Chapter 7
Inclusive Practices in Mathematics Education

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Abstract Inclusive mathematics education acknowledges human diversity and involves supporting the diverse learning needs of all students in general mathematics classrooms. In this chapter we review Australasian research concerning the various categories of diversity using the three themes of our framework: Access to the curriculum through policies and leadership practices; Diverse approaches to learning mathematics; and Teaching approaches for inclusion. Our analysis of the literature explored commonalities in research approaches and issues across the field. Our framework deliberately avoids reviewing literature under categories of diversity which would only serve to further segregate. Our review focused on issues arising in the teaching and learning of mathematics and the policies and practices that enable those endeavours. We were unable to identify any research that indicated some groups of learners needed to be taught away from other students. Those strategies or techniques needed for some could be used to enhance the learning of all. Following our review under the three themes, we propose areas of needed research and encourage mathematics education researchers in our region to further develop this field.

Keywords Inclusive education · Approaches to teaching · Mathematics attainment · Numeracy · Educational leadership · Diversity

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1 Introduction

The scope of this chapter is mathematical attainment for all learners, which is a fundamental concern for all interested in understanding mathematics teaching and learning. Inclusive education is founded on the recognition of human diversity and involves "supporting the belonging and full participation of all people together" (Cologon, 2014, p. 4). Inclusive mathematics education requires welcoming, valuing, and supporting the diverse learning needs of all students in the shared general mathematics classroom (Faragher, 2015; Thousand & Villa, 2000). Therefore, inclusive education encompasses, but is not a synonym for, special needs or learning difficulties. In this chapter we review Australasian research findings concerning the various categories of diversity such as gender, learning difficulties, giftedness, location, and cultural and linguistic diversity as they relate to mathematics education. These are considered thematically in terms of access to the curriculum through policy and leadership, as well as approaches to learning and teaching mathematics. The categories and themes are not exhaustive but reflect the extant literature, particularly in the Australasian context. We have used this structure in the development of our conceptual framework described below and represented in Fig. 7.1.

A major aspect of research in inclusive education pertains to the overlap between research disciplines, particularly special education. The relationship between mathematics education literature and special and inclusive education literature is of relevance as is the extent of overlap of definitions of construct (e.g., Direct Instruction). This overlap of fields brings richness in the variety of methodologies but also challenges in the development of a shared corpus of knowledge. As part of this review, we consider methodological issues related to conducting research in the area of inclusive education and offer suggestions for greater synergies between fields. Our analysis of the literature explores commonalities in research approaches and issues across the categories of diversity.

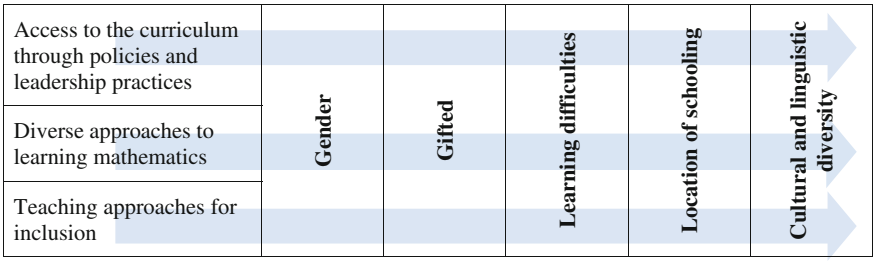

Fig. 7.1 Conceptual framework

2 Conceptual Framework

The conceptual framework that supports this chapter is shown in Fig. 7.1.

Equity has been a central focus of policy and curriculum documents in Australasia for many years, for example, The Melbourne Declaration on Educational Goals for Young Australians (Ministerial Council for Education, Employment, Training and Youth Affairs [MCEETYA], 2008); Australian Curriculum: Mathematics (Australian Curriculum, Assessment and Reporting Authority [ACARA], 2009); The New Zealand Curriculum (Ministry of Education, 2007); Early Childhood Education curriculum framework, Te Whāriki (Ministry of Education, 1996). Research, however, has tended to focus on specific aspects of diversity and inclusion. This chapter provides a synthesis of relevant research across the range of categories of diversity and interprets them in the context of inclusive mathematics education for improved learning outcomes for all students. We aim to contribute to the maturing of the field by providing a more holistic framework through which diversity can be examined, with the ultimate goal of improving inclusive mathematics education practice.

In structuring our review, we have taken the framework themes (see Fig. 7.1) for our chapter. This is a deliberate approach to underline the philosophy behind inclusive practice. Every learner is diverse in some way and thinking in categories of learners merely serves to segregate. It is recognised, however, that there are common factors in groups of learners that have an impact on their learning of mathematics and this is reflected in the research literature. Therefore, we review these areas as they arise under the overarching themes, exploring the literature with a view to curriculum and learning practices in the primary and secondary schooling years. Our work here overlaps material reviewed in other chapters (see e.g., Chap. 6 , this volume, that takes a socio-cultural perspective to inclusivity and diversity, and Chap. 8, this volume, on Indigenous learners). The different emphases in analyses make all three chapters on diversity and inclusivity distinct. We now turn to review literature under the three themes of our framework.

3 Access to the Curriculum

Access to a rich mathematics curriculum is at the heart of inclusive educational practice. Education is a right for all; however, disparity continues to exist in the nature of mathematics education provided. For some students, particularly in the secondary years, access to the general mathematics curriculum continues to be an aspiration (Faragher, 2014). Along with most other countries in the Asia Pacific region, Australia and New Zealand are signatories to the United Nations Declaration on Human Rights and the Convention on the Rights of Persons with

Disabilities. These two international agreements are binding, and national legislation has followed in both countries to enshrine the right to inclusive education in law. From these national laws, policies have been implemented to ensure compliance in various educational jurisdictions. The implementation of policies is the responsibility of those in educational leadership positions and it is at this point where considerable variance can occur. In this section, research that considers access to the mathematics curriculum is reviewed from the perspective of leadership approaches, policy and practice.

3.1 The Impact of School Leadership

School leadership teams have a significant impact on the mathematics attainment of students (Gaffney & Faragher, 2010). They also have an impact on inclusion of students with disabilities (Bawa Kuyini-A & Paterson, 2013). The leadership dimension in mathematics education has received some attention from researchers in recent years, and the impact on inclusive mathematics education practice has begun to emerge. However, our search of relevant literature returned very little published in the years of this review. It would seem that the 2010 special issue of the Mathematics Education Research Group of Australasia (MERGA)'s *Mathematics Teacher Education and Development* (Volume 12, Issue 2) was a major publication in the area and little has emerged since. Here we review the few exceptions and encourage future research in this field. An exception is a chapter by Gaffney, Bezzina, and Branson (2014). Reporting findings from a larger study (Gaffney & Faragher, 2014), the chapter identified key aspects of the practices of principals and other school leaders that have an impact on student achievement in learning mathematics. Similar to Bawa Kuyini-A and Paterson (2013), who identified links between school principals' expectations of teachers to implement inclusive education practices and the practices of teachers in affecting learning outcomes for students, Gaffney, Bezzina, and Branson (2014) emphasised the importance of alignment between vision, organisational structures, teaching approaches, and community engagement on student learning outcomes. Policies and approaches around community engagement, particularly engagement with parents, have been reviewed in a study by Clinton and Hattie (2013). Their analysis would suggest that parental involvement in schooling is important but the type of involvement matters. This would resonate with research by Averill (2012) and Polidano, Hanel, and Buddelmeyer (2013) that indicated the importance of high expectations of student achievement by parents, teachers and the students themselves.

The value for student learning, of a vision shared by school leadership and teaching teams, was noted in a case study report by Jorgensen (2015). Research by Mills et al. (2014) exposed problems that occur when common understandings of

differentiated learning are not shared by school leaders and the teachers who are implementing the policies. Without a shared vision and clear conceptualisation of differentiation, a variety of approaches resulted with varying success.

3.2 Allocation to Classes

A very common approach for managing diversity of learners is the practice of allocating students to classes according to individuals' school achievement. Studies from the 1960s began to report the detrimental effects of such practices for the majority of learners, and particularly those in the bottom streams. Macqueen (2013) has studied a variation on this practice that is seen as more palatable to a community becoming aware of the negative impacts of streaming. She investigated the use of regrouping in primary schools, defined as the practice of allocating students to "separate achievement-based classes for individual subject areas such as English or mathematics" (p. 296). The mixed methods study involved schools in New South Wales and examined the practices of eight schools—four that used regrouping practices matched with four like schools that did not. All schools in the study were considered disadvantaged. Macqueen's research indicated that the practice of regrouping showed the same equity issues as streaming. An overview of these issues can be found in the National Numeracy Review (Council of Australian Governments Human Capital Working Group, 2008). Therefore, regrouping should not be regarded as a way to respond to diverse learners of mathematics.

Macqueen made an interesting methodological point in the analysis of the quantitative data arising from the Quality of School Life survey used in her study. Numbers in the low-achieving classes were smaller than the high-achieving groups due to school policies. Small numbers of students providing data from the low-achieving class made obtaining statistically significant differences more challenging. The use of a mixed methods approach in this study enabled the use of qualitative data to investigate trends in the quantitative data.

Another approach to accessing Australasian education is the provision of single sex schools, most frequently in non-government schools. A study by Forgasz and Hill (2013) analysed data from examination results published in metropolitan newspapers that highlighted boys' achievement in mathematics. They reported, "students in single-sex schools, particularly boys schools, were over-represented amongst the highest achievers in all three VCE [Victorian Certificate of Education] mathematics subjects" (2013, p. 493). However, they also discussed their challenge in untangling the impact of socio-economic advantage on the results. In discussion of their findings, the authors posed questions about how the public may interpret these results. Without the awareness of other factors at play, they suggested that the general reader may gain support for gendered views of mathematics achievement. They may also make assumptions about school quality without considering the impact of the socio-economic status (SES) of the school.

3.3 Socio-Economic Status

Perry and McConney (2013), explored the effect of school socio-economic status (SES) on student reading and mathematics learning outcomes. It is well-established that students' and schools' SES are strong predictors of educational attainment, although the strength of the relationship varies between countries (OECD, 2013). Perry and McConney compared results from Australia and Canada as these two countries were considered to have similar educational challenges such as remote populations. However, it was noted that Canada appears to ameliorate some of the effects of SES without compromising quality. The authors argued that the difference is attributable to policies that have led to a system in Australia that is much more marked by "school choice, privatisation and social segregation" (Perry & McConney, 2013, p. 138) than Canada. Attending a high SES school in Australia has a much more marked positive effect on achievement. This finding links to Forgasz and Hill's (2013) study, who pointed out these effects can flow into other areas and perhaps confuse other issues, such as inviting the public to the view that there is a gender difference in mathematical attainment. This serves to underline the risk of considering categories of diversity in isolation.

Conflicting findings on the impact of SES on school achievement were generated from an analysis undertaken by Polidano and colleagues (Polidano et al., 2013). Their study used statistical techniques from the field of economics to analyse data from two related sources: the 2003 OECD Programme for International Student Assessment (PISA) Australian cohort and its linked sample from LSAY, the Longitudinal Survey of Australian Youth (Department of Education Employment and Workplace Relations (DEEWR), 2011). LSAY is one of only a few datasets that links to PISA and the only one in Australasia. LSAY tracked 10,000 students who were 15 years old when they sat for PISA in 2003 until they reached the age of 24 years. The datasets provide information on school completion and school and individual characteristics through surveys completed by principals and students. The Polidano et al. study investigated factors contributing to the differences in school completion rates with respect to school SES. Their results suggest that school characteristics for students after age 15 are relatively unimportant. What mattered in predicting school completion were educational aspirations of students and their parents as well as achievement levels of students at 15.

The conflicting findings between Perry and McConney's study and the work of Polidano et al. could have a number of possible explanations. It could be that in the study of 15 year olds, the damage had already been done and school characteristics were no longer of importance. Polidano et al.'s study recognised the lower achievement of students in low SES schools and this gap would match the work of Perry and McConney. Economic modelling is an uncommon methodology in mathematics education research and differences in methodology may account for some of the differences in findings. However, it is fair to say the studies have not addressed identical research questions. Paired studies that did so, using different methodological approaches, would provide useful comparisons between techniques.

Another finding of the work of Polidano et al. (2013), is the effect of teachers. Those contributing to a positive school culture were found to have a greater estimated effect on retaining students from low-SES backgrounds than those from higher SES backgrounds. Walshaw and Brown (2012) gave a description of the practices of one mathematics teacher who made consideration of affect an explicit part of his practice. The study used the work of the seventeenth century Dutch philosopher, Spinoza, to explore the connection between affect and thinking. For the purposes of this review, we are interested in the example that analysed teaching practices with a Year 9 low-attaining mathematics class in a low SES school. They noted the impact of policies: "Prevailing mathematics education policies and discourses at his school invoke a commitment to a wider understanding of diversity than was previously expressed through stereotypical images based on group affiliation" (p. 189) and "at the school, equitable teaching practices had become a crucially important driver to embrace diversity and to redress social injustices" (p. 189). One of the challenges the teacher faced was the erratic attendance of the students, some of whom missed significant amounts of schooling. In dealing with this issue, the teacher made explicit decisions to enable students to keep with the classroom collective, opting for "the use of rules, repetition of tasks and small procedural steps" (p. 192). Although this practice is commonly documented in low-attaining classes and even advocated in special education literature (Westwood, 2000), the authors noted that this practice encourages "ways of thinking and being in the classroom setting that may be perpetuating the marginalisation of … an already disadvantaged class" (p. 193). This idea is mentioned briefly in the paper and not pursued due to the focus on other aspects of study. It would be illuminating for further research to explore this thesis in greater depth.

3.4 Location of Schooling

We have been considering policies and practices that affect access to the curriculum. In some cases, access is dependent on opportunity to be taught. In regional, rural and remote areas, this could depend on suitably qualified teachers being available and sufficient student numbers to offer mathematics, and particularly the more specialised topics. Handal and colleagues (Handal, Watson, Petocz, & Maher, 2013) investigated factors influencing teachers to remain in non-metropolitan areas. Using a questionnaire, the authors collected quantitative and qualitative data from 191 secondary teachers in 27 rural or remote New South Wales schools. The regions were undergoing population decline and respondents described the impact of this on schools. With falling enrolments, staffing numbers fall, requiring teachers to teach across key learning areas (KLA) and often outside their area of training. One respondent noted, "… specialist areas are a luxury".

Small secondary schools also employ few staff in each teaching area and this leads to lack of mentoring of beginning teachers from more experienced subject specialists. "Despite being beginning teachers, most have to function as if they were

curricular experts" (p. 23). The authors identified policy practices that were influencing the retention of the teachers in the study and suggested that lack of professional development, curricular mentoring and curricular support were problems that could be addressed using technologies to overcome distance and connect into professional communities beyond their local area. Compensation for living and working in remote areas as well as mechanisms to allow transfer to other schools were considered important policy matters to address retention of teachers in regional, rural and remote schools. Accommodating the effects on schools of declining rural populations may be a more difficult policy to develop.

Handal et al. (2013) found no significant difference between the responses of teachers of mathematics and science and those of teachers of other KLA, noting teaching in a small school necessitated teaching across a number of areas. Hobbs (2013) explicitly studied teachers in rural or regional secondary schools who were teaching "out-of-field", that is, they were teaching subjects for which they had not been trained. She identified a concerning practice of out-of-field teachers who were "content to perpetuate dominant subject pedagogies regardless of their effectiveness" (p. 293). Noting that this was not the case for all out-of-field teachers, she identified an area of needed research—the impact on the engagement and achievement of students of being assigned an out-of-field teacher. It is likely that policies and practices relating to the allocation of teachers may have a significant impact on the achievements of students. Again, it is essential that multiple factors are analysed in this required research. If there are fewer qualified teachers to be assigned, the choice of which school and which class matters. In studies on streaming, Zevenbergen (2005) noted low stream classes most often were assigned the least qualified staff. Hobbs' model suggests that some school policies may make out-of-field teachers more effective, that is, if policies encourage "communities of practice where teachers are supported and enabled to expand their professional identity" (Hobbs, 2013, p. 293).

In remote Australian communities, the student population is often largely or totally Indigenous. By contrast, with the exception of Indigenous Education Officers (IEO), the teaching staff rarely are Indigenous. Warren and Quine (2013) discussed an aspect of their research in remote schools in Queensland, describing changes in classroom structures that led to improved learning outcomes for students in mathematics. In their qualitative study using grounded theory, the IEOs were considered equal partners in the learning process and due to their stability in the community, they were deemed crucial to the success of the initiative. The paper examined changed leadership structures that explicitly involved Indigenous community leadership in partnership with non-Indigenous leadership, in seeking to address challenges arising from a context with high teaching staff turnover in remote locations. This is an example of a policy approach that has an impact on the learning outcomes of students in diverse settings.

This section of our review has considered the Australasian research studies that deal with the opportunity for diverse groups of students to access mathematics. Policies and their implementation have a substantial effect on the opportunity for students to learn mathematics. In the following section, we will discuss research relating to the learning of mathematics itself.

4 Diverse Approaches to Learning Mathematics

A key aspect of inclusive mathematics education is acknowledgement of the diversity inherent in all learners. It is recognised in the research literature that some individual learners cluster into categories that can have an impact on their achievement in mathematics. In this section, we review literature about groups of students, all from the perspective of the learner. Five general themes have emerged and in this section, and we discuss these themes in turn.

4.1 Context of the Learner

Mathematics learning theory that explored situated cognition (Lave, 1988) encouraged the teaching of mathematics in contexts that were relevant to the learner. Current research literature indicates this practice has continuing merit for inclusive classrooms.

A study undertaken by Grootenboer and Sullivan (2013) investigated the prior mathematical knowledge of 56 primary students in north-western Australia. Data were collected through a task-based, one-on-one interview that focused on mathematical concepts related to measurement, with tasks designed to connect to students' experiential world through the use of contexts and themes from their local community and their hobbies, interests and activities. With reference to inclusive practices, the researchers concluded that the students' capacity to engage with tasks and questions was influenced significantly by the context of the problem, with many students unable to answer questions with irrelevant or unknown contexts. In addition, questions that were related to familiar contexts were more likely to be answered correctly, suggesting students were able to demonstrate mathematical conceptual knowledge when they were able to personally connect to the task. Inclusive practices in mathematics need to take into account factors such as geographical location and experiences.

Challenges of context extend to understanding the language of instruction. Verzosa and Mulligan (2013) reported on an intervention phase of a study aimed to assist second grade Filipino children in solving addition word problems in English, a language they primarily encounter only in school. The researchers commented that "the fact that children who cannot understand simple statements such as 'Alvin had 3 coins' are obligated to learn mathematics in English says much about how their school experience must be too far removed from their daily lives" (p. 238). It was found that minor interventions such as providing definitions for English words commonly found in word problems were not effective as children struggled to remember what these words meant. Findings showed that children's difficulties were not confined to the lack of English language proficiency but were also related to students not possessing the mathematical knowledge necessary to handle more complex mathematical structures. Difficulties with developing mathematical

understanding due to the language of instruction may serve to exacerbate feelings of exclusion in students, which may then lead to further disadvantage.

4.2 Playing to Their Strengths

Mathematics teachers have always had concern for those who struggle to learn mathematics. Likewise, researchers in the field have sought understanding of how to enhance the mathematics attainment of all learners, including those in defined groups. Research undertaken in the review years in Australasia continues to support the finding that while some approaches may make learning mathematics easier for some specific groups, these approaches are of benefit to students in general. We have not identified any approaches that are needed for some students that would not benefit others. In essence, there are no special approaches that require some groups of students to be taught mathematics away from their mainstream peers.

An indicative example was provided by Clarke and Faragher (2014) who reported data related to early number development from a larger study. It was concluded that children in this study developed alternate ways of counting and that the development of number understanding was enhanced through the use of symbols. The authors explained that there appeared to be some evidence to suggest that children with Down syndrome were more comfortable with the numerical symbol than the verbal count word. The authors argued that this can be linked to the relative weakness in verbal processing of children with Down syndrome. They raised the issue that the focus on skill development emphasising the count word first that is used with typically developing children may not be as productive as the use of models that emphasise the use of numerals. Teachers in a subsequent study (Clarke & Faragher, 2015) indicated that they found use of resources such as a number paddle and tens frames to be helpful in inclusive primary classroom settings. This study investigated the practices of effective primary school teachers in Victoria and the ACT who were including a student with Down syndrome in their regular classroom mathematics lessons. A key point here is that even though learners with Down syndrome require an emphasis on numerical symbols to enhance early number development, other learners in the classroom can make use of these connections as well. It is not necessary to teach some students separately from others.

4.3 Issues of Affect

The concept of *affect*, particularly with respect to the effect on learners and the impact of gender, also received research attention in the review years. As noted earlier, Walshaw and Brown (2012) extended the theorising of affect. They cited McLeod (1992, p. 576) to define *affect* as "a wide range of beliefs, feelings and moods that are generally regarded as going beyond the domain of cognition" and in

their own synthesis of the literature, note the importance of affect for learning, stating, "affect influences thinking, just as thinking influences affect. The two interact" (Walshaw & Brown, 2012, p. 186).

The relationship between positive affect towards science and mathematics and achievement in these disciplines was explored by Ng, Lay, Areepattamannil, Treagust, and Chandrasegaran (2012) in a study of Malaysian and Singaporean Grade 8 students. It was found that positive affect towards science and mathematics indicated statistically significant predictive effects on achievement. There were also predictive effects on mathematics achievement for the students' gender, language spoken at home and parental education. The researchers concluded that educators should consider implementing self-concept enhancement intervention programs and suggest that this may also serve to increase inclusion for students by counteracting the effect of aspects such as home and everyday influences.

In a study by Ng (2012), the origins and impact of mathematics anxiety on 294 Singaporean secondary students were examined. As early as Primary 4 (Year 4), students in Singapore are "ability-grouped" (p. 570) by four subjects, including mathematics. In Primary 6, mathematics contributes to their Primary School Leaving Examination (PSLE) score. Results on this exam are used to assign students to secondary courses. Research findings revealed a negative correlation between anxiety level and achievement. Of the top five situations that worried students, four were test-related. Even so, highly anxious students were reported to persevere and enjoy the subject.

An international, longitudinal study (Watt et al., 2012) explored gender differences in, and gendered relationships among, mathematics-related motivations towards high school mathematics participation, educational aspirations, and career plans. Participants were from Australia, Canada, and the United States in Grades 9/10 at Time 1 and Grades 11/12 at Time 2 and came from suburban middle to upper-middle socioeconomic backgrounds, primarily of Anglo-European descent. Stereotypic gender differences in educational and occupational outcomes were found only among the Australian sample. Male adolescents held higher intrinsic value for mathematics in the Australian sample. Ability/success expectancy was a key predictor in the North American samples, in contrast to intrinsic value in the Australian sample. Attainment/utility ("importance") values were more important for female adolescents' career choices, except in the Australian sample. The importance of gender socialisation practices and its relationship to engagement and inclusion are emphasised, with reference to differences in perceptions of mathematics-related motivations between students from Australia, Canada, and the United States.

4.4 Learning with Technology

The role of technology in inclusive mathematics practices has been the focus of a number of recent studies. Casey (2013) used action research to study curriculum

design in the context of social media in secondary mathematics. As an approach to learning mathematics, Casey designed online projects around students' real-life experiences and day-to-day knowledge to help students link mathematics to their activities, inside and outside the school. It was found that students benefited from this approach in many ways, with students creating multimedia resources to help those in other classes understand particular concepts. Incorporating students' out-of-school activities assisted them to come into the mathematics classroom with a relaxed tone; their interests were more visible and using visual clues strengthened their understanding and meaning making, which also supported their literacy practices. Providing students with the means to utilise their own interests in an inclusive and supportive environment encouraged them to share their knowledge with other students.

In a similar vein, Australian researcher Daniel Shank and US colleague Sheila Cotten (2014) investigated how the use and ownership of different aspects of technology could empower urban youth through increasing their self-efficacy. It was found that compared with owning one's own computer, both not owning a computer and sharing a computer were positively related to self-efficacy in the domain of science and mathematics. Shank and Cotton speculated that not owning a computer may have driven students to collaborate more and potentially use their laptops more often. The work of Shank and Cotten (2014) and Casey (2013) suggest that collaboration and inclusion are linked to students' efficacy.

4.5 Assessing Learners

It hardly seems a revelation to note that valid assessment instruments and interpretation of results is critical to making an accurate judgement of what learners know and can do. Even so, development of assessment techniques is a continuing area of research in the field of inclusive mathematics education. These techniques are required for researchers to determine the effect of interventions as well as for classroom teachers to use in their work. The development and use of modified assessment instruments for teachers' use with learners undertaking modified programs within an inclusive classroom would appear to be an emerging area of expertise, and research into this aspect of teachers' work would be welcome.

Reviewed research made use of a variety of assessment approaches, many developed specifically for the particular studies being undertaken. Task-based assessment interviews between individual learners and their teacher or the researcher continued to be an important methodology. Faragher and Clarke (2014) discussed the use of this technique in research with learners who respond atypically, as was the case for their population of students with Down syndrome. Interviewers required expertise in mathematics pedagogy as well as understanding of learner behaviours. Task based interviews were also used by Grootenboer and Sullivan (2013) who developed their own instrument based on the lived contexts of the Indigenous students in the study. By testing students on their knowledge of

mathematics in familiar and unfamiliar contexts, they noted: "The findings of this study suggest that, at least in part, the under-achievement of these students in these formal tests may be due to the relevance and veracity of the assessment instrument" (Grootenboer & Sullivan, 2013, p. 181). As a result, the researchers assert that "there are real concerns about national testing regimes that discriminate against some students, and the use of these flawed results to make claims about the students' mathematical (or other subjects) knowledge and understandings" (p. 184).

In another study of Indigenous students and their mathematics achievement, Yeung, Craven, and Ali (2013) asked a sample of Indigenous and non-Indigenous students (n = 1342) from schools in New South Wales to respond to a survey measuring five domains of self-concept (i.e., school, reading, mathematics, art, and physical abilities), two learning-related factors (enjoyment and participation), and a self-assessment of their school work. Student scores in a NSW state-wide assessment of students' literacy and numeracy were also obtained. The researchers found that Indigenous students scored lower in both reading and mathematics than their non-Indigenous peers and concluded that Indigenous students were clearly disadvantaged in terms of academic achievement, irrespective of region (urban or rural). They concluded that "the consistent pattern of Indigenous students displaying lower scores for both achievements and self-concepts leads us to conclude that Indigenous students were disadvantaged in both" (Yeung et al., 2013, p. 420) and that Indigenous students did not seem to have a good estimate of their abilities in reading and mathematics. With reference to the research of Grootenboer and Sullivan (2013), the possibility exists that results may be related to the "non-inclusive" aspects of the test items used in the state-wide assessments of the students. Indigenous students' lower scores for achievement and self-concept may be a side-effect of the nature of the tests given to them, and not necessarily due to a lack of mathematical conceptual knowledge. In order to promote Indigenous students' academic self-concept and academic achievement, methods of assessment may need to change.

The research of Verzosa and Mulligan (2013) can be seen as following the same vein in regards to the effect of question context and assessment and its relationship with inclusive practices in mathematics. It was conjectured by Verzosa and Mulligan (2013) that using Filipino to convey mathematical concepts would not prevent students from accessing the same concepts in English once they had acquired proficiency in the language, but if children had poor understanding of number concepts and part-whole relations, then even substantial linguistic support in the form of narration would fail to help them construct appropriate situation models. They found that there were very few instances when a problem in English was solved and children's unfamiliarity with the language continued to impede problem solution.

Assessment of diverse learners remains a challenge for policy and practice. The Mills et al. study (2014) indicated that some teachers in their study were uncomfortable with modifying secondary assessment. In some subject areas, teachers were prevented from doing so by policy determination. In mathematics, they note, "in the non-senior years teachers suggested that the assessment tasks catered to different levels. However, this appeared to relate to such practices as extension tests for the

high achieving mathematics students" (p. 342). The researchers argued that assessment as well as learning can be modified in a way that is challenging and meaningful, allowing all students to demonstrate their learning, however expectations around quality should not be different.

In this section of our chapter, we have reviewed studies from the perspective of the learner. In the following section, we move to the final part of our theoretical framework and consider Australasian research from the perspective of teaching.

5 Teaching Approaches for Inclusive Practice

Learners of mathematics are unique individuals. Inclusive mathematics education practice would be simply impossible to achieve if teachers had to plan for and teach each student separately. There is a growing corpus of research and practice that underpins inclusive mathematics education. In this section of our review, we examine this literature under three sub-themes: Location of schooling; Values, expectations and beliefs of teachers; and Direct Instruction. A body of work on mathematics education exists in the special education literature and the third theme arises from this work. However, it is rare that the two fields of special and general mathematics education coincide and there is little overlap between authors writing in both areas. This has implications for methodological practice and subsequent findings of research. Advice given to teachers wishing to develop their inclusive practice can be confusing when it arises from different theoretical backgrounds. We review research in mathematics education and special education research fields in an attempt to find common ground and identify areas where further work is required.

5.1 Issues of Context/Location of Schooling

Where teachers do their work has an impact on their practice. In particular, location of schooling arises in the literature as an important variable in inclusive practice and we have already considered this in the previous two themes. The impact on teaching is now discussed.

A challenge for education in areas of sparse population is the provision of a range of educational opportunities for learners. One solution adopted in the western region of New South Wales is a program for gifted and talented students, called the XSEL program. Furney, McDiarmid, and Bannister (2014) have provided a descriptive account of the program with some initial data on student learning outcomes. This program makes use of sophisticated technology to offer learning opportunities to students enrolled in their local school but attending classes with selected students across the region. The online lessons are supplemented by residential schools. Further, more rigorous research is needed into the effectiveness of programs of this type. Research questions abound, for example, in teaching approaches. The teacher's

role in this program is fundamentally different from traditional classroom teaching as policies such as this point would indicate: "*xsel* teachers do not teach 'face to face' any *xsel* students in their own school. All *xsel* teachers teach only *xsel* students at other schools" (Furney et al., 2014, p. 43). The impact on schools where some students are not included in the local classes and the effect on learners of not being selected for these programs would also be rich areas of research. On the face of it, it would seem programs like *xsel* offer segregated education to a select group of students and would be contrary to inclusive education practices.

Lowrie and Jorgensen (2012, 2014) have studied a different aspect of rural education—distance education (DE) in the home. Several aspects of the research reported in these two papers are of relevance to this review, including: the changing population of students accessing DE to include students with disabilities, those disenfranchised by traditional schools, those with challenging behaviours, as well as those in rural areas; the use of parents (mostly mothers) as teaching assistants; and the changed role of pedagogical practice with the adoption of new learning technologies. The researchers used an ethnographic study conducted at a school site and a connected home site. Semi-structured interviews in conjunction with formal observations (lesson studies) were undertaken. The data analysis revealed insights into teaching approaches and changes that had occurred as new technologies were implemented. Constraints of technology, such as unreliable connectivity, and resources (provision of electronic materials supplemented by print materials) led to individualised teaching, often as one-on-one phone conversations. The authors note,

> some of the common social, environmental, and cognitive dimensions of classroom engagement cannot be replicated. … everyday social perspectives so influential in learning … are restricted by the influence of the dominant medium of communication – that is, a blended or digital resource base. Consequently, teachers may feel somewhat disconnected to the students they teach. (Lowrie & Jorgensen, 2012, p. 2)

A powerful aspect of Lowrie and Jorgensen's research is that it was undertaken at two time points separated by 8 years. This longitudinal focus allowed the initial anticipated benefits of technological innovations to be contrasted with the actuality.

Understanding the variables that affect teaching approaches for learners in different contexts and locations is critical for improving mathematics education across Australasia. Much is made of the promise of learning technologies to improve learning outcomes and yet Lowrie and Jorgensen's work would suggest that this promise is not necessarily achieved in practice. Research is needed to understand and remove impediments to achieving the hoped for benefits for learners and their teachers.

5.2 *Values, Expectations and Beliefs of Teachers*

> Why do we usually say that we do not know the needs of people with disabilities while we do not know anybody's needs, actually? As a matter of fact, there is some research showing that both groups can have the same difficulties in learning mathematical content. (Marcone & Atweh, 2015, p. 773)

The impact of values, expectations and beliefs of teachers on student learning outcomes has been recognised for some time, particularly when education is viewed through socio-cultural theoretical frameworks. Similarly, the teaching profession has a specific focus on student engagement as a necessary component of learning. In working with students from diverse populations, research indicates these teacher attributes are important variables and here we consider research arising in the review years.

Bishop and Kalegeropoulos (2015) reported on a small-scale study of student engagement in the mathematics classroom. In their chapter they refer to (Dis) engagement signifying that they are talking about "engagement, disengagement and re-engagement together" (p. 194). This is in acknowledgement that engagement is not a static state but one that is influenced by a range of factors including the teacher and the classroom context. They argued that consideration of teacher and student values help us understand this dynamic process. The choice to engage is the student's but the pedagogical practices and teacher expectations influence that engagement. They argue against practices of labelling and other excluding pedagogies and argue for inclusive pedagogies.

Seah and Andersson (2015) advocate for a process of values alignment to support effective inclusion in culturally diverse classrooms. They argue theoretically with support of two secondary school cases. They claim that it is important for teachers to be able to negotiate values difference and values conflict situations that arise. From a perspective of managing cultural diversity they suggest that the acknowledgement of difference in values can be important.

> Thus, teacher capacity to actualise values alignment between herself/himself and her/his students go [sic] a long way towards acknowledging students' cultures, knowledge, skills and dispositions, thereby contributing to diversity in mathematics learning and teaching in ways which are inclusive and empowering. (p. 180)

Owens (2015), reporting on case study data from one of the schools involved in the *Make it Count* project, found considerable change in teachers' practices through including Indigenous community and cultural considerations. The school was in a large regional setting with around 10 % Indigenous students. The teachers initiated small step changes "but only with consultation and mentoring and significant two-way sharing of cultural and intellectual knowledge by the Aboriginal community locally and nationally" (p. 75). She argued that an ecocultural critical pedagogy was developing and was characterised by initiatives including, "establishing a garden that can be used easily for mathematics lessons, recognising the value of land links, outside lessons, non-verbal teaching, and stories" (p. 76).

A rural setting was the focus of another research study (Hunting, Mousley, & Perry, 2012), this time investigating rural preschool practitioners' knowledge and practices concerning children's mathematical development prior to entering their settings. To undertake the research, 64 practitioners in rural areas in three Australian states were surveyed and interviewed. Site visits were also made. While

respondents were noted to have good knowledge of the mathematical content displayed by young children, they were not as aware of mathematical processes. The researchers recommend that professional learning programs put greater emphasis on processes, making clear the link between "understanding basic concepts and words and the development of ways of thinking and other mathematical processes" (Hunting et al., 2012, p. 46). Recognising mathematical thinking displayed by children and knowing how to develop this further is an important aspect of expectations of teachers about their students. If they expect to see mathematical processes being used by young children, they are more likely to look for them and encourage this activity through planned learning experiences.

Averill (2012), in a mixed methods study in the context of Year 10 multiethnic classrooms in New Zealand, took a perspective of culturally responsive teaching with a focus on teacher care. In reporting on 100 observed lessons from three teachers, patterns within the data indicated that, "the lessons exhibiting the most caring teacher behaviours and practices were those with greatest student engagement (i.e., highest levels of on-task student behaviour) and the most student-initiated interactions (related and unrelated to mathematics)" (p. 121). The teachers articulated the challenges and their own personal limitations as they strove to teach to the needs of culturally diverse classrooms.

The literature reviewed here provides some evidence of the value of inclusive and alternate pedagogies. It also highlights the importance of teachers' expectations and values and the need to be mindful of those of their students. One of the difficulties with using this literature to inform teaching is that it often comes from a variety of theoretical perspectives beginning with the particular area of student need or disadvantage. There can then be a tendency to argue for inclusive practices that include those who are being studied but does it genuinely expand the opportunities for all? Sullivan (2015a) argues that while it is much more difficult to redress student differences than to identify them, "it is also possible that steps that education providers take to redress differences can sometimes exacerbate the exclusion of some students" (p. 3). He acknowledged the complexities of providing advice to teachers based on research but argues that, "age appropriate experiences are more likely to enhance the inclusion of marginalised students than merely activities that are matched to the levels achieved by the student on systemic or standardised assessments" (p. 12).

Faragher (2014), in reporting on two case examples involving students with Down syndrome in inclusive settings presents a similar argument. While these cases are anecdotal, they provide existence proofs of the possibilities for surprising mathematical development with students who have generally been excluded as they have not been considered capable of engaging in secondary mathematics. She argued for greater inclusion of students with mathematical learning difficulties rather than a limiting of their mathematical experiences.

5.3 Direct Instruction

In recent times, renewed discussion at the policy level has involved the teaching approach, Direct Instruction (DI). This is claimed to be of particular benefit for low attaining students such as those with learning disabilities and in more recent applications, Indigenous Australian students. Initially developed in the United States in the 1960s, it has been revised and refined over the years. The US Department of Education's *What Works Clearinghouse* defines the approach as, "a teaching technique based on extensive task analysis. Instruction is fast-paced, teacher-directed, prescribed, and explicit with all children receiving instruction on a pre-specified sequence of activities at the same time" (Institute of Education Sciences, 2007, p. 3).

A significant body of research into the effectiveness of DI has occurred over the decades with conflicting results. The What Works Clearinghouse considers "the extent of evidence for Direct Instruction to be small for oral language, small for print knowledge, small for cognition, and small for math" (p. 1). The challenge here is at the heart of the disparity between advocated approaches in special education and general mathematics education. Ewing (2011) reviewed evidence for and against DI and noted the tension between traditional and behaviourist approaches to mathematics teaching and learning and noted criticisms were at the level of theory (assumptions about human nature and society) and practice (classroom practice is typically different from ideal formulations of DI). Ewing's review was published prior to the time scope of this review, however, we include it here as it provides a valuable source of research findings to underpin the discussion of this approach which is receiving renewed attention from education authorities in Australia.

In 2012, the Australian Council for Educational Research (ACER) was contracted by the Queensland Department of Education, Training and Employment, to evaluate the Cape York Aboriginal Australian Academy (CYAAA) Initiative, which features the use of DI for teaching mathematics. In the final report (ACER, 2013), the authors note that the initiative had only been underway for a few years and limited data were available to assess the impact of the initiative. They were unable to determine if the initiative had made a positive impact on student learning outcomes, though they noted teacher comments that achievement had increased more for literacy than numeracy.

With increasing interest by Australian governments in the implementation of Direct Instruction (Attwood, 2015), it is clear that mathematics education researchers need to be involved in rigorous evaluation of the teaching approach. Longitudinal studies are needed to provide sufficient time for the innovation to be implemented. Investigations of actual classroom practices would address the criticism of research findings that have been sourced from clinical settings. Finally, research is needed that tackles differences in the theoretical stance of researchers from special and general mathematics education communities, where reconciliation between behaviourist approaches and socio-cultural perspectives of learning is made.

This section has reviewed literature from the perspective of teaching. Across the three themes, common factors emerged such as location of schooling. In conclusion to this chapter, we turn now to implications for mathematics education research.

6 Conclusion

Inclusive practices in teaching mathematics has been a field of great importance in Australasia in recent times. The implications of the enacting of this practice has been the subject of on-going research, but much more is needed. In our chapter, we have reviewed the literature in a way that emphasises an inclusive approach. We have considered three key themes: policies and approaches that affect access to a mathematics education for all learners; diverse approaches to learning mathematics; and mathematics teaching approaches in inclusive contexts. In essence, we have looked at policies, learning, and teaching.

6.1 Areas of Needed Research

Our literature searches identified considerable research activity in the area of inclusive mathematics education research between 2012 and 2015. Even so, much, much more research is needed. Throughout this chapter, we have indicated gaps in the literature. Here we propose a composite list of areas where we advocate research:

- The impact on students of being taught by out-of-field teachers
- How teachers modify assessment instruments for use in inclusive classrooms
- The impact of negative stereotyping on school-aged students
- Influence of information and communication technologies on learning mathematics
- Roles of teacher assistants and parents in supporting the mathematics learning of students in specific contexts such as intellectual disability or distance education
- Carefully designed objective research trials of teaching innovations, such as Direct Instruction, especially with a longitudinal focus.

6.2 Recommendations for the Research Community

Continuing high standard qualitative research is critical in Australasia to ensure that findings from research studies into inclusive mathematics education practice are recognised and valued. Small populations and therefore, sample sizes, are likely to minimise opportunities for robust quantitative studies. However, qualitative

methodologies are well-established, as are protocols for gathering and analysing the data. Those used should be clearly documented in research reports. In addition to preparing scholarly publications, researchers can support each other in the development and use of qualitative techniques through master classes organised by research communities such as MERGA, training of research students, and sharing techniques in conference presentations.

While it is important to acknowledge that all classrooms are places of diverse student experience, background and capability, more specific research is needed into the effective practices of teachers in inclusive settings with specific categories of diverse learners. Even though we can learn much from research where a specific category of learner is the starting point, it is also valuable to research the classroom as the starting point. Sullivan (2015b) argues for a model of mathematics teaching designed to address the diversity of student preparedness in mathematics based on work focused on including and engaging all students. It assumes a common mathematical learning focus and requires teachers who are clear on the intent and the sequencing of tasks associated with that learning, have developed a communal classroom environment and are explicit about the pedagogies of mathematics teaching. Such work might also inform practices with specific groups of students.

Longitudinal studies are also to be encouraged. Innovations in educational practice take time to implement and become established before effects on student outcomes are observed and able to be measured (ACER, 2013). Unfortunately, these studies are rare and many innovations are not given sufficient time to become established before a new practice is implemented. Researchers may need to look to pseudo-longitudinal approaches where similar data are collected from different participants but in similar contexts at points separated by a number of years.

Research into enhanced inclusive mathematics education has the prospect of increasing the accomplishment and enjoyment of mathematics by all learners. This is a worthy goal, indeed.

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