Journal of Urban Mathematics Education
December 2012, Vol. 5, No. 2, pp. 157–181

Reflecting Heritage Cultures in Mathematics Learning: The Views of Teachers and Students

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In this article, the author explores the views of six teachers and 136 indigenous (Māori), Pacific Nations, and New Zealand European students on reflecting the heritage cultures of Māori and Pacific peoples in mathematics learning. Findings show that teachers responded to students' cultures through their classroom interactions but not through contexts used in mathematical tasks—participants largely viewed Māori and Pacific Nations cultures and mathematics learning as distinct. Findings indicate that substantive incorporation of heritage cultures in mathematics instruction requires changes in teacher and student beliefs regarding the place of heritage cultures within mathematics learning and sector and school-based support for teachers to develop their cultural knowledge and understanding of how to utilize such knowledge in their teaching.

KEYWORDS: culturally responsive teaching, diversity, indigenous populations, mathematics teaching and learning, student voice

International research literature evidences increased attention on addressing the impact of discontinuities between minoritized cultural groups and dominant school cultures on student affect, engagement, and achievement (e.g., Gay, 2010; Kidman, Yen, & Abrams, 2012; Nieto & Bode, 2008; Presmeg, 2007; Sleeter, 2011; Tyler et al., 2008). Education is a complex system. Schools—and teachers' work within them—exist within broader societal contexts in which systemic power imbalances in relation to colonialism, decision-making, resource distribution, and school sector policy and structures (often intrinsically linked to the ideologies of dominant cultures) all affect how issues of diversity in education can be addressed in classrooms (Brayboy, 2005; Samu, 2011). Within these contexts, culturally relevant or culturally responsive pedagogies, which acknowledge, draw from, and strongly link with students as culturally located individuals, are advocated as pathways toward enhancing student outcomes by reducing discontinuities between students' homes and schools where they exist (Gay, 2010; Ladson-Billings, 1994; Wlodkowski & Ginsberg, 1995). These pedagogies employ strong ties between learning contexts and the cultural backgrounds of students which, along with effective teacher-student relationships and student-centred practices, help create class-

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room programmes that are inclusive of the culturally located behaviours, ways of learning, expertise, knowledge, interests, and experiences that students bring to their learning (e.g., Averill et al., 2009; Fletcher, Parkhill, Fa'afoi, Taleni, & O'Regan, 2009; Kanu, 2011; Tyler et al., 2008).

Similarly, Bishop (2008) emphasizes the importance of teachers providing opportunities for indigenous and minoritized students to learn within and through contexts consistent with and linked to their ancestral cultures, referred to in this article as their *heritage cultures*. Students are part of many cultural groups, each with their own set of behaviours, practices, ways of interacting, and values (Banks, 2004). For example, students may belong to church groups, sports clubs, school-based groups, social groups, and family groups. In this article, heritage culture is used to refer to the languages, practices, knowledge, ways of being, and behaviours linked to the heritage ethnicities of students as nurtured within them by their family and others in their extended heritage cultural group. Also included within the term are current and historical issues, events, and other information (e.g., legends, celebrations, customs) clearly related to a heritage culture.

Differences between students' and teachers' cultural backgrounds and teachers' limited knowledge of the students' cultures present challenges for teachers to plan and teach in ways that capitalise on their students' background experiences (Villegas & Lucas, 2002; Zumwalt & Craig, 2008). Here, I describe a recent study designed to examine the potential for links to be made between students' heritage cultures and mathematics instruction in New Zealand. In the study, I investigated the perceptions of mathematics teachers and students of teachers' knowledge of the students' Māori and Pacific Nations heritage cultures, mathematics learning linked to Māori and Pacific Nations heritage cultures, and beliefs about the role of the students' heritage cultures in their mathematics learning. Due to the fundamental importance of effective teacher-student relationships for the learning of Māori and Pacific Nations students (Bishop, Berryman, Tiakiwai, & Richardson, 2003; Fletcher et al., 2009; Hill & Hawk, 2000), the perspectives of teachers and students of these relationships in their own mathematics classroom were included in the investigation. I begin by describing the national and international context and theoretical background, and then outline the study and present teachers' and students' views on teacher-student relationships and incorporation of cultural heritages within mathematics learning. Finally, I discuss the study findings and their implications for educators, policy makers, and future research.

The New Zealand Context

There are approximately 760,000 New Zealand school students of New Zealand European, Māori, and Pacific Nations heritages (with approximately 59%, 22%, and 9% in each group, respectively). The proportions of Māori and Pacific Nations students are increasing relative to their New Zealand European counterparts. The ethnicities of New Zealand's Māori and Pacific Nations

secondary school students and those of their teachers are often poorly matched, particularly in mathematics. New Zealand Māori, Pacific Nations, and European students' cultural heritages vary greatly across and within ethnicities. These limited ethnic classifications do not convey the marked diversity that exists within and across groups in relation to the depth of individuals' engagement with their heritage culture/s, the combinations of individuals' heritage cultures, and the number of generations in their family who have lived in New Zealand. Mathematics achievement also varies within and across ethnic groups; New Zealand European students tending to perform better on traditional achievement measures than their Māori and Pacific Nations peers (Crooks, Smith, & Flockton, 2010). Most New Zealand European students are in the ethnic majority in their classes and schools; however, those represented in this study are not.

New Zealand education policy encourages culturally responsive teaching to improve the academic success of Māori and Pacific Nations students, reduce disparities in achievement, acknowledge and strengthen students' cultural identities, and strengthen the understandings of all students of the cultural diversity of New Zealand society (Ministry of Education, 2007a, 2011). According to these policies, it is essential for teachers to acknowledge, reflect, and value student identity and culture in their practice for Māori students to achieve "as Māori" (Ministry of Education, 2008, p. 4). Teachers are encouraged to ensure Māori learners can see themselves in their education, realize their "cultural distinctiveness and potential" (p. 18), and participate in and contribute to *te ao Māori* (the Māori world). Similar policy goals exist regarding Pacific Nations students (Ministry of Education, 2006). However, teaching that reflects such goals has yet to reach widespread classroom implementation. For example, despite observing 100 secondary mathematics lessons, many of which exhibited examples of culturally responsive practices such as student-centred classroom discourse, I found few examples in which the teacher acknowledged the heritage cultures of their students, and none of the observed instructional activities reflected links with students' Māori and Pacific Nations heritage cultures (Averill, 2012).

Traditional Māori pedagogies include experiential learning; context-based and integrated learning; *tuakana-teina* (learning from more experienced peers); learning through stories, metaphor, and song; and strategies that develop shared ownership of and responsibility for learning (Hemara, 2000). Schools successful with Māori students encourage parental and community involvement and incorporate "substantial elements of traditional and contemporary Māori language, culture and knowledge into the curriculum" (Education Review Office, 2002, p. 1). Strong mathematics achievement gains by Māori students have been linked to school-wide commitments to culturally responsive teaching such as by incorporating *taonga* (Māori treasures), Māori language and protocols, and *tikanga Māori* (Māori practices) such as making personal connections and sharing responsibility, into classroom practice (Te Maro, Higgins, & Averill, 2008). For Pacific Nations students, relevant teaching

strategies include using humor to encourage engagement, using Pacific sources as curriculum materials (Ministry of Education, 2007b), and telling stories to explain concepts and locate information within the lives and experiences of students.

A recurrent theme in the literature regarding the learning of both Māori and Pacific Nations students is the potential for growth in teacher recognition of the students' experiences, background knowledge, needs, and skills of how to capitalize on these in their teaching (e.g., Amituanai-Toloa, McNaughton, Kuin Lai, & Airini, 2009; Bishop & Berryman, 2006; Ministry of Education, 2007b; Tuuta, Bradnam, Hynds, Higgins, & Broughton, 2004). To develop their understanding of the diversity of Māori and Pacific Nation peoples, New Zealand teachers are encouraged to learn about linguistic, cultural, and culturally linked pedagogical differences across groups, and between these groups and teachers' own cultures (Fletcher et al., 2009; Hill & Hawk, 2000; Macfarlane, 2004). However, many teachers in Loorparg, Tait, Yates, and Meyer's (2006) New Zealand study felt that adopting culturally responsive practices is challenging in part because it is left for individual teachers to manage, and they called for a range of supports such as increased access to suitable resources to help them respond to cultural diversity in their teaching. Similarly, in a study which included interviewing 32 Māori Year 5 and 6 students in one urban Māori language immersion school, Kidman, Yen, and Abrams' (2012) found that elementary science teachers also face challenges related to positioning indigenous culture and knowledge in the curriculum. They contend that the resulting peripheral inclusion of Māori culture and knowledge in school science conveys tacit and hidden messages for students about the nature of science education and the place of indigenous culture and knowledge within it, contributing to indigenous student disengagement with science learning.

The crucial importance of positive teacher-student relationships—students having a feeling of connectedness with the teacher and teachers incorporating the perspectives students have about their learning in their teaching decisions—for students' engagement, motivation, and learning has been identified and discussed by many in national and international contexts (see, e.g., Anthony & Walshaw, 2007; Eccles, 2004). Strong academic relationships are considered essential for Māori and Pacific Nations student learning in particular because they enable students to feel comfortable and safe in the classroom and to know that the teacher understands and is focussed on their learning and best interests (Bishop et al., 2003; Fletcher et al., 2009; Hill & Hawk, 2000; Ministry of Education, 2007b, 2008). New Zealand teachers are encouraged to establish and maintain effective teacher-student relationships by knowing, respecting, and valuing their students and by building new learning on the experiences, knowledge, and ways of being that students bring to the classroom.

The Cultural Capital of Students and Mathematics Learning

Two recent New Zealand studies highlight the potential for linking mathematics instruction to the cultural capital (forms of knowledge, attitudes, skills, and advantages in relation to society in general) that students who are typically underserved acquire through their upbringing (Bourdieu, 1986). Hunter and Anthony (2011) explored teaching practices aligned with Pacific Nations' cultural practices within inquiry-based mathematical instruction. In their case study of a Pacific Nations teacher working with Pacific Nations students, the teacher referenced core cultural beliefs of reciprocity, collectivism, and communalism as the basis for classroom grouping arrangements and expected behaviours. Teaching styles affected students' mathematical agency and their accountability for their own and others' mathematical learning, demonstrating a relationship between positive student outcomes and the use of instructional methods reflecting group participation values from students' heritage cultures.

In a recent study (Averill, 2012), I reported the extent to which dimensions of teacher care could be referenced to cultural perspectives of indigenous Māori and Pacific peoples through analysing teaching practices observed in multi-ethnic secondary mathematics classrooms using Durie's (1998) indigenous model of health and well-being. Durie's (1998) *whare tapa wha* (the four-sided house) model uses the house as a metaphor for showing the interdependence of four dimensions of personal health and wellbeing: physical, social, spiritual, and cognitive and emotional dimensions. The model has proven useful for examining and developing culturally responsive mathematics teaching practice (Averill, 2012; Tertiary Education Commission, 2010). For example, my study linked caring mathematics teacher practices (such as using inclusive language, providing encouragement, being explicit about teaching decisions) with Durie's cognitive and emotional, social, spiritual, and physical dimensions of health and well-being, indicating the holistic nature of teacher care for students of the target ethnicities. The two studies highlighted (i.e., Averill [2012] and Hunter & Anthony [2011]) indicate the potential of drawing from the cultural capital of indigenous and other marginalised groups for enhancing equity of access to mathematics achievement.

Nasir, Hand, and Taylor (2008) and Bartell (2011) are among many who have advocated that teachers develop cultural competence to enable them to build on the existing cultural capital of their students. Bartell examined the literature regarding theories of care and culturally relevant and responsive pedagogy and provided the following description of a caring teacher:

> Teachers that care with awareness know their students well mathematically, racially, culturally, and politically. They work to understand and make connections with students' cultures and communities; help students develop positive racial, cultural, and political identities; reflect critically on their own assumptions and practices about students' cultures and communities, including rejecting and con-

> fronting deficit and colorblind perspectives; and labor to neutralize status differences within and beyond the classroom walls. (p. 65)

To teach in ways consistent with Bartell's definition, teachers need to know and understand their students as individuals and to care strongly about many aspects of their students' lives. They must recognize students' cultural capital and be able to link learning content and pedagogical practices to it. Strong teacher-student relationships are known to be vital for creating learning environments necessary for students to be comfortable with being known so well by their teachers and with culturally linked classroom activities being used in their learning (Bishop et al., 2003; Gay, 2010; Hattie, 2009).

In their professional development research project, McCulloch and Marshall (2011) focused on teachers' orientation towards, and competence with, connecting the out-of-school experiences of students to in-school mathematics learning. Across their year of involvement in the professional development, teachers participated in eight full days of interactive activities that explored the mathematical content knowledge of teachers and their understanding of how students learn mathematics, and considered the influences of cultural factors on teaching and learning. The researchers found that despite an increase in the number of out-of-school/in-school connections made by teachers in their teaching, these efforts remained infrequent and superficial, and few were "mathematically meaningful" (p. 60). The impact of the professional development included increased teacher use of students' informal mathematics and language. In addition, there was an increase in teacher awareness of attending to possible effects of cultural difference, for example, through teachers clarifying contexts that students may have found unfamiliar. Teachers' lack of mathematical knowledge and the "simplistic connections [teachers] drew between race and culture" (p. 62) were thought to be factors that limited their ability to further reflect students' out-of-school experiences in their practice.

Enhancing teachers' cultural competence is also the focus of an extensive New Zealand professional development project, Te Kotahitanga (Berryman, 2011; Lawrence, 2011). The project, which involved classroom-based professional development for Year 9 and 10 classroom teachers in using an "effective teaching profile" (Bishop et al., 2003, pp. 95–116), has resulted in enhanced teacher-student relationships, improved mathematics outcomes for Māori students, and shifts in the understanding of teachers of their role and of incorporating Māori culture into classroom teaching across curriculum areas (Bishop, Berryman, Wearmouth, Peter, & Clapham, 2012; Hynds et al., 2011). Teachers and students reported deepened teacher understanding of Māori educational concepts and their relevance to the classroom and sensitivity to the perspectives of students (Savage et al., 2011). Māori students were positive about changes in their learning through the project and specific examples of Te Kotahitanga teachers using learning tasks drawn from the Māori culture have been reported in some curriculum areas (e.g., Savage et al., 2011). Although many mathematics lessons were found to feature Māori cultural knowledge or language and

opportunities for student co-construction, no specific examples of mathematics learning tasks drawn from the Māori culture have yet been reported from the project. Mathematics was also the curriculum area with the highest proportion of observed lessons that did not exhibit these elements.

Many studies have shown ways that the cultural competence of mathematics teachers can be developed and discontinuities between the heritage cultures of students and their mathematics learning reduced. Examples include teachers working alongside educators with strong cultural knowledge (e.g., Celedon-Pattichis, 2004; Howard, Perry, & Butcher, 2006), drawing from community knowledges to build mathematics learning opportunities (e.g., Civil, 2007; Civil & Andrade, 2002), teaching mathematics for social justice (e.g., Gutstein, 2003), teachers getting to know individual students and their families to develop their classroom practice (e.g., Foote, 2010), and curriculum development such as that carried out with the indigenous Yup'ik people (e.g., Lipka et al., 2005).

The views of teachers are important to understand in order to inform policy and teacher education. Two recent studies exemplify that student voice is also vital for informing mathematics teaching practice to reduce culturally linked differences in educational opportunities. The stories of Latina/o students in Gutiérrez, Willey, and Khisty's (2011) study indicated a prevalence of ideologies of the dominant cultural group in their instruction, schools' neglect of the culturally linked learning tools and resources of students, and student resistance to particular schooling practices. In Siope's (2011) New Zealand study, secondary school Pacific Nations students described how effective teacher-student relationships enhanced their learning and how they coped with school and home demands by keeping their school and home lives separate.

In summary, researchers and policymakers have called for classroom teaching in general and mathematics teaching in particular to acknowledge and strongly link with the cultural backgrounds of students, and many projects have made valuable contributions towards understanding ways of doing so and of the associated supports and challenges for teachers. The views of teachers and students of such teaching have been less frequently explored but are vital for informing teacher practice and curriculum and policy development. These views were the focus of this study.

Examining the Views of Teachers and Students: The Study

The sites for this research study—part of a larger research project (Averill, 2009)—included three urban, state co-educational, mid-low socio-economic schools, each with roughly equal numbers of Māori, Pacific Nations, and New Zealand European students to ensure data could be collected from students of the three target ethnic groups. None of the study schools were involved in the Te Kotahitanga professional development project (Bishop et al., 2003). The study participants were 136 Year 10 students from the classes of six teachers, with roughly equal numbers of students of the target ethnicities, according to

official data. This article does not discuss differences in the responses of students by ethnicity because students' self-reported ethnicities indicated much greater complexity exists than is shown by the official data (e.g., 42% of students claimed more than one ethnicity).

The three heads of department volunteered to participate and each nominated one other teacher. Four of the teachers (three New Zealand European: Mr. A, Ms. B, and Mr. C; and one Māori/New Zealand European: Ms. D) were very experienced in teaching students of the target ethnicities. Two teachers (both first generation New Zealanders: Mr. E and Mr. F) were in their second year of teaching. (Full ethical approval was gained for the study.)

To capture the desires of teachers and students for mathematics learning at the beginning of the school year as well as their later experiences of mathematics teaching and learning, data were gathered over 9 months including early, mid, and late in the academic year using three cycles of questionnaires and semi-structured interviews. All student questionnaires were available in English, the Māori language, and in Samoan, the language of the largest Pacific Nations participant group to enable students to respond in their heritage language. Questionnaires included both open questions to capture the range of participant opinions and Likert scales to enable measurement of the strength of views.

I assumed a sociocultural epistemological stance for the study and used both qualitative and quantitative methods. Māori and Pacific Nations cultural advisors were consulted on multiple occasions in order that their advice would inform every stage of the study design, implementation, and data analysis. Strategies to maximise data validity included extensive development and trialling processes for creating the data gathering tools, using a sole researcher to gather all data, data triangulation (three research sites and collecting data multiple times at each site), methodological triangulation (more than one method of collecting data), and peer examination feedback from cultural and other advisors collected across the duration of the study (Averill, 2009). The dataset included 18 teacher questionnaires and 96, 107, and 136 student questionnaires respectively for the first, second, and third data gathering rounds. Both a sample of students of the target ethnicities and all teachers were interviewed in each data gathering round to follow up responses and themes arising from the questionnaires (138 student interviews and 18 teacher interviews in total). Students had the option of being interviewed alone or with a peer for their comfort and to maximise the quality of the dataset.

Statistical Package for the Social Sciences (SPSS) was the statistical analysis tool used for quantitative questionnaire data. In analysing the qualitative data, statements were deemed to indicate links with the Māori or Pacific cultural heritages of students if they included any direct reference to the languages, practices, or accepted behaviours of Māori or Pacific Nations heritage cultures or to current or historical issues, knowledge, events, or other information clearly related to Māori or Pacific Nations peoples. In the section that follows, I discuss study results in relation to teacher-student relationships and

students' heritage cultures, beginning with teacher perspectives followed by those of students.

The Voices of Teachers: "It's more than just the maths."

Teacher-Student Relationships

All of the teachers believed it important to develop a positive relationship with each student and all but one prioritized learning students' names. All study teachers believed that both knowing their students as people and making some things about themselves open for students to know were important. For example, one said:

> [Knowing about the students] is useful for interacting with them, and also for getting them to know little bits and pieces about us as individuals. These kids are very inquisitive in that sense. Some staff think of that as being rude or nosy but the kids often want to know about the people around them: where you come from, who your wife is, what kids you've got, and that sort of stuff. And for them, they are always pleased when we show an interest in something that they're doing. Knowing about each other just helps. At times it can help you through an awkward situation in teaching. (Mr. A)

All teachers believed it important to incorporate aspects relevant to students' in-school and out-of-school lives in their teaching to help show relevance of the mathematics to students and enhance student motivation. Teachers liked knowing about their students including being aware of their "successes" (all teachers), "sports" (5 teachers), "personalities" (5), "families" (4), "family commitments" (4), "cultural activities" (4), and "progress in other subjects" (3). Teachers used formal and informal ways of getting to know their students. Two teachers asked their students to write letters about themselves at the start of the year, one telling the students about herself before setting the task:

> I always tell them something about myself, how long I've been teaching, my children, that kind of thing, and if they want to ask me anything, that's the time. Always on the first night for homework I get them to write me a letter to tell me everything that they think I should know. I have particular themes: how their last year went in maths; what they want to do this year; their family; and anything [they think] I need to know. (Ms. D)

Aside from this letter-writing task, there was no evidence of systematic ways of learning information about students. The informal methods teachers used to get to know their students as people included having conversations with students over time (3 teachers) and with families (1 teacher).

Strategies teachers reported using to get to know their students as learners included diagnostic testing, working one-to-one with students, "interacting with as many students as possible each lesson," and "brainstorming" when introducing new learning. Teachers described a range of ways that they believed helped their students know them as a teacher, including "establishing a

worthwhile programme," "encouraging students," "having patience and listening," "having an organised [classroom] environment," and "setting clear boundaries, routines, and expectations."

Teachers reported personal and pedagogical strategies for establishing and maintaining teacher-student rapport: "knowing students' names," "using correct Māori and Pacific Nations pronunciation," "creating a friendly environment," "using a sense of humour," "being patient," "giving students choices," talking with, and listening to, students about their life, their progress, out-of-school activities, and problems, and "helping students in subjects other than mathematics." Four teachers believed that mathematics teachers faced greater challenges than teachers of other subjects in developing teacher-student rapport and knowledge of one another, arguing that it can be difficult to interest students in mathematics content and that missed lessons are more problematic in mathematics than in other subjects due to new learning often building on previous work. National assessment methods ("reducing students' interest in mathematics") and students' negative experiences of, and feelings towards, learning mathematics were also identified:

> Often [mathematics teachers] have to work harder [at developing rapport]. Kids' relationships with you are affected by their view of the subject and if they don't feel switched on by the subject it's probably going to be difficult to get a good relationship with them. So somehow we've got to get them to come in and feel comfortable, so being successful in maths to start with is important. That means on the first test [I make sure] everyone gets more than eighty percent, so they feel good about it. (Mr. A)

Students' Heritage Cultures

No teachers mentioned the heritage cultures of students in questionnaire responses regarding how they get to know and develop rapport with their students. Apart from the focus on pronunciation, teachers did not state any deliberate links between their pedagogical choices and students' heritage cultures. However, when specifically asked about students' heritage cultures, four of the six teachers believed that it was important for students' mathematics learning that they as teachers knew and cared about aspects of the cultural heritages of their students. Views varied regarding the relative importance of showing care for students' heritage cultures and other factors for students' learning: "Caring about students' cultures shows students that you value their background; it is all part of sharing an interest in each other so that the learning environment is one that all cultures can work in." (Mr. C)

Mr. A, who used his knowledge of students' heritage cultures to create connections with them, believed that students' learning was more strongly influenced by factors other than showing care for students' heritage cultures:

> **Teacher A:** I've worked in the Pacific for 12 years. What we've brought back here is knowledge that helps. You look at their faces and look at their names. I said to one of the kids a couple of years ago,

> "you're a Cook Islander" and she said "how do you know?" And I told her the story about a student that I had in the Cook Islands that had the same surname and I said this girl came from Mangaia, one of the outer islands and so does she, so it's from those kinds of clues that you can establish some personal link… it is about caring for kids and showing a bit of interest in them. It's more than just the maths.

Interviewer: Do you think it makes a difference to those students in terms of their learning?

Teacher A: It can do. There are other things that affect their learning more, but it's just that they're more likely to talk to you more…it just helps that [teacher-student] relationship.

Teachers stated that they showed that the heritage cultures of their students are important to them by developing their own cultural knowledge and skills (e.g., by learning some Māori, Samoan, or Fijian language or knowing how to interpret the body language of different groups), by "talking with students about similarities and differences between our cultures" (Mr. C) and by "giving students opportunities to work in the Māori language" (Mr. A). Most teachers were positive about developing their cultural knowledge; "anything that helps with rapport, which is culturally important, I will try to learn about" (Mr E). However, teachers mostly did not identify specific pedagogical practices that they intentionally used in order to teach in culturally responsive ways: "If students of different cultures feel comfortable coming into my classroom, I think in ways I am addressing the differences of the cultures in the room" (Mr. F).

One teacher stated that many of her students want to keep parts of their home and school worlds separate, but she tries to reduce the separation:

> Many [students] go to great lengths to keep their lives in compartments, for example lots have "school" names [in English] because they believe teachers will not be able to pronounce their real names. I hear other students using their Samoan names so I try to know their real names. (Ms. B)

Although five of the six teachers showed some interest in knowing about Māori and Pacific cultures, they were largely neutral or negative about using mathematics examples linked to using such knowledge in their teaching: "I'm not good at this, that's for sure. Overall I don't make a difference between New Zealand European or Māori or something. It's the same, it is in our school. I can't see a difference between them" (Mr. F).

Two teachers felt that they should be reflecting heritage cultures in their teaching, for example the teacher with Māori heritage said: "I know that in my classroom I really should have Māori words up or the kowhaiwhai patterns (Māori rafter patterns)…and I haven't got those…. I should be doing more to promote biculturalism in mathematics" (Ms. D).

All teachers reported finding it difficult to include Māori and Pacific Nations contexts in their teaching due to lack of resources (3 teachers; "textbooks only pay lip service to [incorporating Māori and Pacific Nations cultures]" [Mr. A]) and lack of personal knowledge (3 teachers; "I'm not sure how I can help somebody who's from another culture to learn maths better" [Mr. F], "I don't know enough about other cultures and how they use maths" [Mr. C], "identifying realistic situations to use is difficult" [Mr. A], "to link the culture to the maths you have to have a really good understanding of the culture, and I don't think I have" [Mr. E]). Teachers' practice in relation to reflecting the Māori and Pacific Nations heritage cultures of their students in mathematics learning seemed also to be limited by their beliefs about the nature of the personal engagement of their students with their heritage cultures (e.g., "most of these students don't have strong connections with their heritage culture" [Mr. A], "most of the [Pacific Nations] students are New Zealand born and urban so their contexts are different to those born outside of New Zealand and/or rural" [Mr. A]) and concerns about possible student discomfort (e.g., "students might take it the wrong way and not like it" [Mr. E]).

The Voices of Students: "I see them as different, there's your culture and there's maths"

Teacher-Student Relationships

Teachers and students being able to be themselves in the mathematics classroom was important to the students in this study because it enabled them to get to know the teacher, feel the teacher was interpreting their interactions appropriately, and engage with the learning:

Interviewer: What makes a good maths teacher?
Student: Personality and that he works [well] with people.
Interviewer: How does that help your maths learning?
Student: It makes you get more into it.

Many students felt it important that they and the teacher knew one another for effective communication, mutual trust, teacher-student rapport, and for their learning. Comments from two of Mr. C's students help illustrate students' thinking: "Teachers need to know the [students], so if you're not getting something, they can use examples from things you like…so they are using something you are interested in."

> Because it kind of breaks down the wall, they can relate to you as a person. You normally think it's going to be a scary thing talking to your teacher but if you know a bit about them and they know about you, you feel confident in talking with them. If they get to know you, you know you can trust that teacher and you know you're going to get a good lesson, but if they just write something on the board and get you to copy it, you're not really learning anything.

Overall, students valued knowing some things about their teacher and their teacher knowing about them. They held differing preferences regarding what they wanted to know about their teacher, what they wanted their teachers to know about them, and how they wanted their teachers to find those things out. The first set of questionnaire responses showed that "my successes," "my personality," and "how well I learn in other subjects" were what students most wanted their teachers to know about them, with over 40% of students in each heritage culture group selecting each of these. Almost one fifth of students wanted their teacher to know something about their "family," "sports," and "cultural activities." Four of the 136 students indicated that they did not want their teacher to know anything about them.

Most students who had been asked to write letters to their teachers were in favour of that way of sharing information about themselves: "Because if you were too shy to speak about it in class, or didn't want to tell anyone, you just write down in the letter and she'd just read it."; "[Writing the letter] was a really good idea because it gave us a chance to explain about ourselves. It's giving us a chance to write what we want." However, one student stated that she would not be comfortable sharing information about herself with her teacher until later in the year when she would know her teacher better. Students who had not been asked to write letters about themselves liked their teachers to get to know them through teacher-student interactions over time, completing a questionnaire, or by talking with their previous teachers. Some felt comfortable telling the teacher what they would like the teacher to know but stated that it was harder to do in mathematics than in other subjects because fewer spontaneous opportunities for this existed:

> **Student A:** I'd just tell them straight up and then they'll understand.
> **Student B:** I reckon that's pretty hard in maths though, 'cause, you just work with numbers, you don't have conversations about reading a book and then you can't talk about applying it to your personal life or something.

Students' Heritage Cultures

Many students believed their mathematics learning and their heritage culture were not linked ("culture doesn't really have anything to do with maths") and although some students (22%) believed that mathematics teachers being responsive to their heritage culture may positively affect their learning opportunities, most either stated they did not know (between 47% and 60% of each group) or that it would not be important for their learning (24%). Pacific Nations students were more likely than Māori or Europeans to believe their culture was both relevant at school (59% compared with 37% and 28% respectively) and to their mathematics learning (25% compared with 11% and 12% respectively). The recurring theme of students believing that mathematics learning and their heritage cultures are two separate things suggests they had

experienced or noticed few or no links between them in their current or previous mathematics learning:

Interviewer:	You've been learning maths from year one all the way through to now, so is that something that you're used to happening in maths, teachers bringing in examples from different cultures?
Student:	No, just one usually, European, which is all right 'cause I kind of understand it better.
Student:	It would just be the same as normal maths if they added on a bit of culture.
Interviewer:	But do you think it would help you with learning maths?
Student:	I think it would be better if they keep it how it was.

Moreover, students often showed surprise at the inclusion of questions regarding their heritage cultures, further evidence that they did not expect such links to be made. However, one interview indicated that despite initially viewing mathematics and heritage cultures separately, students could quickly think up an example linked to their heritage nation:

Student C:	I see them as different, there's your culture and there's maths, so maths is with all these numbers and the teacher, and the culture is with your parents and family, so it's quite different.
Interviewer:	So you see them as two separate things?
Student D:	I reckon you could use culture for, like statistics, like how many people live in Samoa and things like that, or how many children were born there in certain years.
Interviewer:	And you'd like examples like that to be used?
Student C:	Yeah, like to have true statements that were taken from the [Samoan] census would be good.

Some students felt uncomfortable about mathematics learning being linked to their heritage culture, being concerned for themselves (such as avoiding feeling shame in relation to their own lack of knowledge of their culture or language), or for others:

Interviewer:	Do you see your heritage culture as something that is separate to your mathematics learning or something that is important in your mathematics learning?
Student:	I kind of want it to be separate.
Interviewer:	Can you explain why?
Student:	Well, I really don't know my own culture, or how to speak it.
Student:	If you have examples and they're all to do with, like Pacific type questions, and then people would think, "Oh, why is she just doing that culture? Why not anything else?" But if you do a range of them then that would be all right, but kind of different.

Responses gathered in the second and third questionnaires showed that most students did not know whether or not their mathematics teacher knew about their heritage culture (more than 35% for all groups, and 61% of Māori students). Pacific Nations students were more likely than other groups to be-

lieve their teacher knew about their heritage culture (51% compared with 28% and 38% for Māori and European respectively). Higher proportions of Māori and Pacific Nations students wanted their teacher to know about the Māori and Pacific worlds (20% and 45% respectively) than to use examples that drew from this knowledge in their mathematics lessons (9% and 28% respectively). Later questionnaire data showed that despite learning for many months with the same mathematics teacher, most students did not know whether or not their teachers knew about the Māori and Pacific worlds (over 64% and over 59% across all groups respectively), suggesting either that the teacher had not shown such knowledge or used learning examples linked to Māori or Pacific Nations cultures, or that if they had, it had not been noticed by their students. Some comments suggested students thought their teacher needed only limited knowledge about their heritage cultures:

> I think it's good for [teachers] to know what your cultural identity is and what one you belong to but for them to fully understand it, that's not really necessary 'cause as long as they know who you are, they don't need to know everything about you.

Some students believed that subject areas such as English, art, languages, and social science were more suitable than mathematics for connecting learning with their heritage culture: "We're there for maths and not for discussion about cultural things, that's for a different classroom"; "Focus on the maths and leave other things to other teachers."

While many students did not believe teachers needed to know much about their heritage cultures, they did believe it very important that teachers showed respect for them:

> It just depends on how they use my culture…if they're going to use an example in the language they may as well speak it properly because if they're going to describe something in maths, they should get it right.

According to students, teachers showed the importance they placed on students' heritage cultures by showing "respect" for them, "giving help," trying to learn words in the students' heritage languages, and treating students of different cultures in the "same" way or in different ways. This apparent contradiction was explored further in the interviews. Students believed both to be important with the way in which it was shown dependent on the context. For example, students felt teachers should treat everyone the same in relation to respecting everyone's cultures equally, while believing that teachers should treat students differently by responding appropriately to cultural difference:

Student:	Teachers need to respect our cultures.
Interviewer:	Should they treat everybody the same or treat everybody differently?
Student:	The same but respect everyone's culture. Yeah, the teacher might say something that would offend someone from a dif-

> ferent culture, so if she knew that was their culture she wouldn't say it.

Students' expressed that their teachers' concern for their heritage culture was important for their mathematics learning. Reasons for this belief included themes of inclusion, fairness, workload, and suitability of linking heritage culture and mathematics learning:

> ***Important:*** so that the teacher would be inclusive, so they could reflect class cultures in maths activities, to enhance students' feelings of cultural identity, because we might learn in different ways.
>
> ***Not important:*** teachers should treat everyone the same, teachers are already too busy without having to learn about students' cultures, culture and maths are two separate things, our cultures do not affect our learning, it is none of the teacher's business. (paraphrased from student questionnaire responses)

One Pacific Nations student suggested "teachers could have a good ethnic buddy," a practical suggestion consistent with Celedon-Pattichis's (2004) and Howard and colleagues' (2006) research which includes incorporating cultural experts as partners to enhance teachers' cultural knowledge and expertise. Such practice has the potential to develop teachers' knowledge of, and sensitivity towards, students' heritage cultures and their pedagogical approaches to reflecting these in their mathematics teaching.

Discussion and Conclusion

Teacher-Student Relationships

Overall, the study results are consistent with those of previous studies and the literature on teacher-student relationships (e.g., Bishop et al., 2003; Eccles, 2004; Fletcher et al., 2009; Hill & Hawk, 2000) in that both students and teachers believed in the fundamental value for effective learning of positive teacher-student relationships and knowing about one another. This study adds to the literature by providing evidence of the connection between effective teacher-student relationships and teachers knowing students well as individuals, including identifying what students may want their teacher to know, and how teachers can sensitively learn these things without detracting from curriculum delivery time. The findings indicate the value of enabling student choice about what and when to share, as demonstrated by the range of students' preferences regarding what they would like their teachers to know about them and how and when they would feel comfortable for the information to be gathered.

The findings indicate that Bartell's (2011) ideal of "teachers who care with awareness" (p. 65) is likely to be difficult for mathematics teachers to achieve. To teach in ways consistent with Bartell's definition teachers need to know, understand, and strongly care about many aspects of their students' lives. Teachers who work exclusively with one group of students (such as many el-

ementary school teachers) from one or a small number of different cultural backgrounds (as in Hunter & Anthony's [2011] study) must be better positioned to demonstrate cultural competence and achieve elements of Bartell's description of caring teacher practice than teachers who work across many class groups with students of a wide range of cultural backgrounds. This study shows that some students may not want to be known by their mathematics teacher as well as would be required for all aspects of the definition to be adopted. Furthermore, this study indicates that teachers and students may need convincing that knowledge of heritage cultures will assist mathematics learning and can be used with sufficient respect and sensitivity.

A teacher's knowledge about their students' heritage cultures was not amongst the main factors directly reported by teachers and students as fostering or maintaining effective teacher-student relationships or rapport. However, participants' responses regarding the importance of teachers respecting students' cultures and responding to students in culturally appropriate ways indicate that participants believe teachers' knowledge of students' heritage cultures is essential in relation to interpersonal interactions. This study indicates that teachers were teaching in culturally responsive ways in some respects (e.g., placing importance on knowing their learners as individuals, acknowledging cultural differences, developing positive teacher-student relationships, and managing student-centred classrooms), but had few systematic ways of knowing they were being culturally responsive in their teaching or of developing their culturally responsive practice. For example, the study teachers were interested to know about some aspects of their students' lives but such knowledge was mostly gathered informally through *ad hoc* individual interactions with some students during class lessons.

Students' Heritage Cultures

The study findings provide further evidence of discontinuities between schools and students' cultural heritages and contribute to understandings of how and why such discontinuities occur and how they can be reduced. In contrast to participants in the Te Kotahitanga project (Berryman, 2011), neither the study teachers nor the students readily identified how students' heritage cultures were linked with mathematics learning. No evidence emerged in the study of schools, teachers, or students drawing from the heritage cultural knowledge of parents, *whānau* (family groups), or the wider school community to inform mathematics teaching and learning. The study results could indicate that teachers and students may not have strong personal cultural identity or if they do, they may see it as something they prefer to keep apart from the classroom. No school- or discipline-based discussions focused on responding to cultural diversity in learning programmes were mentioned by participants, suggesting either such conversations and development are not taking place in the study schools, or if they are, mathematics teachers do not see them as relevant, important, or easily implementable. The student voices outlined the dichotomy

many students encounter in identifying with their own cultural heritage while being part of the other cultural groups in their lives; for example, their class, school, sports, and social groups and the mainstream cultures within which these sit. In addition, the students in this study were in their adolescent years, a time when many can desire or feel compelled to minimise differences between themselves and others (Meece & Daniels, 2008). It may be that the opinions and practices of teachers are a deliberate or subconscious response to their sense of the complexities of students' beliefs, perceptions, and prior learning experiences in relation to culturally responsive mathematics teaching and variation in the cultural identity of individual students.

Both the teacher and student voices in the study indicate that many conflicts and challenges exist for teachers in developing and using culturally linked mathematics learning tasks. Consistent with the findings of Amituanai-Toloa and colleagues (2009), Loorparg's (2006) team, and others, and claims of researchers such as Villegas and Lucas (2002), the teacher voices collected in this study illustrate that development of teachers' knowledge of students' heritage cultures, how to reflect these in their mathematics teaching, and why this is important to achieve are necessary and urgent. Whilst many New Zealand mathematics textbooks do not yet incorporate Māori and Pacific Nations cultural contexts in a substantial way, a few suitable resources have been available (e.g., Averill, Phillips, & French, 2003; Heays, Copson, & Mahon, 1994). The absence of mathematics tasks linked to contexts drawn from Māori or Pacific Nations cultures in study students' current and previous mathematics learning was strongly apparent, despite the teachers' access to mathematical tasks with links to Māori and Pacific Nations cultures, and study schools being situated within multiethnic communities. Given this finding, responses to questions regarding integration of aspects of cultural heritages within mathematics learning must have been based largely on participants' beliefs of what such practice *might* be like, rather than from experience.

Culturally Responsive Teaching

The study included six mathematics teachers and their students from one year group across three urban schools in the same city and caution should be used in interpreting the findings more widely. Limitations notwithstanding, this study adds to what is known about culturally responsive teaching in several ways. First, students may not recognize some elements of teachers' responsiveness to students' heritage cultures. Teachers' knowledge of cultures and cultural difference informs their classroom behaviours and decisions, how they conduct one-to-one teacher-student interactions, and their body language, any of which may be deemed by their students as suitable, comfortable, and caring. The absence of such culturally responsive behaviours, however, is perhaps more likely to be noticed by students than their presence (Banks, 2004). For example, although culturally responsive methods were the teacher's intention and practice in Hunter and Anthony's (2011) study, it is unlikely that the stu-

dents recognised that the ways in which their learning was being managed were consistent with practices used in their heritage cultures, unless this was explained. Findings from Hunter and Anthony's (2011) and Averill's (2012) studies suggest that mathematics learning is enhanced when classroom practices are compatible with important aspects of students' heritage cultures. However, unless the nature of those practices that are intentionally or unintentionally linked to classroom practice is discussed with students, it is unlikely that they will also contribute to policy and research goals of strengthening students' cultural identities.

Secondly, many students viewed mathematics and culture as separate and, in spite of multiple opportunities to consider the place of heritage cultures in relation to mathematics learning over the study, most did not readily identify benefits from integrating cultural knowledge and mathematics instruction. The students' varied and often vague responses and their surprise at the inclusion of questions linking cultural heritage and mathematics learning may also indicate that some had not previously considered the place of deliberate acknowledgement of students' heritage cultures in their learning or that they do not prioritise such practice. While teachers did not seem as surprised as their students to be asked questions linking heritage cultures and mathematics learning, they generally appeared not to have developed a firm philosophical stance nor to have deeply considered how they would or could incorporate students' heritage cultures into their mathematics teaching. This is particularly surprising given four of the teachers had extensive experience teaching Māori and Pacific Nations students and held departmental leadership positions. Despite the reasons for their practice, as found by Kidman and colleagues (2012) and cautioned by Sleeter (2011), teachers not linking mathematics learning to their students' heritage cultures is likely to portray to their students that such links are not able to be made or are not desirable. There is growing evidence that teachers need substantial assistance to enable such practice.

Finally, the findings indicate that practices consistent with educational research and policy regarding reducing discontinuities between students' homes and schools in relation to cultural heritage are not yet in place across mathematics classrooms, indicating likely limitations in relation to the learning and career opportunities of students not of the dominant culture (Gay, 2010; Kidman et al., 2012). These results, from multiethnic schools educating indigenous students in a multiethnic community and country, are of concern. The findings support those of others (e.g., Fletcher et al., 2009; Macfarlane, 2004) in indicating that increased teacher knowledge of students' cultural heritages, of *te ao Māori*, and Pacific Nations is urgently needed. It is hard to see how teacher-student connectedness can be maximised and teaching be truly culturally responsive while a mismatch between teachers' and students' ethnicities remains, teachers' cultural knowledge base is either limited or invisible to students, and students' understandings of links between heritage culture and learning are tenuous.

Implications

There are implications from this study for school communities, professional development and teacher education, and policy development and implementation. This study's findings, alongside those of others (e.g., Bishop et al., 2003; Gorinski, Ferguson, Samu, & Mara, 2008; Siope, 2011), indicate the challenges for New Zealand mathematics teachers to substantially reflect Māori and Pacific Nations cultures in their work are so great that substantial resources, professional development, and community involvement are required for the Ministry of Education's (2006, 2008) goals, and calls from the literature, to be fully realised. Teachers are but one part of the education system and of wider society. Historical and current societal contexts within which schools sit amplify the challenges teachers face in developing culturally responsive practice because the ideologies of dominant cultures are often not only entrenched, but they and their effects can be invisible to teachers, parents, and students (Brayboy, 2005; Samu, 2011). Issues of power and influence within education as a whole, what counts as knowledge and achievement, and whose cultural heritages and languages are valued in schools and in society are vital to attend to in order to establish the conditions necessary for inequalities in relation to diversity in education to be addressed in classrooms. All share responsibility for addressing these issues. For example, school communities are needed as partners in working together to support policy implementation by voicing high expectations of cultural responsiveness within schools, teaching, and learning, and sharing their cultural knowledge, understanding, and expertise, and how they believe this should be reflected in the learning of their students.

Evidence suggests that school-wide projects in which teachers develop close links with individuals of different cultural groups and their families (as in Foote's [2010] project), the use of accessible cultural models on which to base classroom practices (as in Hunter & Anthony's [2011] study), and mathematics teachers having easy, frequent, and ideally, classroom-based access to educational cultural advisors (as in Howard et al.'s [2006] project) offer positive ways to develop culturally responsive mathematics teaching practice. This study provides a glimpse into the beliefs and understandings of teachers and students regarding culturally responsive practices that could inform such developments. The extent to which school communities are involved in professional development, mathematics teacher behaviours and the contexts used in mathematical tasks are visibly and sensitively linked to students' heritage cultures, and teacher and student beliefs regarding the relevance of heritage culture to mathematics learning are altered, could provide useful measures of the success of such professional development in advancing culturally responsive teaching and providing environments that can enhance students' cultural identities.

In response to the challenges identified for teachers above and education policy requirements, initial teacher education programs must also prepare students well to understand and implement, and even to be leaders in, culturally

responsive practices. Aspiring teachers without knowledge of the heritage cultures of New Zealand students have much knowledge and cultural understanding to acquire through their initial teacher education and will need guidance, support, practice, and critical reflection on their practice that school-based associate teachers may not be able to provide. Such development must be expected and supported by initial teacher education providers and qualifications.

The development and implementation of education policy are complex processes affected by many factors. It is reasonable to argue that to enable social change, education policy must be idealistic, inspirational, and aspirational. However, it must also be grounded by indications research provides regarding what is possible to achieve within societal constraints (Marshall, Coxon, Jenkins, & Jones, 2000). Furthermore, policy must be supported by in-depth processes and resources to maximise its implementation and the impact it will have within schools, teaching, and students. International contexts will vary. This study indicates the value of uncovering teacher and student beliefs towards understanding the challenges for teachers and education systems and society in ensuring culturally responsive practices are the norm rather than the exception. Students being able to draw from, and link to, their heritage cultures through their mathematics learning is a vital and challenging goal to pursue towards enhancing students' cultural identities, continuity between homes and schools, inter-cultural knowledge and understanding, and equity of access to mathematics achievement. Teachers' and students' perspectives are essential to consider in developing practice. Internationally, this study offers glimpses of the complexities that can exist in relation to incorporating pedagogies and learning experiences linked to heritage cultures in mathematics instruction that can help to inform teacher education, curriculum and resource development, school practice, and policy implementation.

Acknowledgements

The author sincerely thanks Megan Clark, Fuapepe Rimoni, and Herewini Easton for their careful and wise advice through the study, the New Zealand Institute of Mathematics and its Applications (NZIMA) for funding which contributed to the completion of this study, and the study participants for their very thoughtful contributions and very valuable time.

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