacher in their mathematics learning. When students participate in

mathematical tasks, the caring for students requires some cognisance of the stages of stimulation and depletion that are part of any mathematics investigative process.

Biddulph (1999) suggests that because of past experiences learning mathematics, students can have very negative feelings and expectations about mathematics and learning mathematics. Such feelings can negatively affect the learning and teaching of mathematics and need to be addressed (Biddulph, 1999; Grootenboer, 2003; Hawera, 2004; Herewini, 1998).

### *Maori and learning*

In traditional Maori society, education was oral, thematic and holistic (Riini & Riini, 1993). Students were often presented with situations and asked how they might respond (Hemara, 2000). Holt (2001) argues that a constructivist approach to learning will encourage “problem-solving, communication, active participation and social interaction” (p.24). However, if interaction between teacher and student is poor, this can result in low expectations and long-term pathologizing of Maori who are blamed for their own lack of educational achievement (Bishop, 2005).

### *Maori and learning mathematics*

For many years there has been great concern in New Zealand about the very noticeable low achievement by Maori in mathematics (Forbes, 2002; Ohia, 1995). Despite recent government initiatives to address the situation (Ministry of Education, 1992; Ministry of Education, 2001), the gap regarding mathematics achievement between Maori and non-Maori is still widening (Young-Loveridge, 2004).

## Theoretical Framework of the Study

The theoretical framework chosen for this study was based on a combination of social constructivism and humanistic learning theory. In social constructivism, ‘knowledge’ is not seen as an eternal body of truths but is socially constructed by the learner (Ernest, 1994). Humanistic learning theory espouses the idea that emotions play a large part in either inhibiting or facilitating learning. This theory acknowledges that notions of relevance, control, temporary discomfort, success and genuine interaction, are integral to learning mathematics (Biddulph, 1997). These theoretical underpinnings to learning seemed appropriate because the students would be encouraged to start ‘constructing’ by using their knowledge and strategies to begin their mathematical investigations.

## The Study

This study focussed on the responses of 18 Maori Preservice Primary Teachers whilst they carried out mathematics investigations during the first five weeks of their Year 1 compulsory mathematics education course. Students were expected to attend a two hour class each week and complete other investigations and associated work in their own time.

The students had all chosen to be part of the group being educated with the intention of teaching in Maori immersion, bilingual or mainstream classrooms from Year 0 to Year 8 (5-12 year olds). Because of the wide range of ability in Maori language within the group, much of the interaction in their mathematics classes was in English.

The students were expected to engage in four out of eight possible mathematical investigations. They were required to record their mathematics thinking, their reflection on that process and their links with learning theories.

An example of an investigation was:

### *The Plumber*

A plumber needs to create a drainage channel out of a 10cm wide piece of sheet metal. In light of the recent 'leaky building' problems he is keen to maximize the area of the cross section of the channel so that the greatest amount of water can flow along the channel. How would you suggest he folds the 10cm wide piece of sheet metal? Justify your suggestions.

Data collecting procedures involved perusing student journals and photocopying excerpts. Observations were also undertaken during class sessions. These focussed on students' involvement and their responses to the tasks. They were recorded as field notes. On two occasions tape recorders were used to catch conversations between students as they worked on class investigations. Students were encouraged to work together in class time but write about their mathematical thinking and reflecting individually. They were able to work together on homework investigations if they wished, but again needed to record their thinking independently.

## Results

The data collected indicate that there was a range of responses which have been grouped into two main themes. Favourable responses that support this approach and those that showed concern towards it have been identified and noted below.

### *Favourable Responses to the Investigative Approach:*

#### 1. Multiple Solutions

Ten of the students commented on their surprise with the idea of having more than one solution to a problem or mathematics investigation. This seemed at odds with their perspective of mathematics and past mathematics experiences.

"I thought there would only be one answer like there was at school." (S)

#### 2. Different strategies

Eleven students expressed surprise at learning that there might be more than one way of gaining a solution:

"I like finding out different ways of answering a question and solving a problem". (Anon)

"I didn't realize there would be other ways of doing this." (T)

#### 3. The Value of Equipment

Using equipment and discussing their workings seemed also to help in the making sense of mathematical ideas for seven of the students, e.g.;

"Length, width and height now makes sense to me.....what volume is. Using a 1cm square grid sheet also helped me to understand how many cubes fit into each container" (M)

#### 4. Links with Prior Knowledge

Six of the students attempted to make links with past learning regarding formulae. An example of a conversation is:

Student 2: First we all estimated it and we just looked and worked out this was a bit from here and a bit from there.

Student 4: So it's base times height?

Student 1 and 2: Divided by two.

Student 1: Because base times height gives the rectangle or square and you divide that by two and it gives you a triangle.

Although not always mathematically "correct", past learning provided a place to start and to move further along in the investigation.

"...trying to remember what I learned from school, the formula for finding the **volume** of a circle is  $\pi r^2$ ". (H)

## 5. The Value of a Mathematical Challenge

Eleven students commented on finding the mathematics challenging:

"I have really been enjoying the maths we have been doing as it is stimulating my brain and I do love challenges, especially those I overcome." (J)

"These tasks are very challenging. Got us out of our comfort zone." (H)

## 6. Accessibility of Tasks

Three students commented on the ease of moving back into doing mathematics:

"This is a good introduction, so we could get back into maths, as a lot of people left school years ago." (E)

## 7. Links with real-life experiences

At times it was evident that students were attempting to make links between their mathematics and real-life experiences. Four students made such links:

"This is what I did when I was thinking about the plumbing pipes or spouting that are on houses and I applied that to my maths investigation." (H)

## 8. Collaboration

Seven students commented also on how helpful they found it to be able to work collaboratively:

"It's good to be able to work with someone else on this maths because by the time we share our ideas we actually manage to do quite a bit. I don't know if I could do this much by myself. We seem to get something out of what we both put in. I'm surprised." (M)

## 9. Teacher-student interactions

Three students commented on their interaction with their teacher and seemed to appreciate the opportunities given to pursue their own solutions:

"It's good she doesn't really give us the answer ay? She just gives us a bit so we can move on... like ask us a question when we're stuck." (H)

## *Concerns about the Investigative Approach*

### The Openness of Tasks

1. Two students found the idea of multiple solutions daunting at times and too open. For one student,

“There are too many possible answers! Maths should just have one answer and be right or wrong!..... This is what I don’t like about maths investigations, and when do you know when to stop?” (T)

One student wondered how that might affect her as a teacher. Would she have to know every possible solution to a problem or investigation?

Two students commented that the idea of more than one way to find a solution(s) was challenging.

“I find it difficult when a task is solved that differs from the way I would’ve solved it”. (M)

For four of the students, following an idea right through appeared to be too difficult for them. It seemed that posing questions and attempting some exploration without reaching any conclusions caused them concern. Their investigations were just left to “hang”.

2. Three students expressed dissatisfaction with the challenging nature of the tasks:

“No I don’t like challenges. Just tell me what you’re doing.” (T)

3. Interruption to reflect and write:

Writing and reflecting on their engagement with the mathematics learning process was required of the students. The time allocated during class sessions for this was not always appropriate for them. Two students commented:

Student 2: “Isn’t it funny how it’s like school? You just get into something and then get stopped.

Students 1: I could have done this for a while.”

4. Interpretation of investigation:

Unless students asked, they were left to interpret the tasks themselves. Four students thought they knew what to do and therefore did not see a need to seek clarification that led to mathematical misunderstandings and frustration for them.

“These tasks are set up to trick you and make you fail”. (D)

## Discussion

The investigative approach to learning mathematics which these students experienced supported the notion of education through exposure to problematical situations (Hemara, 2000) and social constructivist practices (Ernest, 1994; Holt, 2001). Most students were able to respond positively to the investigations to find possible solutions and at times, the best outcome. The approach encouraged the students to construct ideas in ways that made sense to them. They used problem-solving strategies including collaboration with others to determine which mathematics ideas would or would not work. These processes were very familiar to Maori in earlier times (Hemara, 2000) but some of the responses given by these students indicated that they were new ideas to them in terms of learning mathematics. It may be worthwhile to explore this avenue further.

The attempt by some to link their investigations and thinking to real-life experiences is consistent with humanistic learning (Biddulph, 1997) as well as the thematic form of education (Riini & Riini, 1993). It was found that mathematics needed to be something that could be related to the students’ own world and experiences. Being able to see where these ideas were relevant and practically applicable seemed useful and gave them a context in which to consider the mathematical ideas. It may be helpful to promote mathematics

investigations that relate to particular Maori cultural contexts for those students who wish to start from that arena.

The nature of the tasks appeared to be appreciated and enjoyed by most. Persisting, taking risks and enjoying the challenge, helped to increase a positive disposition towards learning mathematics (Maxwell; 2001). The emphasis on recording their investigative process and thinking skills also seemed to have relieved any pressure to find a “right answer” quickly (Bastow et al., 1984; Colomb & Kennedy, 2005).

Responses also indicated that the investigative process helped students to maximise opportunities for their participation. It encouraged them to try different ways to begin an investigation, work collaboratively, discuss and use equipment for modelling, over lengthy periods of time. These factors were especially important for students who were mathematically anxious (Biddulph, 1999; Grootenboer, 2003; Hawera, 2004, Herewini, 1998).

Some concerns raised by the students indicated that tasks needed to be clearly understood by them and that support for them to begin engaging in the investigations was necessary. How to support those who struggle to begin and maintain their engagement in mathematics investigations requires consideration by the teacher (Hackenberg, 2005).

Carrying out an investigation successfully also required recording and tracking information so that patterns could be exposed and noticed. These students noted that being aware of their own thinking processes assisted their mathematical investigative work. Any intervention to ensure that such recording and reflecting occurs needs to be carefully considered so that students’ train of thought or work is not compromised.

It seemed helpful for these Maori pre-service teachers to focus on their own development as learners of mathematics. Two hours a week for five weeks meant that only some key mathematics ideas could be explored. Further research could involve determining what the benefits are for Maori students when focussing on particular content ideas (e.g., number and algebra), while engaged in mathematical investigations.

## Conclusion and Implications

The widening gap between Maori and non-Maori achievement in mathematics is continuing. A greater emphasis on an investigative approach to mathematics teaching and learning within the framework of social constructivism and humanistic learning may be worthwhile pursuing as one way of helping raise the mathematics achievement of Maori. These particular students gained new perspectives regarding processes and strategies for learning mathematics. It also enhanced their disposition towards engaging in mathematics. Exposing more Maori pre-service teachers to this approach may bode well for Maori children learning mathematics in schools and help lessen any deficit thinking about Maori capability and mathematics learning.

An obvious limitation of this study is the small number of students who were involved. While this approach seems to have been beneficial for a number of these students in some way, it would be useful to gather more information with a larger sample.

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