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Māori mathematics: content or culture?

In this paper I examine the issue of Māori low achievement in mathematics, and evaluate two possible paths toward overcoming it: Māori mathematics content, and Māori mathematics as an aspect of Māori culture.

I summarise the evidence for Māori low achievement in mathematics and the evidence that it is not particular to mathematics, but rather an aspect of Māori low achievement in the education system as a whole. I summarise research into and theories of why Māori have low achievement, with specific reference to the theories of ethnomathematics. I argue that deficit thinking, failure to incorporate culturally appropriate content, and cultural dialectics are all significant causes. I describe some of the work being done to eliminate this low achievement, and the research into how effective this work has been. I reach the conclusion that immersion in Te Reo and training in eliminating deficit thinking are showing positive results, without dependence on developing a Māori mathematical content. Finally, I consider the implications for curriculum developers of these findings.

1 Māori low achievement: the evidence

Traditional Māori society included mathematical components that enabled counting, measurement, design, navigation, and construction (Barton, 1995; Forbes, 1994). This mathematical knowledge was not separated into a specific area of study (decontextualised), but was an integral part of the arts and sciences that it supported: trade, agriculture, hunting, navigation, architecture, tool-making, boat building, and the visual arts.

With the arrival of teachers of formal arithmetic teaching in the Māori language,[1] Māori are reported to have quickly embraced the subject and demonstrated aptitude in it (Barton, 1995, p.152). Subsequent developments in education[2] heralded a decisive move away from instruction in the Māori language.

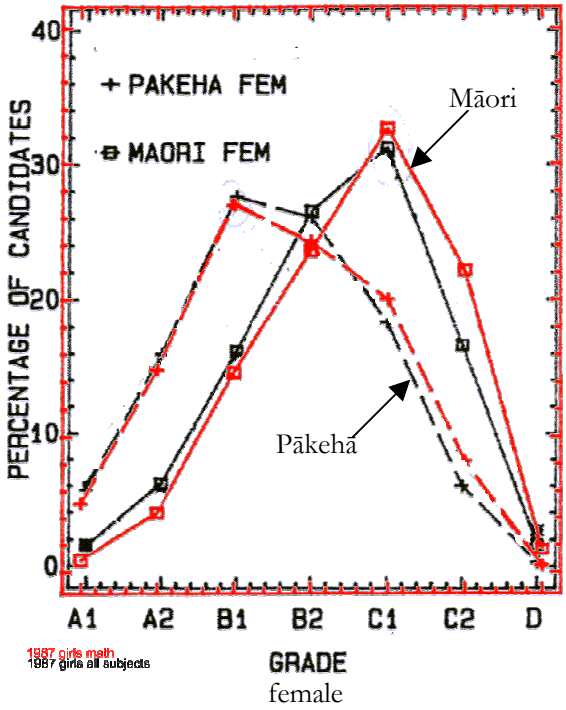
Recent research shows Māori students performing less well and participating less in mathematical education than the average Pākehā . Forbes, Blithe, Clark, & Robinson (1990) report on research in high school and university mathematics education in New Zealand spanning the years 1981 to 1989. They conclude: "The mean performance of Maori students in all the mathematics tests analysed is substantially lower than that of Pākehā students" (p. ix). They also report lower retention and participation rates of Māori students in high school mathematics (p. vii). By university level, participation rates in mathematics papers[3] were so low that performance comparisons were not made (p. viii). As well as reporting significantly lower achievement in mathematics for Māori when compared with Pākehā , the researchers also concluded that the situation was not showing signs of improving with time during the closing decades of the twentieth century.

There have been some signs of improvement this millenium, but, as Karen Sewell puts it:

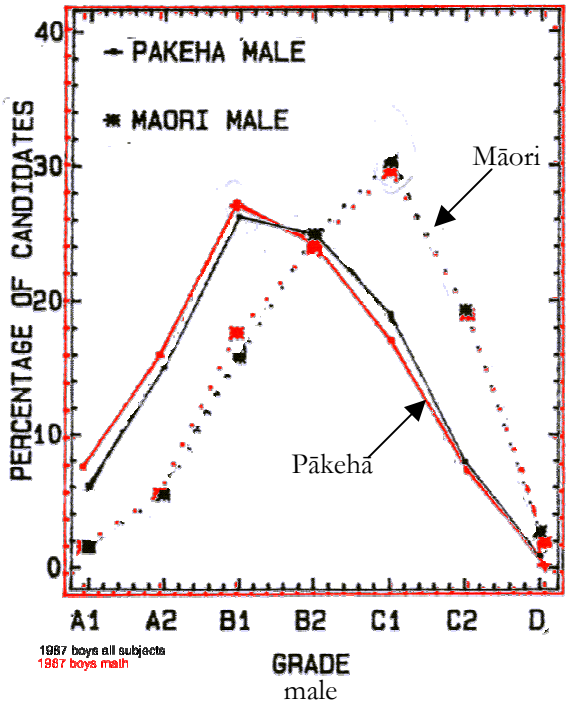
[1] 1814 saw the first mission in the Bay of Islands (King, p.141)
[2] 1867 Native Schools Act, 1877 Education Act
[3] 1-2% Māori in first year mathematics papers in 1981-1989

> We have had some success in the past 10 years but the successes have not been spread evenly across the system, nor have they yet produced any of the transformational shifts we need. (Ka Hikitia, 2007)

Is there evidence that Māori low achievement is specific to mathematics? Forbes et al do not analyse the data with this specific question in mind. In an attempt to answer this question, I have carried out a very simple comparison using some of their data. I have separated the male and female charts showing grade distributions for 'Y3E3' candidates in School Certificate mathematics and all subjects (pp. 90-91), and superimposed the 'all subjects' charts on the 'mathematics' charts.



female



male

These charts allow a rough comparison to be made of performance in School Certificate mathematics against performance in all School Certificate subjects in 1987. The 'mathematics' lines are in red, the 'all subjects' lines are in black. For girls the red lines sit a little to the right of the black lines, which means that the girls on average did worse in mathematics than in their other subjects. Conversely, for boys the red lines sit slightly to the left of the black, which means that on average boys did a little better in mathematics than they did in their other subjects. However, both Māori and Pākehā show almost the same pattern in this respect, which suggests that while Māori achieved lower grades than Pākehā in mathematics, this is a reflection of an overall trend of Māori to have lower grades than Pākehā in all subjects and not a particular trend towards lower grades in mathematics[4]. Without the original data, and without looking at a wider range of years, it is not possible to say anything about the statistical significance of this comparison, but it suggests there is little justification for thinking that Māori comparative achievement in mathematics is *substantially* different from Māori comparative achievement in other school subjects.

[4] There are some slight differences, especially in the A1 and A2 grades, where Māori grades sit slightly lower than they would if they followed the Pākehā pattern. This might indicate a trend for Māori to be slightly less likely to excel in mathematics ahead of other subjects when compared to the Pākehā likelihood to excel in mathematics ahead of other subjects, although it is a comparatively small effect and one that would need better analysis of the data to substantiate.

2 Why low achievement

2.1 Issues that apply to all subjects

Deficit thinking

Historically, deficit thinking has been based on the racist belief that Māori are an inferior race of lower intellect than Pākehā . There is no justification for holding this belief, but consciously or subconsciously, to a greater or lesser extent, it nevertheless exists in the minds of many Pākehā and Māori, and is a very potent force for low achievement when it does exist.

Socio-economic factors are often considered important in affecting educational outcomes. Teachers are likely to consider these factors as 'deficits'. There is a connection between low socio-economic status and low educational achievement for Māori students of mathematics. (Forbes et al, p. 159). This fact can fuel deficit thinking without the tinge of racism, but is nevertheless just as powerful a force for low achievement.

Socio-economic factors are not the only factors that are connected with low achievement. Forbes et al, when summarising research results for the third form, state: "Mean performance increases with social advantages, but this does not account for all of the above [large] ethnic difference." (p. 159).

Even Dewes's assertion (which is not evidence-based) that Māori are naturally talented as right-brain thinkers (1993) runs the risk of tacitly acknowledging a deficit of left-brain thinking.

Deficit thinking is a powerful, but not complete explanation for Māori low performance at mathematics.

Cultural failure

Ohia (1993, p.41) says that:

> Poor performances by Māori learners in mathematics could be attributed to the failure of mathematics educators to make the connections between the students' experiences and the subject matter … the subject matter of mathematics programmes at all levels may need to be either reconstructed or revamped to reflect Māori thought and philosophy.

I have called this cultural failure because it is a failure of the teaching of the subject to respond to the culture of the students. By reflecting European values and using examples from European culture, the teaching of mathematics makes itself Eurocentric. This alienates the Māori student and leads to 'entrenched negative attitudes towards mathematics' (*Mathematics in the National Curriculum* (1992), cited in Ohia, p. 41).

Dialectical analysis

Willis (1996) develops four perspectives on disadvantage and the mathematics curriculum. The *remedial* perspective embraces what I have called deficit thinking, and amounts to trying to fix the students by providing what they are missing. The *non-discriminatory* and *inclusive* perspectives embrace what I have called cultural failure, and amount to trying to make the curriculum culturally relevant to the students. The *socially critical* perspective takes the more radical position that the mathematics learner is constructed through the curriculum. With this perspective "the school mathematics curriculum is considered to be implicated actively in producing and reproducing inequality." (p. 46). Willis, like Dewes (1993), is offering a dialectical perspective: the mathematics curriculum serves to keep the oppressed group in their place by constructing the mathematics student in accordance with the oppressors' world view, and thereby, as far as

possible, denying success to the oppressed group. Operation of this principle can be subtle, as Willis explains with reference to gender issues: teachers who believe that sexism has been removed from textbooks are surprised to discover "deep gender bias" in the books (p. 48). As Freire (1972) points out, liberation from oppression cannot be done 'for' the oppressed. The act of oppression has economic and socio-political benefits for the oppressor, so even well meaning attempts by the oppressor at reform (such as attempting to remove sexism from textbooks) are likely to fail. The stubbornness with which Māori low achievement and participation in education remained in place throughout the 1980's (Forbes et al) and remains even today (Ka Hikitia) suggests that oppressor led reforms are ineffective in ending oppression.

2.2 Ethnomathematics

According to Bishop (1991), up to the mid-1980s the conventional wisdom was that mathematics was 'culture free' knowledge. Since that time the idea of mathematics as a cultural phenomenon has gained strength, and goes by the generic name 'ethnomathematics'.

Ethnomathematics is the mathematics of a particular cultural group (Barton, 1996, p. 206). It is many things to many people, but two central strands of thought emerge from the literature.

1. Ethnomathematics as 'indigenous' or 'folk' mathematics (Barton, p.211), which I refer to as *traditional ethnomathematics*.
2. Ethnomathematics as a movement involving the active reclaiming of and construction of the mathematical point of view of an indigenous culture (Barton, p. 208), which I refer to as *dialectical ethnomathematics*.

Traditional ethnomathematics

Traditional ethnomathematics has benefits that address the issues of deficit thinking and cultural failure that I have outlined above.

Stories of the history of mathematics can counteract deficit thinking by affirming the ability of all human societies to create mathematics, and give students reason to believe they are part of that world-wide mathematical tradition. Ladson-Billings gives an example of a teacher telling latino students that their "ancestors, the Mayans, were the first to discover the concept of zero, something neither the Greeks nor the Romans had considered." (p. 132) and another example of a teacher talking to students about "the African origins of algebra" (p. 134). In a similar way New Zealand writers such, as Ohia, talk about teaching "kowhaiwhai designs in geometry … navigation techniques in vectors … the Māori lunar calendar in measurement" (1993, p. 41). Topics like this not only counteract deficit thinking by validating indigenous Māori mathematics as being mathematically sound, but also provide possible culturally relevant ways to engage Māori students in mathematics.

Comparative traditional ethnomathematics, where different cultures' ways of doing mathematics are studied, is not only interesting and therefore motivating, it also counteracts deficit thinking by showing how all races have always been involved in doing and creating mathematics. It validates alternative systems and invalidates the belief that mathematics was invented entirely by the Greeks. An example would be studying the use of different systems of gesture counting used throughout Africa (Zaslavsky, 2001, p. 312).

Dialectical ethnomathematics

Dialectical ethnomathematics is a more radical idea. It requires an acceptance that despite there being a component of universal truth to mathematics, there is a process by which each culture constructs its own mathematics to be congruent with its cultural context. This is by no means restricted to, and does not even necessarily include, the culture's indigenous traditional mathematics. It is the mathematics of today embedded in the cultural context of the moment.

Zevenbergen (1996) holds that despite a radical constructivist theory being embraced, mathematics teaching essentially *must* involve the recognition of "the forms of knowledge that are

seen as legitimate". I agree with this for without it we would all be free to construct our own personal mathematics and no-one would be able to communicate, nor would universal mathematical truths be able to emerge. Social constructivism provides for the means of recognising legitimacy to arise from social discourse, but tends to focus on the smaller social unit. What Zevenbergen points out so strongly is that, regardless of what flavour of constructivism is applied, there are culture-wide ways of recognising legitimacy, and they are a necessary and unavoidable part of the educational process.

Traditionally, recognising legitimacy has been applied in a very draconian way in the teaching of mathematics. It has been expressed as the idea that there is only one 'correct' way of doing mathematics. This traditional approach has tended to be resistant to change despite the effects that constructivist theories have had on curriculum development, as I point out in an earlier essay with reference to the TIMSS video study and the persistence of formalist approaches to teaching mathematics in the countries studied (Hilder, 1997).

Dialectical ethnomathematics tells us that by using the process of recognising legitimacy we can all expect to arrive at certain universal truths (for example, the theorem of Pythagorus), but that the *process* of recognising legitimacy is actually culture-specific. When one culture imposes its *process* on another it causes a dissonance. Dewes describes this dissonance as a "threat" to the people of the culture that is imposed upon. Freire describes it as oppression.

I define dialectical ethnomathematics as: the activity of establishing a culture-specific and culture-appropriate process for recognising legitimacy in mathematical constructions.

The dialectical ethnomathematics of an oppressed people is something that only the oppressed people can do. It cannot – almost by definition – take place in the schools of the oppressor and must therefore call for the emergence of a new school system. Traditional ethnomathematics is a useful adjunct to the process, but it is not, by itself, transformational. In New Zealand, the emergence of a new school system, Kura Kaupapa Māori, is under way and with it the development of a Māori dialectical ethnomathematics is taking place. The vital ingredient in this process has not been content-based traditional ethnomathematics, but instead has been culture-based: Te Reo.

3 The reform of Māori mathematics education

Theories of mathematical pedagogy, and even practical techniques for teaching mathematics, are of little value unless we know the answer to the crucial question: do they work? There has been a development over recent years of an evidence-based approach to evaluating the usefulness of teaching theories and practices. A major project that takes this pragmatic approach and applies it to a mass of research is the Best Evidence Synthesis programme of the NZ Ministry of Education. The mathematics Best Evidence Synthesis (Anthony & Walshaw, 2007) is a synthesis of over 600 research studies (p. ix).

> "The research makes it clear that mathematical outcomes for students are affected by a complex network of interrelated factors and environments, not just individual preferences or the language of instruction." (Tony Trinick in Anthony & Walshaw, 2007, p. xiv)

However, there is some data to support the idea that dialectical ethnomathematics is the most important factor in attaining equity, followed by overcoming cultural failure and deficit thinking.

According to Ka Hikitia

> in 2006, Year 11 candidates attending Māori-medium schools had a higher attainment rate of NCEA than Māori students in English-medium schools. A high proportion of these candidates from Māori-medium schools achieved some NCEA qualifications above the level typical for their year of schooling. (p. 15)

This demonstrates the importance of language, and therefore culture, in teaching. Students taught in Māori do better in mathematics, and I suggest that this is for the dialectical reasons set out above.

The Te Kōtahitanga professional development programme for teachers has found that

> This evidence suggests that significant growth, perhaps twice that expected, occurred in the Māori students taught by Maths teachers participating in Te Kōtahitanga in numeracy. … What is interesting of course is that these results have come about due to changing classroom relationships and interactions not from any content or strategy professional development. (Bishop, Berryman, Cavanagh , & Teddy, 2007, pp. 176-177)

This supports the idea that reforms of the cultural practices of teaching (including overcoming deficit thinking, which is a significant part of Te Kōtahitanga) are more significant than reforms of content. After all, no shift towards improved equity was seen in the mathematics results during the eighties (Forbes et al), but since Te Kōtahitanga has been running we have finally seen some overall positive results. Recent analyses of the 2004 Numeracy Development Project (NDP) data for 70,000 students in years 1–8 (English-medium) show a decrease in disparities between ethnic group performances. (Anthony & Walshaw, 2007, p. 9).

4 Implications for curriculum developers

As every culture develops its own dialectical ethnomathematics it will not be possible for there to be a new school system for each one in an increasingly multi-cultural society. As New Zealand becomes increasingly multi-cultural it will be necessary to transform the mainstream schools and mainstream curriculum into one that recognises multiple processes for recognising legitimacy in mathematical constructions. However, as Dewes warns, the dominant culture will not want to give up its position of dominance. There will be struggle.

Teacher training will need to focus on overcoming deficit thinking, and understanding student learning in terms of process and learning stages, not product. Accompanying and supporting this, good quality resources that draw on traditional ethnomathematics will be of great assistance.

Kura Kaupapa Māori will be a necessary part of the future, because it is near impossible to define a Māori ethnomathematics from within the dominant cultures' schools. Support for and willingness to learn from Kura will continue to be a necessary part of mainstream policy development.

Word count 3,000

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