Mathematics education for Maori students in Mainstream classrooms

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There is increasing national concern regarding the educational achievement of Maori in New Zealand. Recent international studies have highlighted Maori mathematics under-achievement in particular. This paper discusses appropriate teaching and learning practices, ethno-mathematics, constructivist approaches, the development of classroom culture, increasing teacher and learner expectation, and assessment practices that will improve the mathematics achievement of these students.

Introduction

The performance of New Zealand students and particularly that of Maori, in the Third International Mathematics and Science Study (Garden, 1996, 1997) is of considerable concern. In general the study showed some pleasing results. Gender differences were no longer apparent; statistics was identified as an area of strength, and achievement overall was just below the average for years 4 and 5 and at the average for years 8 and 9. However, when the scores for Maori and non-Maori are separated, the results are disturbing, with the average for Maori students significantly lower than that for non-Maori and students from most other countries. More-over, results from the National Education Monitoring Project (Ministry of Education, 1998) indicate that this trend is continuing and that the delivery of mathematics education to Maori students is still not as effective as it could

Information from Statistics New Zealand (2000) shows that in 1996 the number of New Zealanders that identified themselves as Maori numbered more than half a million, or 15.1% of the total population. The Maori population in 2051 is expected to reach nearly one million, or 22% of the population. With the Maori population increasing, it is imperative for all New Zealanders that education in general, and mathematics education

in particular, is delivered effectively to Maori. This aim will not be achieved until Maori performance in national and international studies is at the same level as non-Maori.

The current commitment of the 2000 Labour-lead government indicates the gravity of concern at a national and political level. With the injection of funding into developing and implementing a numeracy initiative, targeting in particular decile 1 – 5 schools, this government is determined to make a significant effort to close the achievement gaps. Improving mathematics education for Maori will require a multi-faceted approach. Teaching and learning practices, curriculum design, classroom culture, teacher and learner expectation and assessment practices all need to be addressed if progress is to be made.

Teaching and Learning

Barton & Fairhall (1995) provide an argument for a re-think of mathematics curriculum and delivery by taking an historical approach. They write that prior to the mission schools of the 1800's Maori education was formalised, and took place in Whare Wananga (traditional Maori places of formal learning). Within the Whare Wananga agricultural, martial, spiritual, technical and artistic subjects were taught. They note that traditionally, formal education was mainly oral and argue that this was linked to the oral nature of the Maori culture. Mathematical aspects included

> the design (of canoes, buildings and tools); astronomical, meteorological and oceanographic information and analysis; geometries of pattern in weaving (raranga), painting (kowhaiwhai) and carving (whakairo); and the logic of argument in oratory (p.3).

These mathematical concepts were never separated from the activities in which they were based so education was holistic and thematic. Perhaps Maori students in the mainstream classrooms of today would benefit from teaching and learning practices that emphasis the oral, holistic and thematic learning of traditional Maori education.

Barton, Fairhall & Trinick (1998), however, warn of the dangers inherent in attempting to find culturally appropriate teaching and learning practices for Maori. They believe that many suggested practices, including apprenticeship and rote learning, along with algorithmic teaching, are based on memories of early colonial teaching. These modes are not holistic but grounded in behaviourist learning theory, therefore conflicting with traditional Maori education. They also warn that attempting to remove any traditional teaching practices from their total cultural context is likely to be ineffectual. Knight (1995) agrees with this view and further argues that shifting the mana from mathematics to culture would positively influence the cultural alienation of Maori students from mathematics.

Utilising the oral foundation of traditional Maori culture in today's mathematics classrooms is paramount to improved learning for Maori. Maori history was shared and maintained through oratory and song and an "accurate memory was a survival tool" (Barton & Fairhall, 1995: 4). Knight (1995: 39) uses the example of Sir Apirana Ngata who describes the practice of singing the multiplication tables in chorus and labels this "teaching through the ear". This method of teaching number word sequences, basic facts and multiplication tables can be heard in mainstream classrooms today and a number of commercially produced products can be purchased to assist this practice.

Recent educational trends have seen recognition of the importance of learning styles in effectively meeting the learning needs of students. Nathan & McMurchy-Pilkington (1997) state that the preferred learning styles of the Maori women interviewed in their study were visual and hands-on. Many of them preferred activities that involved manipulating equipment and the use of games, describing them as interesting and fun. Students who perceive mathematics in this way will be more engaged in their learning and have a positive attitude towards it. This is seen as key to improving mathematics achievement for all students (Ministry of Education, 1992).

The holistic nature of traditional Maori education and the integration of mathematical aspects in particular have been described by a number of writers (Barton, 1995; Barton & Fairhall, 1995; Riini & Riini, 1993). Holistic learning experiences are context-based and meaningful material is not broken down into small discrete skills or chunks of knowledge. Support documents recently published by the Ministry of Education and supplied to all schools use this context-based approach. Mathematics programmes that demonstrate the place of mathematics in students' daily lives, and use contexts that are relevant to them, will improve mathematical understanding and attitudes. Students interviewed in a recent development project, Achievement in Multi-Cultural High Schools (*AIMHI*), indicated that they wanted to know why they were being taught something and how it could be related to their own everyday experiences (Hill & Hawk, 1998). In determining factors that have lead to New Zealand student weaknesses in recent mathematics studies, Clarke (1999a) suggests that children are involved in less mathematics at home than in the past. Teachers should give serious consideration to including aspects of these home-linked activities in the classroom programme. Baking, for example, gives an opportunity for integration with other learning areas while also providing a relevant, authentic context in which students can learn mathematics.

Ethno-mathematics

Although there is no consistent definition of ethno-mathematics, it is seen as incorporating all that concerns both mathematics and culture. Barton (1995: 157) gives two differing definitions: "the mathematical practices of cultural or social groups" and "the study of the mathematical aspects of the ideas and practices of cultural and social groups". The second definition is preferred, as it does not lead to comparisons between the mathematics practised in educational settings and those of different cultural groups, both historically and in the present. It also reflects the fact that many indigenous societies, including pre-European Maori, did not have a separate subject for mathematics and that it is inappropriate to create one. Masingila & King (1997: 116) discuss two forms of ethno-mathematics that can be used in the classroom. They label these " the mathematics practice of others … and … our own mathematics practice".

The first category encompasses the mathematical ideas found in cultures of the world, including traditional Maori culture, along with the mathematics practices of others in the society in which they live. Teachers who successfully incorporate this type of ethno-mathematics into their classroom programmes will be utilising the base-ten counting system of the Maori language, the geometry of köwhaiwhai patterns, taniko, cloak and kete weaving, and the algebraic patterns found in tukutuku patterns. Mathematics will be introduced in a way that is meaningful for Maori students, enhancing their understanding, while also acknowledging and valuing their culture. These teachers will also be providing opportunities to include the mathematics practice of others. Family and community members could be surveyed to determine the mathematics that they use in their lives. Students would see the relevance of mathematics to every day life and authentic scenarios for problem solving would emerge. Knight (1995) states that introducing elements of Maori culture into the presentation of mathematics, the use of Maori people in illustrations, using Maori names and numbering pages in Maori are approaches that have been used to eliminate bias in mathematics education. That these approaches have not improved Maori results in successive international studies supports Knight's belief that they do not address the issue of Maori cultural alienation, which he sees as the basis of Maori under-achievement. Knight’s position is valid, given the examples he puts forward, however it is to be hoped that the introduction of ethno-mathematics would go beyond the surface methods Knight describes.

The second of Masingila & King’s (1997: 116) categories is "our own mathematics practice" with the everyday mathematics used by students and teacher being capitalised on as a readily available resource. Astute teachers will learn about the mathematics of their students and use this information as the basis for authentic contexts. Teachers should realise that students may need prompting to recognise the mathematics in their world and how they use it. The older child could keep a log of the mathematics they use over a period of time while the teacher could share the mathematics involved in their everyday lives, also keeping a log. A number of everyday classroom activities could

provide the basis of a shared mathematics log for the class. These include fitness activities, lunch ordering, timetables, attendance rolls: the possibilities are infinite. Maori women in the Nathan & McMurchy-Pilkington (1997: 7) study "believe they would have learnt more maths at school if the context had been made relevant for their lives". Ethno-mathematics engages students in meaningful contexts, promotes understanding of the mathematics in everyday living and provides opportunities for them to connect new concepts to the experiences, knowledge and skills they already have. For Maori students these are essential for improved achievement.

Constructivism

Constructivist learning theory is based on the work of two theorists, in particular, Piaget and Vygotsky. Piaget's theory is labelled personal constructivist theory and does not address the social and cultural aspects of learning while the social-constructivist or socio-cultural theory, according to Vygotsky, is based on his belief that " one makes sense of the world in ways that are always historically and culturally specific" (Begg, 1999: 5). Education in classrooms based on social constructivist theory is holistic, with familiar contexts used to scaffold learners from the familiar to abstract ideas. Interaction between the learner and expert is necessary and active participation by all is required. In this way oral communication is a tool to facilitate students' construction of mathematical knowledge. Teachers must know students well in order to move them into their 'zone of proximal development', that is the distance between what the child can do independently and what they can do with guidance or the support of an expert.

A social constructivist approach to mathematics curriculum design, where hierarchical ordering of behavioural objectives is replaced with a more flexible model, will allow for teaching practices that encourage problem solving, communication, active participation and social interaction that will benefit all learners. Cooperative learning has been promoted as a mode based on social constructivism and Lane (1999: 5) states "In groups, there is the opportunity for ideas to be shared, and for understanding behind the ideas to come out in ways which link easily into the lived world of the student." Working in

groups allows members to share their combined knowledge, give and receive support, share success and failure, modeling the concept of whanau. When working together to solve mathematical problems students are interdependent and motivation to achieve is enhanced. The more able students have the opportunity to assist others and, if roles are allocated, all members participate actively.

Classroom Culture

Developing a classroom culture that actively fosters cooperative learning in mathematics and supports all learners will create a learning environment that also emulates the Maori concept of whanau. Nathan & McMurchy-Pilkington (1997: 11) state "the whanau co-operates as a unit to achieve shared outcomes, and to construct common understandings and knowledge". They maintain that encouragement and scaffolding is provided within the whanau in order for individuals to contribute to the group and that the group is responsible if a member does not achieve some success or development. Individuals are not singled out, all members share successes or failures. Lane's (1999) model links four aspects of learning: cognition, the social situation, beliefs and the task. His ideas about cognition are very interesting when thinking about mathematics education for under-achieving children, especially those relating to processing space. He believes, with others, that we have only seven spaces available in the short-term memory for thinking. These spaces can be taken with social or emotional concerns leaving a diminished capacity for thinking. It follows therefore that students who are confident, comfortable and emotionally safe have "the mental space to be thoughtful" (p. 3) and those who are unhappy or fearful do not. Classrooms that promote group as opposed to individual learning experiences create an atmosphere for improved learning in mathematics.

Teacher / Learner Expectation

It is important that the results of international testing (Garden, 1996, 1997) are not used as the basis for lowering teacher and learner expectation in mathematics achievement for Maori. Teachers have an obligation to believe that all their students have the ability to be successful in mathematics and that they can provide programmes that will meet their

students' individual learning needs. "People successful at mathematics often speak of experiencing homes and classrooms in which it was believed *everyone* can do maths" (Clark, 1999a: 11). The belief that Maori students can achieve as well as their peers will impact on the mathematical education they receive. This includes their placement in groups, interaction with the teacher and the emphasis placed on their work (Nathan & McMurchy-Pilkington, 1997).

Teachers who expect Maori students to achieve mathematically will provide programmes that are challenging, including motivational contexts that utilise their developing skills. Means & Knapp (1991) discuss the pitfalls of conventional programmes designed for students who are identified as 'at risk'. They describe these programmes as less challenging and more repetitive, with the teacher breaking down each task into small pieces, working through procedures step by step and leaving little opportunity for higher-order thinking. They propose a re-shaped curriculum based on the premise that "children from all kinds of backgrounds come to school with an impressive set of intellectual accomplishments" (p. 286). They argue that such a curriculum would be based on focussing on complex meaningful problems, embedding basic skills in global tasks and making connections with the students out-of-school experience and culture. They emphasise the importance of modelling powerful thinking strategies, encouraging multiple strategies to solve problems, providing scaffolding to enable students to accomplish complex tasks and making dialogue the central medium for teaching and learning. The teaching methods proposed by Means and Knapp are applicable to all learners. The underlying principle that all children, from whatever background, can achieve highly is a message for all teachers in the multi-cultural, mainstream classroom. We cannot expect less from some of our students because of their background, gender or ethnicity. To do so is to condemn them to continued under-achievement in mathematics.

Assessment

The document *Mathematics in the New Zealand curriculum* (Ministry of Education, 1992) prescribes behavioural achievement objectives which are progressive and linear, and often assessed using traditional pencil and paper tests. It is interesting to note

however, that the same document describes this form of assessment as unreliable for Maori students, acknowledging that "traditional time constrained pencil and paper tests have proved unreliable indicators of Maori achievement in the past" (p.13). A body of mathematics assessment tasks reflecting constructivist principles is required which will allow students to use equipment, share their understandings and demonstrate or articulate the processes and strategies they use in mathematics. Begg (1999) believes that the focus should be on formative assessment, where the teacher is interested in how new and prior knowledge are interacting, on students' thinking processes and on measuring understanding. Assessment through concept maps, student journals and portfolios allow students to use their developing mathematical understandings in non-competitive situations. "Assessment which emphasises competition and individual performance may reinforce European practices and disadvantage Maori … students" (Begg, 1993: 217). Clarke (1999b) believes that performance tasks and oral assessment should be more widely used and would be more appropriate to Maori students. She asserts that asking direct questions of individuals or testing basic facts can lead to public humiliation and suggests assessment of collaborative work should sometimes be used. Trinick (1993) suggests that assessment activities should reflect Maori cultural values, promote communication and involve co-operative work and the use of concrete materials. Assessment examples that are culturally appropriate and set in real contexts will assist Maori students succeed.

Conclusion

Improving the mathematics achievement of Maori students in the mainstream classrooms of our primary schools is imperative. The strategies suggested in this paper could be implemented into classrooms with little financial input and require only a change in attitude and a willingness from both the teacher and student. At my place of practice our staff is predominantly Pakeha and does not reflect the ethnic mix of our student body. The appraisal process has highlighted a need for increased staff knowledge of tikanga Maori. This is a pre-requisite for successful integration of Maori culture into teaching and learning programmes and incorporating Maori values into school and classroom

culture. The use of culturally relevant contexts for Maori can only enhance mathematics learning for these children.

Continuing professional development and support will be required if consistent assessment practices, based on constructivism, are to be established. The challenge is for these to be correctly administered and this requires a shift in some teachers' personal pedagogy. When this has been achieved we will be able to build an accurate picture of the mathematical achievement of Maori students. This will allow us to celebrate their successes and develop programmes to meet their needs.

There must be a commitment to change at the classroom, school and national levels if Maori achievement is to be improved before the Fourth International Mathematics and Science Study.

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