Cascading collaborative research on science teaching in diverse classrooms

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Key terms: science teaching, diversity

Abstract

As part of the Ministry's Quality Teaching Research and Development project, we report on how the Ministry of Education, two universities and teachers studying a Masters paper used collaborative research to investigate the question: what is effective science teaching for diverse students? The cascade effect relates to how: the university lecturers collectively planned the collaborative activities for participants to develop their ideas; the teachers planned science teaching interventions and then collaborated with other teachers to implement the lessons; and the research processes, by the teachers and the university lecturers, that underpinned all of the above. The multiple levels of collaboration provided opportunities for multiple stakeholders to have constructive conversations for intentional and meaningful educational reform related to addressing cultural disparities. We indicate the challenges and questions for future directions that emerge from this project.

Introduction

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In New Zealand there is strong recognition that our education system must continually evolve to meet the needs of the diversity amongst our students and that overall achievement levels must keep rising to ensure that all citizens are as highly educated as possible (Ministry of Education, 2007). As a result New Zealand’s curriculum reform has moved strongly from a standardised system to a personalised system. At the same time we acknowledge that there are significant differences in achievement levels among groups within our community (Alton-Lee, 2003). A major challenge is to reduce this disparity while also raising overall achievement. The project reported here is part of a larger Ministry of Education initiative called the Quality Teaching, Research and Development (QTR & D) Project, which spans multiple curricula domains. The objectives of the QTR & D project were to enable teachers to develop pedagogical practices that enhance the learning for Māori and Pasifika students through collaborative inquiry. This paper focuses on:

1. How did the processes of collaboration at multiple levels lead to learning?
2. What was learned about culturally responsive science teaching and learning?

Layers of collaboration

The power of having multiple levels of collaboration is that it can support teacher development and research that leads to enhancing student outcomes. Teachers in schools often plan collaboratively but seldom have the opportunity to collaboratively research the effects or outcomes related to the changes they make to their teaching (Rodgers & Rodgers, 2007). The QTR & D project subsidised the fee for a Masters level paper that led to the teachers’ participation and research. It also provided funding for the universities to conduct research. The Masters papers targeting culturally responsive pedagogies, focussed on Māori and Pasifika students’
engagement in science, and were jointly developed by five lecturers at two different
universities; the University of Canterbury and the University of Waikato. The courses
at each site were co-taught by the authors in that planning and face-to-face sessions
were conducted collaboratively. Throughout the courses, the lecturers and the
teachers shared their teaching and research practices with each other and some
teachers worked with others in their schools to implement them. The interventions
developed by the teachers included teaching and learning activities where school
students worked in collaborative small groups. Hence there was a cascading effect of
collaboration at multiple levels.

Pedagogical practices for increased engagement of Māori and Pasifika
students
Over the past ten years major shifts have occurred in our understanding of the reasons
for the reported underachievement of Māori and Pasifika students in mainstream
schools. Theorising has moved from a focus on deficit pathologising explanations of
individuals and cultural groups who fail, to focus on ecological and contextual
explanations of systems which fail (Bishop & Glynn, 1999; Bishop & Berryman,
2006). Potential solutions are now emerging from within culturally specific
worldviews rather than being imposed from the outside. These solutions are derived
from a recognition and responsiveness to cultural differences in knowledge and
pedagogy rather than from an assertion of sameness. Roth (2008) has recently
highlighted the need to also consider differences within cultures and value the cultural
productions of students and their communities “as productions in themselves rather
than as something lesser than the cultural productions of scientists” (Roth, 2008, p.8).
Alongside this there has been a growing acceptance of Māori education goals
identified by Māori (Durie, 2004) that include the intentions to live as Māori, to succeed in the modern global world and to enjoy good standards of health and wellbeing. The *Pasifika Education Plan* (Ministry of Education, 2001) also provides guidelines for acknowledging and celebrating difference among Pacific cultures. Major New Zealand research studies like the ones by Hattie (2003) and Alton-Lee (2003) highlight that it is the effectiveness of teachers that has the most systemic influence on students’ educational achievement. Although teachers are concerned with how to promote science to their students, including Māori and Pasifika, they reportedly lack confidence in their own science understanding (Cowie, Jones & Harlow, 2003; Jones & Cowie, 2003). However, there has been little research that focused on how teachers can foster their Māori and Pasifika students’ engagement and understanding in science (Hipkins, et al., 2002).

The New Zealand education system is currently prioritizing ways to reduce the systematic underachievement of Māori and Pasifika students in mainstream schooling. The Ministry has produced policy documents to guide this process. *Ka Hikitia- Managing for Success: The Draft Māori Education Stategy 2008-2012* (Ministry of Education, 2008) is focussed on managing the education system to ensure Māori are enjoying education success as Māori. It has identified the following goals:

- Raising the quality of mainstream education
- Supporting growth of quality Kaupapa Māori education, and
- Supporting greater involvement and authority of Māori in education.

*The Pasifika Education Plan* focusses on increasing achievement in early literacy and numeracy and attainment of school qualifications through improving engagement in
schooling. The vision for our young people is stated in *The New Zealand Curriculum* (Ministry of Education, 2007, p. 8) as:

*confident, connected, actively involved, and lifelong learners.*

Focus of the tertiary courses

At both universities, existing “special topic” Masters paper course numbers were utilised to customise the papers for this project. The courses offered participants professional development that focussed on the engagement and learning of Māori and Pasifika school students in science contexts. The courses also aimed to assist teachers to shift from being intelligent and informed *users* of educational research to becoming intelligent and informed *researchers*.

We identified and discussed the dilemma that teachers of science face when bridging the difference between everyday concepts and understandings that children already have about how the world works and Western European scientific concepts. This needs to be addressed for all students but is even more important when teachers want to intentionally acknowledge and appreciate different cultural practices, values, language and forms of knowledge and position themselves in realtionship to their students’ identities (Bishop, Berryman, Cavanagh, Teddy & Sullivan, 2007). This dilemma that multiple forms of knowledge are valued does not necessarily sit comfortably with the academy of science.

There was an emphasis on the ideas that different pedagogical approaches construct and reflect different ways of understanding the world, including human learning and behaviour. Different pedagogical approaches legitimise different ways of engaging with students and helping them learn. Specific examples of culturally responsive pedagogies were drawn from the work of Glynn and Bishop (Bishop & Glynn, 1999),
Hawke et al. (2002) and Hipkins et al. (2002). The importance of relational aspects in teaching were indicated by the Best Evidence Syntheses (Alton-Lee, 2003) and Biddulph et al. (2003). Examples of pedagogies relevant to increasing engagement in science were drawn from a wide range of sources but in particular the work of Aikenhead (2001) and Cowie and Moreland (2007).

Throughout the delivery of the QTR & D Masters papers in 2007, the participants were encouraged to share their thinking and planning to consider the connections between the culture of science and ways to reflect the values inherent in Māori and Pasifika cultures. They had to think carefully about how to express and exemplify pedagogies (incorporate as part of their everyday way of working with children and make this explicit) that would foreground concepts from within Te Ao Māori, such as:

- **Ako** (in this context, learning and teaching as a unified process);
- **Haere tahi, nohotahi, mahitahi** (in this context, learning and working collectively for the good of the group);
- **Tino rangatiratanga and Mana motuhake** (in this context, autonomy and agency - responsibility for one’s own learning);
- **Taonga tuku iho and Nga mahi a nga tupuna** (in this context, affirming and learning from the knowledge and experience handed down from the ancestors) and
- **Wairua, Hinengaro, Tinana, Whanau** (in this context, holistic understanding of human development and learning, incorporating of spiritual, intellectual, emotional, physical and relationship/connectedness dimensions.
Research methods

The course participants used small-scale inquiry-based action research projects to examine their own and other teachers’ practices. The sixteen teachers (10 at the University of Waikato and 6 at the University of Canterbury) plus two science advisors who were the participants in the Masters papers, collaborated in designing teaching interventions for research projects. Their students were mostly in primary schools (years 3-8) but the two science advisors chose to focus on secondary classes (years 10 and 11). The tertiary teachers and members of the Masters class supported the formulation of their research questions related to culturally responsive pedagogies in science contexts. Then they each developed a range of methods to develop case studies about the effects these interventions had on the students in their classes or the classes they were observing (in the case of the science advisors). Written consent from participants was gained in each case. Some teachers used pre-unit and post unit tests or student work, including oral and visual representations that were generated as part of the interventions, whereas others sought comments from students (some through one-to-one or small group conferencing with their students) about attitudinal changes to learning science and perceived engagement. The teachers observed their students, took notes and presented the collation of their findings at the course sessions.

Eleven of the sixteen teachers chose to assess their students’ learning through presentations that the students themselves gave to the classes. This process has cultural connections with the collective ownership of knowledge, and the obligation of those who hold the knowledge to share and use this knowledge for the common good. In six projects, school students gave presentations to younger students in different classrooms, thereby legitimising culturally important tuakana-teina
relationships and responsibilities. These presentations allowed teachers to assess not only the cognitive knowledge but also students’ understanding of cultural issues such as caring and nurturing others and willingness to share what has been learned in an appropriate manner.

Findings
Within the QTR& D project teachers were encouraged to utilise the principles of culturally responsive pedagogy particularly ako, being consistent with the processes involved in inquiry learning in science. The teachers reported that their students took responsibility for formulating inquiry questions, seeking information from both Western-European and Māori and Pasifika worldviews, and sharing what they had learned with younger students. Following are the key aspects that became apparent in this project.

The value of collaboration
The fostering of reciprocal learning/teaching in schools and in the Masters papers emerged as a key philosophical cornerstone throughout the project. The concept of ‘ako’ captured the essence of the collaborative levels of teaching and learning in the project. Classroom teachers both learning from and teaching their students; researchers, course lecturers and classroom teachers giving input which guided the planning of the Masters papers and the various trajectories of research including what was learned that could be incorporated into future practice. As one teacher commented:

.... it was really good to see...listen to everyone else’s experiences within the area of science. And when you are talking about putting your research
together the amount of feedback that we got......it was pretty incredible
because people could say, ‘ah well I’ve tried that and maybe, you know, you
want to have a look at this and maybe you wanna try this, as you were going
through, and that was probably one of the best things about that group in
particular.

Collaborative learning also occurred amongst the tertiary researchers from the two
different universities as a natural consequence of developing their courses
simultaneously, our on-going discussions about the progress of the participants, and
how we would all report the findings to inform future professional development.
The teachers appreciated sharing knowledge and experiences during the courses and
with their teacher colleagues in their schools. Through this sharing they increased
their understandings about the value of forming partnerships with Māori and inviting
other members of the community into their teaching. Teachers believed this is
necessary in order to develop an education system that reflects culturally responsive
relationships and pedagogies. They also appreciated the support from their schools
and communities in their attempts to be more culturally responsive.

Above all, most of the teachers want to continue to develop their practices and are
now more conscious of the content they choose and how they interact with students
and their community to acknowledge cultural values, beliefs and understandings to
enhance the learning of their students. They appreciated the academic rigor of the
courses as well as the focus on enhancing teaching practices. One of the teachers
commented:

…… I just praise the programme that you (we) had such a max of support and
challenge. When we would say we were a bit worried doing this the support
was there, but at the same time we were still expected to do a rigorously academic paper.....to the best we could at the time. If other projects are put out there like this, that that balance is put out there... you need to feel you are being supported and challenged...but you don’t want it to feel like you’ve achieved something too easily.

The university lecturers are encouraged by further initiatives that several of the teachers have subsequently initiated such as connecting more strongly with teacher associations and applying for teaching fellowships to continue to develop and disseminate their learning about teaching. They are also more confident that they can make a difference. As one teacher commented:

This gave you hope to go back to your worksite and express to the ‘non-believers’ that you were doing a good job and that others were doing so too.

Culturally responsive science teaching and learning

The teachers embraced student-centred learning approaches in order to teach in a culturally responsive way. Most of the projects involved students in some sort of collaborative inquiry approach to teaching and learning in science contexts. The collaborative nature of students’ learning increased their motivation to participate. Through this collaborative process, the teachers prioritised and valued students’ knowledge generation and valued the knowledge contributed by the communities that the students belong to. This allowed some of the students to negotiate the boundaries between their home culture and the culture of science. In particular, the respectful representation and inclusion of Māori knowledge and values in their classrooms, allowed students to access and use this knowledge in their project work. As well, it
provided a basis for teachers to take on the roles of learners, and this in turn enabled Māori students to become agentic and take up responsibility for their own learning and the learning of others.

For example, one of the teachers wrote in her work:

> Students were particularly excited about teaching younger children…This shows and awareness of the importance of building collective knowledge – if you have knowledge you have an obligation to share it with others.

School students also learned to share collective responsibility for their learning as a group. The processes of planning, searching for information, monitoring their progress and offering to present their findings to younger students, engaged some students who have had very challenging behaviours in other situations. These concepts and processes of collaborative learning and presentation were modelled in the Masters papers sessions.

Some students had very strong cultural ties whereas for others it was an opportunity to learn more about cultural belief systems and their relationship and place in the science classroom. In general, the Māori children in these classes actively engaged in science learning when the language, Te Reo, and culture were valued within the teaching of science in classrooms. As one student commented:

> ..I know now a lot of stuff that I can use some right now and some later on… I learnt heaps cos I was given the chance….it was something I wanted to learn and not dumb stuff made by whaea….but by us…that was cool.

The consideration of multiple representations of knowledge was new for most of the teachers and they are developing ideas about how to highlight this in their classes in the future.
Some of the teachers involved in the course investigated what their students thought learning in science was and that some of the interventions that included narrative pedagogies were not what students expected when learning science. Although students learned many science concepts, and aspects related to the nature of scientific inquiry, simultaneously addressing the multiple cultures of science, different cultural values, beliefs and understandings and teaching and learning in and for science was a major challenge that provided ideas for discussions during the course work. These discussions throughout the Masters courses helped teachers decide what to focus on in their projects and how they might address some of the challenges of teaching science in culturally responsive ways.

There was an increased respect for representations and inclusions of indigenous and Western European knowledge bases at multiple levels: the school students, the teachers and the tertiary educators. Some teachers invited Māori leaders (Kaumatua) and other community experts to share their knowledge. This was modelled in the Masters classes at the University of Canterbury, to call on the expertise of the community and value it. In schools, the teachers and community members together helped the children to understand that these different knowledge bases provided different ways of understanding the world. This allowed Māori and Pasifika students to see that their home and community’s cultural values, beliefs and practices were being affirmed and respected by teachers. Students who did not identify as Māori or Pasifika also learned about multiple representations of knowledge and they increased their understanding of cultural values and processes through experiencing learning processes that align with the cultural concepts given previously in this paper.
Challenges and future directions

The challenges that emerge from this project relate to understanding the aspects of collaboration, content and pedagogical knowledge and the processes involved in becoming practitioner-based researchers.

There were huge benefits in the multiple levels of collaboration. This proved so useful that on several occasions when individual teachers were unable to be present for the course sessions, they felt they had missed out on getting the feedback they wanted. To some extent this was overcome when there were several teachers from the same school participating in the course, so they could give each other feedback in their own time. The university lecturers at both sites were in contact by e-mail and met in person as part of other projects or as part of the National Hui (meetings) that were run by the Ministry to support the QTR & D projects in multiple curricula. Even so, there were differences in interpretation of planning and facilitating the courses at the two sites and slightly different emphases due to the differences in backgrounds and expertise of the lecturers, the teachers and the students they were teaching. The challenge then is how to have consistency yet allow flexibility within Masters courses taught in very different locations with varying expertise.

There was a huge literature base to provide background about effective science teaching and practitioner research methods, but very little on culturally responsive pedagogical practices that contained evidence of shifts in students’ outcomes. Because of this, the teachers often felt like pioneers but also had a sense they were contributing to new knowledge. The teachers participating in this course were given paid release time to attend the courses and complete their assignments. Busy teachers need a considerable time allocation and support from their schools. All of the
participants agreed that they would not usually be able to take time out of class to undertake academic study and research their own practices as thoroughly as they did. The release time from their regular teaching made it possible. There is a need to find ways to enable more teachers to use action-based practitioner research to build the evidence base.

The courses provided teachers with opportunities to study and discuss examples of New Zealand and international literature and research in the fields of culturally responsive pedagogies, practitioner research, science education and findings from the Ministry of Education commissioned Best Evidence Syntheses of factors influencing quality teaching. A natural limitation of the project was that teachers came to the project with varying understandings and experience relating to the existing research for improving outcomes for Māori and Pasifika students, how to engage students more effectively in science contexts and a range of understandings about conducting research. This influenced what they chose to do for their interventions and the depth of the research processes used. As beginning researchers they needed support and guidance to conduct their studies. Whilst both groups (at Waikato and Canterbury) used collaborative inquiry as the basis of the courses, it was interpreted differently. At Waikato, the majority of the teachers used collaborative inquiry as a pedagogical process in their school classrooms. In contrast, the teachers in the Canterbury group considered that they were taking part in a collaborative inquiry as part of the Masters course but that they could explore a wide range of pedagogies in their classrooms. Due to the varied nature of each teacher’s focus, it has not been possible to report the outcomes from the whole group of projects here. These can be found in more detail in
the final research reports (Glynn, Cowie, & Otrel-Cass, 2008; Conner & Buyers, 2008).

On reflection of the project we celebrate the progress and changes made to teaching. However the following questions will provide on-going impetus for further research into the area of culturally responsive pedagogies in science contexts. These questions are:

- How do we know that we have increased student engagement and especially Māori and Pasifika student engagement?
- How do we decide and reconcile what we do in terms of addressing individual needs and individual outcomes? (This requires recognising that there is heterogeneity within cultures).
- Do collaborative processes for learning enhance the learning of all students, most students, or only some students?
- How can teachers express and exemplify the cultural concepts of:
  - Ako
  - Haere tahi, nohotahi, mahitahi
  - Tino rangatiratanga and Mana motuhake
  - Taonga tuku iho and Nga mahi a nga
  - Wairua, Hinengaro, Tinana
  and at the same time hybridise them with concepts from Western European science?
- How can culturally responsive pedagogies enable students to meet the requirements and expectations of the assessment system (National Certificates of Educational Achievement and tertiary assessment requirements)?
What is the potential for multi-layered collaborative research and development when it's not formally supported?

Conclusion

As a result of the collaborative inquiries undertaken in the QTR & D projects, the teachers gained confidence in their ability to develop culturally responsive teaching and evaluate it. The teachers shifted their thinking and practices both about teaching science to accommodate cultural values, beliefs and understandings. Many teachers commented that they felt supported to extend their knowledge, reconsider their values and evaluate practices due to the collaborative nature of the course work and the willingness of the tertiary teachers to allow flexibility in approaches. The success of the multiple collaborations within this project indicates that there is potential for using such collaboration at multiple levels, between teachers, between schools, between teachers and their communities and between universities in developing teacher professional development courses, for effecting future educational reform.

References


*This document was added to the Education-Line database on 31 October 2008*