RESEARCHER–TEACHER COLLABORATION IN MĀORI-MEDIUM EDUCATION

Aspects of learning for a teacher and researchers in Aotearoa New Zealand when teaching mathematics

*Ngārewa Hāwera**

Merilyn Taylor†

Abstract

This paper describes aspects of learning for a teacher in a Māori-medium Year 7–8 classroom and two mathematics education researchers from a university when they collaborated on a project supporting children to develop their ideas about transformation geometry. Key principles of kaupapa Māori (Māori ideology) methodology such as ako (reciprocal learning), manaakitanga (showing care, respect and kindness) and whanaungatanga (family-like relationships) were integral to the initiation and facilitation of the research. Data presented is qualitative and derived largely from wānanga ā-kanohi (face-to-face discussion) between the participants. Results revealed that the collaborative partnership was conducive to developing insights into the complexities of learning mathematics in an indigenous setting. Issues of collegiality, learning mathematics in a second language, teacher mathematical knowledge and appropriate contexts for learning mathematics are analysed and discussed.

Keywords

teacher, researcher, collaboration, mathematics, Māori medium

* Senior Lecturer Mathematics Education, University of Waikato, Hamilton, New Zealand. Email: ngarewa@waikato.ac.nz

† Lecturer Mathematics Education, University of Waikato, Hamilton, New Zealand.

Background

Mā tō rourou mā taku rourou, ka kī ai ā tāua kete
(With what you bring, with what I bring, our baskets will be full)

—whakataukī (proverb)

Māori are the indigenous people of Aotearoa New Zealand (hereafter referred to as New Zealand) and make up almost 15% of the total population (Statistics New Zealand, 2013). Since the imposition of Western forms of education on Māori 150 years ago, educational outcomes for Māori have been significantly lower than those of non-Māori (Hunn, 1961; Ministry of Education, 1998, 2008a). While researchers for the past 100 years have sought to contribute to improving educational outcomes for Māori, the focus has often been on incorporating Māori into a society based on Western norms, values and ways of thinking. It has only been since the 1980s that researchers have become inclined to collaborate with Māori to ensure greater inclusivity of Māori worldview, values and perspectives in improving the educational system to better meet the needs of Māori. This change in thinking aligns with the demand by many Māori to have their children participate in a more culturally relevant form of education.

The emergence of Māori-medium classrooms and schools since 1985 has been the result of the petition for greater equity for Māori in education. Settings have been established to support the academic and cultural learning aspirations of Māori communities. There are two levels of Māori-medium education involving approximately 17,000 children. A Level 1 school is expected to deliver 80–100% of the teaching and learning of all subjects, including mathematics, through the Māori language. Level 2 settings are expected to facilitate learning through the Māori language at least 51% of the time (Ministry of Education, 2013a). Such schools have their own curriculum document, *Te Marautanga o Aotearoa* (The Curriculum of New Zealand), which was mandated for implementation in 2008 as an alternative to the national curriculum document for English-medium schools.

Recently, specific attention has been paid to mathematics education expectations in Māori-medium classrooms. In 2010, Ngā Whanaketanga Pāngarau (National Standards for mathematics) were distributed to primary schools implementing the Māori-medium curriculum document. These National Standards describe the mathematical skills and knowledge that children are expected to attain at different points during their Years 1–8 in school. Teachers and schools are obliged to assess student learning according to these benchmarks. As with teachers in English-medium schools, those in Māori-medium settings have required much support from researchers and other professionals to guide their thinking with the National Standards (Hāwera & Taylor, 2013; Ministry of Education, 2013b).

In recent times there has been a further demand for educational research to become more collaborative with Māori in supporting indigenous aspirations. This development has been enhanced by the kaupapa Māori (Māori ideology) research methodology that has emerged as a response to Western paradigms of research where Māori were objects to be examined with little power in the process. Kaupapa Māori methodology seeks to retrieve space to value research for Māori and give them greater involvement within the process. An opportunity for facilitating research that supports and legitimates the Māori worldview and values is an integral component of kaupapa Māori methodology (Bishop, 1994; Smith, 1999).

Smith (1999) suggests a code of conduct for researchers when engaging in research with Māori to ensure a positive relationship and legitimate process. This includes key practices such as "kanohi kitea (the seen face); aroha ki te tangata (a respect for people) and titiro,

whakarongo … kōrero (look, listen … speak)" (p. 124). While acknowledging differing views, Bishop (1994) argues that non-Māori researchers have a responsibility to be involved in kaupapa Māori research because of obligations under the Treaty of Waitangi and the highly professional skills they can bring to the process. Non-Māori, however, must understand that their previously dominant role in research has been re-evaluated and they must position themselves accordingly.

Effective collaboration with Māori is based on establishing positive relationships. The concept of whanaungatanga (family-like relationships) is a key factor in determining the success of any enterprise with Māori and its importance cannot be overstated. In Māori educational settings, relationships need to be established and a balance between task completion and maintaining positive and caring relationships is required (Macfarlane, 2004; Macfarlane, Glynn, Grace, Penetito, & Bateman, 2008). Additionally, the concept of ako (reciprocal learning) is a key principle when working with Māori. This idea is based on numerous other Māori principles including how Māori view the world, ways of knowing, values and knowledge (Pihama, Smith, Taki, & Lee, 2004, p. 13). At times the learner becomes the teacher and the teacher becomes the learner (Ministry of Education, 2008b). Macfarlane (2004) discusses key concepts that are important for understanding a Māori worldview. These include the concept of manaakitanga that involves reciprocal care between participants. In terms of education Macfarlane suggests that manaakitanga is obligatory between participants for a compassionate and productive relationship to develop and be sustained. Each member needs to feel valued and culturally safe.

Mathematics learning and communication is about encoding and decoding language, symbols and texts in a number of ways (McChesney, 2010). A teacher's role in supporting children to communicate mathematical thinking is crucial (J. Hunter, 2009; R. Hunter, 2006). Listening to children share their thinking can help teachers gain an understanding of learners' development in mathematics. When children are concurrently developing an additional language and further mathematical content ideas, the process of learning to communicate is compounded (Cady, Hodges, & Brown, 2010; Meaney, Trinick, & Fairhall, 2012; Moschkovich, 2002). Learners of mathematics are expected to develop competency with a mathematics register to communicate conceptual ideas. Acquiring such a register demands that new mathematical terms be embedded in phrases so that learners can be supported to participate in mathematical discourse. "Part of learning mathematics is learning to speak like a mathematician, that is, acquiring control over the mathematics register" (Pimm, 1987, p. 76). Baker (2011) contends that necessary vocabulary should be taught in contexts that are authentic and promote holistic learning. It is incumbent on teachers to provide children with opportunities and scaffolding to express their ideas when exploring mathematics (Meaney et al., 2012; Staples & Truxaw, 2012).

Learning mathematics in a second language is complex. Content and Language Integrated Learning is an approach that integrates content learning and language acquisition. It is suggested that the advantages of this approach are threefold for learners. Firstly, learning a language is quicker when integrated with content. Secondly, the approach is efficient because attention is paid to two foci central to particular learning contexts, and thirdly, children are presented with opportunities to develop competency in academic language, not just their social discourse. Davison and Williams (2001) caution the use of this approach, however, without thoroughly exploring and defining terms such as "content", "language" and "integration". Each of these ideas can appear straightforward initially but become radically complex and problematic upon closer scrutiny, especially when endeavouring to link them together in a classroom programme.

Integral to supporting learners to explore

and communicate mathematical ideas is teacher content knowledge. If a teacher is not clear about the mathematics then children's development will be limited (Anthony & Walshaw, 2007; Ball, Lubienski, & Mewborn, 2001). Sullivan, Clarke, and Clarke (2009) contend that teacher content knowledge of mathematics is crucial for understanding and implementing worthwhile tasks and therefore being able to respond appropriately to learners' actions and thoughts.

The national curriculum document for Māori-medium schools demands that teachers ensure that mathematical tasks for learners are embedded in meaningful and relevant contexts (Anthony & Walshaw, 2007; Ministry of Education, 2008c). The contexts in Māori-medium settings can involve Māori ways of seeing the world where appreciating and learning from the past can support productive engagement with the present and the future to live as Māori (Durie, 2003). A traditional Māori context is the marae (traditional buildings and courtyard) that acts as a key gathering place for Māori today. For many it is an integral part of their identity and the social fabric of the local community. The marae provides a stage for important events as well as a venue for family links to be reaffirmed and celebrated. It is a meeting place for formal and informal discussion and a space where individuals can meet and to which they can "belong". With its social, physical, historical and spiritual presence it provides a rich site for culturally based formal and informal learning experiences, for all ages (Durie, 2003; Gray & Johns, 1987). The numerous mathematical possibilities for exploration include a wharenui (main building on a marae) that generally contains decorative panels illustrating principles of transformation geometry.

Supporting teachers to develop culturally based teaching can be complex and has had varied results (Gear, 2012; Meaney et al., 2012; Nicol, Archibald, & Baker, 2013). In Sweden, teachers attempting to provide learning experiences derived from Sámi culture felt that they needed more support with the cultural knowledge to develop and sustain such a programme. Obstacles included time for planning, perceived restrictions due to national curriculum, and disinterested parents. Some teachers too were reluctant to deviate from a curriculum that was based on a national textbook in case students' futures, regarding employment and ability to survive, were compromised (Nuttī, 2013). Similarly, in Māori-medium settings, research has highlighted time required for collegial discussions, planning, assessment and reflection as concerns by teachers (Murphy, Bright, McKinley, & Collins, 2009). In addition, Rogers (2003) suggests that teachers in Māori-medium settings require an environment where they are able to communicate openly about their needs and experiences without fear of ridicule. Researchers collaborating with such teachers should therefore be knowledgeable and empathetic to the cultural and academic goals of Māori-medium education.

Hargreaves and Fullan (2012) propose that successful teacher professional learning is based on teachers identifying their needs and making a commitment to act upon those with a view towards changes in thinking and practice. Involvement in research can support teachers to become critical agents of change and make shifts in their educational praxis (R. Hunter, 2010; Ilisko, Ignatjeva, & Micule, 2010). Since 2003, professional learning in mathematics for Māori-medium teachers in New Zealand has largely focused on implementing policy for supporting children to develop their ideas in "tau" (numbers). The model promoted for this process has been one where facilitators (external experts) have met and talked with teachers and entered classrooms to demonstrate appropriate teaching pedagogy for supporting children's learning of mathematical knowledge and strategies. Classroom teachers have then been encouraged to develop similar pedagogy for their own teaching practice to improve student outcomes (Higgins & Parsons, 2011).

Active engagement between teachers and researchers has proven beneficial for teacher learning and practice in mathematics education classrooms (Gonzalez, 2012; R. Hunter, 2010; Meaney et al., 2012; Nuttī, 2013; Warren, Quine, & DeVries, 2012). Teacher–researcher collaboration based on tenets of kaupapa Māori research methodology can further extend and enrich the reciprocal learning opportunities for all participants. The enactment of fundamental concepts of ako, whanaungatanga and manaakitanga ensure an environment where cultural safety, expression of ideas and respect are foregrounded (Smith, 1999). In this study we sought to reflect on the learning that occurred for the researchers and the teacher during the research process. The overarching research question that guided this study is "What can be learned by researchers and teachers through a collaborative process when supporting children's learning in mathematics?"

Method

This paper reports on a process of collaboration between a teacher (Māori) located in a Level 1 Māori-medium setting and two researchers (one Māori and one non-Māori), when undertaking research about children learning transformation geometry (Hāwera & Taylor, 2013). The Māori teacher and Māori researcher already had a personal and professional relationship. The non-Māori researcher had demonstrated a long-standing interest in Māori education and was therefore invited to participate in the study by the Māori researcher with the agreement of the teacher. Care was taken to inform and seek permission from the teacher, the principal, the Board of Trustees and the parents of children to approve and consent to the researchers and the research process. Children's consent to participate was obtained at the beginning of the research period.

The methodology to support the form of collaboration in this study draws upon precepts of kaupapa Māori research that embodies principles of ako, whanaungatanga and manaakitanga. Wānanga ā-kanohi (face-to-face discussion) validates the traditional and still relevant form of communication by Māori and was the primary method used to gather data for this study. The idea of wānanga (discussions) on particular topics supports a methodological approach of "titiro, whakarongo … kōrero (look, listen … speak)" (Smith, 1999, p. 124) and embraces notions of mutual respect and unequivocal sharing of power between participants.

Data collection involved observation of class lessons, note taking and audio taping some of the eight in-depth discussions that were held over a 12-week period between the teacher and the researchers. The data focused on conversations about researcher notes, the teacher's planning, assessments and reflections, children's work samples and children's opinion sheets of the tasks. Ensuing discussions attended to key points that were identified by the teacher and researchers as issues arising from the teaching and learning of transformation geometry.

Results and discussion

After the data were collected and sorted, a number of themes emerged. The most significant of these are the notion of collegiality, the issue of learning mathematics in a second language, the mathematics content knowledge needed for teaching and learning, and the exploration of appropriate contexts for learning mathematics. A discussion and analyses of the data for each of these themes are presented below.

Collegiality

Kaupapa Māori methodology prioritizes research that Māori control and that they recognize has clear benefits for Māori participants. Researchers working with Māori need to understand this premise and be prepared to work

with it despite their own agenda (Smith, 1999). Acknowledging and working within the principle of ako throughout the research process ensures that there will be benefits for all from this experience.

Emerging conversations
(R = researcher; T = teacher)

R: For our first hui [meeting] let's see what mathematics ideas the teacher thinks the kids need to work on and let's work together on that.

T: My baseline data shows that the kids need help with geometry … this transformation idea in the Whanaketanga [National Standards].

T: I knew you were coming and that made me work … I usually put effort in but it's different when you have a team … maths people who know the maths.

R: Are you saying it was useful to work with us?

T: Yes … you showed me pictures and the architecture … I would've done a little bit but not as much as we did … Even our little discussion … Is that the mātāoroko [basic unit]? Is that the mātātuhi [transformed unit]? … Good to be able to talk with someone about the maths concept and the reo [language].

R: This is good for us too cos' we're learning about teaching maths in te reo Māori [the Māori language] and whether or not these tasks are any good for helping kids learn.

At the beginning of the research project the teacher and researchers had their own separate agendas but were all committed to children learning specific mathematical ideas about transformation geometry. The researchers' agenda was about trialling possible worthwhile tasks in a Māori-medium context. The teacher had goals for children's learning in geometry regarding Ngā Whanaketanga Pāngarau and wanted support to help children to attain those levels of achievement. At the initial meeting both agendas were "put on the table" for negotiation and a partnership was established.

At first, teacher power and control was more dominant. The teacher selected the mathematics area to work in, had the relationship with the children to facilitate the learning with the set tasks, and knew that she ultimately controlled the pace of the work and would be taking responsibility for the final assessments of children's learning. While kaupapa Māori methodology demands that participants have control and "power" in research, this does not give permission for researchers to abrogate their power and responsibility. Initially researcher power was less explicit in order to focus on teacher goals for improving student outcomes. The exploration and analysis of the value of particular mathematical tasks for children's learning was not considered to be at odds with this teacher's intentions.

Linked to the consideration of power in the overall research project was the notion that the participants (children, teacher and researchers) would all be teachers and learners for each other. This was a fundamental premise of engagement within the research. Smith (1999) notes that the Māori word ako means to teach or learn, thereby encapsulating the fluidity of engagement and power sharing between participants. Thrupp and Mika (2011) propose that embedded in ako are feelings of "stirring and moving" because of the fragile state that people are in while they are learning. Data indicate that this internal state of intellectual arousal became evident. The process of clarifying mathematical ideas and language through discussion triggered the "stirring and moving" that advanced learning for all. For such reciprocity of teaching and learning to occur, participants needed to be prepared to engage with each other and the topic at hand. Acknowledgement and enactment of

shifts in power between participants was essential for goals to be achieved (Bishop, Berryman, Tiakiwai, & Richardson, 2003; Rewi, 2011).

The notion of accountability between participants in a collaborative research project is also raised in the data. While the teacher felt compelled to "do more" than she might have done working independently, the researchers were obligated to ensure that they were knowledgeable and informed enough to discuss issues relevant to the teacher and the context. Understanding the mathematics and having an appreciation of the possible Māori words, sentences and phrases that may be used, as well as any pedagogical issues that might arise, were important for productive discussion in this study. This idea links to the concept of manaakitanga that Macfarlane and Macfarlane (2012) suggest should occur between teachers and learners concerned with creating a culture of care. It seems evident that the concept of manaakitanga was a necessary component between the teacher and researchers in this study. Researchers needed to care about the teacher and her goals and vice versa. The constant reaffirmation of manaakitanga ensures that both parties were ready and prepared to meet their obligations for fruitful outcomes when meeting.

Language

Teachers generally are expected to remain vigilant and skilled in their use of the mathematics register when supporting learning and communication. The ability to support children to communicate mathematical ideas clearly in a variety of ways is critical to enhance learning (Anthony & Walshaw, 2007; J. Hunter, 2009; R. Hunter, 2006; Meaney et al., 2012).

Emerging conversations
(R = researcher; T = teacher)

R: How many names are there for this idea? What does He Tau Anō te Tāu ["Figure It Out" mathematics resource] use? What does the pāngarau [mathematics] dictionary use [when discussing the origin of a pattern]? Which word shall we use?

R: How do we get the language to catch up to conceptual understanding of the mathematics?

T: I might need to do more language tasks to help the kids use the new words.

In Māori-medium classrooms the continual evolution of the mathematical vocabulary means that teachers constantly have to grapple with new words and phrases appearing in the mathematics register to support discussion of particular mathematical ideas. They have to align new vocabulary for particular mathematical ideas with words or phrases used historically, consider how to use these appropriately, and then how to support children to understand and use them correctly. The teacher made formative assessments daily about children's development of mathematical ideas and use of language. She identified key words and sentences that children needed to learn and planned language acquisition tasks to facilitate appropriate mathematical communication.

The complexity of this process is highlighted by two facts. Firstly, the language of teaching is not sustained in the wider society in New Zealand. Secondly, the large majority of teachers in Māori-medium classrooms are second-language learners striving to develop their personal proficiency in te reo Māori generally as well as with curriculum-specific language for teaching. Their engagement with "established", "new" or "alternative" words is a constant challenge (Skerrett, 2011). It proved helpful to the teacher and researchers to be able to converse about these words and ideas to maximize learning for all participants.

One example of such a challenge involved the word "pūtake", which is an established word for the origin or source of a transformation pattern in a Ministry of Education resource.

The pāngarau dictionary (Christensen, 2010), however, suggests using the word "mātāoroko" for this idea, which is derived from "mātāniho" (print or mark of teeth) and "oroko" (for the first time). Teachers and researchers can be in a dilemma as to which word to promulgate. Each of the sources has authority as to the possible words that may be spoken by local Māori communities. Whether mathematical terms and language become standardized across such communities for mathematics education is a matter for further debate between Māori (McMurchie-Pilkington, Trinick, & Meaney, 2013).

While the researchers understood broadly that the children would be learning mathematics in the Māori language involving new mathematical terminology, they gained an added appreciation of the role of the teacher. Skill in designing language acquisition tasks to facilitate mathematical language development is important if children are to learn and communicate mathematical ideas in that language (Meaney et al., 2012). While ensuring that children have sufficient time to learn content ideas in a "new" language can be a challenge for any teacher in Māori medium, it does give a teacher opportunities to broaden his or her expertise and consider the effectiveness of different strategies he or she might use. Additionally, the process of learning mathematics in a second language can have a significant impact on the duration of a unit. In this study the unit of work took longer than anticipated because of the complexity of the process. Davison and Williams (2001) advise teachers to consider all aspects of facilitating learning through a Content and Language Integrated Learning approach. Researchers expecting to work with teachers in Māori medium have to acknowledge and respect the complexity and time required for learning and teaching mathematics in those settings.

Mathematics content knowledge

A teacher's content knowledge is important for assisting learners to understand key ideas in mathematics. Transformation geometry involves ideas that can be complex to understand. These include concepts of translation, rotation and reflection that children were expected to identify, discuss and eventually replicate in their own creations.

Emerging conversations
(R = researcher; T = teacher)

T: What are all the different transformations? Which is the origin or the basic unit in the pattern?

T & R: Can you have more than one mātāoroko in a pattern?

The teacher and researchers found that they needed to discuss the mathematics within the patterns to ensure that they had a clear understanding of the transformation ideas embedded within them. While transformations were relatively clear to identify and describe in some of the patterns that were presented for exploration (as in Figure 1), others were more problematic (as in Figure 2). Consequently, the need for discussion arose to clarify the mathematics so that there could be a common understanding between the researchers and the teacher. Such scrutiny and examination of mathematical ideas by both parties illustrates the reciprocal nature of this study exemplifying enactment of key principles inherent in ako and manaakitanga. The researchers and the teacher needed to be prepared to contribute, listen and learn from each other.

A genuine partnership acknowledges that open communication between participants is important to make sense of complexities inherent in mathematics. Teachers collaborating with researchers need a safe and non-judgmental environment to discuss ideas. Their pedagogy and classroom practice may be interrogated in the pursuit of change to improve children's learning. Taking risks becomes an integral part of the journey (Freedman, 2005). The

FIGURE 1   Feet illustrating one form of transformation. This figure is one of John Conway's seven "feet" pictures. Source: http://euler.slu.edu/escher/index.php/Frieze_Names_Exploration

FIGURE 2   Kōwhaiwhai (painted scroll ornamentation) illustrating more than one form of transformation. Source: "The geometry of Maori art: rafter patterns," by G. Knight, 1984, *The New Zealand Mathematics Magazine, 2*(2), p. 39.

researchers and the teacher in this study had to have confidence and trust in the process and in each other to share ideas about possible tasks and pedagogy when they were not entirely sure whether these would be helpful for children's learning. Discussions between participants take time but are critical for maintaining integrity with the concept of ako for all participants.

Contexts for learning

Māori can have strong links to the physical and spiritual realm. Many continue to acknowledge the importance of natural elements around them as their forebears did. Māori parents expect Māori-medium schools to foster an appreciation of the natural world and how it contributes to people's lives in the pursuit of holistic education (Ministry of Education, 2010).

Emerging conversations
(R = researcher; T = teacher)

T: I never would've thought about doing it this way … starting with the taiao [environment] and then linking that to what we do or use in our world. I like the idea of starting with the environment … Before I would've gone to find the Māori resources, gone online and looked at units … This is more helpful because it helps me to be more specific with these kids.

R: That was a really neat idea that [T] had about the kids taking photographs of examples of symmetry in the school, wasn't it? Why didn't we think of that?

T: Good to go to the marae and focus on the maths … could "see" the maths too when we visited another marae later too.

In this study the teacher appreciated being reminded of the natural world and examples of symmetry within it that had inspired a myriad of manufactured artefacts. Following a discussion with the researchers it became apparent to her that the natural world would be an appropriate context to begin the unit of work with these children. While teachers have access to much published material electronically or in hardcopy for teaching mathematics, busy teachers might take advantage only of what seems easily accessible. Consequently they can restrict themselves and their students to approaches and pedagogy that they are accustomed to and may appear to be more manageable. Encouragement and confidence to use a variety of practices, materials and approaches to meet the specific needs of the children in alternative ways can be the result of teacher–researcher collaboration. However, teacher commitment to transforming classroom practice is essential for any change to occur (Hargreaves & Fullan, 2012).

The researchers appreciated the way the teacher could take the skeleton of a suggested task and then use her "toolkit" of ideas and expertise to "massage" the task to shape it for enhancing the intended unit of work. This teacher expertise was evident, for example, after the initial task, where the children watched a PowerPoint presentation illustrating symmetry in the natural and artificial environment. Following this exercise it made sense to the teacher that the children be given an opportunity to show their understanding of the mathematics they had just observed by taking photographs of symmetry in their school environment. This particular activity was not considered at the initial planning meeting with the researchers but was included as a result of teacher thought and expertise. The teacher learned from the researchers about using the natural world as a starting point for mathematics. The researchers learned how an idea might be extended and developed for deeper learning to occur.

Teachers and children in Māori-medium settings are very familiar with traditional contexts such as the marae. They know that the various components of a wharenui represent ancestors and stories linked to their tribal history. Looking critically at features of a wharenui through a mathematical lens added another dimension to a familiar entity. While there is a risk that children in Māori-medium settings may be overexposed to such contexts, the researchers and the teacher learned that exploring traditional contexts in different ways can enhance mathematical understanding.

Conclusion

The learning for the researchers and the teacher in this study was a result of the collaborative process that was based on adhering to aspects of kaupapa Māori research principles. We appreciate that kaupapa Māori consists of a wider paradigm than has been expressed here (for example, the participation of families in research) and accept that as a limitation of this study. However, this research provided an opportunity to explore in depth some key tenets of ako, whanaungatanga and manaakitanga between the teacher and the researchers during the enactment of the project. Māori values and contexts were paramount considerations that ensured participants gained optimum benefits. The fact that this research involved only one teacher and two researchers in one Māori-medium school is a further limitation. We contend though that the findings do contribute additional insights to revealing the intricacies and benefits of collaborative partnerships between teachers, researchers and their respective communities.

Teacher–researcher collaboration gave the participants a number of opportunities to learn from each other as suggested by the whakataukī at the beginning of this paper. The sharing of ideas through in-depth discussion and the examination of relevant artefacts together contributed to the emergence of fruitful insights. The study also confirmed the variety of skills a teacher in Māori medium must have to ensure the development of desired mathematical ideas and language by learners. Time required for this process should not be underestimated.

In the end, effective collaboration with Māori demands a demonstration of competency with key components of kaupapa Māori research methodology. As researchers collaborating with teachers we need to ask ourselves such questions as: Have Māori benefited here? Have they had opportunities to control and exert influence over the goals of the research and processes that were employed? Have they felt culturally safe? Did the research include consideration of Māori values and context? Did the research support positive change for Māori? All of these questions are important when embarking on research with Māori. We suggest that the model of collaboration presented in this study could offer some insights for future initiatives involving indigenous research.

He mihi

E kore e mutu ngā mihi ki te kura, te kaiako, te whānau me ngā tamariki i whakaae kia uru ki roto i ngā mahi rangahau nei. Mā te mahi tahi ka whai hua hei oranga mō tātou.

Acknowledgements

Glossary

ako	reciprocal learning
aroha ki te tangata	a respect for people
kanohi kitea	the seen face
kaupapa Māori	Māori ideology
kōrero	speak
kōwhaiwhai	painted scroll ornamentation
kura	school
manaakitanga	showing care, respect and kindness
marae	traditional buildings and courtyard
mātāoroko	basic unit
mātāniho	print or mark of teeth
mātātuhi	transformed unit
Ngā Whanaketanga Pāngarau	National Standards for mathematics
oroko	for the first time
pāngarau	mathematics
pūtake	the origin or source of a transformation pattern
reo	language
taiao	environment
tau	numbers
te reo Māori	the Māori language
titiro	look
wānanga ā-kanohi	face-to-face discussion
wānanga	discussion
whakarongo	listen
whakataukī	proverb
Whanaketanga	National Standards
whanaungatanga	family-like relationships
wharenui	main building on a marae

References

Anthony, G., & Walshaw, M. (2007). *Effective pedagogy in mathematics/pāngarau: Best evidence synthesis iteration (BES)*. Wellington, New Zealand: Ministry of Education.

Baker, C. (2011). *Foundations of bilingual education and bilingualism* (5th ed.). Bristol, England: Multilingual Matters Channel View Publications.

Ball, D. L., Lubienski, S., & Mewborn, D. S. (2001). Research on teaching mathematics: The unsolved problem of teachers' mathematical knowledge. In V. Richardson (Ed.), *Handbook of research on teaching* (pp. 433–456). Washington, DC: American Educational Research Association.

Bishop, R. (1994). Initiating empowering research? *New Zealand Journal of Educational Studies*, *29*(2), 175–188.

Bishop, R., Berryman, M., Tiakiwai, S., & Richardson, C. (2003). *Te Kōtahitanga: The experiences of year 9 and 10 Māori students in mainstream classrooms*. Wellington, New Zealand: Ministry of Education.

Cady, A., Hodges, T., & Brown, C. (2010). Supporting language learners. *Teaching Children Mathematics*, *16*(8), 476–483.

Christensen, I. (2010). *Te reo pāngarau. A Māori language dictionary of mathematics*. Wellington, New Zealand: Ministry of Education.

Davison, C., & Williams, A. (2001). Integrating language and content: Unresolved issues. In B. Mohan, C. Leung, & C. Davidson (Eds.), *English as a second language in the mainstream: Teaching, learning and identity* (pp. 51–70). Harlow, England: Pearson Education.

Durie, M. (2003). *Ngā kāhui pou: Launching Māori futures*. Wellington, New Zealand: Huia.

Freedman, S. W. (2005). Teacher research, professional growth, and school reform. In L. Pease-Alvarez & S. R. Scheter (Eds.), *Learning, teaching and community* (pp. 111–130). London, England: Lawrence Erlbaum.

Gear, A. L. (2012). A cultural introduction to math. *Teaching Children Mathematics*, *18*(6), 354–360.

Gonzalez, L. (2012). Valuing the process: Working with teachers around mathematics for social justice. In A. A. Wager & D. W. Stinson (Eds.), *Teaching mathematics for social justice: Conversations with educators* (pp. 127–140). Reston, VA: National Council of Teachers of Mathematics.

Gray, D., & Johns, A. (Eds.). (1987). *Te Ao Hurihuri opening*. Hamilton, New Zealand: University of Waikato.

Hargreaves, A., & Fullan, M. (2012). *Professional capital: Transforming teaching in every school*. New York, NY: Teachers College Press.

Hāwera, N., & Taylor, M. (2013). Children's views about geometry tasks in Māori-medium schools. *SET: Research Information for Teachers*, Set 3, 37–46. Wellington, New Zealand: New Zealand Council for Educational Research.

Higgins, J., & Parsons, R. (2011). Professional learning opportunities in the classroom: Implications for scaling up system-level professional development in mathematics. *Mathematics Teacher Education & Development*, *13*(1), 54–76.

Hunn, J. K. (1961). *Report on Department of Māori Affairs*. Wellington, New Zealand: R. E. Owen, Government Printer.

Hunter, J. (2009). Developing a productive discourse community in the mathematics classroom. *The New Zealand Mathematics Magazine*, *46*(1), 1–12.

Hunter, R. (2006). Structuring the talk towards mathematical inquiry. In P. Grootenboer, R. Zevenbergen, & M. Chinnappan (Eds.), *Identities, cultures and learning spaces: Proceedings of the 29th annual conference of the Mathematics Education Research Group of Australasia* [MERGA] (Vol.1, pp. 309–317). Canberra, Australia: MERGA.

Hunter, R. (2010). Changing roles and identities in the construction of a community of mathematical inquiry. *Journal of Mathematics Teacher Education*, *13*(5), 397–409.

Ilisko, D., Ignatjeva, S., & Micule, I. (2010). Teachers as researchers: Bringing teachers' voice to the educational landscape. *Journal of Teacher Education for Sustainability*, *12*(1), 51–65.

Macfarlane, A. H. (2004). *Kia Hiwa Ra: Listen to culture: Māori students' plea to educators*. Wellington, New Zealand: New Zealand Council for Educational Research.

Macfarlane, A. H., Glynn, Y., Grace, W., Penetito, W., & Bateman, S. (2008). Indigenous epistemology in a national curriculum framework? *Ethnicities*, *8*(1), 102–127.

Macfarlane, A. H., & Macfarlane, S. L. (2012). Weaving the dimensions of culture and learning: Implications for educators. In B. Kaur (Ed.), *Understanding teaching and learning: Classroom research revisited* (pp. 213–224). Rotterdam, The Netherlands: Sense.

McChesney, J. (2010). "Using language, symbols and texts": What might this mean for primary school mathematics and statistics? In R. Averill & R.

Harvey (Eds.), *Teaching primary school mathematics and statistics: Evidence-based practice* (pp. 251–260). Wellington, New Zealand: New Zealand Council for Educational Research Press.

McMurchie-Pilkington, C., Trinick, T., & Meaney, T. (2013). Mathematics curriculum development and indigenous language revitalisation: Contested spaces. *Mathematics Education Research Journal*, 25(3), 341–360.

Meaney, T., Trinick, T., & Fairhall, U. (2012). *Collaborating to meet language challenges in indigenous mathematics classrooms*. New York, NY: Springer.

Ministry of Education. (1998). *Mathematics assessment results 1997. National education monitoring report 9*. Dunedin, New Zealand: Educational Assessment Research Unit.

Ministry of Education. (2008a). *Mathematics trends in year 5 mathematics achievement 1994 to 2006. New Zealand results from three cycles of the Trends in International Mathematics and Science Study (TIMSS)*. Retrieved from http://www.educationcounts.govt.nz/__data/assets/pdf_file/0012/34212/915_TIMSS-06_maths2.pdf

Ministry of Education. (2008b). *Ka Hikitia. Managing for success: Māori education strategy 2008–2012*. Wellington, New Zealand: Author.

Ministry of Education. (2008c). *Te Marautanga o Aotearoa*. Wellington, New Zealand: Author.

Ministry of Education. (2010). Te Piko o te Māhuri: The key attributes of successful Kura Kaupapa Māori. Retrieved from http://www.educationcounts.govt.nz/publications/91416/105966/80403/1.-the-nature-of-success

Ministry of Education. (2013a). *Māori language in education*. Retrieved from http://www.educationcounts.govt.nz/statistics/maori_education/schooling/6040

Ministry of Education. (2013b). *Māori medium kaiako survey*. Wellington, New Zealand: Author.

Moschkovich, J. N. (2002). A situated and sociocultural perspective on bilingual mathematics learners. *Mathematical Thinking and Learning: Special Issue on Diversity, Equity, and Mathematical Learning*, 4(2/3), 189–212.

Murphy, H., Bright, N., McKinley, S., & Collins, P. (2009) *Kia eke ki ngā Taumata, kia Pakari ngā Kaiako. He Tirohanga Akoranga: An exploration of in-service support and professional development provision for Māori-medium teachers*. Wellington, New Zealand: Te Puni Kōkiri.

Nicol, C., Archibald, J., & Baker, J. (2013). Designing a model of culturally responsive mathematics education: Place, relationships and storywork. *Mathematics Education Research Journal*, 25(1), 73–89.

Nuttī, Y. J. (2013). Sámi teachers' experiences of indigenous school transformation: Culturally based preschool and school mathematics lessons. *AlterNative*, 9(1), 16–29.

Pihama, L., Smith, K., Taki, M., & Lee, J. (2004). *A literature review on kaupapa Māori and Māori education pedagogy*. Retrieved from http://akoaotearoa.ac.nz/mi/download/ng/file/group-199/a-literature-review-of-kaupapa-maori-and-maori-education-pedagogy.pdf

Pimm, D. (1987). *Speaking mathematically: Communication in mathematics classrooms*. London, England: Routledge & Kegan Paul.

Rewi, T. (2011). Māori teaching pedagogies: Where to from here? In P. Whitinui (Ed.), *Kia tangi te tītī. Permission to speak*. Wellington, New Zealand: New Zealand Council for Educational Research Press.

Rogers, N. (2003). *Kia whakapakari ngā kaiako pāngarau ki roto i tetehi wharekura kaupapa Māori* (Unpublished master's thesis). University of Waikato, Hamilton, New Zealand.

Skerret, M. (2011). *Whakamanahia te reo Māori*. Wellington, New Zealand: New Zealand Teachers Council.

Smith, L. T. (1999). *Decolonizing methodologies. Research and indigenous peoples.* (2nd ed.). London, England: Zed Publishers.

Staples, M. E., & Truxaw, M. P. (2012). An initial framework for the language of higher-order thinking mathematics practices, *Mathematics Education Research Journal*, 24(3), 257–282.

Statistics New Zealand. (2013). *2013 Census QuickStats about Māori*. Retrieved from http://www.stats.govt.nz/Census/2013-census/profile-and-summary-reports/quickstats-about-maori-english/population.aspx

Sullivan, P., Clarke, D., & Clarke, B. (2009). Converting mathematics tasks to learning opportunities: An important aspect of knowledge for mathematics teaching. *Mathematics Education Research Journal*, 21(1), 55–85.

Thrupp, M., & Mika, C. (2011). The politics of teacher development for an indigenous people: Colonising assumptions within Maori education in Aotearoa, New Zealand. In C. Day (Ed.), *The Routledge international handbook of teacher and school development* (pp. 204–213). New York, NY: Routledge.

Warren, E. A., Quine, J., & DeVries, E. (2012). Supporting teachers' professional learning at a distance: A model for change in at-risk contexts. *Australian Journal of Teacher Education*, 37(6), 12–28.