

## Falling through the cracks of the constructivism debate: The neglect of the Maori Crisis within science education

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### ABSTRACT

This paper examines issues related to Maori underachievement within science in New Zealand schools. It considers the wider context of constructivism debate by which to assess some possible solutions to crises related to Maori experience within schooling and especially within the science curriculum. The purpose is to draw attention to the Maori crisis in science education and in particular to re-focus the debate away from being merely descriptive about problems in science education to a level of practical intervention. In these terms, the measure of the positions advocated on both sides of the constructivist debate ought to be the extent to which they are able to intervene in the 'worst case scenario' - that is the learning crisis in science which accrues to Maori as a group.

### Introduction

This paper examines issues related to Maori underachievement within science in New Zealand schools. It considers the wider context of *constructivism debate* by which to assess some possible solutions to crises related to Maori experience within schooling and especially within the science curriculum. The purpose is to draw attention to the Maori crisis in science education and in particular to re-focus the debate away from being merely descriptive about problems in science education to a level of practical intervention. In these terms, the measure of the positions advocated on both sides of the constructivist debate ought to be the extent to which they are able to intervene in the 'worst case scenario' - that is the learning crisis in science which accrues to Maori as a group.

This paper:

- identifies features of Maori student crisis in respect of non-participation and poor achievement within science and maths;
- assesses the effectiveness of responses to the perceived difficulties of Maori students including the implied strategies within the constructivist debate;
- argues that constructivism as currently articulated and practised in science education needs to adapt further toward more fundamental structural change in order to impact on Maori access, participation and achievement in science and that some of the changes required are signalled within the Kaupapa Maori education responses.

Many of the reforms and strategies directed at Maori students in science and maths have been mostly **cultural** in form, and focused on changing behaviours. A balanced approach which also takes adequate account of **structural** impediments caused by wider societal forces such as unequal power distribution, marginal economic positioning and the debilitating influence of hegemony is needed.

This paper adopts a sociological perspective and acknowledges the correlation between school and the wider social context and in this sense the school is viewed as both reflecting and perpetuating the society at large.

The demographic context of Maori (non) participation in school science can be seen within the following statistics. Despite constituting only 15% of the total New Zealand population, Maori make up nearly 20% of the schooling population. Significantly, few Maori students are to be found in the top end of secondary schooling (Davies and Nicholl, 1993).

The long term projection for the Maori population growth is that it will increase from the 431,000 (1991) to 867,000 by the year 2031. These figures are based on the current growth rates of 1% per year. Despite this slow rate of growth, Maori will increase twice as fast as the non-Maori population (Department of Statistics, Iwi Population and Dwellings, 1993). In this sense the challenge remains and indeed it is suggested its going to become more pronounced.

The underachievement of Maori in official examinations within the state schooling system is high and disproportionately worse than non-Maori performance (Davies and Nicholl, 1993; Nga Haeata Matauranga, 1994). Statistics reinforce the claim that the educational gap between Maori and Pakeha is widening. For example Wiremu Kaua, the Group Manager for Maori within the Ministry of Education noted (Davies and Nicholl, 1993: 9) that:

Taken on their own many of the indicators presented in this report show that the participation and success of Maori in our education system is improving. Yet for many indicators described, the relative performance of Maori to non-Maori has changed little, while on others the gap between Maori and non-Maori appears to be widening *and would suggest that there has been an inflation in the currency required to obtain employment and satisfactory outcomes beyond school.*

That Maori underachievement is inextricably linked to retention (The Treasury: *Brief to the Incoming Government*, 1987) is misleading. It serves to disguise why Maori are opting out of school. Critical questions raised against the structures of the schooling system are often diminished through an emphasis on retention issues. This in turn leads to a subsequent focus on *victim blaming* explanations which locate the fault of underachievement as being with Maori students themselves and their associated socio-cultural baggage (Forster and Ramsay, 1969). For example, analyses of the mono-cultural implications of what is taught, how it's taught, whose interests are being served, what forms of evaluation are used are mostly avoided as current explanations (Young, 1971).

## The constructivist debate

What has become referred to colloquially as 'the constructivist debate' within science education has recently been given a very public airing in the criticisms made by Dr Michael Matthews, formerly Foundation Professor of Science Education, at the University of Auckland. These criticisms are laid out in his paper *Constructivism in New Zealand Science Education* (1993) and in his book *Challenging New Zealand Science Education* (1995). According to Matthews there is a misguided over-emphasis on the constructivist approach within science teaching and learning in New Zealand schools. His dismissal of constructivism as a "looney doctrine" has openly challenged a major epistemological and pedagogical underpinning of New Zealand science teaching. His arguments take direct issue with the ideological basis of the new core science curriculum which was released in 1993. In opening the debate, Matthews' (1993: 2) claimed that:

Since the mid-1980's constructivist learning theory has dominated formal pronouncements, curriculum projects and Ministry funded research programmes in New Zealand school science education. Constructivism has become the official line. Whilst becoming the official line, constructivism has transmogrified from a harmless, if debateable, theory about how children learn science, to an over-arching theory of knowledge (epistemology), of curriculum, of teaching, of teacher development and of education. There has been little scrutiny of this doctrine and particularly of its more ambitious claims.

Although constructivist approaches come in many variants Matthews identifies two underlying themes which are held in common across the different versions:

- individuals make their own knowledge and,
- knowledge, so-called, does not give us truths about the world, but only more or less adequate ways of meeting individual or social needs.

While this paper intends to focus on the pedagogical implications of the constructivist debate for Maori students in science, some clarification needs to be developed in terms of my own positioning within the wider debate. As such, this paper does not purport to engage deeply with epistemological or ontological issues of constructivism deriving from the question of "what ought to count as science?" (Salmond, 1978, 1985). There are claims concerning Maori forms of knowledge made by Matthews which ought to be engaged. My position derives from a sociological perspective which maintains that *all* knowledge is open to co-option by interest groups as a consequence of being a socially constructed phenomenon. As far as school knowledge is concerned, I agree with Young' s (1971) position that school knowledge (such as science) represents a *selection* of knowledge made *by* and *in* the interests of particular groups. In this sense, knowledge is power and there is a correlation between the ability to determine what will be selected and therefore count as official knowledge within the schooling domain with political power and control within wider society.

Furthermore, my sociological position would hold that science is not the sole preserve of particular cultures, although use of the term science in itself is culturally loaded with western commonsense meaning. As such it is well to be cautioned by Freire' s ( 1971) statement; "name the word, name the world". Thus in this view, the notions of *western science* or *Maori science* can be somewhat misleading. What we do have is science *per se* which is given different cultural expressions, each valid within their cultural context (Roberts, 1994).

Some critical interrogation must be made of Matthews' (1995) position in respect to his comments on Maori language, knowledge and epistemological issues. Many of his claims related to Maori issues in science (Ibid) are founded on several contentious assumptions; for example, that Maori knowledge is somehow less relevant than western science, that there is an *either- or* choice to be made by Maori students between western and Maori forms of science, that western science is superior (1995: 146), and that there is an absence of a politics of colonisation and unequal power relations between Maori and Pakeha. One is left pondering the 'sleight of hand' nature of such research which co-opts the notions of scientific to ostensibly make well informed and accurate commentary on Maori language, knowledge and epistemology. Indeed, one might argue that such claims represent a contradiction in Matthews' position, on the one hand arguing against 'social constructedness' and yet on the other demonstrating quite clearly the social construction of science in the privileging of selected definitions of science. Matthews' two-year residence at The University of Auckland with minimal contact with a range of Maori pupils, parents, communities or, indeed, the language or culture, does not provide a sufficiently informed basis from which to extend understandings about the aforementioned Maori cultural categories. This point is reinforced in the alarming gap in the bibliography and reference notes with respect to Maori sources (I could only find one full reference to a source written by a Maori). Such research raises the spectre of the critiques (Unasa, 1994) of early anthropologists in the Pacific who have been criticised for their academic exploitation with regard to their *hit and run* and *carpet bag* research. Much of this work has been criticised and exposed by indigenous scholars as being ethnocentric, paternalistic and opportunistic. It is unfortunate that Matthews leaves himself wide open to be dismissed on these grounds, given that many of his challenges are valid and useful in developing positive and proactive change in science education. It is against this background of research shortcomings pertaining to his commentary on Maori that Matthews' (1995: 148) criticisms have to be read; for example:

Perhaps it is better politically to say that Western science and indigenous knowledge are in different categories of human endeavour. This is intellectually respectable - there are lots of

perfectly good ways of thinking that are not scientific - and it means that unnecessary and harmful comparisons need not be made between mainstream science and traditional knowledge systems.

Maori language, knowledge and culture are still a functional, living reality for many Maori, for example, within cultural settings such as *Marae hui* (formal Maori meetings), such as *tangihanga* (ritual burial processes), *pohiri* (ritual welcoming ceremonies) and so on. Many Maori still require Maori language, knowledge and culture in order to be fully functional (fully human) within Aotearoa. Despite this, Maori language, knowledge and culture has been mostly marginalised or excluded from the mainstream schooling curriculum. This 'outsider' positioning of Maori has had the oppositional effect of constructing Pakeha dominant school curriculum as official knowledge (Apple, 1994).

Significant numbers of Maori operate in two cultural worlds. In this sense, it is not a choice of one knowledge code at the expense of the other. In fact, all the Maori parents spoken to in the Kaupapa Maori research sample (Smith, 1983) were seeking excellence in both Maori and Pakeha language, knowledge and cultural frameworks as an outcome of Kura Kaupapa Maori schooling in order that their children would ultimately be able to operate to a high level in both Maori and Pakeha cognitive and cultural domains. For them the choice is not a simple either or option as implied by Matthews (1995: 140). Nor does asserting the validity of Maori knowledge directly imply the undermining of the validity of Pakeha knowledge.

It might also be useful to co-opt Matthews' (1993) words in expanding his critique of constructivism and at the same time, acknowledge that he has also conceded that this "looney doctrine" may have also contained a few good points. He states:

For those who want to know at the outset how the story is going to end, my judgement of constructivism is that what is good in it is not new, and what is new in it is erroneous and dangerous to both education and culture. Children may be able to construct their own house of knowledge, but only if they are given the appropriate bricks, mortar, a plan and finally some motivation for building. Without education and culture transmitting these necessities to children, their hope of building knowledge is minimal.

On one point, at least, there is little difference between the protagonists and the critics of constructivism who both agree that the science curriculum developments in New Zealand in the 1980s shifted away from the more traditional and conservative science education approaches which tended to concentrate on acquiring scientific knowledge, learning scientific theories, and practising the skills of scientific enquiry to an emphasis on learner-centred approaches. This new 'learner-centred' approach was heavily influenced by a number of science teachers of which the late Roger Osborne of Waikato University was a leading figure (Osborne and Freyberg, 1985). It would also be fair to acknowledge that some of the impetus for a constructivist reorganisation of science education came as a response to the high levels of invisibility and/or underachievement of particular groups of students differentiated by race, class and gender categories. The special needs of these groupings were highlighted within the new sociology of education and critical theory interrogation of schooling and education structures during the 1970s and 1980s. In New Zealand, these critical approaches revealed the underdevelopment of Maori *within* and *as a result of* schooling. Schools and education programmes were increasingly subjected to critical scrutiny in the face of an ongoing educational crisis of underachievement which accrued disproportionately to Maori pupils. Maori disadvantage and a perceived need to respond to Maori educational and schooling needs in specific and targeted ways was identified within the Hunn Report (1960), and later reinforced by the Currie Commission (1962) and the National Advisory Committee on Maori Education (NACME) Reports (1970: 1980). All of these influential committees saw fit to specifically comment on the need for greater Maori student access and achievement in the sciences.

Hodson (1993: 6 85) has written extensively on cultural issues pertaining to science education in New Zealand. He argues strongly for approaches which build on learner-oriented, constructivist-

type foundations as interventions within the race, class and gender crises within science teaching and education. Hodson endorses the following key points as being central to this new trend.

- Addressing *real-life* situations.
- Relating science to wider societal and technological issues.
- Developing scientific literacy in the context of active and responsible citizenship.
- Promoting science as a cultural phenomenon.
- Ensuring that science is more person-oriented.
- Starting from and building on children's existing knowledge and experience.
- Using problem-solving activities to develop creativity and promote decision-making and social skills.
- Enhancing each student's self image and self worth.

These elements conform to what has been described as the constructivist approach and can be generalised as developing science education as a "society oriented and learner centred study" (Ibid). Such an agenda represents a genuine and positive attempt to make science more accessible and relevant for a variety of groups. Certainly constructivist responses must be commended for at least attempting to initiate change in respect of these crises.

The traditional and conservative approaches advocated within Matthews' attack on constructivism ought to be challenged on two accounts:

- The performance record shows that these conservative approaches did not work successfully for a significant number of students, including disproportionate numbers of Maori;
- They offer little prospect of change in respect of access, participation and achievement in Science for Maori.

Before advocates of constructivism get too comfortable, it is necessary to stress that the critical question which is implied here 'how do these strategies and reforms impact on Maori crises?' - also applies to constructivism. It is important to note that from the constructivist view, the debate is more an argument of pedagogy than, as Matthews seems anxious to emphasise, a major attack on the philosophical and epistemological base of "what counts as Western scientific knowledge?".

While the objectives of a constructivist approach appear commendable and potentially transforming of Maori underachievement within school science, significant inroads into the circumstances of disproportionate levels of Maori underdevelopment in science has yet to occur as a result of constructivist strategies.

In this sense while constructivist approaches promise transformation of Maori crises in Science, in reality not much has changed. All of the elements within the Hodson list have merit for transforming the difficulties faced by Maori in this curriculum area. The validity and legitimacy of other knowledge forms are given credence and recognition. Reinforcement is given to where the student is at and what the student brings into the classroom; culturally different learning approaches are also catered for; and above all, science is recognised as being socially and culturally influenced.

Young (1971) stresses the social and cultural construction of school knowledge. The critical insight here is that the school curriculum represents a selection of knowledge made by dominant non-Maori interest groups. In this sense, school science which is reified as neutral, acultural, and value free is clearly open to challenge.

The constructivist debate raises some interesting points of view from both sides. Matthews (1993: 21) should not be misrepresented as advocating a full retrenchment to the conservative past, this point being made in the conclusion to his paper.

I do not believe in over-stuffed curriculum. I do not believe in forced feeding of children. I do not believe in bookish learning at the expense of practical competence. I do not believe that science



is free of values. I do not believe that science should be taught divorced from its human and social context. I do not believe that discussion of the life, times and achievements of Galileo, Newton, Darwin, Einstein, Madame Curie, Rutherford or any other great scientists is elitist, boring or irrelevant. The comprehension of their scientific achievements is not easy, but partial comprehension can be had if the effort is made and if teachers themselves are suitably prepared, and introduce the personalities in the context of studying the appropriate phenomena or concepts.

I see tremendous potential in the constructivist approach, but at the same time, Matthews also makes some important criticisms. I would hold to the position that both schools of thought can be accommodated within an eclectic approach to science education and do not necessarily need to be constructed as an absolute oppositional discourse. My overriding concern is to seek the best approach for delivering success in science for Maori students.

The wider significance of the constructivist debate is contained within the critical interrogation of all curriculum knowledge transmitted through schooling to children, including Maori children and the focus brought to bear by these insights and understandings which derive from the 'Sociology of Knowledge' perspective (Young, 1971 ; Whitty, 1986). These concerns become sharply focused through the posing of critical questions related to what counts as science knowledge?, whose interests are served by this form of science knowledge?, are other forms of science knowledge excluded from the curriculum?, what hegemonic appeals are developed to entrench as mainstream, and therefore privilege particular forms of science knowledge? how and in whose interests is science knowledge evaluated? and so on.

A significant reason for focusing on Maori within the constructivism debate relates not only to the exclusion and marginalisation of Maori forms of knowledge, pedagogical practice and culture within schools but also to the fact that Maori as a group constitute the most severe case in respect of education and schooling underachievement across the curriculum generally and in science as a subject specifically. Three immediate questions arise out of the dire circumstances related to the underdevelopment of Maori within science - what differences will be made (have been made) for Maori through a constructivist approach?; what differences will be made by moving away from this approach?; what positive and proactive alternatives to address the Maori predicament within science are being suggested in its place?

A major problem with past policies and initiatives which were designed to impact on Maori difficulties across the school curricula, was that they tended to emphasise liberal perspectives. As a result, there has been a tendency to respond to the crisis of Maori underachievement in schooling by focusing "victim blaming" and "deficit theory" (Jones et. al., 1990). Generally, there has been a reluctance to critically analyze the system of schooling and associated monocultural structures. This reticence to alter the existing structures of the system is consistent with a liberal outlook in which the emphasis is placed on cosmetic change at the level of social relations. For example, changes aimed at uplifting the academic *misfits* to conform to the system, or providing equal opportunities in order for the underachievers to adapt themselves so that they are able to more readily join in and participate in the existing taken for granted structures. Another liberal response has been to simply put more resources into the crisis area, unfortunately the structural changes which need to also occur alongside, are often overlooked.

Little critical consideration has been given to the influence of elements within wider society which may also impact at the classroom level. Examples of structural influences are contained within the asymmetrical power relations which exist between dominant Pakeha interests and minority Maori interests. Structural factors are also discernible within the detrimental influence of eurocentric ideologies, such as the taken for granted assumptions of Western forms of science knowledge which posit such knowledge as being more rational, more accurate, more technological, more advanced, more modern. Indeed, it would seem that science *per se* does not exist outside western conceptions of it. These same ethnocentric views which would advance Western science as having some prior

claim to truth and reality correlate strongly with the colonising agenda of the early European explorers who ostensibly *discovered* Aotearoa (Smith, 1994: 9).

When Captain Cook came to New Zealand on his voyage of discovery he brought with him a number of specialist science oriented people such as Parkinson and Solander. Another of these *scientists* was Joseph Banks, an amateur botanist. Banks spent considerable time and effort in sketching, collecting and recording the fauna and flora of Aotearoa, completely oblivious to the fact that many of these plants already had Maori names. For example the native flax plant harakeke was to be reclassified as *Phormium tenax*, and the native kouka tree as *Cordyline banksii*. Cook himself mapped the New Zealand coast and renamed various landmarks, ignoring the fact that many of these places already had Maori names which were of significance within the Maori geography of New Zealand.

In order to transform the crisis of Maori underachievement in schooling ( and therefore within science) a more comprehensive and sophisticated approach to reform in schooling and education is necessary. Such an approach ought not to be merely concerned with issues of equal opportunity and compensatory education. It must also target fundamental change in respect of the roles played by power, ideology and socio-economic factors. In critical terms, the social transformation of Maori underachievement within schooling and within science must involve a move away from an over-emphasis on cultural explanations of underachievement to a more balanced approach which also controls for structural implications derived from the wider societal context. Initiatives and approaches applied simply at the level of social relations have been less than successful in overcoming multiple difficulties faced by Maori students within schooling. Thus, in spite of numerous intervention attempts over several years, very little has changed in terms of the outcomes for the targeted group - Maori students remain in crisis in almost every index of learning performance (Nga Haeata Matauranga, 1995).

## The political context

Major economic reform in New Zealand has moved to insert the framework of the free market within schooling and educational structures. In this new order, individualism, competition, meritocratic principles, the emphasis on credentialling (and the central positioning of maths and science within them) are entrenched, legitimated and reproduced. Such an economic framework both produces and reproduces the conditions for the reification of positivistic ideologies and technological rationalities, which in turn privilege particular and selected knowledge forms such as science. In such a positivistic climate, subjects such as maths, science and technology form central components of the new meritocratic order. The struggle to legitimate these subjects provides an interesting context in which Maori students needs ought to be discussed. The ongoing struggle to hegemonise an instrumental view of schooling which puts credentialling in science, maths, technology in the privileged position of being more likely to lead to employment, reinforces through a curriculum hierarchy the differential status of these subjects within the school. A critical point to be understood here is that while credentials might make students more employable they will not necessarily lead to employment given the international and global market forces which impact on the numbers of jobs that may be available.

The capitalistic logic of the free market approach within education and schooling represents a new wave of colonisation and assimilation for Maori. The underpinning values of the free market stand in opposition to preferred Maori values, attitudes, knowledge and culture. Key concepts which underpin the free market such as individualism, competition, consumerism, materialism and capital accumulation is dissonant with Maori propensity towards concepts of collectivity, co-operation, gifting, and sharing. The notion of the free market implies a level playing field with respect to access to wealth, resources and even knowledge by all members of society, however such hegemony also directly contradicts the experiences of the majority of Maori people, inhibiting their ability to attain equal opportunities and access.

## Maori difficulties in science and maths

Study of the available statistical information (Ministry of Education, Statistics Division's Annual Reports) on Maori student performance in maths and science curricula reveals *poor achievement* in examinations in science and maths, and *low participation* rates in science and maths. Of those few Maori who stay on to sixth form, approximately fifty percent are engaged in science subjects. At this level retention of Maori pupils at school does become an issue.

In 1990, for every 100 Maori who began third form study only 15 went on to 7th form. This compares with the non-Maori figures where 40 students went on to 7th form. During this year, 11 % of Maori primary pupils attended a bilingual class or a Kura Kaupapa Maori. By 1991 this figure had increased to 13%.

In 1990, 68% of non-Maori students left school with Sixth form certificate, while 36% of Maori students, left with similar qualifications. In 1990, Maori were 6% of all students attending University. Most were over the age of 25 years of age and 56% of the Maori students in this year were women. Analysis of the available data from the Ministry of Education suggests that Maori student participation in maths and science at fifth and sixth form is high and comparable to other groups. Both Maori and Pakeha students choose English, maths and science as their top three subjects for study in the fifth and sixth forms. Too few Maori students actually stay on at school to sit School Certificate and Sixth Form Certificate. This factor, together with the probability of a high correlation between success in Pakeha oriented subjects with the degree of assimilation of Maori students, tends to cloud the cultural implications of this situation. Many Maori students have left school at age fifteen and subsequently the pressure on the system to respond to Maori cultural needs and aspirations is lessened at the upper levels of the education system. Seen in the light of this information the problem becomes too readily accepted as simply one of retention. It is predictable that raising the school leaving age to sixteen and forcing more Maori students to remain at school longer, may in the future, impact on Maori access and participation rates in these subjects but not necessarily on achievement levels.

There is very little data available about Maori student involvement within maths and science at primary and pre-school level. This is a major gap in developing a complete picture of Maori student attitudes and abilities with science and maths. More research is required in this area and the comments made in this paper are accordingly tailored to reflect the information available. Some important statements can be generalised from the statistics which are available.

- Maori students perform relatively worse than their Pakeha peers based on school certificate and sixth form results.
- Large numbers of Maori students elect to do science and maths at fifth and sixth form level, despite disproportionate levels of underachievement in these subjects relative to Pakeha students.
- Very few Maori students go on to major in science and maths at University although the numbers are increasing at specific institutions which reflect particular programmes (eg. Auckland University Maori Science Students Programme).
- Few Maori go on to careers in science and maths.

A key question here is why do these dire circumstances persist despite various, well intentioned attempts over several years to intervene?

## Strategies for intervention

The emphasis of policy reform during the 1960s and 1970s in respect of Maori nonparticipation and Maori underachievement levels in science and maths had been mostly devised and implemented by policy makers operating from deficit models. Explanations of high levels of failure by Maori in



these subjects were usually deemed to be the result of problems associated with Maori learners themselves; for example, little science or maths literacy in the home, poor English language and therefore poor understanding, lack of motivation and concentration towards learning and low intelligence quotients! The pathological orientation of these theories tended to ignore the structural implications of questioning what was being taught, how it was being taught and the ethnocentric bias of the subject matter.

Education and school policy reform during the 1980s, began to look critically at the existing structures of schooling. Thus schools, the curriculum and teaching were all put under scrutiny in order to establish the extent to which these previously unquestioned structures were implicated in the Maori underachievement crisis in schools. As a consequence some attempts at structural change began to occur. In particular specific components of science and maths teaching were criticised and targeted for change. These changes have been very slow; they have been resisted by those of conservative inclination and they have been constantly struggled over. Some examples of these sites of struggle include the following:

**Pedagogy** attempts have been made to employ culturally appropriate methods of teaching and learning which connect with the cultural backgrounds of the learners.

**Curriculum** attempts have been made to include material from other cultures within the curriculum and critical notions such as the 'selected curriculum' have been emphasised.

**Foundations** debate has focused the critique of notions such as Western science by notions of indigenous science.

**Teacher** recruitment programmes have been designed to target teachers of science and maths.

**Assessment** has been the critical engagement of cultural bias in testing and evaluation.

These strategies attempted to respond to issues concerned with *relevance* and *access*. The concern was to make science and maths more user-friendly in respect of culturally-different students. While these responses began to move toward some structural considerations and changes they were for the most part, limited in their ability to fully impact on Maori needs. The overall weakness of these types of initiatives is that they still emphasise cultural responses and once again the critical influence of structural elements such as power, economics and ideology, in the context of the subordinate positioning of Maori in New Zealand society, are not substantially addressed.

There have also been a number of policy orientations and teaching approaches designed to respond to Maori student needs within science. Some of these state below have been described in detail by Jesson (1991).

**Taha Maori:** an approach where teachers are encouraged to include Maori content, values and cultural examples in the standard science curriculum.

**Science Aotearoa:** an approach which emphasises a science curriculum which reflects the New Zealand context by using New Zealand examples and content.

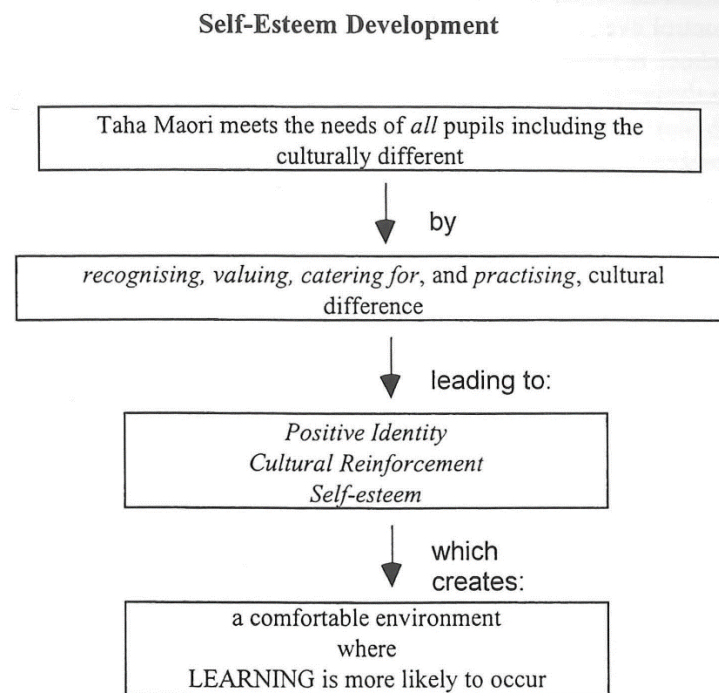
**Bilingual science:** an approach which encourages the incorporation of Maori language; the teaching of the standard science curriculum in Maori language.

**(Bi)Cultural science:** an approach which gives legitimacy and validity to 'selected' cultural forms of science, including Maori science.

**Multicultural science:** an approach which uses a variety of cross cultural examples used alongside the standard curriculum.

Most of these strategies have not to any significant degree changed the crisis in science for Maori. At stake in all of these scenarios is the extent to which validity and legitimacy are genuinely and meaningfully extended to Maori language, knowledge and culture, as against the extent to which

these strategies merely attempt to co-opt Maori culture, language and knowledge to facilitate Western science learning. This can be summed up in the following diagram from Smith (1988) in which he critically analyses the co-option of self-esteem strategies within Taha Maori programmes:



The problem with the Taha Maori *self-esteem* model is that the engagement with Maori language, knowledge and culture is superficial, and is mostly done to the extent of creating a placebo effect in order to facilitate *real learning*, that is, the taken for granted norm of dominant English language, knowledge and culture. This type of approach underpins the liberal solution offered by Matthews (1995: 195) and needs to be exposed as limited and illusionary with respect to Maori needs and aspirations as reflected for example within Kura Kaupapa Maori.

Despite the obvious shortcomings of liberal education approaches which develop limited 'Taha Maori' type changes, they all make an important start towards developing change and they begin to acknowledge a crisis related to Maori in schooling and the science curriculum. A further point is that they have also been able to mobilise the support of large numbers of teachers of science to assist these programmes. However, the need for more substantive change remains.

### Structural considerations

Constructivism begins the intervention process for Maori by emphasising change at the cultural level. Constructivist strategies must be further enhanced in order to disclose and take greater account. Key structural considerations which ought to inform successful intervention measures for Maori schooling crisis include:

**Power-relations:** there is a need to control for the societal context of unequal power relations. Maori social, political, economic and cultural subordination to the dominant group is manifested in many ways including the control over knowledge and the curriculum. What counts as science in the school represents a selection of knowledge which sometimes leads to the exclusion of Maori interests.

**Socio-economics:** there is a need to consider and control for the impact in schools of the marginal social and economic positioning of Maori within the wider New Zealand society.

The consequences of unemployment, social disintegration, 'welfarism', poor health and so on impact at the level of schooling and within the classroom.

**Ideology:** there is a need to respond to Maori aspirations in relation to the validity of Maori language culture and knowledge revitalisation, particularly at the ideological level. There is a need to assert the validity of Maori knowledge and frameworks.

Successful intervention strategies into Maori educational crisis need to utilise both culturalist and structuralist approaches to more adequately account for the learning and teaching needs of the Maori student in regard to the wider societal context of family, school and community. Within this framework the specific needs related to ethnicity, gender and social class also need to be addressed.

### Kaupapa Maori theory and educational intervention

Since 1982 and the beginnings of Te Kohanga Reo (Maori Medium pre-schools), Maori have developed a range of educational intervention programmes for themselves. These programmes have developed at pre-school (Te Kohanga Reo), primary (Kura Kaupapa Maori), secondary (Kura Tuarua) and tertiary (Waananga) levels of the education and schooling system. Maori parents regard 'these initiatives highly and claim that they meet their aspirations and needs with respect to both Maori language, knowledge and culture revitalisation as well as the need for intervention into the learning crisis in which disproportionate numbers of Maori children are trapped. A further example of the success of Te Kohanga Reo in particular is contained in the sworn evidence before the Waitangi Tribunal Claim Relating to Te Reo Maori and cited in the Tribunal's findings (Waitangi Tribunal Report on Te Reo Maori: 1986):

6.1.14. The beginning point in the system has become very important. We have already referred to the Te Kohanga Reo programme and its rapid development. As to its success we cite the evidence of Mr. P. W. Boag, Deputy Chairman of the State Services Commission and a gentleman with personal experience in education where he says:

...The extraordinary success of Te Kohanga Reo is clear evidence that the Maori community sees that Maori language and culture are a necessary element for the self-esteem, dignity and mana of Maori people. The outcome is bilingual, bicultural children and a strengthened whanau. In this respect the Maori language cannot be viewed in isolation but within the context of broader social issues...

What can be learned from examining these successful Maori driven resistance strategies which will impact on Maori needs with respect to science education. How do approaches such as constructivism measure up against the intervention elements embedded within these Maori educational initiatives such as Te Kohanga Reo, Kura Kaupapa Maori, Kura Tuarua and Waananga?

All of these Maori schooling types are underpinned by common elements which, it has been argued by Smith (1990, 1992, 1994) are crucial to developing more meaningful intervention into Maori schooling crises. Smith (Ibid) has described these common elements as forming *Kaupapa Maori* as a theory of social, cultural and educational transformation.

Kaupapa Maori theory, has evolved from inside the Maori community. It is an 'organic' response which has developed out of the Maori driven educational interventions. Given that the curriculum, pedagogy and structure of these Maori immersion learning sites have evolved mostly from Maori parental decision-making, it is interesting to compare both the implicit and explicit intentions and forms of Kaupapa Maori as decided by Maori parents on the inside, as against teaching strategies such as those implied within constructivism which have been applied to Maori from the outside.

Thus Kura Kaupapa Maori (Maori medium primary schools), building on the successful elements of Te Kohanga Reo have produced successful intervention. Some of the key intervention elements which are embraced within Kura Kaupapa Maori and which are common to other Maori educational

initiatives, and which have the potential to speak to the general Maori crisis in schooling are briefly outlined here.

**(Tino) Rangatiratanga** (relative autonomy principle): The goal of control over one's own life and cultural well-being has made gains within the relatively autonomous development of Kura Kaupapa Maori. Greater autonomy over key decision-making in schooling has been attained for example in regard to administration, curriculum, pedagogy and Maori aspirations. Key points are that Maori people have made these choices and are therefore more committed to making them work.

**Taonga Tuku Iho** (cultural aspirations principle): In Kura Kaupapa Maori, to be Maori is taken for granted. Maori language, knowledge, culture and values are validated and legitimated. Maori cultural aspirations, particularly in a wider societal context of the struggle for language and cultural survival, is more assured. A strong emotional and spiritual factor is introduced to support the commitment of Maori to the intervention.

**Ako Maori** (culturally preferred pedagogy): Teaching and learning settings and practices connect with the cultural backgrounds and life circumstances (socio-economic) of Maori communities. Other pedagogy is also utilised including general Pakeha schooling methods, and some cross cultural borrowing, eg. Japanese pedagogy - 'Soroban' maths programme; learning of Japanese language. The move towards Pacific/ Asian cultures and language is a logical development given close cultural similarities, and given the shared commonalities of the Austronesian group of languages.

**Kia Piki Ake I Nga Raruraru O Te Kainga** (mediation of socio-economic and home difficulties principle): The Kaupapa (philosophy) of Kura Kaupapa Maori is such a powerful and all embracing force, through its emotional (ngakau) and spiritual (wairua) elements, that it commits Maori communities to take seriously the schooling enterprise despite other social and economic impediments. It impacts at the ideological level, and is able to assist in mediating a societal context of unequal power relations. It makes schooling a priority consideration despite debilitating social and economic circumstances.

**Whanau** (extended family structure principle): This provides a practical support structure to alleviate and mediate social and economic difficulties, parenting difficulties, health difficulties and others. Such difficulties are not located in individual homes but in the total whanau; the whanau takes collective responsibility to assist and intervene. While the whanau structure implies a support network for individual members there is also a reciprocal obligation on individual members to invest in the whanau group. In this way, parents are culturally *contracted* to support and assist in the education of all the children in the whanau. Perhaps the most significant aspect of whanau administration and management is that it brings back into the schooling setting many parents who were once extremely *hostile* to education given their own unhappy schooling experiences. It has committed parents to reinvest in schooling and education for their children.

**Kaupapa** (collective vision, philosophy principle): Kura Kaupapa Maori have a collective vision which is written into a formal charter entitled *Te Aho Matua*. This vision provides the guidelines for excellence in Maori; what a good Maori education should entail. It also acknowledges Pakeha culture and skills required by Maori children to participate fully and at every level in modern New Zealand society. *Te Aho Matua* builds on the Kaupapa of Te Kohanga Reo, and provides the parameters for the uniqueness that is Kura Kaupapa Maori. Its power is in its ability to articulate and connect with Maori aspirations, politically, socially, economically and culturally.

The above list contains the key elements of Kura Kaupapa Maori schooling which contribute to the success of these schools.

The notion of *whanau* is perhaps the most crucial element within the Kaupapa Maori intervention. It provides both a structural and pedagogical framework for Kaupapa Maori as a theory of change. In this sense the concept of whanau has a multiplicity of meanings and signifiers ranging

from traditional to contemporary meanings. Whanau as a key intervention element within Kaupapa Maori is able to make sense of and mediate the intricate and complex, (at times contradictory), discourses which envelop Maori people attempting to maintain the viability and the legitimacy of their traditional cultural foundations in a contemporary context.

Kaupapa Maori as a theory of change has emerged as the underpinning philosophy and motivation within a range of alternative, Maori driven schooling and education structures. Kaupapa Maori provides both a critique of constructivism as well as a framework of rescuing constructivism to being more productive for Maori students. Many of the shortcomings of constructivism are developed as strengths within Kaupapa Maori. For example, Kaupapa Maori takes for granted the validity and legitimacy of Maori language, knowledge and culture. It incorporates Maori aspirations and needs of cultural revitalisation it critically engages structural impediments faced by Maori in New Zealand society and it is concerned to protect Maori interests. So far, Kaupapa Maori has achieved enough positive results to be popularly supported by a large proportion of Maori society (Nga Haeata Matauranga - Ministry of Education Annual Report for Maori Education: 1994; Education for the 21st Century, 1994). Kaupapa Maori as an intervention strategy is now being successfully transposed and applied within other domains outside of education and schooling to develop wider societal intervention, for example within Media, Health, Employment, Justice and tribal self development initiatives.

## Conclusion

This paper has argued that there are three main areas of concern which have preoccupied the attention of those interested in responding to the underdevelopment of Maori within Science. These are:

- Performance (achievement/ non-achievement issues);
- Participation (access/ non-access and relevance/ non relevance issues);
- Retention (Maori pupil continuance at school past the fifth form).

A range, of initiatives which have intended to respond to these concerns either wholly or in part, have made little difference to the Maori crisis within Science.

The challenge for science education in New Zealand is clear. Current initiatives directed at Maori pupil difficulties within science and maths need to be reframed in a critical way. Constructivism as a theoretical position makes some bold claims but as yet has not made any significant impact on Maori access, participation and achievement in science education. My argument here is not against constructivism, but for a reconstruction of it in the light of what can be learned from Kaupapa Maori strategies. In particular, reorganisation at the pedagogical level in order to deliver more effectively for Maori. On the other hand conservative approaches as advocated by Matthews such as using *additive* science stories from history and cultural tradition needs to be understood against the limitations of liberal education approaches as exemplified in the taha Maori critique. They are limited in their capacity to intervene meaningfully in the Maori learning crisis.

The success of science education as an independent discipline within the New Zealand education context ought to be measured by its ability to respond to and to deal with the most significant crisis in the science and maths area - that related to the non-achievement, and non participation of Maori pupils. Indeed, I would suggest that any claim to international standing and expertise by New Zealand science education academics ought to be relative to the degree to which they are able to deal with domestic issues in the area. Notwithstanding that Maori pupils and communities also have some responsibility in this issue, it is hoped that the challenge implied here is responded to positively by those who work in this field.



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