Journal of Urban Mathematics Education
July 2017, Vol. 10, No. 1, pp. 95–112

Cultural Competencies and Planning for Teaching Mathematics: Preservice Teachers Responding to Expectations, Opportunities, and Resources

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In this article, the authors report on a small-scale study set in a context of a first-year mathematics education course for preservice primary teachers. Professional documentation from three different sources were analysed in relation to the national document Tātaiako: Cultural Competencies for Teachers of Māori Learners*, which was used as a key course resource in a year-one mathematics education course for preservice teachers. The authors found evidence that the pre-service teachers used the resource to identify important learning and teaching practices, and as a source of language and examples. A further tentative finding was how relational aspects of teaching mathematics were adopted as indicators of culturally connected practice.*

KEYWORDS: cultually responsive teaching, preservice teacher's expectations, teacher education

Over many years, there has been a growing international focus on equitable access to mathematics education for students from diverse cultural backgrounds. Yet students from minority cultures continue to be overrepresented in the

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lower end of mathematics assessment data (Boaler, 2002; Civil, 2007; Nasir & Cobb, 2007). This overrepresentation is also the case in New Zealand where the school mathematics assessment data continue to be concerning for Māori (the indigenous) students (Ministry of Education, 2015). National data in mathematics achievement show that 35% of Māori students achieved below the "national standards" at Years 1 to 8 (5 to 12 years old) compared with 20% of Pākehā/ European students (Ministry of Education, 2015). A minority of Māori students are enrolled in *kura kaupapa* Māori education (Māori language immersion schools). In 2011, there were 6,132 students attending *kura kaupapa* Māori, compared with 165,664 learners who identified as Māori, enrolled in mainstream schools (Ministry of Education, 2013). The majority of students of Māori descent therefore are attending mainstream (mostly state) primary schools that are required to provide teaching and learning programmes to meet and satisfy the educational needs of Māori students.

Concerns over equity are not new, nor confined to New Zealand, and teachers have been developing and trialling multiple approaches for addressing student underachievement for decades. Beginning teachers are not exempt from this equity focus and their initial teacher education (ITE) programmes can prepare them to teach students from diverse cultural backgrounds (Downey & Cobbs, 2007; Gay, 2002; Kitchen, 2005; White, Murray, & Brunard-Vega, 2012). Increasingly, expectations that teachers address issues of diversity and culture in their teaching are mandated at national policy level in standards for teachers. In New Zealand, these are explicit in the Graduating Teacher Standards (New Zealand Teachers Council, 2013a) and the Registered Teacher Criteria (New Zealand Teachers Council, 2013b). A teacher graduating from an ITE programme is expected to, for example, "promote a learning culture which engages diverse learners effectively" (2013a), and on completion of registration (after 2 years of teaching in schools), "respond effectively to the diverse language and cultural experiences, and the varied strengths, interests and needs of individuals and groups of (learners)" (2013b). One approach that aims to engage students from diverse backgrounds is known as culturally responsive teaching, an approach that has been around for a number of years (subsequently discussed). Creating opportunities and designing curriculum innovations to address issue of diversity, within an ITE setting, can be a complex task, even when direction and guidance are provided in national policies (Downey & Cobbs, 2007).

Mathematics curriculum courses, however, are legitimate sites for preservice teachers (PSTs) to learn how to implement culturally responsive mathematics teaching. So how might PSTs learn how to plan, teach, and adapt practices that illustrate culturally responsive teaching? One professional learning process for developing expertise is that of teacher "noticing" (Jacobs, Lamb, & Philip, 2010; van Es & Sherin, 2002). In a particular curriculum context, Mason's (2002) notion

of *disciplined noticing* is "to make a distinction, to create foreground and background to distinguish some things from its surroundings" (p. 31). All teachers, particularly PSTs, face the complexity of implementing mathematics teaching practices as well as culturally responsive practices, and teacher educators play an important role in supporting PSTs to develop the ability to professionally notice within the discipline of mathematics. PSTs, unlike more experienced colleagues and without a repertoire of knowledge to draw from, "cannot be aware of or respond to everything that is occurring" (Jacobs et al., 2010, p. 170). Within ITE courses, teacher educators can deliberately include strategies such as making explicit relevant aspects of practice, selecting specific resources, and scaffolding course context for close attention.

In this article, we report our findings of a small-scale study of PSTs based around a first-year primary (elementary) mathematics education ITE course. We collaborated with colleagues who have expert cultural and pedagogical knowledge to *re*design the course in order to embed a focus on culturally resposive teaching. We chose to include a national document as a key resource for the PSTs. This national document—*Tātaiako: Cultural Competencies for Teachers of Māori Learners*—sets out cultural competencies as important features of teacher practice in early childhood, primary, and secondary settings. The focus of *Tātaiako* is for teachers to support "Māori students to enjoy education success as Māori" (Ministry of Education, 2011, p. 4). Our research investigation was to determine what PSTs notice and record about *Tātaiako* within their professional documentation in three different contexts. We discuss how we incorporated a focus on cultural competencies within course requirements as an indicator of valued knowledge for PSTs. Drawn from an ongoing research study, where the main focus is how PSTs plan for mathematics teaching, we report on the ways that a small group of PSTs identified cultural competencies within their planning. We also report ways they included *Tātaiako* in their written planning during a 4-week practicum that followed the completion of the mathematics education course. We believe the findings from this small-scale study have a number of implications for our work as mathematics teacher educators. In the brief final section, we discuss those findings and our proposed next steps.

Culturally Responsive Teaching

A growing number of teachers aim to engage students from diverse backgrounds by adopting teaching practices that are attuned to and connect with students' cultural heritages and educational experiences (Cochran-Smith et al., 2015). Such practices fall under the umbrella of culturally responsive teaching (CRT), an approach that has been around for a number of years. Gay (2002) describes culturally responsive teaching as using "the cultural characteristics, experiences, and per-

spectives of ethnically, diverse students as conduits" for more effective teaching (p. 106). The underlying pedagogical theory of CRT, according to Gay, is that

> when academic knowledge and skills are situated within the lived experiences and frames of reference of students, they are more personally meaningful, have higher interest appeal, and are learned more easily and thoroughly. (p. 106)

In these ways, CRT not only provides students with greater access to learning opportunities but also these more meaningful experiences make a difference to their academic achievement (Gay, 2002; Villegas & Lucas, 2002). CRT has been taken up in a range of educational contexts from early childhood schooling to tertiary and, in particular, with teacher professional learning, including ITE (Kitchen, 2005; Nasir, 2016; Villegas & Lucas, 2002).

ITE programmes can begin preparing PSTs to teach students from diverse cultural backgrounds by implementing various types of courses designed for PSTs to learn how to teach in culturally responsive ways. Some of these multicultural education courses are offered as discrete courses without connections to other courses or as optional courses for PSTs, which means some PSTs may graduate with minimal knowledge of how to teach students from a variety of cultural backgrounds. While these courses play an important role in preparing PSTs for teaching in culturally responsive ways, more in-depth learning can occur when teacher educators commit to including CRT practices within the context of their subject courses. The inclusion of CRT relies on teacher educators having knowledge not only of their subject areas but also of cultural aspects including knowing a range of CRT practices suitable for their ITE setting (Villegas & Lucas, 2002).

In their recent review of teacher education programmes and the preparation of PSTs for teaching in diverse classrooms, Cochran-Smith and colleagues (2015) contend that PSTs need to experience more than one course dedicated to CRT, and suggest they need several opportunities within their entire programme to develop such practices. In addition, PSTs can be agents of change when they influence what happens in a classroom (Kitchen, 2005), and although they are not solely responsible for "transforming the education system," PSTs do have an important role to play (Villegas & Lucas, 2002, p. xix). Teacher educators, therefore, need to design and implement ITE course experiences that help PSTs develop a repertoire of CRT practices (Cochran-Smith et al., 2015). When designing courses, Gay (2009) advises teacher educators to avoid following "the course of least resistance" by either leaving course content as-is, or merely making cosmetic changes (p. 194). Furthermore, PSTs need to do more in coursework than focus on superficial elements of different cultures, such as food, holidays, and festivals, which are described as multicultural "tourism" (L. Derman-Sparks, as cited in Lenski, Crumpler, Stallworth, & Crawford, 2005, p. 87).

Some teacher educators have designed and researched programmes that more effectively address culture and cultural differences. Lenski and colleagues (2005) studied their Beyond Awareness Research Project and identified the importance for PSTs to consider their own beliefs and assumptions about different cultural aspects, particularly the "values and practices of families and cultures different to their own" (p. 85). It is also important for PSTs during ITE course experiences to develop positive "affirming" and "asset oriented" views, as opposed to long-held deficit views of diversity (Cochran-Smith et al., 2015, p. 114). These educators have also noted that there have been many studies about how ITE has influenced PSTs' beliefs and attitudes but far fewer studies of influences on PSTs' practice in school settings, that is, whether changes in beliefs lead to changes in teacher actions.

Culturally Responsive Mathematics Practices in ITE

Nasir (2016) claims that while mathematics has been traditionally viewed as a subject unrelated to culture, like all subject areas, mathematics is a rich source of cultural knowledge and practices. When connections between culture and mathematics are recognised within an ITE setting, worthwhile learning can occur when both are taught together, and ITE mathematics courses are "a viable place to begin deep level changes" (Gay, 2009, p. 191). In a study of secondary mathematics PSTs, Kitchen (2005) found that PSTs needed help to notice explicit connections between cultural and mathematics practices. He designed and implemented course experiences such as exploring the cultural origins of important mathematics ideas and situating mathematics learning in a cultural context of an American Indian reservation. He also included a focus on equity practices by critiquing the effects of ability tracking on students from non-dominant cultures. His aim, within the context of the mathematics education course, was to support the PSTs to incorporate equitable teaching practices in implicit and explicit ways so that they could effectively teach students from diverse cultural backgrounds.

In another study, White, Murray, and Brunard-Vega (2012) found that PSTs' dispositions toward their students' cultural backgrounds influence their awareness and sensitivity toward diverse learners, and consequently shape their selection of classroom mathematical teaching practices. If PSTs do not understand the interconnections between multiple layers of culture and their classroom practices, then PSTs risk continuing to "create classroom cultures and engage in classroom practices that perpetuate limited opportunities and barriers for students to learn and do mathematics" (p. 41). Mathematics teacher educators therefore have an important role in their curriculum (methods) courses to teach both mathematics and cultural practice simultaneously (Cochran-Smith et al., 2015; Gay, 2009; Kitchen, 2005; Nasir & Cobb, 2007). There are two complementary goals: to prepare prospective mathematics teachers to implement the curriculum and to teach diverse learners. PSTs can then begin to develop the skills to "be change agents in the lives of their

students, mediating the educational equalities and experiences by their students by promoting challenging mathematics curriculum and instruction in the classroom" (Kitchen, 2005, p. 37).

Culturally Responsive Mathematics Teaching in New Zealand

Similarly, in New Zealand "while mathematics can be seen by some as being culture free—it can provide powerful contexts for developing knowledge and understanding of one's cultures and cultural values" (Averill, Taiwhati, & Te Maro, 2010, p. 167). Unfortunately, this misconception that mathematics is "culture free" leads some teachers to "abrogate their responsibility to be culturally responsive" (Averill, Te Maro, Taiwhati, & Anderson, 2009, p. 27). Ideally, in a small country with a bicultural focus, PSTs could enter an ITE programme ready to implement culturally responsive mathematical practices, but there is still much for PSTs to learn, and mathematics teacher educators have an important role in explicitly teaching both cultural and mathematical practices to ensure the success of diverse learners. PSTs are unaware of strategies to include bicultural perspectives in their teaching, with a consequence that Māori students perceive that "mathematics is not a subject for them" (Averill & Te Maro, 2003, p. 89).

One approach for teacher educators is to present mathematics as being "of and from our everyday human realms, sitting right there in our culture" because "we can talk it, argue it, and describe it in more than one language, and in many contexts" (Averill et al., 2010, p. 176). If PSTs are to teach Māori students in culturally responsive ways, they need to know about *Te Ao Māori* (the Māori world) and understand how to incorporate this knowledge appropriately when teaching mathematics (Averill et al., 2009). Averill and colleagues also stress the importance of cultural knowledge and practices being taught in ways that avoid superficial and tokenistic interpretations of cultures because teaching cultural aspects this way can have negative effects on both the learning and the achievement of Māori students and can "strengthen their feelings that the only valuable aspects in education are those which come from European viewpoints and knowledge" (Averill et al., 2014, p. 35). PSTs need to understand key cultural concepts and not just "simple translations from one language to another" (Averill et al., 2014, p. 35). Examples include *Te reo Māori* (the Māori language), which is valued as a way to pass on knowledge and traditions; Māori pedagogies such as learning through participation, song, storytelling, metaphor, and observation; and the concept of *ako*, where teachers and learners are intertwined (Averill et al., 2009).

One framework has been developed to help teachers understand key Māori concepts that are relevant for mathematics teaching (Averill, Te Maro, Taiwhati, & Anderson, 2009). The framework includes four elements of Māori conceptual understanding:

- knowing and understanding each other as people,
- knowing and understanding each other as learners,
- knowing and understanding each other's cultures, and
- enhancing feelings of cultural identity. (p. 31)

This framework helps PSTs to focus on broader and less superficial aspects of culture and prompts them to consider these elements when planning for mathematics teaching. In an ITE mathematics education course designed to include bicultural perspectives, there was a focus on active partnerships between learners, Māori language (*Te reo Māori*), as well as Māori pedagogies, contexts, beliefs, philosophies, protocols, and values. These aspects were selected to "model ways that these can be acknowledged and reflected in the student's own teaching" (Averill & Te Maro, 2003, p. 88). At the end of the course, the educators found that the PSTs could identify a wide range of bicultural perspectives within both course content and structure. They also found that they needed to be explicit in their use of bicultural perspectives and practices so that PSTs could "recognise, acknowledge and draw from all perspectives of the course" (p. 94).

Later studies (see, e.g., Averill et al., 2009) generated six conditions necessary for PSTs to teach mathematics in culturally responsive ways. These conditions included: deep mathematical understanding, effective and open teacher–student relationships, cultural knowledges, opportunities for flexible approaches and for implementing change, accessible and non-threatening mathematics learning contexts, responsive learning communities, and cross-cultural partnerships (p. 180). Some of these conditions relate to overarching relational practices and professional self-knowledge, while some relate specifically to mathematics. In particular, deep mathematical understanding may be connected to an ability to recognise culturally related contexts for mathematical learning. One aspect still to be explored was the PSTs' willingness and ability to implement these culturally responsive practices when teaching in classrooms during practicum.

Tātaiako*: Cultural Competencies for Teachers of Māori Learners*

Tātaiako highlights and illustrates aspects of Māori culture appropriate for educational settings and emphasises the importance of teachers' relationships and engagement with Māori learners, their *whanau* (family) and *iwi* (tribal grouping). Its main aim is for Māori students to reach their full potential and "map[s] out a path" for teachers to support students to do so by emphasising how education can be delivered in the context of "vibrant contemporary Māori values and norms, reflecting the cultural milieu in which Māori students live" (Ministry of Education, 2011, p. 3).

Tātaiako sets out five cultural competencies:

- *Wānanga*: Communication, problem solving, and innovation (participating with learners and communities in robust dialogue for the benefit of Māori learners' achievement).
- *Whanaungatanga*: Relationships (students, schools, communities) with high expectations. Actively engaging in respectful working relationships with Māori learners, parents and *whānau*, *hapū* (sub tribe grouping), *iwi*, and the Māori community.
- *Manaakitanga*: Values integrity, trust, sincerity, equity, showing integrity, sincerity, and respect toward Māori beliefs, language, and culture.
- *Tangata Whenuatanga*: Place-based, sociocultural awareness and knowledge affirming Māori learners as Māori. Providing contexts for learning where the language, identity, and culture of Māori learners and their *whānau* is affirmed.
- *Ako*: Practice in the classroom and beyond taking responsibility for their own learning and that of Māori learners. (Ministry of Education, 2011, p. 4)

We included the competencies in full to illustrate how important Māori concepts and practices are explained in ways that link to recognisable aspects of relationships, respect, and values within educational contexts such as schooling. Each competency is explained in terms of "behavioural indicators" (term used in the document) that teachers would demonstrate at different stages of their teaching careers. As an example, for *manaakitanga*, PSTs on entry to an ITE programme are expected to "value cultural difference," and at the point of graduation from the programme demonstrate "respect for *hapū*, *iwi*, and Māori culture in curriculum design and delivery processes," and, finally, experienced teachers are expected to demonstrate "integrity, sincerity, and respect towards Māori beliefs, language and culture" (Ministry of Educaton, 2011, p. 8). Desired outcomes for each competency are also described and are written from both a learner's and a *whānau* (family) perspective. A learner's perspective for *manaakitanga* is "my teacher uses te reo Māori in class and encourages us to speak Māori if we want" (p. 9); and from a *whānau* perspective, the teachers "care about our children and always talk positively about them" (p. 9). The purposes of these exemplar outcomes are to describe each competency and to outline possible teacher actions to support Māori learners in educational settings.

We selected *Tātaiako* as a conceptual framework for the course because we recognised it as a potentially useful document written to support PSTs and teachers, and we also saw the potential for PSTs to develop their understandings of the competencies by linking them to mathematics practices and resources. Additionally, the PSTs had already been introduced to *Tātaiako* in an earlier professional education

course. The mathematics education course is in a 3-year, full-time ITE programme that prioritises bicultural perspectives and practices, and we wanted to provide another opportunity for PSTs to continue their learning of bicultural practices.

Researching PSTs Noticing of *Tātaiako*

Context

The compulsory mathematics education course was in the first year, second semester and had 48 taught hours and 100 independent student hours during 10 consecutive weeks. There were twelve 2-hour lectures for the whole student cohort and eight 3-hour workshops in groups of approximately 35 students. Course content includeed pedagogical approaches for teaching school mathematics with a specific emphasis on exploring New Zealand mathematics curriculum content and related resources and preparing students for planning and teaching mathematics in a 4-week practicum that followed the course. There were two assignments for the course plus a course professional workbook that contained core resources and an organising template for recording notes for each of the lectures and workshops.

Tātaiako was the focus of a second week lecture where Liz, the third author, (in her leadership role of Kaiārahi Māori; i.e., Māori strategy manager in the College of Education) began the lecture by revisiting *Tātaiako* and discussing the meanings of each of the five competencies. Liz provided some general examples of each competency in relation to primary schooling and sought further ideas from the PSTs. In the second half of the lecture, Sue (the first author) focussed on examples from school mathematical practices and resources, and again drew on ideas from the PSTs. For example, *wānanga* (communication, problem solving and innovation) was linked to practices related to mathematical talk (Askew, 2012), such as prompts in Te Reo Māori for example, *kōrero ki to hoa* (tell your partner) and *me pēhea koe ka mahi* (how did you do that?). *Tangata whenuatanga* (place-based, sociocultural awareness and knowledge) was illustrated by linking mathematical learning to local contexts, such as investigating geometric patterns in traditional Māori art and buildings. A variety of photographs were presented to draw attention to existing resources within local communities. Sue then showed examples of readily available New Zealand mathematics learning resources containing a wide range of Māori contexts, and these were used to illustrate existing resources that PSTs could use and adapt for their future teaching. Finally, Sue encouraged PSTs to think critically and to care about the selection of resources in relation to both cultural integrity and mathematical authenticity.

For subsequent lectures and workshops, the PSTs were expected to make links with the competencies of *Tātaiako* in a similar way to the process that was modelled in the lecture. Links were initially co-constructed between lecturers and

PSTs who recorded their notes within the *Tātaiako* section on their workbook template, and over time lecturer support was withdrawn and the PSTs were expected to do this linking independently. PSTs were also required in their second course assignment to make links between the *Tātaiako* competencies and mathematics practices and resources, and then connect the competencies to their detailed written lesson plans, one each for a geometry and a measurement lesson. We chose geometry and measurement as the focus for the assignment because examples were provided during lectures and workshops, such as

> *Whanaungatanga* – students will be able to work with their friends to make the reflective symmetrical patterns.
>
> *Manaakitanga* – students will be introduced to the Māori names for the two dimensional shapes and practice labelling and saying these names as they classify these shapes.

When planning these lessons, the PSTs drew on previously selected and analyzed student learning tasks. They had to transform these tasks for teaching and then design written lesson plans, using a template required for their professional education course. These tasks and lesson plans contributed to preparation for their 4-week professional practicum where PSTs were required to plan and teach three mathematics lessons and to identify and include a cultural focus in their mathematics lesson plans.

Participants and Data Collection

The aim of this study was to determine which aspects of *Tātaiako* were noticed and recorded by PSTs and the links they made to mathematics teaching. Generally speaking, the study is an example of the Coursework category B-2 from Cochran-Smith and Villegas (2015), examining "the impact of opportunities provided to teacher candidates through courses, with or without field assignments" (p. 13). Investigating teacher "noticing" is complicated, and we prioritised PSTs' generated writing as indicators of their thinking that were important enough to record, within the power dynamics of required coursework. We adopted a sociocultural lens in our interpretation of the PSTs' writing, with a particular focus on meanings about practices and relationships (Averill, 2012). We collected documentation data for three main reasons; each data source provided chronologically different data, served different coursework purposes, and lastly, due to living in a post-earthquake environment, we were mindful of any extra pressure of time commitments that might be placed on our PST participants (McChesney & Wilson, 2016).

Thirteen PSTs from Sue's 2014 workshop class volunteered to participate in the larger study, providing informed consent for their contributions to be anonymous. The PSTs had been in different schools during practicum and once all course and practicum assessment requirements were completed, they provided their mathematics education documentation as sources of data. Three PSTs volunteered their workbooks, 11 volunteered their assignment lesson plans, and seven provided practicum lessons plans. The workbooks were not an assessment component of the course, the second assignments had been assessed and returned to the PSTs at the end of the course, and the practicum lesson plans were assessed and returned to them before being used as a data source. Returning student work in this manner provided a gap between course activity and data collection, which protected the students' academic outcomes because all course requirements were completed. The workbooks, assignment plans, and lesson plans were analysed using content analysis based on the language of the five competencies of *Tātaiako*. Data analysis involved reading each document carefully, identifying references to the competencies, and organising them into different categories (which were the five competencies). The data analysis was then checked between the first two authors, eliminating some data before finalising each category (Cohen, Manion, & Morrison, 2011). Within each category (of *Tātaiako* competency) we analysed for specific references, use of terms, and examples either copied or written in their own words from *Tātaiako*, as well as references and notes related to mathematical practices and resources. The data analysis of each category is presented in the next section, beginning with the three competencies with the most data, followed by the summary reporting of the two remaining competencies.

Analysing PSTs' Documentation

Wānanga: *Communication, Problem Solving, and Innovation*

The PSTs linked *wānanga* to mathematics teaching and learning in three ways. The first was students communicating while learning mathematics. The data sources were mostly within the assignment and the practicum lesson plans where PSTs planned for students to learn mathematics by talking and discussing their learning with each other during the lessons. There were 13 references to communicating in the assignment plans, where a range of verbs (communicating, talking, discussing, sharing, describing, and explaining) were used to describe how the concept *wānanga* could be embedded into their lessons. For a measurement lesson, which required students to draw a monster by measuring different lengths and shapes, one PST wrote an extended description:

> Students will be encouraged to talk about mathematical solutions, problems and questions with classmates and the teacher. The students will be able to talk with their

> classmates to attempt the activities which will allow the students to use topic appropriate language. Being able to communicate any problems with classmates could also help the students with any difficulties and means they can solve issues without needing to ask the teacher. Seeking help from the teachers though will still be hugely encouraged.

For this PST, communication meant interactions between students and between students and teacher. This excerpt was similar to data from other PSTs. For example, in her measurement plan, another PST described *wānanga* occurring at the beginning of the lesson "where the students and I will be able to share our ideas about what we think the task requires." In the practicum lesson plans, *wānanga* references were also about talking, discussing, and sharing ideas during the lessons. One PST who planned and taught three lessons about time wrote "students will have discussions and learning interactions with other students," and her lesson plans indicated opportunities for student interactions.

The second connection to *wānanga* related to the PSTs' plans for arranging how students work together. In the course workbook data, three entries described "working in pairs" or "doing the activities in groups." After completing the fractions workshop where PSTs had experienced practical activities and different representatons for fractions, one PST wrote that it was important for students to "be allowed to work together" so that they could manipulate equipment and resources while learning. This sentiment was a common thread in the assignment lesson plans, where 12 references were about arrangements for learning, such as students working in pairs, with partners, or in groups for some or all of the lessons. In a measurement lesson that involved students estimating and then measuring lengths in centimetres and metres, one PST wrote "students will work together in a group of ten with the teacher, and in pairs, switching between each activities," and these *Tātaiako* notes matched her lesson plan.

The third connection to *wānanga* related to aspects of "problem solving," which was noted both in the workbooks and in the assignment lesson plans. There were 13 references to problem solving that included statements related to the problem-solving nature of the mathematics tasks for each lesson, students solving problems themselves and in their pairs or groups, and creating problems for others to solve. The use of problem-solving strategies was also mentioned, for example, in a geometry lesson that required students to follow instructions to create a path. One PST wrote, "students will be using their innovation and problem-solving strategies within the lesson," another wrote, "students will use their problem-solving strategies to investigate why temperatures vary throughout the country." Others were more specific and described how students would be encouraged to use "trial and error strategies" when designing a path for a specified length. Less formal problem-solving strategies were also recorded, for example, "students will have to figure out …." In the practicum lesson plans, a typical example of a reference to

problem solving was from a series of three fractions lessons, "students will need to use their problem-solving strategies within the lesson."

Ako: *Practice in the Classroom and Beyond – Reciprocal Teaching and Learning*

There were six entries in the workbooks that connected *ako* and mathematical learning with the concept of reciprocal discussed during the lecture and workshop sessions. Several PSTs wrote this connection as "Teaching = Learning." In the assignment lesson plans, 10 students made links to the competency of *ako*. These were clustered into main ideas; the first continues the practice of students working together, and with their teachers, to learn mathematics. One PST described *ako* as "the students and teacher developing their knowledge of area and perimeter together," another as "the students will be learning and teaching through discussion about the three dimensional objects they have made," and another as "sharing experiences." Although these descriptions appear to be closely related to arrangements for learning in the previous category, our analysis has identified this shared student activity as more closely linked with social processes of learning and as relational participation between students.

The PSTs' role as a teacher was next identified in the *ako* category. The PSTs wrote that they needed to value and encourage learners, to provide them with the guidance, support, and resources they needed to participate during the lessons. It was important that teachers acknowledge that students had prior mathematical knowledge, and "students will appreciate that I am interested in finding out what they already know, so that we can build on that." Another PST wrote on her geometry plan: "Respecting each other's ideas and working with student's strengths to achieve and acquire new knowledge." These comments were more related to students as learners, what they bring to each new task, and how teachers respond to student's knowledge. The final meaning of *ako* related to using examples from students' worlds as contexts for mathematical learning, for example, "asking children about their own experiences with looking in mirrors and seeing reflections," and using "everyday life in the classroom and beyond e.g., can relate temperature to other objects as well as climate."

Manaakitanga: *Values – Integrity, Trust, Sincerity, and Equity.*

Manaakitanga was the category that had more specific Māori examples related to language and cultural contexts. The data from workbooks recorded examples of mathematical terms in English and Te Reo Māori, and this was more pronounced in the workshops where measurement and geomentry were the focus mathematics topic, for example, "students will be introduced to Māori names for two dimensional shapes." This practice was continued by one student in the assignment plans: "Students will be encouraged to use the Māori words when

counting. The square mats will have both English and Māori representations." Another PST wrote, "Manaakitanga means showing integrity, sincerity and respect towards Māori beliefs, language and culture—Māori place names have been incorporated into the work." She had included Māori place names alongside English place names in the task and had also adopted the terms used for *manaakitanga*. Lastly, PSTs noted that a teacher's role was to provide support for learners, as well as a respectful and safe learning environment. An example of an entry in an assignment lesson plan is "treating all students equally, and respecting their input and ideas. I will create a trusting environment in which the students learn."

Whanaungatanga: *Relationships (Students, Schools, and Communities)*
Tangata Whenuatanga: *Place-based, Sociocultural Awareness, and Knowledge*

With *whanaungatanga* being explicitly linked with relationships, PSTs focused on the relational ways students could work together when learning mathematics. During a geometry workshop, one PST wrote in her workbook "students will be able to work with their friends to make symmetrical patterns." Similarly, in the assignment lesson plans typical entries were "students will build relationships with their peers as they work together as a group and in pairs," and another, "students will be able to work in pairs to solve each question and discuss their buildings" (related to building and drawing three dimensional models with cubes). The final comment written by another PST who planned for a similar geometry task: "students will be able to work with their classmates … and means the students can support each other to achieve the activity."

For *Tangata whenuatanga* there was one workbook entry that related to using local contexts for carrying out statistical investigations and "using statistical activities for the community." This idea continued in the assignment plans where one PST wrote about using "local information within this (measurement) activity" that required students to investigate different temperatures around New Zealand. This meaning of this competency was about situating mathematical tasks within local contexts.

Collectively, the analysis of the workbook entries, the assignment lesson plans, and the professional practice lesson plans provided a window into what was important enough for these 13 PSTs to write as a record for their professional learning. They often used the names of the *Tātaiako* competencies to label their entries, some provided brief explanations of how these could be embedded in mathematics teaching, while others provided more detail.

Discussion and Conclusions

In this small-scale study, we set out to investigate which aspects of *Tātaiako* the PSTs noticed and the links they made between the cultural competencies and practices for teaching mathematics. The PSTs had recorded each competency from *Tātaiako* in some way; some had explicit links to mathematics, some were less explicit but still aligned with current teaching practices for mathematics, and some linked to examples of "the Māori world" that could be embedded in mathematics. In this final section, we discuss these findings, and then focus on implications for initial teacher education.

The PSTs explicitly connected the competency of *wānanga* to mathematics practices as shown by the PSTs linking "communication" and "problem solving" as familiar terms. These terms, along with associated mathematics practices, had been often discussed in the course sessions as important aspects of effective mathematics teaching and learning for all students (Anthony & Walshaw, 2009). "Problem solving" described mathematics practices such as "figuring out" or "working out problems," and some PSTs referred to students using specific problem-solving strategies. We found that communication was a broad term that encompassed a range of actions related to student mathematical learning. Verbs such as talking, discussing, debating, sharing, and explaining their thinking were commonly found in all three data sources. We claim that the use of these verbs illustrates that the PSTs prioritised a social dimension of learning, where talk was not only a communication tool but also an essential ingredient of learning. In addition, the PSTs noted specific strategies in their planning that would promote opportunities for social interaction and shared mathematical learning. In both *wānanga* and *whanaungatanga,* the PSTs made connections to how students are organised for mathematical activity, particularly the multiple references to students working "in pairs" or "in groups."

Related to the importance of social interactions for learning mathematics, we found that all PSTs noted the importance of relationships between students and between teachers and students. *Whanaungatanga* was the competency that was described as being about relationships with students and while not specifc to mathematics, this was connected to teaching practices such as "building relationships with pairs." Similarly, the competency of *manaakitanga* was about relationships, with an emphasis on the teacher–student relationships, highlighting the roles of a teacher in "scaffolding, supporting, respecting" and "treating all students equally." These aspects of both cultural and mathematics practices were also emphasised for *ako,* where there were several entries about teaching and learning being connected. This connection is seen in comments such as "the students and teachers developing their knowledge of area and perimeter together" and the prevalent use of the equation "Teaching = Learning." We suggest this equation was recorded on

documentation because this abbreviation had been used often during coursework to represent the reciprocal nature of learning between student and teachers, and the term "reciprocal learning" was included in *Tātaiako*. This connection also illustrates the PSTs awareness of mathematics teaching and learning being a collaborative endeavour between students and teachers and recognises the important role PSTs have in enacting practices that allow such collaboration to occur (Averill et al., 2009).

While we found less specific inclusion of aspects related to Māori culture, the competency of *manaakitanga* was where the PSTs linked to Te Reo Māori (Māori language) as seen by the examples of Māori words used for learning geometry and measurement (Averill et al., 2010). These translations of mathematical terms into Te Reo Māori had been modelled during course sessions, particularly during geometry and measurement sessions. Another link to the Māori world was the inclusion of specific Māori contexts, such as traditional Māori symmetrical patterns, which was relevant as a context for learning about geometrical transformations.

In conclusion, the PSTs used the resource of *Tātaiako* in different ways. Some PSTs copied *Tātaiako* words and phrases directly onto planning documentation, others used these as prompts to record in their own words. Irrespective of the detail, both were important for helping the PSTs to adapt and adopt cultural practices for mathematics teaching. We suggest that frameworks such as *Tātaiako* have an important role in clarifying for PSTs expectations for embedding culturally responsive practices when teaching, and in our future work we will look for similar sources of language prompts and exemplars. We also want to investigate further opportunties for PSTs to mediate between the cultural competencies and practices for effective mathematics teaching (Kitchen, 2005). Our findings also show that while the PSTs were able to work with *Tātaiako,* the mathematics course experiences were essential opportunities for them to interpet the competencies and make links to mathematics. We found that far from being "culture free" (Nasir, 2016), the mathematics course provided both implicit and explicit opportunities for the PSTs to connect cultural and mathematics practice.

Although our study was small, it highlighted that PSTs can be supported to begin to develop culturally responsive mathematics teaching (Villegas & Lucas, 2002). We have only begun our work in this area and plan to continue with other mathematics education courses. We plan to further investigate how to include opportunities in our mathematics education courses where PSTs can delve more deeply into what it means to support "Māori learners to achieve as Māori in mathematics" (p. 3). In closing, we acknowledge that aspects of the cultural competencies in *Tātaiako* and the practices identified by the PSTs in our study are relevant for all learners, irrespective of their cultural background. Averill and colleagues (2014), however, remind us that Māori students and *whānau* (family)

believe it is more: "Māori students having connections with te reo me tikanga Māori (language and ways of doing things), having pride in Māori identity, feeling valued and comfortable to be themselves at school, and being able to walk comfortably in Māori and Pākehā (non-Māori) worlds" (p. 33). We believe PSTs can support Māori learners to achieve in mathematics and can be leaders in this area as they move beyond the ITE setting (Averill, 2012).

References

Anthony, G., & Walshaw, M. (2009). Effective pedagogy in mathematics. In International Academy of Education (Series Ed.), *Educational Practices Series: 19*. Geneva, Switzerland: International Bureau of Education.

Askew, M. (2012). *Transforming primary mathematics*. London, United Kingdom: Routledge.

Averill, R. (2012). Reflecting heritage cultures in mathematics learning: The views of teachers and students. *Journal of Urban Mathematics Education, 5*(2), 157–181. Retrieved from http://ed-osprey.gsu.edu/ojs/index.php/JUME/article/view/166/125

Averill, R., Anderson, D., Easton, H., Te Maro, P., Smith, D., & Hynds, A. (2009). Cultural responsive teaching of mathematics: Three models from linked studies. *Journal for Research in Mathematics Education, 40*(2), 157–186.

Averill, R., Hindle, R., Hynds, A., Meyer, L., Penetito, W., Taiwhati, … Faircloth, S. (2014). "It means everything doesn't it?" Interpretations of Māori students achieving and enjoying educational success "as Māori." *SET: Research Information For Teachers, 2*, 33–40.

Averill, R., Taiwhati, M., & Te Maro, P. (2010). Knowing and understanding each other's cultures. In R. Averill & R. Harvey (Eds.), *Teaching primary school mathematics and statistics: Evidence-based practice* (pp. 167–179). Wellington, New Zealand: New Zealand Council for Educational Research Press.

Averill, R., & Te Maro, P. (2003). Bicultural perspectives in a pre-service mathematics education course. In L. Bragg, C. Campbell, G. Herbert, & J. Mousley (Eds.), *Mathematics education research: Innovation, networking, opportunity – Proceedings of the 26th annual conference of the Mathematics Education Research Group of Australasia* (pp. 88–95). Geelong, Victoria: MERGA.

Averill, R., Te Maro, P., Taiwhati, M., & Anderson, D. (2009). Culturally responsive mathematics teaching: A bicultural model. In R. Averill & R. Harvey (Eds.), *Teaching secondary schools mathematics and statistics: Evidence based practice* (pp. 27–46). Wellington, New Zealand: New Zealand Council for Educational Research Press.

Boaler, J. (2002). Learning from teaching: Exploring the relationships between reform curriculum and equity. *Journal of Research in Mathematics Education, 33*(4), 239–258.

Civil, M. (2007). Building on community knowledge: An avenue to equity in mathematics education. In N. Nasir & P. Cobb (Eds.), *Improving access to mathematics: Diversity and equity in the classroom* (pp. 105–117). New York, NY: Teachers College Press.

Cochran-Smith, M., & Villegas, M. (2015). Framing teacher preparation research: An overview of the field, Part I. *Journal of Teacher Education*, *66*(1), 7–20.

Cochran-Smith, M., Villegas, M., Villegas, A. M., Abrams, L., Cavez-Moreno, L., Mills, T., & Stern, R. (2015). Critiquing teacher education preparation research: An overview of the field, Part II. *Journal of Teacher Education*, *66*(2), 109–121.

Cohen, L., Manion, L., & Morrison, K. (2011). *Research methods in education* (7th ed). New York, NY: Routledge.

Downey, J. A., & Cobbs, G. A. (2007). "I actually learned a lot from this": A field assignment to prepare future preservice mathematics teachers for culturally diverse classrooms. *School Science & Mathematics, 107*(1), 391–403.

Gay, G. (2002). Preparing for culturally responsive teaching. *Journal of Teacher Education, 53*(2), 106–116.

Gay, G. (2009). Preparing culturally responsive mathematics teachers. In S. Mukhopadhyay, B. Greer, A. B. Powell, & S. Nelson-Barber (Eds.), *Culturally responsive mathematics educati*on (pp. 189–205). New York, NY: Routledge.

Jacobs, V., Lamb, L., & Philip, R. (2010). Professional noticing of children's mathematical thinking. *Journal for Research in Mathemaitcs Education, 41*(2), 169–202.

Kitchen, R. (2005). Making equity and multiculturalism explicit to transform mathematics education. In A. Rodgriguez & R. Kitchen (Eds.), *Preparing mathematics and science teachers for diverse classrooms: Promising strategies and transformative pedagogy* (pp. 33–60). New York, NY: Routledge.

Lenski, S., Crumpler, T., Stallworth, C., & Crawford, K. (2005). Beyond awareness: Preparing culturally responsive preservice teachers. *Teacher Education Quarterly, 32*(2), 85–100.

Mason, J. (2002). *Researching your own practice: The discipline of noticing.* London, United Kingdom: Routledge Falmer.

McChesney, J., & Wilson, S. (2016). Mathematics education in a time of earthquakes: Holding on and letting go. *For the Learning of Mathematics*, *39*(2), 14–18.

Ministry of Education. (2011). *Tātaiako cultural competencies for Māori learners*. Wellington, New Zealand: Ministry of Education.

Ministry of Education. (2013). *Education counts: Māori education statistics.* Retrieved from http://www.educationcounts.govt.nz/statistics/Māori_education

Ministry of Education. (2015). *Education counts: National Standards achievement information.* Retrieved from https://www.educationcounts.govt.nz/statistics/schooling/national-standards/National_Standards

Nasir, N. (2016). Why should mathematics educators care about race and culture? *Journal of Urban Mathematics Education, 9*(1), 7–18. Retrieved from http://ed-osprey.gsu.edu/ojs/index.php/JUME/article/view/298/192

Nasir, N., & Cobb, P. (2007). Introduction. In N. Nasir & P. Cobb (Eds.), *Improving access to mathematics: Diversity and equity in the classroom* (pp. 1–9). New York, NY: Teachers College Press.

New Zealand Teachers Council. (2013a). *Graduating Teacher Standards*. Retrieved from https://educationcouncil.org.nz/sites/default/files/gts-poster.pdf

New Zealand Teachers Council. (2013b). *Registered Teacher Criteria.* Retrieved from http://www.nzei.org.nz/documents/Help/FAQ-docs/RTC%20-%20FRT%20PTCA%20Draft%20April%202011-1.pdf

van Es, E., & Sherin, M. (2002). Learning to notice: Scaffolding new teachers' interpretations of classroom interaction. *Journal of Technology and Technology Education*, *10*(4), 571–596.

Villegas, A. M., & Lucas, T. (2002). *Educating culturally responsive teachers: A coherent approach.* Albany, NY: State University of New York Press.

White, D., Murray E., & Brunard-Vega, V. (2012). Discovering multicultural mathematics dispositions. *Journal of Urban Mathematics Education, 5*(1), 31–43. Retrieved from http://ed-osprey.gsu.edu/ojs/index.php/JUME/article/view/161/103