Chapter 8
Equity, Social Justice, and Ethics

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Abstract Recent Australasian research on equitable, socially just, and ethical mathematics teaching and learning is reviewed and critiqued in this chapter. The literature surveyed includes studies in which researchers reported on the degree of equity for Australasian communities previously identified as disadvantaged in mathematics: girls and women; low socio-economic students; Indigenous, Māori, and Pasifika students; and rural and remote students. Studies of teaching practices and whole-school approaches to improve the outcomes of students in schools in disadvantaged communities are discussed, as are pre-service teacher education programs for teaching and working within these communities. In the reviewed work, researchers drew on various theoretical frameworks for equity, social justice, and ethical practice. In several studies, cultural responsiveness for mathematics learning was explored and the researchers drew attention to the importance of ensuring participation of disadvantaged and marginalised communities. While many of the studies reviewed were small scale, there was also evidence of longitudinal and multiple case study research. Sustained further research is needed to address diversity for social justice in mathematics education within disadvantaged communities, including non-binary gender, cultural diverse, and rural communities.

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1 Introduction

In the chapter on equity, social justice, and ethics in mathematics education published in the previous MERGA 4-yearly review, Vale, Atweh, Averill, and Skourdoumbis (2016) concluded that "equity, social justice and ethics concerns remain high in Australasian mathematics education research" (p. 113). Then, and now, the scope and extent of disadvantage experienced by select students are not readily quantified, though data from large-scale national and international mathematics and numeracy tests provide some provocative snapshots. For example, researchers analysing data from tests such as the Programme for International Student Assessment (PISA) report not only overall performance data, but also provide results for constituent subgroups, including by ethnicity, language background, socio-economic level, gender, and geographic location. Through the inclusion of affective measures, possible links between these factors and students' mathematics achievement can be explored. Inspection of these reports readily reveals that certain groups, on average, consistently perform below or above their peers, both nationally and internationally. These results show the importance of continued emphasis on equity, social justice, and ethics in mathematics education in Australasia. Such work is not straightforward, as "creating, supporting, and sustaining a culture of access and equity require [*sic*] being responsive to students' backgrounds, experiences, cultural perspectives, traditions, and knowledge when designing and implementing a mathematics program and assessing its effectiveness" (National Council of Teachers of Mathematics [NCTM], 2014, p. 1).

The aim of this chapter is to review and critique research focussed on the creation, enactment, and maintenance of equitable, ethical, and socially just educational provisions, in and beyond the mathematics classroom. Issues of particular relevance to Indigenous, Māori, and Pacific Nations learners comprise an important component of this discussion. Research with a focus on these groups is included here, rather than in a separate chapter as in the previous 4-yearly review (Meaney, Averill, McMurchy-Pilkington, & Trinick, 2016). While acknowledging that both Vale et al. (2016) and Meaney et al. (2016) drew heavily on Fraser's (2005, 2013) model of social justice in their analyses of relevant research, this theoretical framework did not unduly shape or constrain the evaluation of the research monitored for this chapter. In some studies reviewed in this chapter, the researchers drew on Fraser's theory of social justice; however, we were also keen to identify other frameworks informing research in this field, notably non-binary gender frameworks and decolonial theory.

In our literature search, we identified a large number of scholarly publications related to the field. We have accepted a core instruction issued by the editors of the previous 4-yearly review: "Since it is impossible to report on all publications of Australasian research in this period," they admonished, "chapter authors are asked to

be selective in the research they reported" (Makar et al., 2016, p. 3). Accordingly, we have attempted to balance the need to focus on robust research, reports of international tests, and theoretically-driven initiatives, while giving voice to smaller but promising research studies. Hence, we generally excluded from our review partial reports or incomplete descriptions of small studies on a single strategy, unless they seemed likely to move the field forward. Although many of the publications reviewed relate to multiple equity issues, we have pragmatically used the main topics to cluster our comments.

We begin by identifying and defining the equity factors explored and providing policy context relevant to studies of these equity groups. Then, we discuss studies of equity factors concerning students' participation, achievement, and attitude. In the third section, we focus on studies of socially just and ethical teaching of mathematics. In some of these studies, the researchers focussed on particular disadvantaged communities, while other studies were situated in disadvantaged communities and thus relate to multiple equity factors, such as low socio-economic status (SES) and rural location. In the final section, about teacher knowledge and school change, we discuss studies where researchers investigated initial teacher education to prepare teachers for teaching in disadvantaged communities, as well as professional learning and whole-school change models to implement socially just practices. The chapter culminates with a discussion organised according to equity groups and a conclusion.

2 Equity Factors

In the previous RiMEA chapter on equity, social justice, and ethics, four equity factors were the focus of the review: SES, gender, ethnicity, and geographic location. In this review, we note the various definitions and measures used to categorise students in large- and small-scale quantitative studies and to describe participants in small scale qualitative or intervention studies. In small-scale studies, researchers typically used descriptors for SES, such as low SES, while, in large-scale international studies, proxies, such as the number of books in the house, were used as an indicator of SES. Several categories are used for ethnicity and/or language background: Indigenous/non-Indigenous, language background other than English (LBOTE)/non-LBOTE, English spoken at home/other language spoken at home, and foreign-born/first-generation/Australian-born parents. In small-scale studies, researchers identified specific ethnic communities (e.g., Māori, speakers of Kimberley Kriol). Geographic location classifications vary according to the study; researchers typically used descriptors such as metropolitan, provincial, and remote. Distances from a metropolitan location are used to define these terms, but these distances vary according to state and study. In most studies, gender is defined by binary categories: male/female or girl/boy. The problems with these categories for gender and other equity factors are discussed later in the chapter.

In the various qualitative studies reviewed in this chapter, researchers noted the interrelatedness of these factors and typically described their participants and schools

as being "disadvantaged schools" due to the existence of one or more equity factors. Warren and Miller (2016) provided a particular definition for "marginalised" communities as "disadvantaged in all aspects of life" (p. 2), including racial isolation, social exclusion, unemployment, financial dependence, drug and alcohol abuse, and low education levels. Schools servicing such communities also report a high turnover of staff and employment of inexperienced and under-qualified staff with no connections to or understandings of the community (Jorgensen, 2017).

As noted, this chapter also includes a review of the studies involving Indigenous and Māori students. Understanding the political context in Australia and New Zealand is necessary in order to review research involving Indigenous and Māori students. Aotearoa New Zealand was founded on a treaty, Te Tiriti o Waitangi, between Indigenous Māori and the British crown. Māori are a diverse group, with differences in culture and language within and between iwi (tribes). With the ideals of the treaty yet to be fully realised, much of New Zealand society largely reflects Eurocentric structures, institutions, and processes. Education policy and research in New Zealand is increasingly focussed on seeking to ensure that the treaty is honoured. The term "Pasifika" is used in New Zealand to refer to people from the Pacific region who live in New Zealand and have family and cultural connections to Pacific Island Nations (Ministry of Education New Zealand, 2018). Māori and Pasifika students constitute 24% and 10%, respectively, of the student population in New Zealand (Education Counts, 2019).

In Australia, Aboriginal and Torres Strait Islanders are 5.6% of the student population (Australian Bureau of Statistics, 2018). Unlike New Zealand, Australia's Indigenous people were not recognised until 1967 when they were "counted" as part of the population. After 200 years of colonisation, there is no treaty or recognition of Aboriginal and Torres Strait Islander tribes as the first sovereign Nations of Australia. In 2017, the First Nations people came together and produced the *Uluru Statement from the Heart*, calling for recognition in the Australian Constitution and their voice to be heard and matter:

> We seek constitutional reforms to empower our people and take a rightful place in our own country. When we have power over our destiny our children will flourish. They will walk in two worlds and their culture will be a gift to their country. We call for the establishment of a First Nations Voice enshrined in the Constitution. ("Uluru Statement from the Heart," 2017, p. 1)

In this statement, teachers and educators are called on to provide a voice for First Nations people in their school communities and practices so that First Nations children and students can retain their cultural identity and excel, including in Western mathematics. Recognising and providing voice to Indigenous, Māori, Pasifika, and Papuan communities was critical in the studies focussed on enhancing opportunities for students in these disadvantaged or marginalised communities (e.g., Edmonds-Wathen, Owens, & Bino, 2019; Jorgensen, 2018; Trinick, Fairhall, & Meaney, 2016; Warren & Miller, 2016).

3 Mathematics Participation, Achievement, and Attitude

Reports of national and international mathematics and numeracy testing include analyses by a range of equity variables. In the review period, there were also a few research studies in which various aspects of mathematics education were explored with multiple equity variables involving primary, secondary, and university students.

Large-scale testing regimes remain contentious. While the intended purpose of tests may be educationally sound, there can be a range of unintended consequences. The foci of scholarly critiques of large-scale testing include how the data are interpreted and reported, the pressures on students to perform well, time and money wasted on preparing students for the test, and the deleterious impacts on low-performing schools, as well as on teachers and principals (e.g., Forgasz & Leder, 2011; Lingard, Thompson, & Sellar, 2016). It should be remembered, however, that it was the early analyses of large-scale mathematics test data disaggregated by gender ("Sex" was the variable used at the time) that led to research efforts to find explanations for the gender differences identified. Responsible and appropriate interpretation of large-scale data can provide effective overviews of the status of equitable educational outcomes.

3.1 Equity in School Mathematics Achievement

To provide an Australasian overview of mathematics achievement by a range of equity variables, results were drawn from the 2015 Programme for International Student Assessment (PISA; May, Flockton, & Kirkham, 2016; National Center for Education Statistics, n.d.; Organisation for Economic Co-operation and Development [OECD], 2016; Thomson, De Bortoli, & Underwood, 2017) and the 2015 Trends in Mathematics and Science Study (TIMSS; Mullis, Martin, Foy, & Hooper, 2016; Thomson, Wernert, O'Grady, & Rodrigues, 2017). The second PISA financial literacy assessment was conducted in 2015. Of the 15 participating countries (Thomson & De Bortoli, 2017), Australia, but not Singapore or New Zealand, took part. Also, it is only in Australia that annual national testing of mathematics (called numeracy) is conducted. The latest (2018) National Assessment Program Literacy and Numeracy (NAPLAN) numeracy results (Australian Curriculum, Assessment and Reporting Authority, 2018) were examined.

Gender differences in achievement in large-scale international and national tests varied according to test and country. Boys outperformed girls for PISA and TIMSS (Year 4) in Australia and New Zealand, for TIMSS (Year 8) and NAPLAN (all year levels) in Australia, but these differences were not statistically significant. Exceptions included TIMSS in Singapore for Year 4 and Year 8 and New Zealand for Year 8, where girls outperformed boys. In Australia, girls scored significantly higher than boys on the PISA financial literacy test.

Findings were consistent across all tests regarding Indigeneity. For each of the tests, Australian and New Zealand non-Indigenous students scored significantly

higher than Indigenous (First Nations or Māori) students. However, findings regarding ethnicity or language background varied according to test and country. In Australia, students who spoke English at home scored lower than those who spoke another language on Year 8 TIMSS and NAPLAN. However, findings were the opposite for PISA financial literacy, as LBOTE students scored lower than non-LBOTE students. In New Zealand, Asian students scored highest on PISA, followed by Pākehā (New Zealand European) students and Māori students; Pasifika students scored lowest.

As noted, different measures of SES were used to compare achievement by SES. However, the results were consistent across all studies, with students from higher SES backgrounds achieving significantly higher than students from lower SES backgrounds. Each of the tests conducted in Australia showed that achievement decreased as distance from metropolitan capital city increased.

In summary, the following patterns were generally found: non-Indigenous students outperformed Indigenous students, students from higher SES backgrounds outperformed students from lower SES backgrounds, and students from metropolitan schools outperformed students attending non-metropolitan schools. Findings with respect to language background (or language spoken at home) and gender were inconsistent and varied according to the test and/or country.

3.2 Equity in Upper Secondary School Mathematics Participation and Achievement

Equity factors impacting student participation and achievement in upper secondary mathematics were investigated. Murphy (2018) focussed on the mathematics subjects that provide pathways to tertiary mathematics. He reported that access to, participation in, and achievement in upper secondary mathematics were lower in low SES schools compared to high SES schools, and in non-metropolitan schools compared to metropolitan schools. Importantly, "a non-metropolitan location can mitigate the apparent influence of school SES" (p. 588), as the students from higher SES schools in non-metropolitan locations did not participate and perform to similar levels as students in high SES metropolitan schools. Watson et al. (2016) reported on Tasmanian rural students' perceptions of the factors influencing their intentions to complete secondary school and study mathematics. The researchers reported findings related to gender, SES, and rural and remote location. From their regression analysis, they identified "Friends, English and Mathematics Ability, Other Activities and Teacher Support as the best predictors of students' aspiration to continue schooling" (p. 4).

3.3 Equity in University-Level Participation in Mathematics and Related Fields

In the following sections, we highlight gender equity-related issues regarding university enrolment and graduation in Australia, New Zealand, and Singapore.

In Australia, only 33% of undergraduate students in the mathematical sciences are women (Australian Mathematical Sciences Institute [AMSI], 2017), compared to 58% of undergraduate domestic students who are women (Larkins, 2018). Thus, women are underrepresented in mathematical sciences programs. Overall, from 2001 to 2014/2015, the number of students graduating with bachelor's degrees in the mathematical sciences has declined, whereas the reverse trend is true for honours degrees (AMSI, 2017). This increase is due to increased numbers of graduations by men, as there have been decreased numbers of graduations by women (AMSI, 2017). At the doctoral level, from 2001 to 2015, there was an overall increase (as well as an increase for men and women, when considered separately) in the number of degree completions (AMSI, 2017). Notably, the increased number of doctoral completions by women was due to international students; there was a slight decline in the number of completions by domestic students (AMSI, 2017). These statistics raise questions regarding the pathways of women who are domestic students in mathematics.

In New Zealand, in 2017, only 4.1% of students enrolled in bachelor's degree programs, 1.5% of students in master's degree programs, and 1.9% of students in doctoral programs were in the mathematical sciences (Education Counts, 2018). Statistics related to gender were only provided for domestic students, of whom, in 2017, 35.2% of bachelor's students, 36.8% of master's students, and 41.2% of doctoral students in the mathematical sciences were women (Education Counts, 2018). In contrast, 61.7% of bachelor's students, 61.4% of master's students, and 58.3% of doctoral students, across all fields of study, were women (Education Counts, 2018). Thus, as in Australia, women are underrepresented in the mathematical sciences at the university level in New Zealand.

In Singapore, statistics about university programs in the natural, physical, and mathematical sciences are combined, so it is difficult to make comparisons to the statistics from Australia and New Zealand, where data regarding the mathematical sciences are provided separately. In 2017, 58.1% of students enrolling in and 64.2% of students graduating from these programs were women, compared to 50.0% and 51.6% women overall in university programs (Ministry of Education Singapore, 2018). Hence, women are slightly overrepresented—both relative to the population in general and to the population of university students—in these fields of study.

3.4 *Gender Equity in Participation, Achievement, and Attitude*

Approximately 20 publications about gender and mathematics education were analysed. The research reported in all but two of these publications was conducted in Australia; the other research was conducted in New Zealand. In the following sections, the findings and methodologies of "gender issues" publications are discussed.

Concerningly, the patterns shown in the analyses of achievement, participation, and attitudinal data show little improvement from earlier studies, in terms of gender equity. As discussed, boys generally outperformed girls on large-scale mathematics/numeracy assessments, such as PISA and NAPLAN, over the past several years (Forgasz & Leder, 2017; Li, 2018). However, at the school level, the patterns were very different, with girls performing better than or as well as boys on classroom assessments (Hopkins & Bayliss, 2017; Sikora & Pitt, 2019). Such differences between classroom and large-scale assessment outcomes by gender have been frequently reported, both in Australasia and around the world (Leder, 2019).

With regard to studying mathematics when it is no longer compulsory (typically Years 11 and 12), concerning patterns were also found: Boys were more likely than girls to study mathematics at these levels and to select higher-level mathematics classes (Forgasz & Leder, 2019; Li, 2018; Sikora & Pitt, 2019). Forgasz and Leder (2019) examined enrolments in Victorian single-sex schools in the Victoria Certificate of Education STEM subjects (2001–2017). For the mathematics subjects, they found no difference in the gendered pattern of enrolment between single-sex and co-educational schools for the lowest and highest level mathematics subjects. For the middle level mathematics subject in Victoria (Mathematical Methods), a higher proportion of girls in single-sex schools than in co-educational schools was enrolled. Forgasz and Leder (2019) concluded that "increasing females' participation in STEM-related subjects and career paths does not lie in perpetuating the naive belief that single-sex educational settings are the answer" (p. 15).

Other focus areas in the literature were attitudinal factors and views of mathematics generally (by students) and of gender and mathematics (by adults). Boys were more likely than girls to report positive relationships with mathematics and to view themselves positively as mathematics learners (Forgasz & Leder, 2017; O'Keeffe, White, Panizzon, & Elliott, 2018). Interventions, such as informing students about growth mindset, were shown to affect girls (positively) more than boys, an encouraging finding (Koch, 2018). When examining adults' views—both those of parents (Glynn, 2019) and of the general public (Forgasz & Leder, 2017)—results were mixed, with participants typically holding gender-neutral views; however, when gendered views were found, they typically favoured boys.

Further studies pertained to parental involvement in children's mathematics learning (Bartley & Ingram, 2018) and the gendered experiences of undergraduate mathematics majors (Hall, Robinson, Flegg, & Wilkinson, 2019). Regarding the former, children viewed their fathers more positively than they viewed their mothers with respect to mathematics, and fathers were more likely than mothers to be involved

in children's mathematics learning. Regarding the latter, gender-stereotyped experiences were reported by third-year students, but not by first-year students; all of the negative gender-related experiences were reported by or about women, which raises concerns about the university mathematics environment and, more broadly, pipeline issues.

The "gender issues" studies typically involved traditional types of data collection, such as interviews (e.g., Glynn, 2019), questionnaires using scale factors (e.g., Forgasz & Leder, 2017), and analyses of large-scale datasets (e.g., Li, 2018). Only a few studies featured other types of data collection. For instance, Hall et al. (2019) used photovoice, a methodology in which participants take photographs to represent key themes/ideas; then, the photographs are used as discussion prompts in focus group interviews. In King's (2018) study with elementary students regarding a gendered interaction in a group work situation, video-stimulated reflective dialogue was used. Given the lack of diversity found in the methodologies and methods of the studies examined, we recommend the use of more varied methodologies and methods to support the exploration of "gender issues" in mathematics in novel and nuanced ways. Additionally, we recommend involving participants besides primary and secondary school students, who featured in most studies, to learn about the gendered experiences of other groups (e.g., pre-service teachers, preschool children).

4 Socially Just and Ethical Mathematics Teaching

Studies of socially just and ethical teaching practice were conducted with students and teachers in disadvantaged communities, primarily classrooms and school communities with Indigenous, Māori, or Pasifika learners. Most studies were based in Australia and New Zealand, with a few based in Papua New Guinea and Tonga. From the publications reviewed, there are positive signs of increased focus on Indigenous and other cultures and languages in mathematics education policy and practice, in relation to learners, learning, and parental involvement (e.g., Anderson, Stütz, Cooper, & Nason, 2017; Averill, 2018a; Edmonds-Wathen et al., 2019; Hunter et al., 2016; Trinick, Meaney, & Fairhall, 2016).

Some researchers explored socially just and/or ethical teaching in classrooms and communities where a combination of equity factors was evident (e.g., low SES and rural, rural and Indigenous, low SES and mixed ethnic backgrounds). SES featured in several studies that were examined, but it was not a variable of analysis in the majority of these studies. Rather, the contextual settings of the research conducted and reported were low SES schools. Enhancing students' financial literacy was the major focus of some studies in these contexts (e.g., Attard, 2018; Sawatzki, 2017). In other studies, researchers focussed on culturally inclusive practices and/or compassionate or caring teaching practices (e.g., Blue, O'Brien, & Makar, 2018), or were concerned with acknowledging rurality as the learning context (e.g., Roberts, 2017).

In most of the studies about teaching practices in disadvantaged communities, researchers used qualitative methodologies, including case studies, ethnography, action research, and design-based research. In four studies (Allen & Taplin, 2017; Finau, Treagust, Won, & Chandrasegaran, 2018; Kennedy, 2018; Salgado, 2016), researchers investigated intervention programs and used quantitative or mixed methods to analyse the outcomes of these interventions.

Across the reviewed literature, diverse theoretical framings and methodologies were found. It is positive that culturally-appropriate methodologies such as Kaupapa Māori methodology were used in some studies (e.g., Hāwera & Taylor, 2017). The theoretical framing of a small number of publications was unclear; thus, making theoretical frameworks more explicit should be a priority for further research. Several publications were based on research- and culturally-informed reflections as opposed to empirical studies. The ideas from this work should prove useful for informing empirical studies.

4.1 Ethnomathematics and Decolonisation Approaches

In the reviewed literature, authors identified and sought to find ways to address the diverse challenges that exist in reflecting, responding to, and incorporating Indigenous and other cultures and languages in mathematics education. Focus areas included incorporation of contexts and pedagogies from, linked to, or consistent with those of the target students' heritage cultures. Factors challenging progress towards enhancing equitable access to mathematics learning included tensions regarding who holds power in policy making, mathematics teaching, and schools; the different status held by Western, Indigenous, and Pacific knowledge systems within English-medium formal education; and the empowerment (or lack thereof) of student involvement in critical reflection on the knowledge to which they are exposed and the processes by which this knowledge is presented (e.g., Edmonds-Wathen, 2017; Meaney, Trinick, & Fairhall, 2017; Trinick et al., 2016). There were calls by researchers in the reviewed literature for Indigenous community control of decision-making; for questioning of curriculum, pedagogical, and assessment regimes and the pervasive focus on learning Western mathematics; and for revisiting where "blame" may lie for achievement limitations (Meaney & Trinick, 2018). However, as acknowledged by these researchers, there are substantial complexities in relation to changing policy to enable substantive utilisation of the languages and cultures of marginalised communities in mathematics teaching and learning (Meaney et al., 2017). Despite such challenges, mathematics education can play an exciting role in revitalising language and culture. For example, Trinick (2019) used Fraser's (2005) theoretical framework to describe how first-hand experiences of developing lexicon, curricula, and teacher capacity to teach mathematics in the medium of the Māori language helped to revitalise the Māori language.

In New Guinea, Papuan language (Tok Ples) is the language of instruction for the first few years of primary schooling. To support teachers to use the home language

for mathematics learning, Edmonds-Wathen et al. (2019) used an ethnomathematics approach to identify Tok Ples words and representations to make connections among language, cultural knowledge, cultural ontology, and Western mathematics, and to develop resources for teachers. The researchers drew on the mathematical knowledge systems of Papuan cultures documented by other researchers, such as Owens (2017), who described various cyclic counting systems (5, 10, 20 systems and base-6 systems) used in Pasifika cultures. Owens (2017) argued that the study of Indigenous and Pasifika number systems would provide enrichment for Indigenous and Pasifika students.

Teaching using contexts linked to the cultural capital of target student groups was investigated in several studies (e.g., Hunter & Miller, 2018; Saunders, Averill, & McRae, 2018; Siemon, 2017; Trinick et al., 2016). A three-step approach to introducing Indigenous ethnomathematical practices, to ensure that the integrity of the practices are maintained while mathematics learning is enabled and student critical awareness is enhanced, was proposed by Trinick et al. (2016). An example of this process was explained in relation to providing focus for a contemporary pāngarau/mathematics classroom through aspects of cultural and mathematical knowledge embedded in highly valued artifacts such as a wharenui (meeting house). In other work (e.g., Hunter & Miller, 2018), researchers reported less focus on the cultural meanings of culturally-embedded contexts, privileging instead the Western mathematics that could be drawn from the context. For example, in their study involving 27 Year 2 students, Hunter and Miller (2018) focussed on using Pacific and Māori patterns to explore sequencing, enabling students to draw from their cultural capital, rather than linking more strongly to the cultural opportunities afforded by the patterning contexts.

Enhancing the responsiveness of teaching to the Indigenous and Pasifika cultures of their students through developing deeper understandings and using pedagogies linked to students' heritage cultures was also explored in the studies examined. Rather than mathematics learning being seen as culture-free, in a range of studies, researchers illustrated the belief that teaching and learning are cultural experiences best tied to the cultures of learners, such as by incorporating collaborative learning activities (e.g., Hill, Hunter, & Hunter, 2019; Hunter & Hunter, 2017; Hunter, Hunter, Anthony, & McChesney, 2018). Indicators of the Māori term and cultural competency "ako" were identified through a study involving the lead researcher and her Year 9 mathematics class using cogenerative dialogue, student questionnaires, reflective teacher notes, and discussion of key themes with cultural advisors (Saunders et al., 2018). Resulting indicators of ako included kaiako (teacher/s) encouraging ākonga (students) to teach and learn from each other, holding high expectations of ākonga learning, and seeking and responding to ākonga and whānau (family) voice about learning. A key strength of this work is that it provides one way of interrogating a powerful culturally-embedded concept within the Eurocentric setting of a school mathematics classroom. Learner engagement and classroom management improved as relationships with students and their families, grounded by students' perspectives, developed over the study.

Research conducted in Australia also led to reassessing the meaning of culturally responsive pedagogies (Jorgensen & Lowrie, 2018; Siemon, 2017). Drawing on her experiences of being in the community and observing Yolgnu teacher assistants, Siemon (2017) shared stories that show the value of observation and imitation for the learning of mathematics in an Indigenous community. She made a distinction between pedagogical practices advocated for Indigenous students and pedagogical practices of Indigenous knowledge systems. Siemon (2017) reported that the use of first language and genuine engagement with community are important to avoid being disrespectful when trying to use culturally responsive pedagogies. Similarly, Jorgensen and Lowrie (2018) found that enabling the use of pedagogical practices of an Indigenous community assisted learning of symmetry. They found that the Western terminology of "symmetry," "mirror," and "reflect," and the use of mirrors did not support students' understanding. Rather, physically copying and reflecting the shapes of images of dancers, including Indigenous dancers, resulted in successful engagement with the concept.

In each of these studies, the researchers reported on the importance of valuing and using the language and pedagogical/knowledge systems of Māori, Pasifika, Indigenous, or Papuan communities for the learning of mathematics. The researchers argued for the need to establish respectful relationships with, and involvement of, the community in order to inform the language and pedagogical approaches to be used with authenticity in the classroom. These studies illustrate a shift toward the use of decolonial theories and methodologies in education (Tuhiwai Smith, 2012). Other studies in which researchers explored culturally responsive practices for Indigenous and Pasifika, low SES, or rural communities were more focussed on the tasks used and on describing student learning. These studies are discussed in the next section.

4.2 Culturally Responsive Teaching Practices

In the reviewed literature, researchers have explored culturally responsive practices in communities disadvantaged by multiple equity factors (e.g., SES and rural location). In some of these studies, the researchers focussed on particular mathematical topics or proficiencies.

In their book *Mathematics at the Margins*, which was a report on a 4-year longitudinal study of students' knowledge and teachers' knowledge and practice, Warren and Miller (2016) recognised that teachers working in marginalised schools need knowledge of the community context and culture, and need to hold high expectations of these students. The researchers argued that equitable teaching practices "support mathematical reasoning, conceptual understanding and discourse" (p. 22). Warren and Miller used design-based research involving culturally appropriate activities, developed with the engagement of Indigenous Education Officers (teaching aides) and based on their RoleM (representations, oral language, and engagement mathematics) model. Warren and Miller described a five-step learning trajectory for

teachers, from "gaining teachers' interest" to "holding higher expectations for students," that coincided with a five-step learning trajectory for students, from "students engaging in learning" to "students engaging in higher cognitive mathematics" (p. 96). Culturally appropriate resources were "rich in representations that were familiar to students" (p. 98).

As part of this longitudinal study, Miller (2016) studied young Australian Indigenous students' engagement in the mathematical discourse of pattern generalisation. She reported findings of a learning trajectory for Year 3 Indigenous students en route to generalising growing patterns and functional thinking. Indigenous education officers at the school participated in the analysis of teacher and student interactions to ensure that cultural nuances of these interactions were included and identified. Miller, Warren, and Armour (2018) explored the cultural discourse that occurred at the boundary between Indigenous and Western knowledge systems for the generalising project. They found two teaching and learning actions that created space for mathematical discourse involved in pattern generalisation: acknowledging cultural ontology and acknowledging semiotic systems. Allowing students to use storytelling together with hands-on materials enabled them to use the oral traditions of their culture to engage with Western mathematics. Gesture (i.e., semiotic mediation) was also critical to students' talk and storytelling. Following cultural ontological practices, students interacted with each other to copy or imitate others' work and demonstrate group ownership. The authors concluded that when teachers have an awareness of students' cultural ontology, they can better interpret the classroom discourse in which students display their knowledge and understanding.

Further insights into pedagogies with the potential for culturally responsive practice include using rich, open investigative tasks, which provide opportunities for student autonomy and decision-making through offering multiple interpretations and multiple solution strategies (Averill, 2018a). Such tasks were explored using kapuapa Māori methodology to explore the learning of four Indigenous Year 3 and 4 students in a Māori-medium context in which show and tell technology was used in a successful intervention to develop both mathematics understanding and mathematical language development (Allen & Taplin, 2017). Using narrative literature review, arguments for including singing, story-telling, metaphor, and dance—pedagogies consistent with those of many heritage cultures (Averill, 2018b; Taeao & Averill, 2019)—as pedagogies for mathematics, included their potential for developing students' mathematical understanding and enjoyment, alongside their holistic wellbeing. The exploration of mathematical ideas using the Samoan dance, the sāsā, was discussed by Taeao and Averill (2019), but was not explored with students in this study. In accordance with Siemon (2017) and Jorgensen and Lowrie (2018), investigation of mathematics learning and student affect in relation to such pedagogical approaches is warranted.

In a few studies, researchers explored the nature and use of culturally or socially responsive curriculum in low SES or rural locations. Salgado (2016) used quantitative methods to explore the impact of tasks based on familiar contexts on Year 10 students' performance. He found that a more familiar problem context did not

improve performance for these low SES students. However, Sawatzki (2017), investigating the role of familiarity in financial literacy tasks with primary students in low SES rural locations, found that students valued tasks that were authentic, familiar, and relevant to their lives.

Roberts (2017) argued that much of the research into social justice was "spatially blind," that is, not concerned with the needs of students from rural locations. He researched rural teachers' and leaders' perceptions of the curriculum and found that those who had been in rural schools longer or were in schools furthest from a metropolitan area were more likely to believe that the Australian curriculum did not value or account for local knowledge or learning needs. Roberts (2017) argued there is a need to value "knowledge produced in, for and with rural [communities]" (p. 34). Further research is clearly needed to better understand this knowledge and these communities' needs.

4.3 Ethical and Caring Approaches

Some of the researchers who conducted culturally responsive studies paid particular attention to the development of respectful relationships and to adopting a caring approach. Rather than focussing on the suitability of tasks, problems, or materials, these researchers focussed on fostering productive learning relationships in the mathematics classroom. A few studies were identified in which the authors focussed on, or reflected, ethical and/or caring pedagogical approaches.

Specifically, Blue et al. (2018) observed and video-recorded a Year 4 inquiry-based mathematics lesson focussing on money and financial mathematics. The researchers adopted the theory of practice architectures to examine and analyse practices in the classroom that might promote a critically compassionate approach to financial decision-making. Several classroom practices were identified that might promote a compassionate approach to learning about financial literacy: positive and collaborative engagement with peers, focussing on connecting the task with ethical and social considerations, and recognising that financial decisions can impact others.

Gibbs and Hunter (2018) used a socio-constructivist view of mathematics learning and a qualitative case study approach to focus on classroom factors that might inhibit or enhance students' participation in mathematical inquiry, as well as the actions that teachers take to promote equitable participation. In a small primary school with predominantly Māori and Pasifika students from low SES backgrounds, two students with achievement, status, and power issues with mathematics were observed and interviewed. The teacher's actions and classroom practices were not seen to address the inequities or to promote the participation of the students. The researchers concluded that unless teachers intervened to address such issues, the mathematics underachievement of diverse students would persist.

Based on a number of linked studies, Hunter et al. (2016) revealed that there are continuing tensions related to cross-cultural misinterpretations, resulting in

inequitable practices for Pasifika students. Hunter et al. provided examples that illustrate that when educators relate to Pasifika students "as culturally located people with rich funds of knowledge to contribute" (p. 208), there can be equitable outcomes for the students and their families. Together, these studies illustrate that in order to enact socially just practices in teaching, teachers must use culturally responsive pedagogies in order to construct productive and compassionate relationships in the classroom as well as respectful academically-focussed relationships and practice.

4.4 Intervention Approaches

Two studies of intervention programs were reviewed: one that involved high-achieving students in Tonga and one that involved low-achieving students in a disadvantaged community in Australia. Using an acceleration programme with Year 8 Tongan students, Finau et al. (2018) indicated that targeted, informed interventions can create positive effects on mathematics achievement, self-regulation, motivation, and ways of learning. Kennedy's (2018) intervention study was conducted in six low-performing primary schools in South Australia. Prior to the intervention, teachers engaged in professional learning to familiarise themselves with the researcher's model for learning for conceptual change within challenging mathematical tasks. A standardised test was employed to gauge students' learning gains over two years. Low-performing students' gains were beyond expected growth levels, which Kennedy attributed to student engagement with challenging tasks.

Overall, there is an increased understanding that mathematics education researchers' responses towards enhancing equity of opportunity for mathematics achievement include relational components and components related to cultural knowledge and language, and that there are complexities around how cultural knowledge can be appropriately incorporated into learning programmes. Consistent with findings in the last RiMEA chapter on Indigenous learners, and international literature more widely (Meaney et al., 2016), with exceptions such as Allen and Taplin (2017), there are again some gaps regarding quantitative studies that show increased achievement of learners in target groups and the positive effects of the teacher development discussed. The absence of quantitative studies is perhaps not surprising, as there are complexities around the meaning of and priorities for assessment across cultural groups. Hence, finding suitable assessment tasks is challenging. Additional research into the focus areas of the material reviewed and ways to spread the effects of the affordances found would be useful.

5 Teacher Knowledge and School Change for Socially Just Policy and Practice

There has been continued interest in researching teacher knowledge of marginalised learners and the ways in which initial and professional teacher development can enhance marginalised learners' opportunities. Not so prevalent in this group of work as for the previous review period are studies involving initial teacher education. In previous related chapters, authors called for more focus on developing capabilities with mathematics content (e.g., Meaney et al., 2016), and some studies in this time period reflect this focus (e.g., Hāwera & Taylor, 2017; Trinick et al., 2016; Trinick & Meaney, 2017). An emerging focus of research was the use of case studies to investigate the culture, knowledge, and practices of schools that demonstrated success or improvement in participation or achievement outcomes for disadvantaged or marginalised students (e.g., Bennison, Goos, & Bielinski, 2018; Jorgensen, 2018; Muir, Livy, Herbert, & Callingham, 2018).

5.1 School Improvement and Whole-School Change

Regarding participation in senior school mathematics, Bennison et al. (2018) investigated effective practices in low SES schools with increased enrolments in the highest level senior mathematics subject. They interviewed mathematics teachers, guidance counsellors, and students to identify effective practices to promote "sustained interest and engagement in mathematics involving the study of calculus" (p. 154). The researchers identified the following factors that contributed to student participation: "curriculum organisation across year levels, staffing of mathematics classes, culture of the Mathematics Department, STEM program, and provision of appropriate tasks and resources" (p. 157). They also noted that the culture in the school involved teachers holding high expectations of the students. Murphy (2019) also found that several factors contributed to relatively high participation and achievement rates in senior mathematics for a small rural P-12 school, including differentiated learning, student self-directed learning, and co-planning and teaching across year levels. This school employed a higher than average class time devoted to learning mathematics from P-12. The teachers at the school endeavoured to show the relevance of mathematics to the real world, but no examples were provided, and it is not known whether these related to their local rural context.

Joseph (2019) investigated factors associated with the high performance on the NAPLAN by students at nine disadvantaged Victorian primary schools. Interviews were conducted with school principals and staff, and literacy and numeracy (i.e., English and mathematics) lessons were observed. Six common themes emerged from the research: clear and consistent discipline practices founded in high expectations, direct and explicit instruction, experienced and autonomous school leadership,

data-informed practice, teacher collaboration and professional learning, and comprehensive reading instruction. Similar findings were reported by Muir et al. (2018) in their multiple case study of three P-12 schools where students demonstrated above-expected growth in NAPLAN numeracy scores from Year 3 to Year 5 and from Year 7 to Year 9. Two schools were private schools with above-average SES; the third was a small government school with below-average SES. A range of data on school curriculum and practices was collected and school leaders were interviewed. Notably, the presence of qualified secondary mathematics teachers was one of the factors that leaders at all schools attributed to growth in achievement in the secondary years. High expectations and a range of assessment tools were used in the two higher SES schools. Consistent whole-school approaches to teaching, including collaboration between teachers across grades, mentoring, and in-school professional learning, were features of the low SES school. Fluid groupings of students and/or differentiation were not common but did occur in the low SES school and one of the private schools.

In case studies of 35 schools in remote and very remote Aboriginal communities from five states and territories, Jorgenson (2018) found that developing language resources and strategies to scaffold Aboriginal students' transition from their home language (or Kriol) to Standard Australian English enabled these schools to provide successful numeracy experiences and outcomes for Aboriginal students. In addition to the production and use of language-rich resources and the use of learning intentions to document mathematical language, Aboriginal education workers (teacher assistants) were central to the success in these schools. They worked with the teachers to plan lessons and materials, co-teach, or act as translators in individual or whole-class discussions.

In other studies, researchers addressed whole-school change through engagement with teacher professional learning at one school or a cluster of schools. In studies about community and parent engagement, researchers addressed power relations and cultural recognition and participation whilst developing cultural competence in working in Indigenous, Māori, or Pasifika communities (Cooper & Carter, 2016) or rural communities (Proffitt-White, 2017).

Armour, Warren, and Miller (2016; see also Warren & Miller, 2016) found that including Indigenous education officers (or teacher aides) in teacher professional learning not only improved their confidence and contribution in the classrooms, but also allowed them and their students to begin to "walk" between the two knowledge worlds—Indigenous knowledge and Western knowledge. The education officers assisted with the design of culturally appropriate materials for lessons, and the interpretation and analysis of interactions between students, and between students and teachers.

Cooper and Carter (2016) foregrounded their study of whole-school change by emphasising that the only acceptable research involving Indigenous and low SES students is that in which researchers use decolonising methodologies (Tuhiwai Smith, 2012) to engage, empower, and benefit research participants. Cooper and Carter (2016) reported on a school improvement program using YuMi Deadly Maths (YDM). They explain that "YuMi" is a Torres Strait Islander Creole term meaning

"you and me" and "deadly" is a term for "smart" used by Australian First Nations people. YDM focuses on three big ideas of Western mathematics: (1) a structure of mathematical ideas, (2) a language for concisely describing real-life situations, and (3) a tool for problem solving. In the YDM program, sequences of lessons built on each other to deepen students' understanding of structure for particular concepts, "chunk knowledge" using common concepts, and connect the big ideas across mathematics topics. Cooper and Carter (2016) worked with an Aboriginal mathematician, Matthews, using his ontological framework of mathematics (2009) to frame their materials and RAMR (reality, abstraction, mathematics, reflection) program. In Matthews' (2009) cycle of reality–mathematics–reality:

> Both abstraction and reflection are *creative and problem-solving* acts; mathematics as a language and structure is built around *symbols* that carry concepts, strategies and relationships from reality to abstraction and back to reality; and the mathematics and how it is used in reality is framed by the *cultural bias* of the person creating the abstraction and reflection. (Cooper & Carter, 2016, p. 176, emphasis in original)

The researchers found that the effectiveness of the YDM program depended on the support of the principal, continuity of staff, and at least two or three teachers with enthusiasm for the project. Using YDM methods improved mathematics teaching and learning for all students at the schools (Carter, Cooper, & Anderson, 2016).

A cluster of researchers described the rationale for and results from the Developing Mathematical Inquiry Communities professional development project being conducted in New Zealand (e.g., Gibbs & Hunter, 2018; Hunter et al., 2016, 2018). Key findings include that when educators reflect the languages and cultures of Pasifika students in their work and explicitly establish respectful and reciprocal relationships with these students and their families, learning can be enhanced and cultural identity affirmed (Hunter et al., 2016). Through a substantial literature review on parental involvement in mathematics learning, Averill, Metson, and Bailey (2016) advocated for expectations on teachers of policy relating to involving family in the teaching of Māori and Pasifika learners, school-wide commitment, learning-focussed parent-teacher partnership and decision-making, and purposeful home-based learning activities are necessary. Challenges to strong parental input include varied expectations, language and cultural differences, and the time needed to develop strong parent-teacher relationships and curriculum-related understanding. Empirical studies are needed to explore these findings in relation to enhancing equity of access to learning and achievement.

As reported by Vale and Drake (2019), schools in rural and remote Indigenous communities are known to have difficulty in attracting and retaining teachers. Using case studies of out-of-field and beginning teachers in remote, rural secondary schools, Vale and Drake (2019) reported that schools need to provide a culture of support if out-of-field mathematics teachers are to successfully transition into (and remain in) their new community and new field of teaching. The kinds of support requested by the beginning and out-of-field teachers in the study included leadership and mentoring from experienced teachers, accessible curriculum and teaching resources that provide sufficient detail for the out-of-field teacher to interpret and enact, and collaborative planning practices.

The Teachers First Initiative (Proffitt-White, 2017) was designed to draw on active principal networks in rural and regional Queensland to enact a cluster-model approach to school improvement. Five clusters of primary and secondary school leaders, organised geographically, focussed on trusting teachers to develop and provide effective mathematics teaching. Proffitt-White (2017) reported enhanced teacher enthusiasm and confidence, and a shift away from exclusive use of explicit teaching to include a stronger focus on proficiencies in the Australian Curriculum, especially problem-solving and reasoning. The creation of cross-school protocols for formative assessment and reflection on practice involving classroom visits and observations by peers developed "a culture of trust, a willingness to not only listen to ideas but to have the collegial support to try things out" (Proffitt-White, 2017, p. 20).

5.2 Initial Mathematics Teacher Education

In studies of initial mathematics teacher education concerning social justice, all of which occurred in New Zealand, researchers were concerned with developing teachers' cultural competence (see also Chap. 5). Most teachers in New Zealand are New Zealand European, with relatively small proportions of Māori and Pasifika teachers compared to the student population. Hence, while variation in educator knowledge bases about Indigenous and Pacific languages, contexts, and cultures exists, many marginalised students are taught by teachers without deep understanding of these students' out-of-school lives. New Zealand education policy and support resources are aimed to ensure greater educational opportunities for Māori learners through enhancing teaching and school leadership practices (e.g., Education Council, 2017; Ministry of Education New Zealand, 2008, 2018). For example, teachers of Māori learners are encouraged to reflect socially-embedded praxis with an emphasis on care, respect, reciprocity, communication, student autonomy, involvement of whānau (family), and new learning being built on the experiences and knowledge of learners (Ministry of Education New Zealand, 2011). Teachers are also encouraged to reflect the values and competencies important to Pasifika people in their work with Pasifika learners, identified from a wide range of research and consultation (Ministry of Education New Zealand, 2018).

Collectively, Pasifika are the fastest growing ethnic group in New Zealand (Statistics New Zealand, 2013); however, Pasifika achievement lags that of non-Pasifika students on many measures. The New Zealand government policy and policy support materials are designed to prioritise improvement of learning opportunities for Pasifika learners through expecting teaching to be underpinned by a Pasifika values base and to be culturally responsive (Ministry of Education New Zealand, 2013, 2018). The material focussed on mathematics learning of New Zealand Indigenous and Pasifika learners reviewed for this chapter indicates positive signs of increased focus on Indigenous and other cultures and languages in mathematics learning. Examples include exploration of the enactment of education policies and resources in relation to

learners, learning, initial teacher education, professional development, and parental involvement.

In some of the reviewed literature, researchers focussed on the importance of reflecting cultural competencies in mathematics education in both initial teacher education and professional development, and the potential effects of doing so (e.g., Averill, Drake, Anderson, & Anthony, 2016; Averill, Metson, et al., 2016; Edmonds-Wathen, Owens, Bino, & Muke, 2018; Hāwera & Taylor, 2017; Saunders et al., 2018; Wilson, McChesney, & Brown, 2017). For example, using Kaupapa Māori methodology (Bishop, 1996; Smith, 1995) and focus group discussion, Hāwera and Taylor (2017) explored six Indigenous student teachers' views about the usefulness of their compulsory mathematics methods courses for supporting their practicum teaching. Using the cultural competencies for teachers of Māori learners (Ministry of Education New Zealand, 2011) as an analysis tool, Hāwera and Taylor (2017) found that the student teachers valued emphases on developing both cultural competencies and content/pedagogical knowledge in their coursework for their development as teachers. Specifically mentioned were course foci on nurturing an ethic of care and respectful classroom relationships, establishing prior knowledge, developing knowledge of content and assessment practices, language learning, planning and pedagogy, and exposing student teachers to different ways to teach mathematics. Participants felt that more assistance in their courses in drawing key ideas from course texts and in preparation for navigating their relationships with their practicum teachers could further strengthen links between course and practicum work.

In their study involving 13 first-year English-medium pre-service teachers, Wilson, McChesney, and Brown (2017) found that student teachers were able to use *Tātaiako: Cultural Competencies for Teachers of Māori Learners* (Ministry of Education New Zealand, 2011) to inform their practice in a range of ways. During their first-year mathematics methods course, the Māori strategy manager discussed the competencies with student teachers. The mathematics lecturer then led a discussion about mathematics resources that could be used to help demonstrate the cultural competencies in mathematics teaching, and encouraged critical consideration of these in relation to cultural integrity and mathematical authenticity. Analysis of students' journal and planning documents showed that student teachers used *Tātaiako* to identify suitable learning and teaching practices, and for their language development. Research about the extent to which these understandings are transferred into teaching practice is needed.

Tātaiako (Ministry of Education New Zealand, 2011) was also used in a study of in-the-moment coaching of student teachers' mathematics teaching (Averill, Drake, et al., 2016). Using design study and incorporating videos of rehearsals of practice, reflective debriefs, and student teacher surveys across a range of courses over 4 years, questioning, rather than directive instructions, was used as much as possible to encourage and acknowledge student teachers' pedagogical decision-making. Using questions to interrogate practice showed promise for modelling and developing two cultural competencies in particular: ako (roughly translated as the reciprocity of teaching and learning) and wānanga (roughly translated as co-construction). Other values vital for culturally responsive practice, such as respect and empowerment,

were also a focus. Limitations to transferring such findings into practice included available course time and student teachers' prior understanding of the competencies.

In each study, research of successful mathematics teaching of Māori learners and government policy in which language and cultural pedagogies and knowledge systems are acknowledged and valued were drawn together to investigate the development of knowledge and practices of pre-service teachers. The findings show the relevance of *Tātaiako* (Ministry of Education, 2011) for initial teacher education practices and the impact of research in the social justice field on those beginning their teaching careers.

6 Discussion

In this section, we comment on the overriding themes and significant findings from the publications discussed, and provide a critique of the focus of research, theoretical frameworks, and methodologies used, organised by equity group.

6.1 Gender

Concerningly, in nearly all of the publications, the authors did not define what they meant by gender and did not provide a theoretical perspective on their gender-related views. Additionally, many authors were inconsistent with their use of gender-related terminology, such as using the phrase "sex differences research" and then referring to "boys" and "girls." Only Hall et al. (2019) discussed non-binary genders when reporting their findings; hence, in other studies, this gendered group was marginalised and the gender binary was reified. While there are admittedly challenges regarding this issue when using large-scale datasets, in smaller-scale studies, such ideas should be taken into consideration so that the views and experiences of students of all genders are explored. In addition to these issues, nearly all authors treated gender groups as homogeneous, rather than examining differences within the groups (See Sikora & Pitt, 2019, for a counter-example). Hence, it appears that the suggestions made by Damarin and Erchick (2010), Esmonde (2011), and Glasser and Smith (2008) approximately a decade ago have not been adopted by Australasian researchers investigating gender issues in mathematics teaching and learning. In future research, we encourage gender issues researchers to provide operational definitions of gender and related terms, be consistent with their use of gendered language, include participants with non-binary genders, and examine patterns within gendered groups, rather than strictly between groups.

6.2 Indigenous and Culturally Marginalised Students

In research published in this time period regarding the mathematics education of Indigenous learners, authors continued to focus on ways to redress imbalances in educational opportunities experienced by Indigenous and other culturally marginalised students. In the reviewed research, authors continued to explore the theme of reducing cultural conflict and culturally-linked differences between students' school and outside of school experiences and learning. The study by Jorgensen (2018) illustrates a shift towards researching practices that have been shown to enhance Indigenous students' mathematics learning outcomes.

As called for in past RiMEA chapters on Indigenous learners, authors (Meaney et al., 2016; Meaney, McMurchy-Pilkington, & Trinick, 2012) recommended the active participation of Indigenous education officers, teacher aides, or mathematicians in recognising and enabling Indigenous ontology to contribute to teaching and teacher learning brings further meaning to Fraser's (2005, 2013) notion of redistribution, recognition, and participation for social justice in education and teaching practices. Much of the literature reviewed in the current period resulted from teams in which at least one team member was a member of the Indigenous or cultural community. Such representation at all stages of the research must become the norm, expected in ethics and research funding applications. For research teams that do not include members of the Indigenous of cultural community being investigated, it is important that consultation strategies used to maximise the suitability of research decisions are clearly outlined.

Generic terms such as "Indigenous," "Pasifika," and "Pacific" run the risk of conveying homogeneity. Overall, authors of the reviewed material promoted understanding of the diversity within each target group through their descriptions of the target groups (e.g., Hunter et al., 2016; Siemon, 2017; Taeao & Averill, 2019). Such descriptions help to develop understanding of the complexities of cultural diversities and the nuances of research in this area.

The reviewed material has useful messages relevant to mathematics education in general. Specific examples include findings in relation to content knowledge development, choice of contexts for and styles of learning activities, using student and family voice, and using questioning in school classrooms and in initial teacher education (e.g., Averill, Drake, et al., 2016; Hāwera & Taylor, 2017; Hunter et al., 2016; Trinick et al., 2016; Wilson, McChesney, & Brown, 2017).

6.3 Low SES Students

There were very few studies in which researchers focussed specifically on teaching and learning of low SES students. The exceptions are those in which researchers explored ethical and caring approaches in disadvantaged communities (e.g., Blue

et al., 2018; Sawatzki, 2017). There seems to be an assumption that the issues pertaining to the teaching and learning of low SES students are addressed by studies of under- or low-achieving students or students with learning difficulties. In a few studies (e.g., Bennison et al., 2018; Joseph, 2019), researchers have begun to explore practices that have been shown to improve student participation or achievement in schools in low SES communities. We need more studies that illustrate how to develop engagement, positive dispositions, and success for students from low SES communities, and identify and celebrate high achievement of students from low SES communities.

6.4 Rural and Remote Students

International, national, and small studies of students from schools in rural locations continue to show lower achievement across all year levels studied and low participation in senior secondary schooling and mathematics. In studies on schools and students in rural locations, researchers used quantitative methods to report on participation, achievement, and attitude gaps. For instance, Watson et al. (2016) reported findings of rural students' perceptions of mathematics and schooling that informed the design of programs to improve participation of rural students in senior secondary schooling and mathematics.

With continued high levels of incidence of out-of-field mathematics teaching in secondary schools, examining ways to support in-field and out-of-field mathematics teachers in rural and remote communities is important. Proffitt-White (2017) described a cluster model for whole-school improvement in rural and regional schools; however, the support that this model provided to out-of-field mathematics teachers was not identified. More studies are needed into ways to support and retain secondary teachers of mathematics, including out-of-field teachers, particularly those in rural locations. Such studies could include engaging with parents and the community, and providing meaningful contexts for student exploration and modelling of mathematical concepts. Investigating the meaning of rurality and the implications for student participation and learning would guide the use of contexts for mathematics learning that are meaningful for students in rural schools.

7 Concluding Comments

Mathematics continues to be widely recognised as a critical filter to further educational and career opportunities. Recording and monitoring the design and implementation of programs aimed at managing and redressing disadvantages encountered by students in their learning of mathematics thus remains of critical importance.

Documentation of factors that might impede optimal access by students to mathematics taught in classrooms continues to be fuelled and reinforced by the reporting of

data from large-scale national and international testing of mathematics. The choice of equity variables used in analyses of the data collected is noteworthy and influential. However, subtle differences in the definitions used in these large-scale tests need to be recognised, both in comparisons of data considered and in the interpretation of findings reported.

The broad and generalised findings from large-scale assessments such as those reported at the outset of the chapter have undoubtedly served as significant prompts and offered a relevant context for the design and conduct of the smaller studies covered in the remainder of the chapter. These more targeted studies not only enabled a more nuanced sketching of outcomes but also collectively contributed to further confirmation, or challenge, to the broader and more global findings presented. Many of the New Zealand studies reported were motivated by a commitment to a treaty partnership and to addressing historical imbalance in how heritage cultures, especially Māori, are acknowledged, reflected, supported, and sustained in educational settings. Australian researchers working with Indigenous school communities have also tried to give voice to Indigenous communities, acknowledge Indigenous ontology, and use culturally responsive approaches. Taken together, these studies provide useful messages relevant to mathematics education more generally, such as content knowledge development of teachers, choice of contexts for and styles of learning activities, and teacher questioning strategies. The scarcity of work focussed on early childhood students and teachers should not go unnoticed.

The challenges faced by educational researchers have been captured eloquently by Melhuish and Thanheiser (2018): "In education research," they argued,

> it is impossible to have the clear, delineated, randomized studies that may exist in the hard sciences. Each study is situated in any number of contextual variables, from the particular group of students and teachers to the nature of any particular school setting (p. 104).

These complexities and constraints are also evident in the 4-year snapshot of research referred to in this chapter—work in which researchers drew on a variety of theoretical and methodological perspectives. While the impact of multiple equity variables on students' lives was often acknowledged, explorations of single-variable effects on performance still dominated in the material surveyed. Replications or small extensions of earlier research were particularly prevalent.

Cai et al. (2018) noted that replication studies fall into two categories: an exact replication of an original study or research involving conceptual replication including exploring, from a different perspective, the contexts in which the original results were obtained. For this chapter, with its emphasis on research set in different countries, the latter interpretation is particularly relevant. While replication studies will no doubt continue to be mounted in the 4-year period ahead, thoughtful planning and justification should precede such work.

The difficulty of gaining funds for longitudinal studies has been raised before, within and beyond the MERGA 4-yearly reviews. Yet, our field will surely be enriched by the findings of an ambitious longitudinal study in which researchers follow students, retrospectively or pro-actively (e.g., Warren & Miller, 2016), from groups still considered to be disadvantaged, as they move through the educational

system and grapple with mathematics and its role in their subsequent development. Productive and pragmatic approaches for such an investigation could be sourced from earlier, ground-breaking studies. Csikszentmihalyi, Rathunde, and Whalen's (1993) exploration of a diverse range of factors that supported or impeded high school students' longer-term success in mathematics, as well as in other subjects, is worthy of renewed inspection. Could this ambitious 5-year longitudinal project be fruitfully adapted and modified to document, showcase, and better understand how and when students faced with equity hurdles can be successful as they progress through school? Bloom's (1985) retrospective study of adults successful in a number of fields, including mathematics, is also worth revisiting. In brief, we echo the comments of others engaged in educational research that longitudinal studies should be encouraged and, critically, be appropriately funded.

To conclude, the survey of recent research reported in this chapter not only adds to the existing body of work on mathematics education and equity, social justice, and ethical issues, but, we hope and anticipate, will also serve as a catalyst for future work.

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