Māori Technology Capacity II: Science in the Universities and Polytechnics of New Zealand

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Abstract: The government is pushing this country towards a future deeply embedded in technology and science. There are serious risks at both the national and personal levels to the socio-economic status of Māori and Pākehā, and it seems likely that those who can adapt to the new society will have an advantage over those who cannot. For Māori who have been at the bottom of the socio-economic ladder for these last 150 years, the risks could be quite serious. The questions are, if New Zealand society is to become a technological society how will Māori fare? What are the risks? Will Māori become even more dependent on Pākehā knowledge, advice, and charity? Will Māori share in the economic benefits of the new society, and how will that be achieved? Māori recognize that the key to economic success is education; however, technological success to a large degree will require intensive technological education in the form of science, engineering, medicine, and technology coupled with business and commerce. In this essay the generation of human capital directly supporting the technological capacity of Māori has been examined according to the latest science degree enrolment figures from the Ministry of Education, and the picture is not great, but nor is it a total loss. While Māori enrolments in the sciences lag behind non-Māori in all degree areas, the overall gap has been narrowed to just below half of the expected enrolments based on ethnic population statistics. This is good news because it means that the gap should be bridgeable without major interventions or miracles. A goal of doubling the number of Māori science students in tertiary institutions over the next ten years might ensure Māori a place in the technological world of tomorrow.

Keywords: Human capital, Māori sciences enrolments, science and technology, technology assessment, technological capital, technological capacity, Vision Mātauranga.

Introduction

This paper is a sortie into the world of technology, attempting to identify a small part of the problem concerning the scientific capacity of Māori as a collective. The paper is confined to the scientific educational development of Māori because of its significance to the future of the nation.

The future prosperity of this country is tied to technology and science. New Zealand's largest funder of science, the Foundation for Research Science and Technology (FRST) in their recently published Statement of Intent (Bazly, Pearce & Bain, 2007) made it quite clear that science and technology is the doorway to innovation and economic prosperity for this country; government is staking its future and the future of its people on its investments in science and technology.

> Research, science and technology can play a pivotal role in lifting productivity through transforming commodities into more value-added products and services while concurrently reducing costs through more efficient production processes. In addition, sustainable economic development will require a society that encourages people to develop skills, celebrate diversity and participate fully in the economy throughout their lives. (Bazly et al., 2007, p.3)

This approach to the future is not unique to New Zealand, but is strongly embraced by all

technologically advanced nations of the world including the United States. For example, in a report to the nation from the National Commission on Mathematics and Science Teaching for the 21st century, Senator John Glenn of the United States wrote:

> …..the Commission is convinced that the future well-being of our nation and people depends not just on how well we educate our children generally, but on how well we educate them in mathematics and science specifically. From mathematics and the sciences will come the products, services, standard of living, and economic and military security that will sustain us at home and around the world. (Glenn, 2000, p.4)

He went on to say:

> Beyond the world of global finance, mathematics and science will also supply the core forms of knowledge that the next generation of innovators, producers, and workers in every country will need if they are to solve the unforeseen problems and dream the dreams that will define America's future. (Glenn, 2000, p.4)

The course is clear, as New Zealand seeks to develop its technology, exports, and value added products, some parts of the economy will blossom while others will decline; some people will prosper while others will not. In this brave new world of mathematics, engineering, electronics, physics, biology, and chemistry where will Māori stand? Will Māori remain at the bottom of the economic ladder, or will they take their opportunities in hand? What is the future for Māori as the world changes? In some ways the challenges facing Māori today, at the beginning of this 21st century, are similar to those that Māori faced at the beginning of the 19th century. Technology as introduced by Pākehā to this country 200 years ago profoundly changed the Māori way, and some of the repercussions are still being dealt with today. Will this new round of innovation and technology have the same disruptive effects on Māori culture as that of the past, or have Māori learned how to deal with change; are they prepared?

In addition to economic reasons, these next 50 years are going to be a critical period for humanity world wide; global warming, rise in sea levels, population growth, species extinction, poverty, disease, and innumerable uncertainties surrounding standards of living, security, jobs, and education are pushing humanity to a point where a breaking point seems imminent. The only certainty seems to be that the rich will get richer and the poor will get poorer.

Māori need to look to the future not as a threat but as an opportunity; an opportunity to bootstrap themselves further up the economic ladder. To achieve that impetus Māori, as a collective, will need to embrace the innovative society, but before they can do that they need an objective assessment of their technological capacity; waiting passively for change is not acceptable. Māori need to know what they have in terms of expertise, and what they need in order to deal with the uncertainties of an impending innovation economy. Do Māori have the people who can lead and keep them safe? Are they training their children for leadership in a technological world? Do they have Māori people who can explain the problems and help them reach agreements, but in a manner that is culturally sympathetic and sensitive? Can Māori make their voices heard in the halls of science and technology or are they to be ignored yet again because their knowledge is dismissed as irrelevant?

This paper is not an answer to the questions raised above. Instead, it reviews and compares the recent academic enrolments of Māori and non-Māori in the sciences. If Māori enrolments in the sciences lie substantially behind those of non-Māori then the assessment may be important in the development of strategies to overcome such a disadvantage. The successful evolution of a technological economy is dependent on human capital as produced in this country's tertiary institutions and the successful integration of Māori with that economy is dependent on the production of Māori science graduates.

The Economic Contribution of Biotechnology to New Zealand's Primary Sector and Vision Mātauranga

The government's estimates regarding the economic contribution of biotechnology to New Zealand's primary sector has been looked at very carefully (Kaye-Blake, Saunders, Emanuelsson, Dalziel & Wreford, 2006). Contributions to New Zealand's economy by the biotech industry have already helped its primary industries (agriculture, forestry, and horticulture) to stay internationally competitive. The following are some key examples offered by the Ministry for Research, Science and Technology:

- the cloning of bulls for superior breeding stock
- marker-assisted breeding to combat foot rot in sheep
- clonal propagation of pine trees
- soil additives to eliminate nitrate leaching into rivers and lakes, and
- vaccines which increase lambing yield.

(Kaye-Blake et al., 2006, p 2, Summary document).

This is wonderful science, highly sophisticated and technically dazzling, but where is Māori in this new vision? Do they drive it? Are they passengers? Do they benefit from it? Do they even know what it's about? Where is the shared vision, the shared future, and the shared benefits, expected of a Treaty partner? The government has not intentionally excluded Māori; it is Māori who have excluded themselves to a large degree because of their lack of expertise. Government opened a door that Māori have difficulty getting through; how does one inject an indigenous economically disadvantaged people into a modern day biotech-mix? Accommodation of Māori has been offered by way of Vision Mātauranga a government directed policy agenda that speaks to the value of Māori knowledge. Vision Mātauranga is an appeasement, an invitation for Māori to come forward, an invitation to the knowledge future:

> Vision Mātauranga is a Vote RS&T-wide policy framework designed to unlock the innovation potential of Māori knowledge, resources and people. It is designed to respond to distinctive needs of the Māori community and also to enable the development of distinctive contributions of Māori knowledge, resources and people to RS&T. (http://www.morst.govt.nz/current-work/vision-matauranga/)

Will Vision Mātauranga ensure Māori a part in the technological world being developed? While the idea of Vision Mātauranga is culturally attractive, and indeed respectful and embracing, the reality may be something quite different. It's a bit like saying to Māori, "Listen up. We're building this technology thing over here and you can help, but you're going to have to use only the knowledge you have that comes under the heading of philosophy, religion, art, language, and culture to achieve it." But we say, "That's not really fair is it? While we want to be part of this technology "thing" the tools we have were not designed to achieve your "thing". Our tools are the tools of a non-technological culture designed for the sustaining of Māori people in the natural world, not your technological world." Basically, Vision Mātauranga while culturally flattering might not give Māori the keys to the technological world of tomorrow. The only way that Māori will achieve economic parity is through technological parity, and the only way they will achieve that is through science and math education. Māori must look to their academic performance.

The Relationship Between Tertiary Study and Technological Capacity

Technology refers to all scientifically-based manufacturing, research, development, planning, and service organizations and includes all scientific, engineering, and medical disciplines. The key term is "scientifically-based". The term "technological capacity" has been defined

previously, (Hook, 2007b). The technological capacity (TC) of a nation engaged in the production of high-tech widgets is defined as the sum of the human capital (HC) plus social capital (SC) (for an enlightening discussion regarding social capital and Māori society see Williams & Robertson, 2004) plus physical assets (PA) plus knowledge assets (KA). Human capital (HC) in this context simply relates to the number of working-age people trained in technology at a sufficiently advanced level as to be engaged, contributing, and/or leading technology development. The technological capacity of the Māori people (TC_m) is then as follows:

$$TC_m = HC_m + SC_m + PA_m + KA_m$$

For Māori to improve their position regarding TC_m, any or all of its four component factors can be increased. The most direct enhancer of technological capacity is HC_m which can be increased relatively easily by, for example, encouraging student learning in the sciences. Research is another pathway because it can result in the development of knowledge assets and indeed our universities are heavily vested in research. In this particular essay only educational aspects will be examined. For the purposes of this study, engineering, and medicine will not be addressed, only the sciences as defined by NZSCED Codes (http://www.steo.govt.nz/NZSCED). For this paper science is defined according to the NZSCED field of natural and physical sciences, plus science degrees in other fields but does not include social or political science, plus anyone with a science subject recorded as a major subject in their degree; this applies to both completions and enrolments.

As seen in Table 1, there is a higher proportion of Māori science students in Bachelor degrees (86.9%) than there is for non-Māori (78.6%). This probably reflects the upsurge of Māori into the sciences in recent times. With this upsurge there is an expectation that proportionately higher numbers of Māori will ultimately appear in the Masters and Doctoral programmes in the years to come. In the Honours degrees Māori are under represented by about half (3.6%) of that of non-Māori (6.7%). This is a difficult degree area and in view of the greater representation of Māori in Bachelor degrees might lead to an expectation that proportionately more Māori will enter Honours programs in the years to come. In Masters degrees, Māori tend to be under-represented (8.5% versus 11.9%, respectively) although the percentages are not so different as to represent a major disjunction. At the Ph.D. level Māori are under-represented by half and at the higher doctorate level Māori are not represented at all.

For technology and science, the major sources of human capital are the universities, the Institutes of Technology and the Polytechnics, although not exclusively. Some training also occurs within the Crown Research Institutes and the Private Sector. For both Māori and Pākehā the bulk of the degree completions in science are to be found in the universities (Table 1) with the universities accounting for 85.9% of the degree completions in science for Māori and 84.4% for non-Māori. Table 1 also indicates that the preferences of Māori for institutional learning is little different from that of Pākehā. The Colleges of Education, Private Tertiary Establishments (PTEs) etc., did not attract Māori into science degrees while for non-Māori the numbers on a percentage basis were also minor excepting for the Colleges of Education which accounted for 3.0% of the Bachelor degrees. The OTEPs (other tertiary educational providers), PTEs and Wānanga were very minor in their contributions to science development in this country.

The most direct link to human capital development in a technologically advanced society are the postgraduate studies programmes because of their direct link to knowledge assets, innovation, leadership, and technological capacity building. However, engagement of students at the undergraduate or bachelor level is an important indicator of things to come, because it is from this pool that graduates are drawn into Honours and Masters degrees. Doctoral level study is also important although only a small percentage make this transition (2.7% of Māori science students, see Table 4).

Table 1. The distribution of Māori and non-Māori completing science degrees by level and subsector for the year 2005*.

Level	Subsector	Māori	% Māori	non-Māori	% non-Māori
Bachelors	Universities	224	73.4	15,711	63.8
	Institutes of Technology and Polytechnics	41	13.4	2,688	10.9
	Colleges of Education	0	0	730	3.0
	OTEPs	0	0	16	0.06
	PTEs	0	0	194	0.8
	Wananga	0	0	22	0.09
	Total students in Bachelors	265	86.9	19,361	78.6
Bachelors with Honours	Universities	10	3.2	1,599	6.5
	Institutes of Technology and Polytechnics	1	0.3	40	0.2
	Colleges of Education	0	0	20	0.1
	OTEPs	0	0	0	0
	PTEs	0	0	0	0
	Total students in Honours degrees	11	3.6	1659	6.7
Masters	Universities	26	8.5	2,938	11.9
	Institutes of Technology and Polytechnics	1	0.3	69	0.3
	Colleges of Education	0	0	18	0.1
	PTEs	0	0	36	0.2
	Wananga	0	0	0	0
	Total students in Masters	27	8.9	3,061	12.4
PhD	Universities	3	1.0	526	2.1
	Total students completing Ph.D.s	3	1.0	526	2.1
Higher Doctorates	Universities	0	0	29	0.1
	Total students obtaining higher doctorates	0	0	29	0.1
Total students	Universities	262	85.9	20,803	84.4
	Institutes of Technology and Polytechnics	43	14.1	2,797	11.4
	Colleges of Education	0	0	768	3.1
	OTEPs	0	0	16	0.1
	PTEs	0	0	230	0.9
	Wananga	0	0	22	0.1
	Total students	305	100	24636	100

*Unpublished data generously provided by the Ministry of Education.

Māori Science Enrolments 1994 and 2006

The engagement of Māori with science education in the universities is of vital concern for the future of Māori social development. As seen in Table 2, the number of Māori in Bachelors degrees more than doubled from 808 in 1994 to 1686 students in 2006. This represents a 2.1-fold increase whereas the corresponding enrolments of non-Māori increased only 1.5-fold. This increase of Māori in the sciences at the undergraduate level shows excellent progress and indicates that overall Māori enrolments in the sciences are increasing at a faster rate than non-Māori. Māori enrolments in postgraduate degrees (Honours and Masters) also increased substantially (2.5-fold) during the same time period, whereas non-Māori increased only about 1.2-fold. Total Māori students in Bachelors, Honours, and Masters programmes increased 2.1-fold for Māori but only 1.5-fold for non-Māori. Although the numbers are small, for Māori there is a definite upward movement that speaks to a greater engagement of Māori with science in the tertiary sector.

Table 2. Māori and non-Māori enrolled in science degrees at Bachelors, Honours and Masters levels in the years 1994 and 2006*.

Degree	Māori enrolments in the sciences		Fold-increase	Non-Māori enrolments in the sciences		Fold-increase
	1994	2006		1994	2006	
Bachelors	808	1686	2.1	13041	20161	1.5
B. with Honours	12	30	2.5	567	637	1.1
Masters	43	109	2.5	1545	1799	1.2
Total Students	862	1822	2.1	15976	24345	1.5

*Unpublished data generously provided by the Ministry of Education.

The Target Norm

The target norm is defined as that percent of the population that Māori comprise, but in the appropriate age group. The target norm is the figure that allows estimates to be made regarding over- and under-representation. Māori constitute 14.7% of the New Zealand population, therefore, one might think that for Māori 14.7% would be the target norm for determining under- or over-representation. However, the University student group consists of primarily the 15-64 age group. According to the 2006 census the number of Māori in that age group is 374,248 (QuickStats National Highlights: 2006 Census) and the total number of New Zealanders in the 15-64 age group being 2,664,762. Therefore, the percent Māori in the 15-64 age group is 14.0%; this then is the target norm assuming that the student population is made up primarily of the 15-64 age group. Perhaps a better target norm might be found in say the 15 to 59 year age group rather than the 15-64 age group, but the population data was not readily available. Omitting the 60-plus age group from both Māori and non-Māori might tend to raise the target norm. The true target norm probably lies somewhere between 14.0 and 14.7%

Table 3. Percent of all students who are Māori enrolled in science degrees in 1994 and 2006 (excluding doctoral students).*

Degree	% Māori	
	1994	2006
Bachelors	5.8	7.7
Bachelors with Honours	2.1	4.5
Masters	2.7	5.7
Total Students in science	5.1	7.0

*Unpublished data generously provided by the Ministry of Education.

The percent of the student population engaged in science studies at universities and polytechnics and who are Māori is shown in Table 3 (doctoral studies are excluded). Between 1994 and 2006 there was a positive movement in all science degrees towards the target norm

of 14%; this is especially true in the higher degrees such as Bachelors with Honours and Masters degrees. The overall gain of 5.1% to 7.0% was small but positive. However, It can be seen that Māori are considerably under-represented in the sciences, but not so far removed from the target norm to be beyond reach. The trends are all positive, but there is much ground to be made up.

Doctoral Degrees

The transition of science students into doctoral programmes requires a postgraduate qualification. As seen in Table 4, the transition rate for Māori in doctoral science programmes did not change significantly from 2001 to 2006, being 2.6% and 2.7%, respectively. However, the corresponding rate for non-Māori increased considerably from 4.5% to 7.6%.

The data in Table 4 also show that the number of Māori students in doctoral science programmes increased by 13% between 2001 and 2006 whereas the corresponding number of non-Māori increased markedly by 24%. The investment for non-Māori in science is increasing at a greater rate than for Māori.

The concern is that while the number of Māori enrolled in science degrees is increasing, at the very highest end of the educational spectrum, the doctoral end, the rate of increase appears to be very low if there is any change at all. Strategies may have to be devised to increase Māori doctoral enrolments. Mentoring programmes within the universities might help overcome these deficits.

Table 4. Transition of science students into doctoral programmes in 2001 and 2006.*

Māori and non-Māori enrolments in science degrees	2001	2006	% Change
Total Māori in all science degrees	1740	1873	+7.6%
Total non-Māori in all science degrees	23572	22523	-4.5%
Total Māori doctoral students in science	45	51	+13%
Total non-Māori doctoral students in science	1058	1313	+24%
% Māori in doctoral science programmes	2.6%	2.7%	
% non-Māori in doctoral science programmes	4.5%	7.6%	

*Unpublished data generously provided by the Ministry of Education.

Māori Participation in the Sciences

Māori are behind mainstream in the sciences and there is a need to catch up. Māori participation in the sciences increased between 1994 and 2006 and the overall gap between Māori and non-Māori, appears to be decreasing. Part of the reason for this difference between Māori and non-Māori may be that Māori have come to tertiary education late notwithstanding some very early successes. Investment by Māori in university education did not begin in substantial numbers until the late 60s or early 70s. Māori investment in advanced tertiary education is a relatively recent phenomenon so should it be surprising that, at the moment, Māori are lagging behind?

Another question that needs to be considered concerns whether or not Māori as individuals do well in the sciences; do Māori make good science scholars? While this a difficult question to answer it is, nevertheless, an important one to consider. In order to answer this question one would need access to the grades of all Māori students in the sciences, and for comparative purposes all non-Māori students, but unfortunately such data about grade averages is not available. Answers to the question concerning performance will have to wait for further research. While any such answer might be subject to numerous qualifications, and could be quite controversial, its value could lie in dispelling the myth promoted by some social scientists that Māori can't do science because somehow it contravenes their special relationship with the gods and nature.

Do Māori Scholars Exist In the Academic Sciences Today?

Participation is one thing, excelling as a scholar is another. Do Māori scholars exist in the academic sciences today is a question that evokes subjective answers, because only one's peers can really make that assessment. However, there are a couple of ways available to us, one of which is an assessment of Māori science scholarship basically by mainstream and the other an assessment by Māoridom. A rough measure of Māori science scholarship is provided by the success of Māori in obtaining what was the Tūāpapa Pūtaiao Fellowships as granted by the Foundation for Research, Science, and Technology and the other the Māori Academic Excellence awards as administered by the University of Waikato.

Certainly, Māori science scholars exist as evidenced by the success of candidates for what was known as the Tūāpapa Pūtaiao Māori Fellowships as offered by the Foundation for Research, Science, and Technology (Figure 1). All of the data presented here is from the Tūāpapa Pūtaiao Māori Fellowship scheme that existed from 1996 to 2006. The Tūāpapa Pūtaiao Māori Fellowship was one of few government support fellowships offered specifically to Māori scientists. In 2006, the scheme changed to the Te Tipu Pūtaiao Fellowship and it is no longer specifically targeted to Māori. The Tūāpapa Pūtaiao Māori Fellowship was invaluable for the development of Māori in the sciences. The outlier in Masters degrees shown in 2004 was due the fact that in 2002 the scheme was run twice for that year and not the usual once. Candidates for these fellowships were and are subject to rigorous evaluations by the Foundation based upon their undergraduate achievements and their potential for success. However, the success of any candidate may not only depend on the quality of the student, but also on the institutional support received (Figure 2).

Figure 2 shows that the University of Waikato, of all the universities, has been the most successful in producing successful Māori science Masterates through the Tūāpapa Pūtaiao Māori Fellowship scheme which began in 1997 and ended in 2006. The University of Waikato produced 26 successful Tūāpapa Pūtaiao Māori Fellows over this 10-year period while the University of Auckland produced only 8 (Figure 2). However, during that same time period the University of Waikato produced only three doctoral candidates but the University of Auckland produced 10. The University of Waikato appears to be particularly successful with their Masters programmes in developing Māori scientists whereas the University of Auckland appears to be very successful with its doctoral programmes; perhaps the two should get together. The University of Otago was consistently successful for both Māori Masterates and Doctorates over this 10-year period

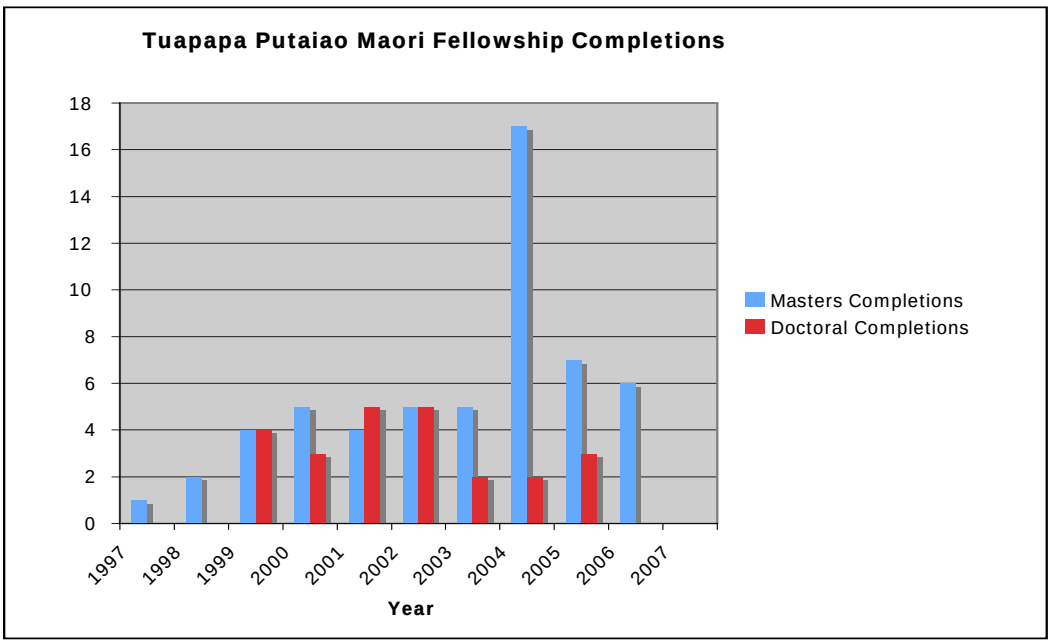

Figure 1. Successful Māori science candidates for the Tūāpapa Pūtaiao Māori Fellowships offered by the Foundation for Research, Science, and Technology (the previously unpublished data was generously supplied by the Foundation for Research, Science, and Technology).

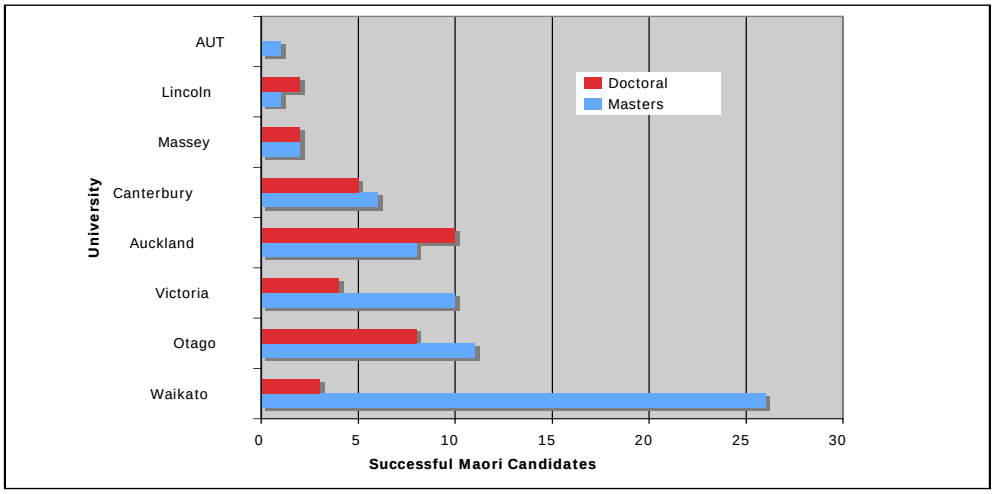

Figure 2. Successful Masterate and Doctoral degrees supported by the Tūāpapa Pūtaiao Māori Fellowships of the Foundation for Research, Science, and Technology and their host university over the period of 1997 to 2007 (the previously unpublished data was generously supplied by the Foundation for Research, Science, and Technology).

Other potential measures of Māori academic scholarship are the The Māori Academic Excellence Awards, organized and run by the University of Waikato; however, those awards simply recognize a Māori receiving a doctorate and for most doctorates, scholarship has yet to be proven. Unfortunately, an analysis of the awards was not possible at this time. Without competition for the award it is hard to say what level of academic excellence is actually involved, and so the awards ceremony has become more of a whānau love fest than recognition of achievement. While scholarship is hard to define there seems to be several

other ways that might provide a measure of academic excellence including the PBRF and Health Research Council Fellowships; however, such an investigation is a major undertaking in itself and should be the subject of future research. It would be particularly interesting to examine the academic achievements of Māori in academia and to compare those achievements between the universities with those of non-Māori.

Based on awards given on the basis of academic achievement one must conclude that good Māori scholarship exists within the sciences at the highest academic levels within the universities. However, some claim that indigeneity hinders indigenous people from approaching the world in a manner conducive to the study of so-called western science. Others suggest that somehow the glitch resides somewhere between the words "quantitative" and "qualitative"; that is, somehow analytical reasoning does not sit well with Māori. It is true that problems have been experienced by indigenous students trying to learn subjects grounded in western culture (Aikenhead, 1997), and the fear of cultural identity loss may be sufficient to interfere with the learning of some indigenous peoples; however, for Māori the data presented here is not consistent with the theory that Māori by nature cannot do science. On the contrary, when you consider the recent start in the sciences it could be said that Māori are not only doing well, but could be on the path to scientific stardom if the trends continue at the undergraduate level.

Factors in the Development of a Māori Scientist

There are many factors that impinge upon the development of a Māori scientist. Quite possibly, of the many factors listed below, the two most significant may be predisposition and childhood experience. Predisposition and childhood experience are the foundation, and education the doorway to the world of science:

- Scientific predisposition
- Childhood experiences
- The home environment
- Secondary education
- Gender
- Tertiary education
- The university or other tertiary institution
- Philosophy of an institution
- Student support services
- What an institution does for its teachers?
- The effect of teachers on Māori academic development
- Teacher training
- Mentoring
- Networking

The factors that combine, and the combinations required, that result in the development of a Māori scientist, or a non-Māori scientist for that matter, are not known. More research is needed in this area in order to understand and possibly influence the desired outcomes. Predisposition speaks to the genetic makeup of a person and may, therefore, be fixed but most of the other factors could be changed at will. We tend to focus on the university experience as being the most important part of a scientific education, but by this stage the path to science is probably set. That is not to say that quality of an institution is not important because it most certainly is.

Childhood experiences are especially important in the development of a scientist. The enthusiasm of children for scientific things begins with play and the construction of

engineering marvels. Encouragement from friends and family are certainly an important part of that early experience. Piaget (1962), considered child's play as the foundation of a child's ability to use symbols and the key to the entry of a child's mind into the process we call thinking. It would be interesting to learn what the influence of acculturation has on that ill-defined process in children called "play" and to determine if indeed there is a relationship between early childhood and the development of scientific preferences in later life.

Secondary education can make or break a budding scientist; those secondary schools that are especially conducive to the development of Māori scientists should be identified and encouraged. The influence of a single gifted teacher can play a critical role in the development of young people interested in science. Indigenous education is necessarily embedded in culturalism (Hook, 2006; 2007a), and to some indigenous people education means receiving education at the hands of mainstream educators suitably heightened in sensitivity and trained in minority cultural peculiarities; however, indigenous education is more effectively communicated by indigenous people. Unfortunately, the number of Māori trained in the teaching of science is insufficient to take over the teaching of science to Māori students.

Certainly, part of the problem lies with our secondary educational system. People come to science early and the secondary school environment can assist this preference or arrest it. In addition, disengagement of Māori from secondary school education occurs frequently and drop out rates are high (Hook, 2006). The so-called "hidden curriculum" (Adams et al., 2000, p. 242) still exists within New Zealand schools whereby Māori children are subliminally taught to value the mores of the dominant culture and to devalue their own. Under such circumstances the development of Māori scientists will need special attention for determining how such obstacles may be overcome. Home life is probably also part of the problem with some Māori who are not given the encouragement or do not have the resources needed to walk the pathways to a science future. However, in my own personal experience socio-economic disadvantage may not be an insurmountable barrier to science interest as long as a student has their whānau approval.

Table 5. Number of Māori students enrolled in Doctoral level science degrees by gender and age group.*

Gender	Agegroup	2001	2002	2003	2004	2005	2006	Total
Female	18-24	3	3	3	4	3		**16**
	25-39	15	16	19	19	22	24	**115**
	40+	2	1	1	2	2	3	**11**
Female Total		20	20	23	25	27	27	**142**
Male	18-24	4	1			2	2	**9**
	25-39	15	15	14	16	13	15	**88**
	40+	6	5	6	3	5	7	**32**
Male Total		25	21	20	19	20	24	**129**
Grand Total		**45**	**41**	**43**	**44**	**47**	**51**	**271**

*Unpublished data generously provided by the Ministry of Education.

Is gender important? The world of science is dominated by males, but does this reflect a predisposition, or is tradition and culture playing a role? With Māori scientists at the doctoral level a gender reversal may be occurring whereby Māori scientists might be dominated by the

female gender. As noted in Table 5, within the younger groups (18-24 and 25-39) there are more women than men, while in the 40+ age group there are more men than women. This may reflect differences in maturation rates or gender differences in the student body.

The institution where a student goes to receive his/her scientific training might be of paramount importance in the shaping of a Māori scientist, and indeed successful scholars tend to cluster in reputable colleges. However, research specifically addressing the importance of institution to the success or failure of students, indicate that the institution may not be as significant to the success of students in general as it is to the clustering of scholars. According to Prebble et al., (2004 p. 4-5) "The impact of different types of college, size of the college, racial composition, and location all exercise relatively weak influence on student outcomes." The significance of institution lies more in its character because as Pascarella & Terenzini (1991, p. 610) state that "certain experiences tend to attract students with certain traits or dispositions, and many within-college effects are essentially the accentuation of these initial students characteristics."

The philosophy of a particular institution is important to both scholars and students (Hook, 2007a). Of particular importance is the philosophy upon which the institution is built because without that basic philosophy harmonizing with the prospective student's belief structure, assimilation of the student into that institution is unlikely to occur. Institutional fit for a student is important (Tinto, 1993) because without that fit a student with unmet needs might come to feel that they were misled and consequently withdraw (Braxton, Vesper & Hossler, 1995).

The fundamental belief that underlies all teaching establishments including universities is that teaching influences learning. The work of educationalists has been to identify the factors that contribute to successful outcomes and to quantify the degree to which those outcomes may be influenced by the various complexities of teaching and learning. Universities have been the drivers of educational research which is somewhat ironic since the culture of those institutions has often looked down upon the very outcomes that they, the institutions, were designed to create. Sometimes, in their desire to discover new knowledge, universities forget that they too are educational institutions, ascribing lesser status to those that specialize in teaching. In the USA tenure is tied more to research achievements than teaching and yet it is the teacher that can make or break an institution because of their reputations and influence on their students. Ideally, teachers are informed by their research, but too often the ideal researcher is not the ideal teacher. However, an institution of higher learrning must have at its foundation the principles of universality and the search for new knowledge; these are founding principles of university systems around the world. Also the PBRF funding formula puts an additional premium on Māori (and Pacifika) doctoral completions thus offering a strong incentive for the universities to make greater investments in their Māori science mentoring and coaching programmes; the more Māori completions at the doctoral end of the spectrum the greater will be their rewards.

A culturally friendly environment would suggest that the preferred institution might be a Māori wānanga for the scientific training of Māori scientists; however, to be trained in the rigours of science, Māori need access to the highest quality and the highest academically enriching institutions in the world. This means that for the training of Māori scientists, mainstream will be a prominent part of that pathway. Training could begin in a Māori wānanga but ultimately movement into a mainstream university would be needed in order to receive in depth research training in the sciences. There is a role here for the Crown Research Institutes (CRIs), the main research arm of the government. The CRIs are a major depository of technological expertise that could also be harnessed for assisting the transition of Māori into the world of technology, and to a certain degree this is already happening. For example, within NIWA (National Institute of Water and Air) a Māori science unit has been established that could be instrumental in raising the intensity of Māori dedication to the sciences.

Finally, the dichotomy of technology and Māori culture must be addressed. The issues raised in this debate are not new, only different. Basically, the issues are those that have been debated since the industrial revolution where the fears of dehumanizing technology were weighed against cultural renewal. Dewey in a 1916 article, "American Culture and Education" as quoted by Arthur Wirth (1972, p. 307) once said in reference to the settling of the American continent:

> It means nothing less than the discovery of a method of subduing and settling nature in the interests of a democracy, that is to say of masses who shall form a community of directed thought and emotion in spite of being masses.

What Dewey said in an entirely different context is basically the same issue that Māori will have to struggle with.

Summary and Conclusions

As the economy moves towards innovation and technology, the technological capacity of Māori is important to their socio-economic future. In this essay, the generation of human capital directly supporting the technological capacity of Māori has been examined according to the latest science degree enrolment figures from the Ministry of Education, and the picture is not great, but nor is it totally depressing. While Māori enrolments in the sciences lag behind non-Māori in all degree areas, the overall gap has been narrowed to just below half of the expected enrolments based on population statistics. This is encouraging because it means that the gap should be bridgeable without major interventions.

There are greater concerns at the very highest level of science degree attainment; that is, at the doctoral level. Here only about 2.7% of Māori science students make that transition whereas it is close to 7.6% for non-Māori. Comparing 2001 figures (2.6%) with 2006 (2.7%) indicates that the gap at the doctoral level is not closing and indeed might even be increasing. Again some degree of intervention might be necessary to overcome this widening of the gap at the doctoral level, because it does not appear to be simply a glitch due to the time it takes for a science student to reach this point in their development. Hopefully as more data become available the trends will become clearer.

Overall, Māori are moving quite well in the sciences and with the support of the universities and the government the deficit could be overcome within less than a generation. This sounds like a long time, but when one considers that the time it takes to progress a science student from primary to tertiary education is around five to ten years then a generation is probably not unrealistic in terms of doubling or perhaps tripling the number of Māori science students in the universities and polytechnics. Consider also that the current state has been achieved over a period of just over one generation assuming a generation time of 25 years. A goal of doubling the number of Māori science students in the universities and polytechnics over the next ten years might even be doable, and another doubling over the subsequent decade would ensure Māori a place in the technological world of tomorrow.

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