# Secondary School Teaching and Māori Student Achievement in Science

**Teresa Taurima**

**Abstract:** This paper reviews and discusses literature selected on the basis of themes that focus on teaching and learning conditions for Māori students and the roles of collaboration. The literature supported the assertions that Māori students learn best in student centred classrooms and that teachers can influence Māori student achievement. The material on collaboration indicated that the predominant barriers to collaboration were psychosocial in nature. These barriers included fear of criticism, fear of being considered incompetent, fear of what other teachers might think, feelings of vulnerability and the desire to keep good ideas confidential. The literature reviewed also showed that collaborative networks appear to be more successful when a common unit of work is utilised.

## Introduction

New Zealand's secondary school science curriculum contains an array of abstract and conceptual knowledge requirements. Secondary school science teachers are commissioned with the task of successfully influencing the minds of students with this scientific awareness in a meaningful way. It is recognised that dynamic, interactive, innovative and imaginative lesson planning requires considerable preparation and that ill-prepared teachers may rely too heavily on textbook exercises or a lecturing, transmissive style of teaching. It is suggested that Māori students achieve best in student centred classrooms that incorporate creativity, small group work and "hands on" learning experiences.

It is suggested that a collaborative network amongst secondary school science teachers that facilitated resource pooling is necessary to alleviate the burden of creating successful lesson plans in solitude. Creation of such a network would allow for the trialling, critiquing and development of effective resources. It is asserted that collaboration and resource pooling of secondary school science teachers would raise Māori student achievement in science.

The literature has been categorised into four themes related to key points and assertions advanced in this paper. The primary, underlying assertion is that Māori students learn best in student centred classrooms where small group work is utilised through activities designed to have relatively limited teacher involvement. Instead, the focus is on allowing students to teach each other and progress together.

The second assertion is that teachers influence Māori student achievement. A significant amount of research in this field has been conducted within the last five years by Russell Bishop and Mere Berryman (2006). They have designed an "Effective Teacher Profile" that identifies key characteristics and attributes of teachers who have had success in raising Māori student achievement. Their research has also supported the design of a professional development programme entitled Te Kotahitanga for teachers of Māori students, that emphasises the need to incorporate student based learning and small group activities into their classrooms.

The second theme of this literature review focuses on investigating the roles of collaboration; first amongst teachers and secondly amongst scientists. This research identifies the challenges

of collaboration, more acutely when that collaboration is imposed through legislation. The work further acknowledges that collaboration supports the development of interactive learning and cooperative group work.

The third and fourth themes pertain to research and reports of actual collaborative networks trialled both in New Zealand and abroad. The third theme is specific to networks involving secondary school science teachers and university science lecturers while the fourth theme is networks containing only secondary school teachers. The fourth theme is broken into two parts: part (b) being where the teachers share a common unit of work, and part (a) without the common unit.

The purpose of the literature review is firstly to find support in the literature for the assertions and implied assertions advanced in this paper, and secondly to explore the advantages and challenges, resulting from collaborative networks.

## Theme 1 (a): Māori students learn best in student centred classrooms.

### Taylor, N., Lucas, K. B., & Watters, J. J. (1999)..

This article addresses the disparity of academic achievement between the two major ethnic groups, namely the indigenous Fijians (50%) and the ethnic Indians (45%). Indigenous Fijians lag behind Indian academic achievement is most pronounced in the areas of science and mathematics. Fijian science education is dominated by a didactic teaching style, driven by a series of external summative examinations. This competitive system is highly individualistic and does not sit well with, in particular, traditional Fijian cultural norms which value cooperation and group work.

The authors contend that the introduction of a constructivist view of teaching and learning, utilising collaborative group work would improve the understanding of science concepts held by pre-service primary teacher education students in Fiji. A study was designed by the authors to test their belief and to explore whether such an approach would be effective for students from different ethnic groups. Two classes at the sole Government provider of primary teacher training in Fiji studied a physical science unit, one class being involved in extensive collaborative group activities and the other, the comparison group, being taught in the usual transmissive fashion.

Students enter the college in a cohort containing equal numbers of females and males from both indigenous Fijians and ethnic Indian populations, as a result of a quota policy aimed at ensuring gender and racial equity. Each class was studied by the authors over six weeks, adopting an interpretive methodology, involving a range of data sources and analytical techniques.

Data gathered supported the authors claim that the collaborative group work stimulated increased levels of discussion and fostered deeper conceptual understanding. Indigenous Fijians responded positively to this style of teaching as members in the collaborative group reporting higher levels of understanding than the indigenous Fijians of the transmissive comparison group.

The authors discussed the correlation in findings between indigenous Fijians and other Polynesian groups.

### New Zealand Ministry of Education. (2004).

Tony Renshaw is a maths teacher at Rotorua Lakes High School whose involvement with the Te Kotahitanga and Te Kauhua Projects resulted in him being awarded a scholarship to study

classroom techniques used successfully with indigenous students in Canada and Hawaii. (Te Kauhua is Phase II of the Te Kotahitanga Project)

Renshaw testifies that cooperative learning techniques along side an emphasis on building positive classroom relationships has produced students that are confident, engaged and successful. He maintains that Māori students have latched on naturally to these techniques as they are just an extension of how they have learnt all along.

The power sharing arrangement encourages students to take ownership of their learning and is empowering for both teacher and student. As well as learning mathematical concepts Renshaw's students learn cooperation, responsibility, self discipline, tolerance and leadership.

## Theme 1(b): Teachers influence Māori student achievement.

### Bishop, R., & Berryman, M. (2006).

Bishop and Berryman present a highly researched work regarding Māori student achievement in Year 9 and 10. The authors drew conclusions and created a professional development programme entitled, Te Kotahitanga, based on the narratives of teachers, principals, whānau and students that were identified as either engaged or unengaged students.

The authors identify, based on their research, that the barriers to Māori achievement includes deficit theorising which results in the teacher having low expectations of Māori students. They assert that the quality of the relationship constructed between teacher and student in day to day classroom activities determines student level of engagement with their class work.

An effective teaching profile is offered, containing six observable traits of an effective teacher including:

1. Manaakitanga: they care for the students as culturally located human beings above all else. (Mutual trust, respect and concern).
2. Mana motuhake: they care for the performance of their students. (High teacher expectations of students).
3. Whakapiringatanga: they are able to create a secure, well managed learning environment by incorporating routine pedagogical knowledge with pedagogical imagination. (Superior teacher organisation and management).
4. Wānanga: they are able to engage in effective teaching interactions with Māori students as Māori. (Interactive teaching with the use of feedback and feed forward techniques).
5. Ako: they can use a range of strategies that promote effective teaching interactions and relationships with their learners. (A range of teaching strategies).
6. Kotahitanga: they promote, monitor and reflect on outcomes that in turn lead to improvements in educational achievement for Māori students. (Ongoing assessment and an awareness of the needs and capabilities of individual students).

The authors maintain that unless educators and policy makers acknowledge and attend to the pervasive effects of deficit discourses and subsequent "pathologising" practices, change cannot be meaningfully implemented. The relationships that are formed in the classroom between teachers and Māori students are paramount.

Bishop and Berryman's research findings support the claim that Māori students learn best when teaching techniques are varied, imaginative and utilise small group dynamics. They assert that having a prepared, engaging and effective teacher in the classroom will ultimately raise Māori student achievement.

***New Zealand Ministry of Education. (2004).***
This expository article highlights the Te Kotahitanga project. Bishop is recorded as having spent fifteen years conceptualising and developing the project along with Mere Berryman. Bishop contends that teachers are the key to improving the level of Māori achievement and affirms that the Te Kotahitanga project provides the opportunity for the teachers to act as agents of change.

The article states that Phase 1 of the Project launched in 2001 and that Phase 3 of the Project involving 400 teachers in 12 schools in the Bay of Plenty, Waikato, Auckland and Northland began in 2004.

***Secondary Futures. (2006).***
Te Kotahitanga Project has raised Māori students' achievement through these seven areas:

1. Increase in teacher-student interactions; Traditional to Discursive
2. Increase in proximity of teachers to students (means more possibility of positive interactions)
3. Increase in cognitive level of class (expectations)
4. Increase in student academic engagement
5. Increase in student work completion
6. Increase in, or maintenance of high levels of student attendance
7. Increase in student short term achievement.

***The University of Waikato. (2006).***
This link outlines the current progression of the Te Kotahitanga Project which has now entered its third phase involving 12 schools, nearly 400 teachers and over 10 000 students. Professional development programmes, in-class observations, feedback and reflective practice sessions provide the structure for the Project.

The aim at the outset of the founding research was to find out how education in its many forms could make the greatest difference in raising the educational achievement of Māori students.

## Theme 2 (a): Collaborative theorising for teachers.

***Lang, M. (2000).***
Lang evaluated the reflective collaboration in an interactive and reflective network of a school system project in Germany. Practicing Integration in Science Education (PING) was introduced in as a regional project in one German state in 1989 and expanded nationwide in 1998.

Teachers in the project collaborated via direct interpersonal exchange (e.g. training sessions, workshops, and meetings) or through mediated exchange (e.g. computer based networking) with the aim of curriculum development for integrated Science teaching.

Lang distinguishes his work from current collaboration dialogue that focuses on interconnecting clients and the technical aspects of computer networking, by examining instead the supportive capabilities of a network in mediating reflection.

Challenges to collaboration identified by Lang include the contrived congeniality provoked by collaboration that is imposed through legislation. Such imposition neglects the individual uncertainty, fear and stress for persons unfamiliar with the openness of the setting and social environment (Huber, 1999).

Lang asserts that:
> Collaboration is a complex task, dependent on mutual help, trust, openness, open access to various sources of information, reflective experiences from inside and outside school, and autonomy in a community of the individuals involved (Lang, 2000, p. 10)

> Networking in teaching and teacher education supports the development of key qualifications of interdisciplinary thinking, interactive learning, co-operative work and responsible behaviour. (Lang, 2000, p. 11).

He maintains that mediated exchange is not a substitute for interpersonal exchange, especially between colleagues, and that it does not overcome the teachers' individualistic role in class. However, it is socially less constrained by rivalries and unequal workload than interpersonal co-operation.

He concludes by acknowledging that reflective collaboration is highly challenging for teachers, researchers and the supporting network. He further asserts that communication must be a reciprocal dialogue amongst teachers and also between teachers and innovators.

## Theme 2 (b):  Collaborative theorising for scientists

### Fox, M. F., & Faver, C. A. (1984).
This article explores and analyses collaboration, as related to scientists. The authors quote biographical and clinical studies that consistently show that productive scientists are independent, self-sufficient, and self directed. The article seeks to analyse the advantages and motivations as well as the costs and disadvantages of collaboration as they reflect the tensions between the individualistic dispositions of scientists and the communal norms and needs of science.

The authors' research focused on social scientists, conducting in-depth interviews with twenty social scientists in the fields of sociology, psychology, economics and political science. Discussions initiated focused on collaboration in the context of research.

The interviewees reported similar themes in their motivation to incorporate a collaborative approach to research including a desire to alleviate academic isolation, join resources and the ability to disperse the workload. Collaboration was most endeared by scientists who face conflicting demands for other-than-research performance. Two such "marginal" groups are women, who often have competing demands from roles and responsibilities other than academia and scholars who have heavy teaching appointments.

Another reported benefit of collaboration is the sustained motivation entailed from work commitments to other individuals and that an interpersonal energy for the completion of projects is created. An interviewee reported that although solitude can heighten reflection, absorption, and concentration, it may, at the same time; result in a loss of reality about the status of the project.

## Theme 3:  Trials of collaborative networks between secondary school science teachers and university scientists

### Levey, D. (2005).
This brief article highlighted a government funded American initiative entitled Science Partners in Inquiry-based Collaborative Education (SPICE) where high school science teachers collaborate with university lecturers (fellows) in science during a two-week summer institute to create an interactive and 'hands-on' science program for high school students. The designed program would then be presented to the students as a teacher and fellow partnership.

The SPICE fellows would also spend at least 60 hours helping students in one-on-one activities outside the classroom, including tutoring, helping with science fair projects and involving the students in research activities at the university.

The purpose of the article was expository and to act as a recruiting device encouraging participants with individual remuneration and computer equipment for the high school.

### Mattheis, F. E., & Byrd, J. W. (1981).

This article describes the conception of a cooperative between East Carolina University and a group of rural secondary schools during 1974-1975. Certain resources were pooled to upgrade science teaching in the secondary schools. In an effort to minimise transportation costs, only schools within a fifty mile radius from the university were selected for membership. The cooperative was financed by, and governed by, the participating schools and each school paid annual membership fees.

During the first five years of operation activities included:

- Visiting Scientist Program: University scientists were guest speakers in the classroom presenting on topics of interest.
- Teacher Workshops:  These were held at the university on topics that were suggested by the teachers, and presented by the university scientific staff.
- Honour Student Seminars: Ten of the top students were selected to attend seminars at the university.
- Student Workshops:  Held during the summer months, these optional workshops were attended by interested students, again at the university.
- Film Festival:  A two day festival was held for the teachers to view the latest scientific films.
- Film Library:  Reels of film were held at the university. Teachers would send written request and subsequently receive the film in the mail.
- Equipment Repair Service:  Schools would pay for parts while the university provided labour without charge.
- Culture Centre:  The University grew living organisms for member schools such as isopods (slaters), crickets and Elodea (oxygen weed).

### Hoff, D. B., & Leiker, P. S. (1992).

This article reported on a project where the Harvard University Centre for Astrophysics and the Harvard's Department of Earth and Planetary Sciences and one hundred and twenty master earth-science teachers joined together to improve earth-science education in American Secondary Schools.

Summer programs were held where attendees examined, presented and evaluated the best activities for the course. After peer review these materials were assembled into resource books which provided the basis for in-service workshops that were conducted throughout the United States of America.

## Theme 4 (a): Trials of collaborative networks between school teachers.

### Ham, V., & Wenmoth, D. (2001).

This comprehensive research report is an evaluation of New Zealand schools' contributions to and usage of the Online Learning Centre Te Kete Ipurangi (TKI) during its first two years of operation. The aim of TKI in the year 2000 was to act as a portal through which users could access high quality, comprehensively cross-referenced resources and information on the World Wide Web, as a repository of official information and similarly high quality and cross

referenced home-grown educational resources, and as a virtual community for educators in New Zealand schools.

The main findings were that the awareness and usage of TKI grew significantly over the research period and that the nature of the usage was consistently focused on one, or perhaps two overriding purposes. Secondary school teachers were likely to focus on one or two particular Communities (subject areas) within TKI, while primary school teachers went to more of it, and generally found it more 'useful' in their daily professional lives. Both primary and secondary school teachers tended to use the site primarily as a source of specific teaching ideas and resources. Teachers found the site least useful as a place to locate professional readings or to make collegial connections.

### Pearson, J. (1999).
This Australian article reports on the extent of use of an electronic network by trainee teachers in facilitating the sharing of ideas about teaching and encouraging reflective practise.

Advantages of electronic communication identified by Pearson included that:

- a virtual 'audience' is created for teachers to share their work. Pearson outlines Shulman's (1987) frustration with the collective amnesia of teaching as a profession, stating that "Practitioners simply know a great deal that they have never tried to articulate" He postulates that the difficulty in accessing this knowledge arose because teachers had no audience with which to share their work and no system of notation. An electronic network effectively removes that barrier to progress of the teaching profession.
- the creation of revisable, archivable and retrievable educational ideas and practises into a rich database that would provide reference, guidance and support for teachers.
- the minimising of inhibitions felt by many participants in face-to-face meetings. Contributors who need time to formulate and present ideas can participate to the same extent as more confident and assertive individuals.
- participation is deemed more equal as the absence social and physical cues (social status, physical appearance) results in focus on the content of the message rather than the presenter
- participants who are not geographically proximate are facilitated, making common interests and particular expertise spread more widely.

Disadvantages of electronic communication when utilised for reflective practise included:

- the absence of physical cues (facial expressions) and nuances of speech (irony, humour) adds vulnerability when the reactions of other participants cannot be anticipated.
- the time factor as conceptualising reflections into text can be an overly time consuming task.
- the fear of criticism prevented some trainee teachers from fully expounding their views. Fear of what judgements might be made of their professional competence caused some teachers' reluctance to contribute. Pearson created an anonymous persona on the network that the trainee teachers could utilise to express opinions. This helped alleviate the sense of anxiety for some teachers.
- the difficulty of managing large amounts of information in active conferences.

This study revealed only minimal use of the network by the trainee teachers for reflection. Pearson stated the network was underutilised and would mostly likely remain so, in the

context of initial teacher education, until the pedagogy of the course as a whole had been developed and clarified.

### Sunal, D. W., & Sunal, C. S. (1992).

This article outlines a study conducted in Alabama of the United States of America, researching the attitudes towards, and implementation of, a local area network (LAN) communication technology by pre-service teachers. The research was conducted in 1992, a time when the internet was barely grasping at conception and not as readily accessible as it is now. Consequently the LAN was limited to facsimile machines and electronic bulletin boards created between the Alabama computers involved in the education sector. At that time 60% of American States operated a state wide telecommunication network for educational purposes.

Fifty eight pre-service primary school and early childhood teachers were grouped into control and experimental groups. Both groups prepared and taught Science curricular at local schools, lessons that were evaluated and critiqued by instructors from the University of Alabama's School of Education.

Research findings highlighted and emphasised the need for facilitative administrative support. The group of teachers that had this support were rated as higher performing and more effective at lesson planning than the control group. They also accessed the LAN more frequently and described a more favourable attitude towards the use of technology than the group with the support.

This research testified a direct correlation between effective use of communication technology and increased effectiveness in classroom practise.

### Suntisukwongchote, P. (2006).

This study investigated the use of email and the internet among secondary school science teachers to test the Fishbough models of collaboration. Fishbough proposes that there are three models that structure teacher collaboration, namely, consulting, coaching and teaming. In the consulting model the expert gives advice to the person with less knowledge, while the concept of the coaching model is parity. Teachers that collaborate as a team who share ownership of the purpose and the outcomes fall under the teaming model.

Suntisukwongchote studied both heads of science departments and science teachers in Perth, Australia and discovered that all three models were very rarely used. The majority of the sample teachers had a negative perception of the potential of collaboration on the internet. Particularly, they were not confident about using the internet as a tool for collaboration and most of them wanted to keep good ideas to themselves.

The author maintains that the culture of schools does not offer sufficiently responsible support for teachers to work with their colleagues on both teaching and learning. Some teachers had reported a desire to collaborate if they had sufficient computing skills, time and a technician to support the activity.

He concluded that computer proficiency and technical accessibility of the network are not the only factors in building a collaborative electronic community of professionals. Sociopsychological factors such as user perception of the nature of the network, their perception of other users on the network and their perception of themselves and their role on the network are of equal importance.

### Theme 4 (b): Trials of collaborative networks for secondary school teachers utilising a common unit of work.

#### Thompson, T. (1993).
This semi-autobiographical article accounts the authors experience as a rural teacher with the 'Star Schools Project'. The project consisted of nine units, from which each school would select a unit. Clusters of around seven schools would communicate regarding the common unit via the internet, creating a collaborative network.

Thompson reflected that when he went online: "it felt like being in a room of some very talented teachers who are all sharing these wonderful ideas. (His) isolated feeling was suddenly gone and resources that were missing at his rural school were suddenly at his fingertips".

He reported how students had feelings akin to stage fright when utilising the network, yet once their message or question was electronically 'posted', the students would eagerly anticipate response.

Thompson's telecommunication experience was entirely positive, and he described how the network expanded throughout the state of Oregon, USA where he resided.

#### Caggiano, M. E., Audet, R. H., & Abegg, G. (1995).
Thirty two high school science teachers from several states across the United States of America joined together for a two week summer in-service where a science unit titled 'Patterns in Nature' (PIN) was introduced. An electronic forum was established whereby the teachers involved could communicate and network with each other during the school year following as they introduced PIN to their students. Participants were designated into either the primary group that contained science teachers, or the secondary group which contained project directors in science, scientists who researched and developed the educational material, technicians and research associates. The authors studied the interactions of both groups on the PIN network and compiled this report of the ensued collaboration.

Approximately three quarters of the original group continued to interact electronically. The authors found that teachers interacted on the PIN network primarily for what was classified as administrative needs (e.g. inquiries regarding credit, institute preparation, etc.). The next most common interaction was classified as resource sharing, which included interactions where requests for clarification from primary participants were answered by the secondary participants. The authors concluded that there was a strong potential for developing a collaborative community of professional practitioners.

#### Brettschneider, A., & Mather, M. A. (2005).
This report described the Adolescent Literacy Collaboratory, a yearlong professional development initiative for secondary schools teachers to integrate effective literacy into the areas of science, mathematics and social studies. The Collaboratory was designed to provide opportunities for collaboration amongst teachers, a literacy expert, and content-area coaches through a blend of online and face to face activities.

It was noted by the authors that purely online learning can feel impersonal for individual participants who may not be as motivated to interact and complete learning tasks as they might in groups that met face to face. This Collaboratory was designed as a hybrid learning experience, blending online activities with face to face interactions. Facilitators and coaches guided the collaborative learning online, while school teams met face to face.

Participants reported overall satisfaction with the Collaboratory and retention rate was high.

## Summary of Findings

The literature supported the assertions that Māori students learn best in student centred classrooms and that teachers can influence Māori student achievement. Further supportive data is currently being gathered as the Te Kotahitanga Project is implemented in more New Zealand secondary schools.

The New Zealand based trials of a collaborative network were confined to the Ministry of Education supported online network entitled Te Kete Ipurangi (T.K.I). This network was originally established in 1999 to behave as a portal, directing users to websites beneficial to lesson planning for both primary and secondary school teachers. In 2004 a forum was added that was designed to facilitate collaboration amongst teachers. This forum is entitled "Teacher Talk" and Science is amongst the fourteen moderated subforums. The intention of the science subforum was for teachers to ask questions, share knowledge, and offer insights on science education. In the three years since conception only twelve discussion topics have been contributed, five of which have received no response, and none have received more than three responses.

There was no literature available at the time of this review that addressed the possible causes for the lack of teacher involvement with the subforum. Collaboration amongst New Zealand science teachers is currently an area that has not been researched.

The predominant barriers to collaboration identified through offshore research were psychosocial in nature. These barriers included fear of criticism, fear of being considered incompetent, fear of what other teachers might think, feelings of vulnerability and the desire to keep good ideas confidential.

The research of this literature review has shown that collaborative networks are more successful when a common unit of work is utilised. Commonality gave clearer direction and parameters around which collaboration could be scaffolded. The open ended and overly directionless nature of the T.K.I. Teacher Talk science subforum may have contributed to its counter-productiveness.

Research is needed that would allow New Zealand science teachers to reflect on their attitudes towards a collaborative network. The compilation of such data would allow for a collaborative network to be established that would be more successfully utilised. The success of a collaborative network may result in an increase in the success of Māori student achievement in science.

## References

Bishop, R., & Berryman, M. (2006). *Culture Speaks: Cultural Relationships and Classroom Learning.* Wellington: Huia Publishers.

Brettschneider, A., & Mather, M.A. (2005). *Improving Online Collaborative Learning for Teachers: How Changes to Design Features of the Adolescent Literacy Collaboratory Influenced Participant Retention, Overall Satisfaction, and Engagement.* Providence: Education Alliance at Brown University.

Caggiano, M.E., Audet, R.H., & Abegg, G. (1995). *A Pilot Study of an Electronic Community of Interdisciplinary Secondary Science Teachers.*

Fox, M.F., & Faver, C.A. (1984). Independence and Cooperation in Research. The Motivations and Costs of Collaboration. *Journal of Higher Education, 55*(3), 347-359.

Ham, V., & Wenmoth, D. (2001). *Educators' Use of the Online Learning Centre (Te Kete Ipurangi) 1999-2001*. Christchurch, New Zealand: University of Christchurch, College of Education.

Hoff, D.B., & Leiker, P.S. (1992). A National Teacher Network To Improve Earth Science Teaching. *Journal of Geological Education, 40*(2), 104-108.

Lang, M. (2000). Mediated Exchange and Reflective Collaboration: a model of science teaching development. *Teachers and Teaching: theory and practice, 6*(1), 9-22.

Levey, D. (2005). Adding SPICE to Science. *Science Scope, 28*(7), 30-31.

Mattheis, F.E., & Byrd, J.W. (1981). Pooling Resources: A Science Teaching Cooperative. *Science Teacher, 48*(8), 48-51.

New Zealand Ministry of Education. (2004a). Nothing But Positive Spin Offs For Tony. *Te Mana Kōrero: Building Māori achievement – a newsletter for educators.*(12), 5.

New Zealand Ministry of Education. (2004b). Project a "Win-Win" for Teachers and Students. *Te Mana Kōrero: Building Māori achievement –a newsletter for educators.*(12), 4.

New Zealand Ministry of Education. (2006, 17 November 2006). Te Kotahitanga.  Retrieved February 17, 2007, from http://www.minedu.govt.nz/index.cfm?layout=document&documentid=8771&indexid=5875&indexparentid=5871

Pearson, J. (1999). Electronic Networking in Initial Teacher Education: Is a Virtual Faculty of Education Possible? *Computers & Education, 32*(3), 221-238.

Secondary Futures. (2006). Te Kotahitanga - Shifting Attitudes to Raise Student Achievement.  Retrieved February 17, 2007, from http://www.secondaryfutures.co.nz/matrix/2006/06/te_kotahitanga_research_php

Sunal, D.W., & Sunal, C.S. (1992). The Impact of Network Communication Technology on Science Teacher Education. *Journal of Computers in Mathematics and Science Teaching, 11*(2), 143-153.

Suntisukwongchote, P. (2006). Testing Models of Collaboration among High School Science Teachers in an Electronic Environment. *High School Journal, 89*(3), 22-33.

Taylor, N., Lucas, K.B., & Watters, J.J. (1999). Collaborative Science Activities and the Social Construction of Understanding of Physical Science Concepts by Pre-service Teachers in Fiji. *Research in Science Education, 29*(4), 479-500.

The University of Waikato. (2006). Te Kotahitanga: Improving the Educational Achievement of Māori Students in Mainstream Education.  Retrieved February 17, 2007, from http://edlinked.soe.waikato.ac.nz/departments/index.php?dept__id=2

Thompson, T. (1993). Ready for a Change. *Journal of Research in Rural Education, 9*(1), 25-28.

**Author Notes**

Teresa Taurima (Ngäti Kahungunu, Kai Tahu) is a Science Teacher at Hamilton's Fraser High School and is a student in the School of Education at the University of Waikato, Hamilton, New Zealand.

E-mail:  Taurima@quicksilver.net.nz