Equity, social justice and ethics in mathematics education

Chapter 6
Equity, Social Justice and Ethics in Mathematics Education

Colleen Vale — *Deakin University*
Bill Atweh — *Philippines Normal University; University of South Africa*
Robin Averill — *Victoria University of Wellington*
Andrew Skourdoumbis — *Deakin University*

Abstract
The performativity policy mindset driving national and international testing highlights issues of equity in access and success according to socio-economic status, geographic location, ethnicity, gender and combinations of these factors. Researchers seek explanations for these inequities in terms encompassing engagement, participation and achievement to identify socially just and ethical practices at system, school and classroom level. The emergence of a theoretical perspective involving redistribution, recognition and participation (Fraser, 2013) is evident in a range of studies concerning leadership, professional learning, pre-service teacher education, and pedagogies that focus on equity and social justice in mathematics education. The challenge of ethical and socially just practices at all levels and social groups is in providing access to deep learning in mathematics and success in "knowledge making" (Jorgensen, 2014).

Keywords
Equity, Social justice, Redistribution, Recognition, Participation, Ethics, Socio-economic status, Rural, Ethnicity, Gender

1 Introduction

Research on equity and social justice in mathematics education shows that "Australia lags behind many other OECD countries in terms of our equity outcomes" (Jorgenson, 2014, p. 311; Thomson, De Bertoli, & Buckley, 2013; Thomson, Hillman, & Wernert, 2012; Thomson, Hillman, Wernert, Schmid, Buckley, & Munene, 2012). This is also true of New Zealand "where around 75% of the between-school variation in performance is accounted for by the socioeconomic background of students and schools" (Thomson et al., 2013, p. 278). Socio-economic status, gender, Indigeneity[1], and ethnicity have typically featured in research concerning equity and social justice. Previous literature reviews on equity and social justice (Atweh, Vale, & Walshaw, 2012) identified a growing concern regarding the geographic context of school communities and the disadvantage of students in rural and remote locations. In this chapter we review studies concerned with socio-

[1] We acknowledge that Indigenous people in different places in Australasia prefer to use the term Aboriginal or their own cultural or tribal name to describe themselves.

economic context, geographic location, language and culture, and gender. We identify theoretical frameworks and themes, and critique these studies in order to further understand these issues in differently-advantaged school communities.

A number of studies reviewed acknowledge the duplicitous nature of disadvantage within a school community, for example Jorgensen and Lowrie (2013), so that research which focussed on one equity factor often involved others. Literature that specifically focussed on Indigenous students is reviewed in Chapter 8 and the research concerning diversity within the classroom, differently-abled students, and inclusive practice in Chapter 7.

Given the over-riding policy culture of performativity, systemic responses to international and national achievement tests continue to focus on teacher quality (Skourdoumbis, 2012). Hence many of the studies reviewed focus on teacher quality through research of professional learning opportunities and programs; some also researched pedagogical approaches for social justice. We therefore expect that themes explored here are likely to intersect with the chapters on education policy and teacher professional learning. Implications for policy, teacher education, school communities, and teaching practice will be drawn along with issues for further research. We begin this chapter with a discussion of the theoretical perspectives informing this review.

2 Theoretical Perspectives

The previous review of the Australasian research in this field (Atweh, et al., 2012) revealed divergent theoretical foundations and whilst still dominated by a deficit discourse, emergent theoretical frameworks were evident:

> There seems to us to be a movement from the disparate agendas such as equity, diversity and inclusion to a more comprehensive and perhaps unifying construct of social justice. Likewise, a few authors are beginning to understand the agenda of social justice in terms of ethics. (Atweh et al., 2012, p. 57-58)

This aspect mirrors the chapter's alignment with the critical tradition given the concern with distributions of power, resources and knowledge, and links to schooling. With this in mind, the chapter draws on the work of Nancy Fraser (2013), in particular her notions of justice in terms of *redistribution, recognition* and *participation* reiterating her concern for an integrated conceptualization of justice in socio-economic, cultural and political terms.

The new 'facts' driven sensibilities of measurement systems change what tallies and what is calculated for social justice in education. Lingard, Sellar, and Savage (2014), for instance, suggested that the proliferation of national and global testing and data substructures has re-articulated social justice as equity in current schooling policy. This represents a marked difference from previous considerations of social justice and equity in the education research literature with its emphasis on equality of opportunity, inclusion, diversity, fairness, and access. In many respects, the new technologies of governance in education and their performativity overlays determine the empirical research investigations of our time.

To be true to the critical stance we adopt here, we note that some researchers in the field have reflected upon some of the theoretical stances that different researchers on equity and social justice

have adopted and, by implication on the types of research that is being conducted. Jorgensen (2014) discussed the general shift from cognitive and psychological theories that have guided early research in the field to more sociocultural perspectives that Lerman (2006) called the social turn in mathematics education. Jorgensen identified several emerging theoretical constructs guiding many of the new researchers. Her paper presented the robust view that

> These social theories have gained precedence in the field up to this point in time, but I want to disrupt this power base and question whether this position is creating a sense that the social conditions within which learning mathematics occurs is shifting focus away from the core learning of mathematics. My reason for this challenge is the continuing (and perhaps even growing) number of students from socially, culturally and linguistically diverse backgrounds who are still not performing well in mathematics. (Jorgensen, 2014, p. 313)

She went on to say that these theories "may have explanatory value but they may be causing educational research to be 'barking up the wrong tree'" (p. 313). Jorgensen concluded her call for a new paradigm that is needed in researching mathematics education and she provided examples suggesting that

> learning environments that powerfully shape the potential for mathematical knowledge making for ALL students becomes the agenda for the future paradigm ... This paradigm is one where all students are effectively scaffolded by excellent teachers who are able to create knowledge making. (Jorgensen, 2014, p. 317)

In a similar vein, Atweh and Graven (2016), using the construct of "ethical imagination", raised some issues for researchers working with excluded students. They argued that researching inclusive education demands a level of empathy and responsibility from researchers towards the 'subjects' of their research. They argued that ethics in research, particularly with marginalised groups, should go beyond 'ticking boxes' for informed consent and confidentiality on standard ethical clearance forms towards a commitment to enter into meaningful dialogue with participants focusing on anticipated benefit. They urged researchers to engage critically and embrace dialogue with teachers in the research relationship avoiding deficit discourses which further shut down the space for teacher learning enabling redress. The authors raised some questions for researchers to consider. Is research that identifies problems and complexities in questions of inclusion, and research 'on' the excluded and their helpers sufficient? Does the researcher have an obligation to lobby for and work towards inclusion? What research designs allow for the understanding of exclusion and at the same time attempts to redress it?

3 Socio-economic Context of School Communities

Links between educational achievement including aspiration and socio-economic context are predictably consistent (Jorgensen, 2012b; Jorgensen, Gates, & Roper, 2014; Thomson et al., 2013; Thomson, Hillman, & Wernert, 2012; Thomson, Hillman, Wernert, Schmid, et al., 2012; Vale, Weaven, Davies, Hooley, Davidson, & Loton, 2013). Contributing factors include: student mix, student family background, parental connection(s) to school, teacher quality, student language skill(s), curriculum alienation, and so on (Jorgensen, 2012b; Jorgensen et al., 2014).

Education systems are, as Bok (2010) pointed out, "a fundamental aspect of the social mechanisms that reproduce unequal access to, and outcomes from, education for students from low SES backgrounds" (p. 164). In contrast to their 'elite' counterparts, students from low socio-economic communities cannot draw upon the requisite cultural and social capital needed that conditions and positions them for schooling and beyond. Schools often reflect and transmit the structured dispositions of a pedagogic order, including those framing teaching practice. The teaching of mathematics is particularly susceptible to routinised practice, the usual arrangement one of teacher-led lecture style presentation(s) with minimal student interaction(s) followed by individual student work through text based exercises. Atweh, Bose, Graven, Subramanian, and Venkat (2014) argued that such approaches also raise social justice issues since:

> Research provides consistent evidence that suggests that teachers often adjust their teaching to their perceptions of students' achievement levels. While this may appear to be appropriate, it can restrict the opportunity to learn for low-achieving students. This is of particular concern when it involves groups of students from certain social, cultural or language backgrounds. Sztajn (2003) noted the tendency of using rote teaching for low SES students and problem solving with high SES students.... Luke (1999) warned that the "dumbing down" of the curriculum for low-achieving students excludes them from developing high order thinking and intellectual quality work. It also diminishes their opportunity to learn content needed at higher levels of schooling. (Atweh et al., p.17)

In a social and political context where the grand equalizer of public education no longer holds, teaching actions and practices are likewise re-set so that a 'back-to-basics' logic in teaching gains favour over experimental and holistic teaching approaches. Yet, in mathematics education, studies (see Duru, 2010) showed that innovative teaching approaches are conducive to sustained gains in achievement, particularly for the disadvantaged.

Articles reviewed for this section of the chapter generally indicated one major noteworthy point, namely that socio-economic disadvantage is still a major determiner of student achievement. The articles also illustrated effective features of programs for the early years of schooling and number learning (Gould, 2014; Perry, Gervasoni, & Dockett, 2012), the value of using technological tools in under-resourced and disadvantaged communities (Goodwin & Gould, 2014), pedagogical beliefs that enable changing practice (Atweh & Alai', 2012) and the importance of curriculum leadership in disadvantaged schools (Jorgensen, 2012a).

3.1 Challenging hegemonic practice

Jorgensen's work (2012b) on scholastic mortality rates among disadvantaged students (working class and Indigenous) highlighted the difficulties these students encounter in schooling. She used Pierre Bourdieu and his theoretical notion of 'miscommunication' and 'habitus' to outline how the education system and its inherent system(s) work to the detriment of the most disadvantaged. The symbolic violence of communicative codes, the language (linguistics) used in school education and in various disciplines, for example mathematics, is complicit in the learning outcomes of students. Jorgensen (2012b) suggested that student and teacher "behaviour is complicit in the stratified outcomes of learning school mathematics" none more so perhaps than when there is "no recognition of the linguistic codes that learners bring to school mathematics" (p. 37). In suggesting that students of different class backgrounds *do* school differently, that is by virtue of their habitus,

she has acknowledged that the "process of miscommunication becomes a subtle form of exclusion of which the child and teacher may be totally ignorant" (Jorgensen, 2012b, pp. 37-38).

Learning school mathematics is about mastering the codes of the discipline. Most current mathematics teaching involves the transmission of knowledge and less reliance on rich or authentic engagement (see Boaler & Staples, 2008). Successful acculturation to school mathematics means mastering its sedimented disciplinary knowledge. Jorgensen reminded us that students "most likely to succeed in the discipline are those whose habitus is strongly aligned with the objective structuring practices of the field" (2012b, p. 38). The impact of habitus was further revealed in another study by Jorgensen et al. (2014). This study showed how a teacher's practice of streaming in their classroom, which provided more or less access to hegemonic mathematics knowledge, reproduced cultural dispositions and disadvantage as the teaching practices for lower streamed students contributed to delayed progression and underachievement. Jorgensen advocated that teachers and in particular mathematics teachers be mindful of how their teaching practices or indeed their beliefs may actually reinforce disadvantage, for instance by presenting mathematics problems in class in a reified and de-contextualised way or by denying disadvantaged students access to creative mathematical thinking.

Work by Atweh and Ala'i (2012), like Jorgensen's (2012b), addressed a core code of the education system, pedagogy (teaching) and its relationship to learning. These researchers, like others (for example, Gutstein, 2006) in the field of mathematics education, noted that teaching practices of mathematics teachers contributed to the engagement and presumably achievement of learners. Importantly their work on specific teaching practices, what they term a "socially response-able approach to mathematics education" (Atweh & Ala'i, 2012, p. 98) with its notable concern about social justice, provided one approach towards developing students' responsibility through mathematics education.

A key part of their study involved working with several teachers to develop and enact, within their teaching, socially response-able mathematics activities. The Atweh and Ala'i study pointed to the reticence that many mathematics teachers display towards alternate "open ended pedagogies" (2012, p. 103). It also illustrated that when teachers use approaches other than what may be conveniently termed 'direct instruction', students invariably demonstrate a "deeper understanding and engagement in the class" (Atweh & Ala'i, 2012, p. 103). The Atweh and Ala'i study reinforced how important teacher beliefs about the epistemological nature of mathematics are in shaping teacher attitudes and beliefs about the discipline of mathematics that then determine their "readiness to take risks in changing classroom practices" (Atweh & Ala'i, 2012, p. 104).

3.2 Addressing disadvantage in the early years

The Gould (2014) study of the association between students' number knowledge and social disadvantage at school entry, was concerned with the number knowledge of students from different socio-economic backgrounds at point of school entry. Gould cited evidence suggesting that disadvantaged children enter school already behind their more advantaged counterparts and, importantly, that early mathematics knowledge tends to predict subsequent school achievement. His study suggested that early intervention aimed primarily at developing basic number knowledge, namely object counting, identifying numerals, and flexible use of oral counting (core knowledge that Gould has found correlates with Family Occupation and Education Index of the School) of disadvantaged young children is needed. Indeed, it is not simply that disadvantaged children need support but that planned and "designed experiences in early number are particularly important in preschool settings servicing low socio-economic communities to reduce the disparities in the background knowledge" (Gould, 2014, p. 261) of the already disadvantaged. Interestingly his study also pointed to the contested nature of the early childhood curriculum in Australia and the place of mathematics education within it (see Cohrssen, Church, Ishimine, & Tayler, 2013). Nonetheless like the researchers he drew upon, Gould advocated for a programmed approach to the teaching of mathematics in the early years. There is a simple and sound reason for this: identifying "what needs to be addressed to reduce the risk of those starting behind in mathematics learning staying behind in their mathematics learning" (Gould, 2014, p. 262).

In another study Perry et al. (2012) also showed that targeted early mathematics programs such as *Let's Count* in low socio-economic communities provided opportunities to enhance mathematics learning outcomes. Early childhood educators also reported that they too benefited as learners and teachers of mathematics from programs such as *Let's Count* as these programs "build or maintain positive dispositions and increased confidence towards mathematics" (Perry, Gervasoni, & Dockett, 2012, p. 600).

3.3 Leading curriculum change

Jorgensen's work (2012a) on Curriculum Leadership focused on how vital it is that local school and community context be considered before major curriculum change is enacted. In considering the specific model of devolved leadership, the most common type of model, Jorgensen was able to examine how common curriculum practices were enacted in particular types of schools (regional and remote). Issues identified included the use of commercial numeracy programs, sustainability, high expectations and curriculum leadership and community. There were particular issues linked to sustainability including the high turnover of staff and the "constant change in provision of numeracy programs within schools" (Jorgensen, 2012a, p. 374). Remote settings were at particular risk here as constant staff changes including Principal/Leadership changes often resulted in program change. Her study indicated the general acceptance of high expectations in all schools and communities analysed. Strong and accepting relationships between curriculum leadership and community were seen as vital to the success of any numeracy curriculum program.

The achievement outcomes arising from initiatives to provide curriculum leadership to networks of disadvantaged primary and secondary schools and to develop whole school and network approaches to teaching were investigated by Vale et al. (2013) using longitudinal statistical

analysis of achievement data. They found that growth exceeded expectations during Terms 2 and 3 of the school year, but decreased and tended to be below expectations in school terms 4 and 1 (the Spring/Summer months), mirroring US data on the 'summer slowdown' phenomenon. The significance of this issue takes on a heightened importance when one considers that in Australia there are "large gaps in achievement between students from the highest and lowest socio-economic backgrounds" (Vale et al., 2013, p. 2). Schools servicing low socio-economic communities need to work at reducing the impact of the 'summer slowdown' if they are to close the achievement gap.

Alternative teacher certification pathways (Teach For Australia for instance) are marketed as replacement modes of teacher training and education designed specifically to address stagnating student achievement and reducing educational disadvantage. Despite this, disadvantaged Australian school students continue to trail their more advantaged peers (Skourdoumbis, 2012). Further research of such programs is warranted.

The studies reviewed here reveal the duplicitous nature of social disadvantage, as schools serving low socio-economic communities are often also schools in rural or remote locations, and have significant school populations of Indigenous students or students of other cultural and language backgrounds. The next section focuses on research concerning equity issues of geographic location.

4 Rural and Remote School Communities

Research regarding disadvantage and inequities in mathematics outcomes for students in rural and remote communities have addressed systemic and structural issues of staffing encompassing teacher retainment, curriculum leadership and quality of teachers and teaching in these schools. Each of the studies reviewed in this section were conducted in Australia as the literature search did not reveal studies conducted in New Zealand, a change from the previous review period. Attending to issues of teacher quality these studies report on teacher preparation, support for teachers and the outcomes of professional learning for teachers in schools in rural and remote locations which usually service Indigenous communities.

International tests show that 25% of Year 4 students are taught by teachers who are not 'very confident' in teaching mathematics and 34% of Year 8 students are taught by teachers without qualifications in mathematics (Thomson, Hillman, & Wernert, 2012; Thomson, Hillman, Wernert, Schmid, et al., 2012) and that students of teachers with lower levels of qualification or confidence score lower than others. These studies do not identify the location of the less qualified and less confident teachers, but reports of *Staff in Australian Schools* (McKenzie, Weldon, Rowley, Murphy, & McMillan, 2014) consistently show that less qualified and beginning teachers are disproportionately located in remote and rural locations and low socio-economic metropolitan communities. The studies reviewed below either directly confront the issue of attracting, training and retaining staff to teach in rural and remote pre, primary and secondary schools or consistently identify less qualified or beginning teachers as the target of professional learning and curriculum innovation projects in remote and rural communities.

4.1 Teachers, identity and practice in rural and remote schools

Building on previous studies Handel et al. (2013) conducted a survey involving 191 secondary school mathematics and science teachers from 27 schools in New South Wales to find the factors that determined their intention to stay or leave the school or the profession. Their previous research had found that high proportions of teachers returned to the coast or left the profession after completing their required tenure. This study identified instructional, school organisational, and curricula issues that impacted retention. These included being the only trained teacher in the subject, being expected to teach in another discipline, that is out-of-field, few opportunities for professional development, lack of support services such as mentoring and coaching within the school or district and lack of funding for resources and materials because of small school budgets. As inexperienced teachers they were also expected to take on administrative and leadership responsibilities. The respondents indicated that inducements to take up rural and remote appointments were not sufficient to out-weigh these professional or personal factors concerning rural or remote living. These findings confirm the critical role of leadership for social justice in rural and remote schools (Jorgensen, 2012a).

Aware of the high incidence of out-of-field teaching in rural and remote schools and that poor attraction and retention factors contribute to the extent and longevity of out-of-field teaching, Hobbs (2012) used socio-cultural theories of learning, boundaries and identity to identify factors contributing to out-of-field identity. She interviewed 18 secondary teachers from three rural secondary schools in Victoria who identified as out-of-field and developed the "Boundary Between Fields" model to conceptualise three factors contributing to out-of-field identity: context, including rurality and school culture and organisation; support mechanisms such as: provision of professional learning; mentoring; coaching and resources; and personal resources, including adaptive expertise, teacher knowledge and dispositions. Concurring with Handel et al. (2013) and Jorgensen (2012a), Hobbs found that access to collegial support and professional learning and leadership practices impacted on their identity as out-of-field. Adaptive expertise enabled teachers who might otherwise identify as out-of-field to take the initiative in developing their knowledge and engage in professional learning. Hobbs concluded that "rurality...demands adaptive expertise" (p. 285).

Three case studies explored professional learning programs to respond to transience of teachers in rural and provincial schools, in-field/out-of-field identity and the absence of leadership or professional learning opportunities (Owens, 2015; Sandhu, Kidman, & Cooper, 2013; Warren, Quine, & De Vries, 2012*)*. The pedagogical frameworks used in these projects were culturally responsive and related to Fraser's notion of participation and involved engagement with the community in different ways and to varying degrees. Sandhu et al. (2013) tracked the pedagogical shifts of an in-field mathematics teacher with six years' experience of teaching in a remote secondary school where at least 30% of the student population were Indigenous. This teacher was a participant in a professional learning and curriculum development project conducted in nine schools in Queensland involving in-field and out-of-field teachers using the Reality-Abstraction-Mathematics-Reflection (RAMR) pedagogical framework. Warren et al. (2012) reported on the first stage of a longitudinal study of the professional learning of beginning teachers of Foundation to Year 3 students. Their pedagogical framework, RoleM (representations, oral language and engagement in mathematics) used socio-cultural theories of learning and involved teachers in

dialogue with experts and collaborative planning, enactment and sharing. Owens (2015) investigated changes to pedagogical practice of schools serving communities with significant populations of Indigenous students in New South Wales. The case study school participated in three curriculum development projects, each involving culturally responsive teaching: *Stronger Smarter Learning Communities*, a project for school leaders, *Make It Count*, a project to develop approaches for teaching Indigenous students, and *8 ways*, a project to develop teachers' cultural competence in the classroom.

Sandhu et al. (2013) found that in-field teachers can identify as out-of-field when they don't know their students or how to address the learning needs of their students. The RAMR enabled the teacher to become more flexible in their teaching methods to meet the needs of underachieving students. Warren et al. (2012) reported positive changes in beginning teachers' attitudes, beliefs and practices about the teaching of mathematics, expectations of students and confidence to be innovative. Sustainability of these collegial practices in the context of the high levels of leadership and teacher transience will be tested in the next phase of their study. Key findings from Owens' (2015) study included the importance of funding to enable involvement of a critical mass of teachers and to give the Indigenous community a voice and role in decision-making. The curriculum frameworks used in these studies are also reviewed in Chapter 8.

4.2 Preparing to teach in rural and remote contexts: Pre-service teacher education

One of the strategies allegedly employed to overcome shortages of qualified teachers in rural and remote schools is the alternate teacher education pathway *Teach for Australia* (TFA) that recruits elite, high performing graduate students and places them in underperforming, hard-to-staff schools (Weldon, McKenzie, Kleinhenz, & Reid, 2012). The education program consists of a 6-week intensive teacher education program, followed by appointment as an associate teacher for 2 years in a disadvantaged school. At the beginning of the school year following completion of the TFA program only 26 of the 42 initial cohort had secured a tenured position (Weldon, et al., 2012). Skourdoumbis (2012) provided a critique of this teacher education pathway drawing on Bourdieu's (2000) critical theory. He argued that the initiative is deficit focussed and employs a "teacher-hero" scenario, where high achieving, inexperienced teachers are expected to solve the problem of low achievement without addressing the reproduction of social inequalities, evidenced in the studies tracking retention and border-crossing reviewed above. Skourdoumbis (2012) argued that policy responses such as TFA contribute to, rather than subvert, the reproduction of social disadvantage.

One study of pre-service teacher education concerned with teaching rural locations specifically addressed primary mathematics teaching, while another involved pre-school teachers. Wilson (2013) was concerned that beginning teachers may pass on mathematics anxiety or use inappropriate teaching practices to students in rural and remote schools. She compared the level of mathematics anxiety of primary pre-service teachers in a rural campus and metropolitan campus of a university using the Revised Mathematics Anxiety Rating Scale (RMARS) instrument. She found that the mean level of mathematics anxiety was higher for rural pre-service teachers than for metropolitan pre-service teachers, though the difference was not statistically significant. Hunting, Mousley, and Perry (2012) conducted a study of rural pre-school teachers' perspectives of young children's mathematical thinking using structured individual interviews with 64

preschool teachers across three Australian states. The interviews focussed on five themes: awareness of children's mathematical thinking, support for mathematics teaching, use of technology and computers, their attitudes and feelings about mathematics and assessment and record keeping. Missing from their study were perspectives and practices on engaging with parents on mathematical activity and cultural or context-based pedagogies for pre-school children in rural, remote or Indigenous communities.

In summary these studies reported inexperience in teaching mathematics or in the school and community context, transience of leadership and absence of support structures and opportunities for mentoring and professional learning. They revealed the complexity of rural school communities and the importance of school culture, organisation and leadership structures and provision of resources to enable schools to form partnerships with their communities and that support teachers to develop cultural and pedagogical knowledge and be adaptable and culturally-responsive. Teachers and leaders in rural and remote schools must want to stay and contribute to sustained change in pedagogical practice that makes a difference to students' mathematical learning. Socio-cultural and critical theory informed the research studies, with Fraser's (2013) meaning of social justice foregrounding some studies and Jorgensen (2014) arguing for a shift in paradigms to enable a focus on mathematics knowledge making. Our review now turns to consider another intersecting cultural factor of equity and social justice, namely the ethnic and language contexts of school communities.

5 Ethnic and Language Context of School Communities

Articles reviewed for this section of the chapter were initially sorted by whether they related to Indigenous students' learning, culturally responsive practices, or language issues. This process resulted in around half falling within two or all of the three categories, illustrating the complex and interrelated issues inherent in examining equitable approaches to teaching and learning mathematics for students in Indigenous and minority ethnicity groups, particularly when language issues are also pertinent. Such complexities demonstrate the suitability for this review of utilising Fraser's (2013) conceptualisation of social justice as an integration of socio-economic, cultural and political factors.

The overarching theme of the work reviewed is that of enhancing equity of access to mathematics learning and achievement through teachers being aware of and attending to students' cultural capital in mathematics instruction (e.g., Averill, 2012a, 2012b; Averill & Clark 2012; Edmonds-Wathen, 2014; Meaney, Trinnick, & Farihall, 2013; Owens, 2014a). Cultural capital discussed includes the ways of being, knowledge, and skills that students possess and the ways of being, knowledge, and skills inherent within their heritage cultures. Emerging themes include the increasing emphasis on recognising the suitability and importance of involving the people that are closest to students (their parents, families and school communities) in decisions about and awareness of their learning (e.g., Averill, 2012a, 2012b; Meaney, Trinnick, & Fairhall, 2013; Owens, 2014a), and recognising the essential nature of 'place' within mathematical learning, such as through understanding and acknowledging customary links between environmental and cultural activity in order to utilise 'ecocultural' mathematics within teaching (e.g., in space and geometry, see Owens, 2014b). Areas such as these provide opportunities for rich and valuable future inquiry.

5.1 Culturally responsive teacher practices

Most of the reviewed literature focused on culturally responsive teacher practices shown to assist or advocate for learning that improves achievement. Methods used included: recognising the role of contextual artefacts and gesture in young Indigenous students' learning of growing patterns (Miller, 2014; Miller & Warren, 2012), focussing on mathematisation and contextualisation to help make mathematics meaningful, in turn enhancing mathematical resilience (Thornton, Statton, & Mountzouris, 2012), and considering learning in relation to a holistic model of health and wellbeing encompassing cognitive, social, physical and spiritual aspects of classroom learning and interactions (Averill, 2012a). In contrast, Jorgenson (2013) discussed ways in which schools help their Indigenous students successfully navigate their school experiences by explicitly illustrating how to 'play' the 'game' of school mathematics.

An increasing number of articles focus on describing the value of recognising or incorporating culturally linked knowledge and practices into instruction and learning (e.g., Grootenboer & Sullivan, 2013; Warren & Quine, 2013). These researchers seek to align classroom practices and pedagogies with the diverse experiences, identities, values and norms students bring from their out of school lives to their learning. The examples given are likely to enhance not only the learning of indigenous and/or minoritised students, but of all. For example, Averill and Clark (2012) found teacher professionalism, consistency, courteousness, flexibility, and one-to-one teacher-student interactions contribute to respectful classroom environments, developing effective teacher-student relationships. Teachers and students knowing each other including knowing individuals' learning preferences and needs, and teachers' use of specific feedback and encouragement, contributed to students' learning (Anderson, Averill, Te Maro, Taiwhati, & Higgins, 2013).

Language-based equity issues discussed in the reviewed literature included challenges associated with English, which is often the language of instruction and assessment, yet not the first language of some learners, teachers, or researchers (Edmonds-Wathen, 2013; Matang & Owens, 2014). Further issues included cultural differences in mathematical understandings between students and their teachers (Edmonds-Wathen, 2014), and classroom metaphors which can create culturally-bound concepts, particularly for Indigenous students (Edmonds-Wathen, 2012). Language-linked research also reported achievement improvements resulting from a classroom focus on representations, oral language, and engagement (Warren & Miller, 2013), and reduced language dependency questions impacted positively on overall numeracy scores (Wilson & Barkatsas, 2014).

Equity issues relevant to instruction in students' heritage languages included challenges for teachers and students in adopting mathematical terms often new to these languages and language revitalisation (Edmonds-Wathen, Sakopa, Owens, & Bino, 2014; Trinick, Meaney, & Fairhall, 2014). Evidence from the enactment of two iterations of curriculum development, demonstrated the part mathematics curriculum can play in language revitalisation. McMurchie-Pilkington, Trinick, and Meaney (2013) described how, despite and in part due to, curriculum development occurring within contested spaces in relation to Ministry of Education expectations and Maori aspirations, processes and products were used to support revitalisation of te reo Maori. Despite such affordances, substantial challenges can still exist for mathematics instruction in languages other than English. For example, Trinick et al. (2014) outlined societal, policy, in-school,

mathematical, and linguistic factors that can assist and hinder the adoption of the registers of mathematics and mathematics education by teachers within Maori medium schools, themselves second language-Maori learners, found within their study of 19 teachers across two schools.

Challenges to culturally responsive mathematics learning identified across the reviewed literature included teachers' (lack of) culturally-based knowledge, teachers viewing mathematics learning and students' heritage cultures as distinct (Averill, 2012b), and the likelihood that the place of English language in instruction and research may constrain mathematics education possibilities (e.g., Meaney, 2013). Given these substantive challenges to advancing culturally responsive mathematics teaching, surprisingly little of the reviewed literature focused primarily on initial or in-service teacher education. Exceptions include Hurst and Sparrow's (2012) study into a pilot project training teaching assistants to plan for helping individuals and small groups with mathematics learning. The study found not only that teachers had an enhanced confidence and ability in their teaching, but the teaching assistants too became integral to their professional learning communities. Other promising work includes Owens's (2012; 2014a; 2014b) explorations of student teachers' project reports, which illustrated how activities linking culture and mathematics can help develop their mathematical identities, and Owens, Edmonds-Wathen, Kravia, and Sakopa's (2014) use of design principles for teacher professional learning in Papua New Guinea. In addition, Anthony, Hunter, and Thompson's (2014) description of one teacher's learning journey following an inquiry-based intervention showed the importance of safe learning environments and including individual and collective learning for successful continued use of high leverage and culturally responsive intervention strategies. Given persistent achievement differences due to ethnicity (e.g., Forgasz, Leder, & Halliday, 2013; Leder & Forgasz, 2014), further work in this area is needed to build on research into effective culturally responsive teaching practices.

In summary, recent work in the areas of culture, language and ethnicity adds to the development of understandings of factors that impact on the mathematics learning and achievement of Indigenous and marginalised students, including those for whom language issues exist, whether related to English, a heritage language, or the language/s of instruction. A theme, that although present explicitly (e.g., Anderson et al., 2013; Owens, 2014a; Warren & Quine, 2013) and implicitly (e.g., Miller, 2014), appears underdeveloped is that of the importance of partnerships in advancing understanding of effective culturally responsive practice. Themes across the reviewed literature suggest that such partnerships best provide suitable ways forward in Australasian schooling contexts towards increased consistency in practice reflecting Fraser's notions of participation and recognition, and through this, increased equity of access to mathematics achievement. The three equity factors explored thus far have often been entwined in the school communities and have revealed strong overlaps in theoretical frameworks, themes and findings. The final equity factor, gender, whilst also present in the disadvantaged contexts reviewed, is also an equity issue in otherwise advantaged school communities.

6 Gender

Australasian research has continued to investigate the incidence of gender inequity and the factors contributing to gender differences in achievement, participation and attitude. International studies, TIMSS and PISA, continue to show gender differences in achievement favouring boys in Year 4 (Thomson, Hillman, Wernert, Schmid, et al., 2012), Year 8 (Thomson, Hillman, & Wernert, 2012) and at 14 years of age (Thomson et al., 2013). These differences are significant for secondary students in Australia and New Zealand, have increased since 2003, and are higher than the OECD average in the PISA study (Thomson et al., 2013; Thomson et al., 2012a). Socio-cultural identity theory dominates the theoretical frameworks informing the research in this field of equity and social justice. The literature search found only one study that investigated social justice pedagogy for women and girls (Tanko & Atweh, 2012).

6.1. The widening gender gap

The proportion of students participating in senior secondary mathematics is continuing to decline. Mack and Wilson (2015) reported that the steepest declines and lowest participation rates in New South Wales from 2001 to 2014 are for girls. Observing that the gender gap revealed in international studies was widening, Forgasz and Hill (2013) analysed results of the highest achievers for all three Year 12 mathematics units in the Victorian Certificate of Education from 2007 - 2009. The factors explored included gender, socio-economic status, geographic location and learning setting. They found that "males, students from higher socioeconomic backgrounds and those attending metropolitan schools predominated amongst the highest achievers in all three VCE mathematics subjects" (Forgasz & Hill, 2013, p. 481). Moreover the gap increased with the level of difficulty of the mathematics subject. However, their study did not use inferential statistics to test for statistical significance. Their findings show that gender differences were not as large as differences for socio-economic status and geographic location.

Carmichael (2013) used data from the large Longitudinal Study of Australian Children, for children aged six years; and two years later when aged eight years, to investigate the influence of prior achievement and teachers' assessment on gender differences in achievement. Using Rasch modelling to analyse data he found that gender differences favouring males whilst small at this age, did increase in the two-year period. Gender differences were also related to content as teachers rated girls more highly than boys for data content, but boys more highly than girls for place value and computation.

6.2 Socio-cultural perspectives and identity

Concerned about declining participation of boys in post-compulsory mathematics subjects, Easey et al. (2012) surveyed Year 10 boys at an all boys' school in Queensland. They found that boys who intended to study at least one of the two more advanced Year 12 mathematics subjects valued the relevance of mathematics for their professional career aspirations, whereas the boys intending to study the less demanding mathematics subject were more likely to base this decision on their perceived lower mathematics ability. This group also believed that mathematics was "not critical in society" (p. 248). These findings suggest a shift away from gender stereotyping of mathematics

as a male domain. Other studies continued to search for any shifts in this long established phenomenon.

Carmichael (2014) explored the influence of parents' attitudes on gender differences in mathematical outcomes. Parents were asked to predict how far their child would progress in their education and how well they were progressing in mathematics. He found that "parents of boys tended to have more positive perceptions about their son's mathematics achievements than parents of girls" (Carmichael, 2014, p. 124). However they were more likely to predict that their daughters would achieve a tertiary education and their sons a trade qualification. This finding is somewhat surprising given mean level of socio-economic status reported for the sample.

Adopting a more complex view of the social context of learning, "that is the attitudes, actual and perceived, of critical 'others' in students' homes, at school, and societal beliefs more generally" (p. 373), Forgasz, Leder, and Tan (2014) conducted an international study of the gendered perceptions of mathematics, technology capabilities and STEM-related careers. They used Facebook to recruit participants from 81 countries but focussed their analysis on nine countries with larger numbers of participants. Analysis showed significant differences by country on gendered perceptions of mathematics capability, parents' gendered perceptions of mathematics and teachers' gendered perceptions. In most countries, but not all, these perceptions favoured males, especially in China. Non-gender stereotyped perceptions predominated in six countries including Australia. Participants in all nine countries agreed that there was no gender difference in importance of mathematics learning. Further studies involving a similar instrument are reviewed in Chapter 5. Together these studies report changes to gendered perspectives of mathematics, at least in English-speaking countries.

One study reviewed here explored students' gendered mathematics perceptions. Tan (2012) conducted an online survey involving students from Singapore and Australia about their beliefs about learning and knowing of mathematics with graphics and CAS calculators. Her study was informed by feminist theory of women's ways of knowing (Belenky, Clinchy, Goldberger, & Tarule, 1986) and metaphors of interacting with technology (Goos, Galbraith, Renshaw, & Geiger, 2000). She found significant gender differences in ways of knowing and learning mathematics with males scoring higher on Connected Knowing – Deep Approach and girls scoring higher on Surface Knowing – Surface Approach. She also established association between these ways of knowing and the use of calculators as Master with Surface Knowing and the use of calculators as Collaborator with Connected Knowing. Tan argued that these findings have implications for students' mathematical achievement. They also indicate that further research of the learning environment and learning expectations are warranted.

6.3 Social justice pedagogy

Tanko and Atweh (2012) used Gustein's (2006) framework for teaching mathematics for social justice with a group of Arab women participating in a tertiary mathematics bridging course. This framework included goals for mathematical learning as well as goals for using mathematical knowledge for change and social justice. The mathematics program involved student selected mathematical projects on issues of significance to the women along with worksheets to enhance mathematical content and skills relevant to these projects. Interviews confirmed increased

confidence among participants, and the women's project work and exercises displayed development of mathematical understanding and skills beyond the basic numeracy skills expected. The researchers noted the challenge of selecting problems that provided opportunity for engagement with challenging mathematical ideas and meeting the social justice goals of the students.

In summary these studies continue to provide evidence of gender differences in achievement and approaches to learning. They also reveal that whilst gender-stereotyped perceptions of mathematics persist for some social groups, shifts away from the perception of mathematics as a male domain are also evident, especially in the English-speaking world. However, more research on pedagogical approaches that transform deficit and gendered perceptions are needed.

7 Concluding Remarks

Every care was given in this review to identifying research studies conducted by researchers from and within Australasia. We note that other studies relevant to this chapter theme are reviewed in Chapter 7 or Chapter 8. Summarising the complex issues researched by the various studies reported here is difficult. Here we offer overall comments about the patterns arising from this review and consider some of the gaps we have identified, some pending research questions and some implications for policy and teacher training.

First, equity, social justice and ethics concerns remain high in Australasian mathematics education research. Research is diverse, incorporating a wider range of social groups not equitably participating in mathematics learning and achievement. We note in particular, that in addition to long standing concerns about gender and socioeconomic status, there is an increase in the number of studies around Indigenous, language and culture issues and rural and remote schools.

Second, we note a common theme and finding regarding the development of partnerships between schools and their communities. Social justice through representation and participation (Fraser, 2013) is a prominent theoretical perspective. Leadership and school culture are pivotal to forming partnerships with community to develop cultural understanding and whole school approaches to teaching mathematics. These approaches have been variously described as inclusive, culturally responsive, socially response-able, and place-based pedagogies. Jorgensen (2014) argued that these approaches must place mathematics learning and knowledge making as the learning objectives. Questions regarding the way in which recognition, representation and participation is enacted in these approaches and their impact on mathematics learning and success are addressed in Chapters 7, 8 and 11.

Third, support mechanisms, including curriculum leadership, and professional learning opportunities and culture enable teachers to develop cultural and pedagogical knowledge, and to be adaptable, flexible and committed to social justice. These findings speak to the redistribution aspect of social justice (Fraser, 2013) and the need for systems to fund and support school organisational structures, resources and cultures if social disadvantage is not to be continually reproduced.

Fourth, in terms of future directions for research in the topics addressed here, we call for an increase in research that looks to how learning environments can be created with the help of teachers, to focus on mathematical knowledge building. In other words, we call for more research designs and theoretical stances that directly target the elevation of disadvantage enabling teachers and communities to gain mathematical knowledge towards that aim.

Lastly, we consider the implication of research in this area for pre-service teacher education. A number of studies reviewed in this chapter conducted research involving pre-service teachers. The studies show that teacher education needs to prepare teachers who are adaptable and ready to implement equitable and socially just pedagogies appropriate for the students in their school community. In many teacher education courses students undertake general education classes that deal with issues of exclusion and equity, and study separately the teaching of mathematics. Atweh et al. (2014) call for greater care in the education of mathematics teachers so that their teaching reflects awareness of equity, social justice and ethics issues. Issues of this kind should be included as integral components of all pre-service teacher education mathematics courses.

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