Research in Mathematics Education in Australasia 2008–2011

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This is the eighth edition of the four-yearly review of mathematics education research in Australasia. Commissioned by the Mathematics Education Research Group of Australasia (MERGA), this review critiques the most-current Australasian research in mathematics education in the four years from 2008–2011. The main objectives of this review are to celebrate and recognise significant findings; highlight relationships between research; identify themes; and forecast further research directions. This theme-based review has produced a comprehensive analysis of Australasian research in a politically challenging time—producing a manuscript with implications for a wider, international, audience. As the 2009 Felix Klein medal winner Gilah Leder states:

A substantial body of research is captured in the chapters of this review. It encompasses the labours of a community of active researchers, with varied interests and diverse theoretical perspectives. Some of the issues explored in the period covered by this volume clearly resonate with questions and concerns particularly pertinent to the changing educational environment; others are more aptly described as continuing or renewed explorations of areas of long standing concern.
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INTRODUCTION

MATHEMATICS EDUCATION RESEARCH GROUP OF AUSTRALASIA (MERGA)

MERGA is a professional association for those interested in mathematics education research in Australasia. MERGA is an association that aims to:

- promote, share, disseminate, and co-operate on quality research on mathematics education for all levels particularly in Australasia;
- provide permanent means for sharing of research results and concerns among all members through regular publications and conferences;
- seek means of implementing research findings at all decision levels to the teaching of mathematics and to the preparation of teachers of mathematics; and
- maintain liaison with other organisations with similar interests in mathematics education or educational research.

MERGA has an annual conference. It also has a regular schedule of publications. These include refereed conference proceedings, two journals—Mathematics Education Research Journal and Mathematics Teacher Education and Development, a four-yearly review of mathematics education research in Australasia, books arising from Special Interest Groups, and some sponsored monographs. Electronic newsletters are distributed to members, and there is a moderated list for announcements as well as a web-based discussion forum for members. Further information concerning MERGA can be found at the group’s website (www.merga.net.au).

SCOPE OF THE REVIEW

The review is the eighth such four-yearly review of research in mathematics education that has been commissioned by MERGA. Beginning with the Summary of research in mathematics education in Australia (Briggs, 1984) which was published to coincide with Australia’s hosting of the fifth International Congress on Mathematical Education (ICME), the publication has grown into an important critique and celebration of Australasian mathematics education research that is eagerly anticipated by MERGA members and many other mathematics education researchers across the world.
This review, entitled *Research in Mathematics Education in Australasia 2008–2011*, uses the same definition of Australasian mathematics education research as the previous one did:

The editors have defined “Australasian research” as research conducted in Australasia, about the Australasian context, or by Australasians. Australasia comprises: Australia, New Zealand, Papua New Guinea, and the Pacific Islands closely allied to Australia and/or New Zealand. (Forgasz et al., 2008, pp. 1–2)

The primary purpose of *Research in Mathematics Education in Australasia 2008–2011* is to highlight significant findings, demonstrate links among research, identify trends and foreshadow possible future research directions. Only research which has been published (books, book chapters, peer-reviewed journals, peer-reviewed conferences, research reports for funding bodies) during 2008–2011 has been considered. Space precludes the reporting of all Australasian mathematics education research published during the four-year period designated and chapter authors have made decisions about the selection of publications on which they have reported.

EDITORS OF THE REVIEW

The editors for the *Research in Mathematics Education in Australasia 2008–2011* were chosen from expressions of interest submitted to the MERGA executive. The successful editorial team consists of experienced and early career mathematics education researchers drawn from the Research Institute for Professional Practice, Learning and Education (RIPPLE), a leading research centre within Charles Sturt University. All editors are members of MERGA.

THE PROCESS OF WRITING CHAPTERS IN THE REVIEW

Two complementary processes were used to choose lead authors and author teams for each of the chapters:

- some MERGA members were approached directly by the editors to seek their willingness to lead chapter author teams; and
- a general call for chapter author teams was made via the MERGA Vice-President (Publications).

In either case, it was suggested by the editors that chapter author teams should include a mix of mathematics education research experience, gender and country of origin. All authors needed to be members of MERGA. The result of this recruitment drive was 15 author teams made up of 50 individuals spread across all of these variables.

Each author team (except for those writing the first and last chapters) developed a draft of their chapter by early 2011. Each of these 13 chapters was sent to two reviewers for assessment of their suitability for the review. The editors consolidated these reports and sent them to the author teams who had the task of revising the chapters by the end of October. Two of the editors met with representatives of most of the author teams at the MERGA conference in July, 2011 to follow up on the
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suggestions made by the reviewers. Final drafts of these 13 chapters were submitted by the end of October, 2011. Drafts of the first and concluding chapters were submitted during November, 2011 and were reviewed independently by members of the editorial committee. Revisions were undertaken by the author teams as necessary. All chapters were copy-edited by Dr Rosemary Farrell between November, 2011 and February, 2012.

COMPONENTS OF THE REVIEW

Research in Mathematics Education in Australasia 2008–2011 is broken into four major sections:

- Contexts for Mathematics Education
- Mathematics Learning and Teaching
- Teachers
- The Future.

Contexts for Mathematics Education

The importance of contextual aspects in mathematics learning and teaching is emphasised by both the size of this section and its diversity. Chapters around the contexts of mathematics learning have featured strongly in previous MERGA research reviews and this is reflected again in the current review. Although there is not specifically a chapter on the politics of mathematics education, as has been the case in a number of the previous MERGA research reviews, politics abounds in many of the chapters in this section (and, indeed, in other chapters). Similar comments can be made about issues around gender in mathematics learning and teaching. For the first time in this series of reviews, there is no specific chapter on gender as it is highlighted in many of the chapters. In both cases, such developments can be seen very positively as these topics are being incorporated into other challenges in mathematics education in ways that highlight their influence in these areas.

The section begins with a reflection on the previous review: Research in Mathematics Education in Australasia 2004–2007 in which Clarke and her colleagues highlight what had been seen as the strengths and deficiencies in the research reported in the previous review and ask readers to use these to measure changes reported in the current review. This chapter challenges readers to consider how the political and social contexts of Australasian mathematics education research have changed since 2004–2007 and to reflect on whether the research reported in the current review has met the challenges arising from these changes. While not every reader will agree with some of the conclusions made by Clarke and her colleagues, there can be no doubt that this chapter does set down some criteria against which the impact of the current review can be measured.

In what is the third chapter on affective issues in mathematics education to appear in MERGA research reviews, Lomas and his colleagues report a lessening
emphasis on the study of beliefs and an increase in matters of identity in mathematics education research, as well as continuing interest in a diverse range of research into affective aspects of mathematics education. There appear to be increases in the amounts of research at the primary school level, coupled with an increase in observational approaches to data gathering. While there are some strong developments reported in this chapter, the continuing challenge for the authors is the relative lack of strong theoretical frameworks informing both research and practice in the affective domain.

The third chapter of this review considers a very broad area of mathematics education research centred on various aspects of the social contexts in which people learn mathematics. Atweh, Vale and Walshaw (2012, p. 39) suggest that the chapter is based on the premise

students’ experience the education of mathematics differently, based on their learning opportunities and achievements that depend on the social context of their families and the schools they attend. Often such ‘background’ factors are associated with disadvantage, marginalisation, disengagement, and exclusion from the study of mathematics. There is also a heavy economic, social and political cost for the students individually, their communities and the broader society.

While the chapter reports a great deal of research in the areas of ethics, gender, diversity, rurality and socioeconomic status, it does note a move towards research using the more encompassing construct of social justice. It also notes the importance of globalisation in current and future research in the area. The chapter concludes with a stark reminder that, in spite of the large body of work in the many areas covered by the chapter, inequality still exists and continuing effort and commitment are required.

The next two chapters of the review build on the work of Atweh and his colleagues by considering two specific groups of students: Indigenous students and exceptional students. While there are some overlaps across these, and other, chapters in terms of the research cited, the editors see this as a strength of the review. Considering different research outputs from multiple perspectives means that their relevance to various aspects of mathematics education research can be tested and critiqued.

Meaney and her colleagues provide a strong critique of the substantial and increasing amount of mathematics education research relating to Indigenous students that has been reported in the 2008–2011 period. While critical of the positioning of Indigenous people in much of this research, the authors have considered the available research from theoretical, methodological and practice-based perspectives. They have celebrated research that has emphasised the strengths of Indigenous people and have been quite critical of the reliance on tests such as the National Assessment Program – Literacy and Numeracy (NAPLAN) in Australia. There is need for much more research around Indigenous students’ learning of mathematics but focused on the strengths of these students rather than on their continued poor showing on tests developed from a Western paradigm.
Borrowing from Gervasoni and Lindenskov (2011), Diezmann and her colleagues consider the characteristics of learning environments in which exceptional children—those who are gifted and those who are experiencing learning difficulties—can thrive. The authors consider both groups of exceptional children separately and critique the research pertaining to each. For gifted children, matters such as identification, educational provision, role of adults and cultural perspectives are canvassed. For children experiencing learning difficulties, the challenges of identification and labelling are enormous. Consequences of these challenges and attempted solutions are discussed in the chapter. Approaches to teaching and learning for children experiencing learning difficulties are critiqued with a contrast being drawn between socio-constructivist and direct instruction approaches. Some warnings are given concerning the possibility of over enthusiasm in the interpretation of some evaluation results. The research on ability grouping and its impact on exceptional children is discussed, with one conclusion being the need for further research focused on pedagogy within the groups as well as the structural aspects. The chapter concludes with a plea for further research that considers how exceptional children can thrive in their mathematics education.

The final two chapters in the *Contexts for Mathematics Education* section of the review—*Technology in mathematics education* and *Assessment beyond all: The changing nature of assessment*—also canvass some of the same research, particularly in terms of the impact of ICTs and web-based technologies on assessment. However, their perspectives are quite different.

The technology chapter is organised into four sections: Learning Contexts and Curricular Design; Learners, Learning, and Digital Technology; Teachers, Teaching, and Digital Technology; and Gender, Affect, and Technology. In each of these sections, a comprehensive summary of the extant research is provided. Generally, the research reports the benefits of the use of technology in mathematics education. However, there are a number of warnings about students’ and teachers’ abilities and knowledge and curriculum traditions perhaps constraining the potential of the technologies to enhance mathematics learning and teaching and indeed change the nature of the mathematics being taught and learnt in Australasian schools. Geiger, Forgasz, Tan, Calder and Hill (2012, p. 133) suggest “that the inclusion of technology in mathematics education may not be fulfilling its promise of revolutionising the way mathematics is taught and learnt”. The Gender, Affect and Technology section has some overlap with the Lomas, Grootenboer and Attard chapter, but considers the research through a different lens. The varied results reported in terms of gender and other affective matters point towards the need for much more research in this area. The chapter concludes with a list of such ‘future’ research, including the need for larger scale studies in areas such as the impact of digital technologies on learning trajectories, social interaction and learning communities, and understanding and attitudes to mathematics learning.

In many ways, the chapter on the assessment of mathematics learning is a direct ‘sign of the times’ in Australasian, and particularly Australian, mathematics education. There has not been such a chapter in previous reviews but the development of several regimes of both national and international high-stakes
testing of students and increased standards-based accountability for teachers has made such a chapter a high priority. The chapter is organised into sections dealing with the national assessment agenda, classroom assessment, curriculum content and related assessment items, and assessment of both the content and pedagogical content knowledge of teachers. Lowrie and his colleagues, whilst recognising the potential of national assessment for mathematics education researchers, counsel against building a reliance on such assessment in spite of its political—and, therefore, potential funding—importance. Research is presented questioning the nature of the assessments being undertaken and the dangers that may be lurking for particular learners. Paradoxically, research in classroom assessment of mathematics learning has developed and evaluated many innovative approaches to assessment for learning that have assisted teachers at all levels from preschool to secondary school. Along with this has come an increased interest in curriculum content and items designed to assess this content. Important work is reported concerning ways in which small changes in the design of test items can change apparent student outcomes. The chapter concludes with suggestions for future research in what will inevitably become a key area of Australasian mathematics education research.

**Mathematics Learning and Teaching**

Five chapters in the review have been grouped under this heading. The first four deal with ‘levels’ of education and the learning and teaching of mathematics at each of the levels. The fifth chapter is anomalous in that it is the only content specific chapter in the entire review.

The strong tradition of early childhood mathematics education research in Australasia continues to be represented through the chapter from MacDonald and her colleagues. While noting a slight reduction in the quantum of research output, they highlight much quality research that is destined to have a higher profile than in the past because of national political and educational interest in both Australia and New Zealand in the importance of early mathematics learning to future success. The chapter is divided into three key sections: context; pedagogy; and content. The first section highlights the extensive research effort over the review period in the area of mathematics education for young Indigenous learners. In both Australia and New Zealand, this area has been a key focus politically, educationally and through funding. Results have been mixed in quality and impact, as might be expected in such a burgeoning field. While there are many contextual differences, there is much that New Zealand researchers can learn from their Australian counterparts and vice-versa. The use of technology in early childhood education is a key field of endeavour, as are play, assessment of mathematics learning and the professional development of early childhood educators. Research into mathematical content and young children has been restricted generally to number, algebra and measurement. The chapter concludes with an extensive list of research required over the next four years, including: enhancement of current research with Indigenous children, educators, families and communities through
the development of more appropriate methodologies; the impact of new curricula on the mathematics learning of young children; and the impact of assessment regimes, including school entry assessment on young children’s mathematics learning.

An early decision by the editors of this review, partly motivated by the current emphasis in both Australia and New Zealand on new, national curricula, was to conceptualise the chapters dealing with the school years and mathematics education not into the traditional ‘primary’ and ‘secondary’ groupings but into ‘pedagogy’ and ‘curriculum’.

The chapter *Powerful pedagogical actions in mathematics education* considers Australasian mathematics education research under three main themes: creating powerful learning environments; selecting tasks and models that promote deep learning; and knowing and using pedagogical knowledge. There has been a great deal of research about creating powerful learning environments, particularly in terms of the construction of positive, culturally appropriate relationships between teachers and students and among students. The importance of relevant interactions among all the players and with the curriculum, are highlighted. In these interactions, language clearly plays an important role, as do questioning, generalising and the development of sound argumentation strategies. The selection of rich and authentic tasks for use in children’s mathematics learning, along with problem solving and modelling derived from these tasks, are critical pedagogical actions. The research reviewed has highlighted the links between powerful pedagogical actions and teachers’ content and pedagogical content knowledge. Not all teachers would appear to be sufficiently knowledgeable in these areas and more work needs to be done. This is particularly the case in the use of digital technology (see Geiger et al., 2012). Gervasoni and her colleagues conclude their chapter by suggesting that there needs to be extensive continuing collaborative research about relationships between culturally responsive pedagogy and powerful mathematics learning.

The chapter *Mathematics curriculum in the schooling years* provides a survey of the Australasian research undertaken in what will become a burgeoning area for mathematics education research over the next few years. The opportunities provided by the development and introduction of new curricula in both New Zealand and Australia should stimulate much innovative work. The current chapter begins by considering both the mathematics and numeracy lenses on school learning. Key research and reports are canvassed as background to the development of mathematics curricula in both Australia and New Zealand which is described in some detail. Critique of the curriculum content in Australian schools and of the level of expectation raised by mathematics textbooks commonly used in schools suggests that there are ongoing challenges around what has become known as the ‘shallow teaching syndrome’. Summarising the research on the implementation of mathematics curricula in Australasia leads Anderson, White and Wong (2012, p. 240) to conclude that “curriculum reform through the written or intended curriculum does not necessarily lead to reform in the enacted curriculum via new teaching practices”. The need for ongoing research is emphasised.
Tertiary mathematics education research has featured in a number of the previous reviews. In the chapter *Growth and new directions? Research in tertiary mathematical science education*, Barton and his colleagues explore a number of themes that have been canvassed in previous reviews and others that are new. One key theme is that of transition between school and university and the implications for mathematics education of that transition. While the contexts are quite different, there are many similarities between this section and the corresponding section in MacDonald, Davies, Dockett, and Perry (2012), emphasising the generalisations that can be made across many educational transitions. The teaching of specific mathematics topics, particularly linear algebra, mathematical modelling and calculus, at the tertiary level has received some consideration over the review period, as have the more generic issues of undergraduate mathematics and quantitative skills in science and engineering degrees. There is also substantial quality research in tertiary statistics education.

The numbers of tertiary students undertaking courses in mathematics is of universal concern and New Zealand and Australia were part of the International Mathematical Union (IMU) and International Commission for Mathematical Instruction (ICMI) *Pipeline Study* investigating this matter. Other research related to this study is also reviewed in the chapter. In terms of general pedagogical research at the tertiary level, it is perhaps surprising to see an amount of work being undertaken into lecturing and little in the area of technology use in tertiary mathematics education.

The area of tertiary mathematics education research is complex in terms of its diversity, who does it—mainly mathematicians, and what impact it has on practice. MERGA reviews have considered it over a number of years and this chapter continues to think critically about research into an area of practice that is critical in the development of future mathematicians and mathematics teachers.

The strength of the research in statistics education in Australasia has resulted in a separate chapter reviewing this area in the 2008–2011 review. This chapter, entitled *Uncertainty in mathematics education: What to do with statistics?* reflects both the curriculum and research pressures that have been exerted in Australasia and beyond as statistics education strives for its place in mathematics education. By considering the synergies and tensions represented by statistics education, Callingham, Watson and Burgess critique the Australasian statistics education research published in the review period resulting in commentary on differing aspects of mathematics and statistics and their teaching. The authors make a distinction between statistics and mathematics education on the basis of the importance of context and use this to explore pedagogical content knowledges in statistics education. The chapter concludes with implications from the synergies and tensions for research, policy and practice.

The *Teachers* section of the current review comprises two chapters, one dealing with pre-service teacher education and the other with the professional learning of practising teachers. Both of these chapters have their counterparts in many of the previous reviews, reflecting the ongoing interests and expertise of Australasian mathematics education and teacher education researchers.
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The political, social and economic contexts in which pre-service teacher education is undertaken is highlighted by Anthony, Beswick and Ell in the chapter *The professional education and development of prospective teachers of mathematics*. They critique Australasian research on recruitment of teachers, knowledges of teaching, transition to teaching, teacher education practices and researching of mathematics teacher education by mathematics teacher educators. While they acknowledge and celebrate the high quality of the research under review, the authors agree with Ball and Even (2009) that there was still much to be done, particularly in the areas of researching mathematics teacher education practice, knowledges and supports required for quality mathematics teacher education and the assessment of teachers’ learning.

The political, social and economic imperatives raised by Anthony and her colleagues are continued by Bobis, Higgins, Cavanagh, and Roche in their chapter which focuses on research into knowledge in mathematics education and development in practising teachers. This sharp focus not only allows the critique of a substantial number of Australasian research publications but it also celebrates the increased attention being given to teachers’ knowledge and its importance in the educational endeavour. The chapter considers four substantive areas: nature of teacher knowledge; frameworks for researching teacher knowledge; domains of teacher knowledge; and acquisition of this knowledge. Future research needs are outlined including cultural aspects of teacher knowledge, the extension and development of frameworks for researching teacher knowledge and research into the links between teacher knowledge of mathematics and student learning outcomes.

*Research in Mathematics Education in Australasia 2008–2011* continues the trend begun in the 2000–2003 and continued in the 2004–2007 review by asking one of Australasia’s eminent mathematics education researchers to write a future-looking chapter which reflects on the overall review and move the field forward into the next quadrennium. In this review, the editors are honoured that the 2009 recipient of the Felix Klein medal, Professor Gilah Leder, has written the ‘into the future’ chapter.

For each of the chapters in the review, Leder summarises, critiques and offers her view on what might be ‘the next steps’ in each of the areas. In her conclusion, she consolidates these thoughts and then considers a number of areas of endeavour which, she believes, are not so well represented in Australasian mathematics education research.

CONCLUDING COMMENTS

For the editors of this review, it has been a pleasure to interact so closely with the output of their mathematics education research colleagues. While there are many benefits to the authors in writing chapters for the review, the major benefit of their substantial and careful work lies in the increased access researchers, students, policy makers and practitioners have to the research that has been critiqued. Past reviews have been praised for their impact on doctoral studies, ongoing research.
programs, policy and practice both within Australasia and beyond. Providing the chance to celebrate Australasian research and make it more easily available is something about which MERGA should be very proud.

Readers of this review are assured of quality critiques of important research in mathematics education. While the research does have an Australasian flavour through its authors and/or its settings, its impact goes far beyond this geographical region. Of course, care needs to be taken in adapting research methodologies, methods, analysis and results to fit different contexts and different times. Nonetheless, the review will provide a solid basis in many of the most important and popular fields of current mathematics education research. We commend the review as both an excellent starting point for thinking about readers’ own research projects and a celebration of a fine tradition of Australasian mathematics education research.

ACKNOWLEDGEMENTS

The editors wish to acknowledge the financial and in-kind support provided by both the Mathematics Education Research Group of Australasia (MERGA) and the Research Institute for Professional Practice, Learning and Education (RIPPLE) at Charles Sturt University. In particular, Colleen Vale, MERGA Vice-President (Publications) for most of the production period for the review, has been generous and firm in her ongoing support to the editors. Michel Lokhorst from Sense Publishers has been at the ready whenever questions needed to be answered and has continued his enthusiastic support for the review throughout the production period. The 50 chapter authors and 26 reviewers deserve particular credit for their work, their willingness to accept the time pressures involved and their good graces in reacting positively to critiques of the chapter drafts from the editors. Finally, the editors wish to acknowledge the work of Dr Rosemary Farrell who took on the task of ensuring the entire publication was appropriately and consistently formatted, proofread and generally made Sense.

As editors, we are proud of what we have achieved in delivering this latest MERGA review. We have worked hard to get to this stage and are, of course, responsible for any deficiencies, errors or gaps that remain. We could not have reached this point without a great team effort from everyone involved. We hope you enjoy the result.

REFERENCES


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CONTEXTS FOR MATHEMATICS EDUCATION
REFLECTIONS ON THE MERGA RESEARCH REVIEW 2004–2007

INTRODUCTION

The tradition of the MERGA four-year review provides evidence of sustained and evolving research within the Australasian mathematics education community. As part of the editing team for the previous review (Forgasz et al., 2008) we appreciate the opportunity to reflect on that review and to provide some personal insights into recent developments.

The chapter headings from the 2004–2007 review were:

- The development of young children’s mathematical understanding
- Learning mathematics in the middle-years
- University learners of mathematics
- Adults returning to study mathematics
- Mathematics education and Indigenous students
- Research into the teaching and learning of applications and modelling in Australasia
- Teaching and learning with technology: Realising the potential
- Characteristics of effective pedagogy for mathematics education
- Sociocultural perspectives in mathematics teaching and learning
- The affective domain and mathematics education
- Gender and mathematics: Theoretical frameworks and findings
- Research on the pre-service education of teachers of mathematics
- Teachers as learners: Building knowledge in and through the practice of teaching mathematics

While many of these are similar to those from previous reviews, the inclusion of a specific chapter on teachers as learners reflects the increased interest in researching teacher professional learning. There was also a reduced focus on content specific chapters.

In his concluding chapter to the 2004–2007 review, Ken Clements (2008) noted various reasons why not all areas of Australasian mathematics education research are covered in any review. Clements identified three particular areas that were not covered in the previous review:

- Australian and New Zealand performances on recent international comparative performance studies;
whether mathematics education research has generated important and measurable improvements in mathematics curricula and mathematics teaching and learning; and

- the role of theory in mathematics education research.

A comment on each of these areas seems appropriate.

On a regular basis, Sue Thomson and her colleagues at Australian Council for Educational Research provide detailed reports of Australia’s performance in PISA and TIMSS (e.g., Thomson, De Bortoli, Nicholas, Hillman, & Buckley, 2011; Thomson, Wernert, Underwood, & Nicholas, 2008), including on a range of affective and other measures. Since 2008, the Australian Curriculum and Reporting Authority have provided detailed reports on NAPLAN performance across Australia. Mathematics education researchers, who are particularly interested in the relative performance of identifiable sub-groups in the population or researching affective factors, increasingly use the data to support the rationales for their research domains and/or specific research studies. When relative performance is of interest, some of the following variables alone or in combination are examined: gender, socioeconomic status, Indigeneity, geographical location, and ethnicity (as measured by language background). These types of data are consulted by those focusing on state and territory differences as well as those interested in relative performance of students in specific content domains of mathematics. While much of this information is canvassed in various chapters in the current review, future editors might consider a chapter dedicated to an overview of government and other significant reports on performance, as well as other critical issues related to mathematics education or, alternatively, a return to a chapter on the politics of mathematics education.

A less straightforward dimension of our work to assess is Clement’s second area, the impact of mathematics education research on curricula and mathematics teaching and learning. Specific funding for evaluations is scarce, particularly in the longer term. Often evaluations are included in government funded projects such as interventions, but studies of whether any benefits obtained in the short term are sustained over time are less often supported financially. Currently, in Australia, the program emphases and opportunities are to examine and explore the impact of the curriculum on children’s learning, on teachers’ practice, and on pre-service education and professional development. It is to be hoped that the preliminary work that has been undertaken in the review period will be extended into the future (see chapters by Anderson, White, and Wong; Anthony, Beswick, and Ell; Bobis, Higgins, Cavanagh and Roche in this review).

As Clements also highlighted, there was a lack of theoretical discussion in many of the chapters included in the 2004–2007 MERGA review and authors also identified a lack of theoretical development in various fields. This again is partially explainable through a dearth of research funding for theoretical and/or philosophical pursuits in our field. Research based in theoretical frameworks that are old is not necessarily poor research; nonetheless such work can, and should be building on the theories that underpin them. Often, however, researchers do not capitalise on the new dimensions or variables that their research has uncovered.
Challenging researchers to do this and to write in ways that herald that their research has resulted in a new or revised theoretical model or framework will strengthen the field.

IMPACT OF THE RESEARCH POLICY ENVIRONMENT

In the introduction to the 2004–2007 review, the editors identified the changing political context in which mathematics education researchers found themselves (Forgasz et al., 2008). They predicted a further tightening of accountability measures for research funding and research activity developments in Australia and New Zealand. They identified four dichotomies and their complementarities which they characterised as:

– A decrease in creative and idiosyncratic research versus an increase in programmatic research
– A decrease in individual research versus an increase in group or team research.
– A decrease in funding for basic research versus an increase in funding for practice-oriented projects
– A decreasing concern with the quantity of research versus an increasing concern with the quality of research

Particularly following the voluminous and stressful work that universities undertook in the Excellence in Research in Australia [ERA] exercise, and the ongoing demands of the Performance-Based Research Fund in New Zealand, the previous editors’ predictions appear to have come into being. The dichotomies and complementarities listed above remain and, if anything, are more clearly apparent during the 2008–2011 period. Readers of this review may want to consider the impacts of recent and current research policy frameworks on Australasian mathematics education research.

UNDER-REPRESENTED AREAS AND RECENT DEVELOPMENTS

Authors and editors of the 2004–2007 review identified areas that remained under-researched and under-theorised, following the trend that the authors of previous reviews had established. Wood (2008) described mathematics learning and teaching at university as being in a state of flux. No research had been reported on university students’ attitudes toward the difficulty, the cognitive competence and the perceived value of university statistics courses. To some extent, this has been addressed by Barkatsas (in press) who reports that female Australian university students demonstrated increased confidence in their competence as learners of tertiary statistics. Other research on tertiary statistics education has been reported in this review in the Barton, Goos, Wood, and Miskovich chapter.

In the previous review period there was little published research in the Australasian mathematics education literature focusing on children with special needs. The work on early years intervention, particularly within the context of systemic-based projects, has continued but there appears to be little work within
mathematics education research about students with physical disabilities or students with learning disabilities. It is estimated that approximately 3% to 8% of the school-age students have mathematical disabilities. In their meta-analytic study, Swanson and Jerman (2006) reported that “mathematical disabilities (MD) are as common as reading disabilities (RD) and that a similar deficit may contribute to the co-occurrence of MD and RD in some children” (p. 249). It has been many years since children with various physical and learning disabilities have been integrated into mainstream schooling, yet knowledge on effective teaching approaches to adopt with them is sparse. Working with our colleagues with expertise in special education should be encouraged.

The impact of gifted and talented students’ education on attitudes toward the gifted and the self-perceptions of gifted are other areas that continue to be under-researched.

In the current review, research on the mathematics learning of both children with learning difficulties and gifted children is considered by Diezmann, Stevenson, and Fox in their chapter ‘Supporting exceptional students and the learning of mathematics’. The foregrounding of this research is encouraging.

A final area in which there has been limited writing in recent times is in the philosophical realm of mathematics education. Is the mathematics we teach defensible in the political, economic, and technological world of students? Are the contexts we use for problem-solving and investigations ethically and morally sound? Are the teaching and learning approaches equitable and culturally sensitive? These philosophical elements are also deserving of Australasian mathematics education researchers’ time and attention.

BUILDING ON AND DEVELOPING PREVIOUS WORK

Reflecting the trends noted in the previous review, Australasian research, adopting the sociocultural perspective to mathematics learning and teaching, has continued to utilise approaches that were not hitherto employed much, if at all, in the region. It is an area of relative strength that continues to develop. Thus, for example, Prescott and Cavanagh (2008) reported on their employment of situated learning perspectives (Lave & Wenger, 1991), while McMurchy-Pilkington, Bartholomew and Greenwood (2009) made use of the notion of space of learning (Johnston, 2002) in their study with Māori students and their parents. Brown and Redmond (2008), on the other hand, interpreted the professional activities of a few teachers using the construct of teacher agency (Pickering, 1995). The approaches used in these studies reflect a maturing sociocultural research agenda in Australasia as researchers built on and expanded previous frameworks of investigations.

The current review period also saw the continuation of the research activities of Galligan (2008) and Goos (2008) in adopting Valsiner’s theory of human development, applying it to deepen our understanding of the mathematics skill development of adult learners, and of the professional development of teacher educators respectively.
The apparent focus on the adoption of novel research approaches and perspectives might have reinforced Seah, Atweh, Clarkson and Ellerton’s (2008) observation in the previous review that

the literature abounds with interesting ‘mapping’ exercises, but studies which peel back the layers of respectability and accepted theories, to lay bare realities and fundamental ways of finding research-based strategies which make a difference in the mathematics classroom, are few and far between. (p. 242)

However, Brown and Redmond’s (2008) study investigated teachers’ agency during professional conversations and provided an example of a research overlap between mapping the field and finding research-based strategies. It represents a study in which socioculturally-based pedagogical strategies were identified through a design experiment (Schoenfeld, 2006) that began with no pre-conceived notion of how teachers negotiated their dance of agency (Pickering, 1995) between disciplinary agency and human agency.

On the other hand, research into the values aspects of mathematics pedagogy has developed in ways which broaden the mapping-the-field approach. The Australian-coordinated Third Wave Project, initiated in 2009 to document what students from 11 different countries and regions valued in effective mathematics lessons, extended our understanding of students beyond Australian classrooms (e.g., Kor, Lim & Tan, 2010; Law, Wong & Lee, 2011; Seah, 2011). Data collected from students across the countries/regions enable cross-cultural comparisons to be made, which potentially deepens our understanding of what students value in multicultural Australia.

INFORMING POLICY AND PRACTICE

In addition to the increased accountability within the tertiary sector in relation to research, schools and systems have also seen the impact of accountability policies. A significant series of events since the previous MERGA review included the consultation around the Shape Paper that established the principles for the Australian Curriculum: Mathematics, followed by the consultations associated with the development of the content descriptions. It is interesting to consider the extent to which the reviews of MERGA research influenced both the consultations and the outcomes. Reviews are an important opportunity to synthesise evidence that can inform policy and practice as well as provide synthesis for those within the field. This notion is canvassed in the current review chapter by Anderson, White and Wong.

While mathematics education researchers were well represented at each of the consultations associated with the curriculum development through appointments to advisory committees, the types of debates and discussions that occur at MERGA meetings, and in journals, were not prominent. It is relevant at this time to reflect on why this appears to be the case.

It is possible that the nature and content of the consultations is an artefact of the highly consultative process used to develop the curriculum. Substantial input was
sought from teachers and others around successive drafts, piloting in schools across the nation, mapping of the drafts against the various state curricula, and many other steps beside. The advantage of this process is that a curriculum could be developed which was as familiar as possible to many teachers. The disadvantage is that the writing was informed by many contributions. In other words, there is a tension between seeking consensus and maximising coherence. In this process, the ‘voice’ of the mathematics education researchers was hard to hear. Perhaps this suggests that if mathematics education research has messages, then these messages need to be disseminated to the broader teaching community, as well as using the four-yearly reviews to endeavour to influence policy makers.

Perhaps there could be more emphasis by authors of MERGA research reviews on contributing to policy development. Indeed, it might be appropriate for some debate about the extent to which our research does seek to influence policy and practice.

Hattie’s (2009) 800 meta-analyses highlight one further issue that arises from the consideration of the impact of research on policy. The respective meta-analyses had synthesised results where changes in student learning were measured. These measurements are made by comparing experimental and control groups, or by pre- and post- treatment comparisons. But in all cases the studies that contributed to Hattie’s influential findings on schooling, learning, pedagogy, and even structures were informed by results that included measures of student achievement. On balance there seem to be too few of such studies reported and reviewed in the MERGA reviews. Are we likely to see changes as a result of stronger accountability frameworks including NAPLAN? Will they be changes for the better?

As previous editors, we look forward to studying the content of this review to see how our field has developed, to find out more about new and emerging areas, as well as how we have built on our strengths. While we have expressed concerns about the limitations and focused on possible gaps, it is important to acknowledge the strong contribution of these reviews both to the historic record but also to building our research and our discipline.

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THE AFFECTIVE DOMAIN AND MATHEMATICS EDUCATION

Key words: identity; self-efficacy; beliefs; attitudes; anxiety; motivation; methodological approaches.

INTRODUCTION

This is the third chapter on affective issues to appear in MERGA reviews of research in mathematics education and as such reflects the ongoing importance of affective issues to the mathematics education research community. The first two chapters (Grootenboer, Lomas, & Ingram, 2008; Schuck & Grootenboer, 2004) noted a continuing move away from studies on attitudes to projects on beliefs and the consideration of a broader range of affective aspects. In the current review period, 2008–2011, there is a lessening focus on beliefs, a growing focus on identity, and an even spread of studies on other affective aspects.

While there has been some work internationally on evolving understanding and description of affective concepts (e.g., Zan et al., 2006) this does not seem to be reflected in Australasian studies. Given the continuing relative paucity of work in Australasia on clarifying concepts, the use of Australasian or international frameworks, or the development of new theoretical frameworks, there has been little evolution of definitions in the four key aspects of affect considered in the first review chapter (Schuck & Grootenboer, 2004). As a consequence these continue to be used here and are restated below:

Beliefs are positions held by individuals that they feel to be true and their nature cannot be directly observed but must be inferred from actions. Although there are a variety of definitions of attitudes the common elements to these definitions are that attitudes are learnt and are evident in responses to a situation or object, and are seen as positive or negative. Emotions or feelings are described in terms of their transitory and unstable nature arising as an affective response to particular events/contexts whereas values are seen as criteria by which choices or assessments, in terms of desired/desirable outcomes or behaviours, are made. (Schuck & Grootenboer, 2004, p. 257)

There is work starting to theorise on the concept of identity including affective aspects and the impact of philosophical paradigms on the formation of identity. In contrast, there is little evidence of a more holistic view of the affect domain as a continuum, along with the cognitive, as proposed by Leder and Grootenboer
(2005), being used as a theoretical framework. This view was presented in the second review chapter (Grootenboer et al., 2008) as a prompt to the mathematics education research community to give greater consideration to theoretical frameworks and the place of individual studies within such.

The following sections consider Australasian mathematics education research on the affective domain. It discusses identity (or self-concept), self-efficacy, beliefs, attitudes, anxiety, motivation, and methodological approaches.

TOPICS/FINDINGS

In the broad area of affect in mathematics education, research has focused on a number of aspects, with about a third of the studies centred on identity and about a fifth on self-efficacy. Other affective aspects with around five studies each are beliefs, attitudes, anxiety and motivation.

Identity

The concept of identity has continued to be explored by Australasian researchers in mathematics education. Indeed, two of the keynote speakers at the annual MERGA conferences (Kemmis, 2008) have had a theme of ‘identity’ imbuing their address and associated papers. Apart from Ingram (2008a) who focused on secondary students, this research has primarily been undertaken with pre-service teachers (Tobias, Serow, & Schmude, 2010; Walshaw, 2009) and in-service teachers (Grootenboer & Ballantyne, 2010; Walshaw, 2010). Tobias et al. (2010) focused on ‘critical moments’ in pre-service teachers’ mathematical histories that influenced their ‘self-concept’. Grootenboer and Ballantyne (2010) examined mathematics teachers’ negotiation of their pedagogical and mathematics-based identities. The study of Ingram (2008a) was interesting in that it examined methodological issues in researching affective issues in learning mathematics through the lens of identity.

Unlike some aspects of the affective domain, research around the notion of identity has received particular theoretical attention. This was first noted in the previous review (Grootenboer et al., 2008), and has been continued with a particular emphasis on post-structural and psychoanalytical theory. Significantly, Walshaw continued her work examining mathematics education and identity primarily through psychoanalytical theory. In particular, she examined the negotiation of identity by pre-service teachers during their practicum (Walshaw, 2009), mathematics education researcher identity and mathematics teacher identity, reflective practice, and teacher development (Walshaw, 2010). Together, these articles and conference papers, along with her work prior to 2008, provide a rigorous theoretical foundation for continued research into the affective domain in mathematics education, and in particular the concept of identity. Despite advances in theoretical consideration of identity as a concept, it is still ill-defined. This requires more attention to the meaning taken in individual studies, and given the lack of statements on any theoretical position in many papers, this is problematic.
Self-efficacy

There were a small number of research reports that focused on the concept of mathematical self-efficacy. The qualitative study of teacher-researchers by Redmond and Sheehy (2009) focused on senior school mathematics teachers’ sense of agency as they used the ‘collective argumentation’ pedagogical approach. Carmichael and Hay (2008) reported on the development of an instrument to measure middle-school students’ self-efficacy vis-à-vis statistical literacy, and McConney and Perry (2010) examined the relationships between mathematics achievement, school socioeconomic status, and student self-efficacy with 15-year-old students through a secondary analysis of 2003 Trends in International Mathematics and Science Study (TIMMS) data. While these studies are interesting in and of themselves, there does not appear to be any themes of particular note across all the studies.

Beliefs

A continuing trend as seen in the last two MERGA reviews is a focus on beliefs about mathematics teaching and learning (Grootenboer et al., 2008; Schuck & Grootenboer, 2004). The studies conducted in the period 2008–2011 have predominantly focused on pre-service and practising teacher beliefs, with few studies focusing on student beliefs as in previous reviews. Researchers who have continued to address the area of beliefs are, for example, Beswick (2008, 2009, 2011a, 2011b), Beswick and Dole (2008) and Grootenboer (2008).

The focus of several studies was on the beliefs of pre-service teachers. Lo and Anderson (2010) conducted a study based on beliefs about mathematics teaching and learning in Hong Kong. Participants ranged from first to fourth year primary teacher education students intending to become specialist mathematics teachers. Lo and Anderson found beliefs were supportive of contemporary reform focused approaches and became stronger as students progressed through their course. In another study on pre-service teacher beliefs, Grootenboer (2008) focused on belief change during the course of study and found the responses fell into three categories: (a) non-engagement, where the focus was on passing the course; (b) those who formed a new set of contextualised beliefs based on their tertiary experience; and (c) those who engaged in belief change but found this challenging in terms of classroom practice.

A study by Bennison and Goos (2010) built on their previous work (Goos, 2009; Goos & Bennison, 2008) using their zone theoretical framework. It explored changes in Queensland secondary mathematics teachers’ pedagogical beliefs towards the use of technology in the mathematics classroom as a result of participation in professional development. Bennison and Goos (2010) reported that teachers who participated in technology related professional development were more likely to influence technology integration in a positive manner.

In a longitudinal study that followed people from their time as pre-service teachers through to five years later as practising teachers, Beswick and Dole (2008)
explored initial changes in beliefs and whether those new beliefs were maintained. During the initial phase of data collection the pre-service teachers described positive changes in beliefs that were attributed to the pre-service mathematics course and were in line with the course aims. After five years of teaching, the authors reported that teachers’ beliefs remained positive but were accommodated to the extent that the teachers perceived their beliefs as always having been positive.

Beswick (2008) evaluated a brief professional learning program aimed at improving the teaching repertoires of primary school teachers of mathematics. The evaluation found that teachers held differing beliefs about appropriate goals and methods of mathematics teaching for students with mathematics learning difficulties. These beliefs were susceptible to change when facilitated through professional learning with the teachers most likely to change their beliefs being those who volunteered to participate in professional learning.

The consistencies and inconsistencies between teachers’ professed and attributed beliefs remains a topic of study with, for example, Jorgensen, Grootenboer and Niesche (2009) examining this issue in a remote Indigenous education setting using a survey and lesson observations to collect data. Evidence from classroom observations highlighted discrepancies between teacher beliefs and actual practices, a finding comparable to those from other studies (e.g., Grootenboer, 2008; Sherley, Clark, & Higgins, 2008) where classroom observations were one method of data collection. Areas of mismatch found were inclusiveness, “group work, connectedness or applied contexts, and multiple pathways” (p. 284). For example, in the survey the participating teachers professed a commitment to group work as an effective and useful pedagogical approach in mathematics education, but during the lesson observations there was little evidence of students working in groups. The authors argued that the tension inherent in any mismatch should be seen as providing opportunity for professional growth, and their espoused beliefs should be seen as aspirational.

Other studies on beliefs focused on specific aspects of teaching mathematics. In an investigation of teachers’ beliefs about mathematics as a discipline and the work of mathematicians, Beswick (2009) explored data from one teacher who was found to have positive beliefs about the nature of mathematics as a discipline, while not fully understanding the nature of mathematicians’ work. Beswick claimed that any attempts to influence teachers’ practices should address both beliefs about school mathematics and the discipline itself. Additional studies focused on teachers’ beliefs in regard to textbook use (Jamieson-Proctor & Byrne, 2008) and teachers’ beliefs in regard to five-year-old children beginning school and mathematics (Sherley, Clark, & Higgins, 2008).

However, there is an international consensus developing (e.g., Leatham, 2006; Liljedahl, 2008) that many identified discrepancies between espoused beliefs and practices arise from methodological limitations, and the ways in which data is interpreted often without adequate theoretical underpinnings. Beswick (2011a, 2011b) discussed teachers’ various belief systems about aspects of mathematics and its teaching, and suggested these act as a matrix from which practice arises.
This more holistic view may help explain apparent discrepancies. Further work by Beswick, Callingham and Watson (2011) extended this approach in their measurement of teachers’ knowledge to include teacher beliefs about mathematics teaching and learning and their confidence to use and teach certain topics. Their results showed that this gave rise to a single construct measured by the instrument, implying that the affective aspects were integral to the teachers’ knowledge.

**Attitudes**

As in the previous review (Grootenboer et al., 2008), there have been few studies focused on attitudes towards mathematics. Young-Loveridge (2010) investigated how pre-service teachers’ attitudes towards teaching mathematics may be different to attitudes towards mathematics. Data was collected from a range of pre-service teachers via a mathematics test and questionnaire. However, findings in this study were limited, as students who chose not to participate also displayed a lack of confidence in, and negative attitudes towards, mathematics. Meaney and Lange (2010) also included data from a mathematics test taken by pre-service teachers and a questionnaire that explored their affective responses to being tested on primary school mathematical knowledge. The results suggested that the way mathematical knowledge was tested may have been detrimental in terms of its influence on future teaching practices, by consolidating procedural rather than encouraging conceptual understanding. In both studies the authors indicated some concern over the level of mathematical knowledge of pre-service teachers.

A variety of research into student attitudes was reported, many of which incorporated teaching interventions focusing on specific areas of mathematics. Norton and Windsor (2008) reported on a case study in which primary students in Brisbane developed more positive attitudes as a result of using concrete materials in an algebra intervention. However, several students stated that once the concept was understood, using materials actually slowed down their calculations. Similarly, in Jennison and Beswick’s (2010) study, Year 8 Tasmanian students indicated that the use of concrete materials and practical activities in a fraction intervention improved understanding and hence promoted positive attitudes towards mathematics. The study also highlighted interrelationships between attitudes, anxiety and understanding of mathematics. Afamasaga-Fuata’i (2009) reported that for some students intervention during the later stages of schooling (Year 10) may be too late to reverse entrenched negative attitudes.

Within a larger longitudinal case study on engagement, students’ attitudes towards mathematics following transition to secondary school were explored by Attard (2010). This followed an earlier report of the same group of students’ attitudes during their final year of primary school (Year 6). Attard found that although the Year 6 participants were aware of certain negative attitudes from peers and some parents, this was not an influence on their own positive attitudes. During the first year of secondary school (Year 7) the students’ attitudes appeared to become more negative towards mathematics as a result of difficulties forming positive pedagogical relationships with their secondary mathematics teachers.
The impact of pedagogical relationships on attitudes towards mathematics has been explored in several studies (Attard, 2011; Averill, 2011; Sullivan, Clarke, & O’Shea, 2010). A commonality between each of the studies was the finding that student learning was enhanced by the positive attitudes of teachers who were able to plan and modify tasks to suit specific student needs. In addition, Averill’s focus on teacher care highlighted the impact of cultural awareness within a multicultural school context.

The influence of others was also a theme in Leder and Forgasz’s (2010) research into the public’s perceptions of gender issues and school mathematics. The authors suggested an ongoing need to explore the views of all ‘critical’ others in the lives of students who may have some influence on their educational and career directions.

Motivation

During the period 2008–2011 some studies have emerged focusing on the construct of motivation. Carmichael (2010) wrote about the concept of ‘interest’ and its motivational influence on learning mathematics within the context of developing statistical literacy. In a mixed method study involving 425 secondary students, Carmichael (2010) found that students preferred to learn about statistical literacy within contexts outside the mathematics classroom. It was suggested that this finding was related to negative attitudes to mathematics rather than an interest in statistical literacy. Carmichael and Hay (2008) argued that interest development will be the result of a complex interplay of classroom influences and individual factors, such as “students’ knowledge of statistics, their enjoyment of statistics and their perceptions of competency in relation to the learning of statistics” (p. 109).

In a study of practising teachers, Anderson (2008) investigated reasons why 109 teachers attended professional development events, and the type of knowledge they valued. Anderson found that motivations for participation ranged from personal growth and recognition to a desire to learn new ideas for implementation of the mathematics curriculum.

Other Affective Aspects

Other studies on the affective domain have included focuses on mathematics anxiety, optimism, and the effects of seating arrangement on students’ affect. Two studies using bibliotherapy with pre-service and practising teachers were reported (Wilson, 2009; Wilson & Thornton, 2008) that build on the work of Wilson (2007). Wilson and Thornton (2008) found the use of guided reflections about school students’ learning difficulties were powerful in assisting the participants to overcome their own anxieties about mathematics. Wilson (2009) had the same results when five practicing primary teachers participated in professional learning. Wilson and Thornton’s (2008) work has implications for pre-service teachers in particular, with the potential to change attitudes, thus helping to prevent them
Lapsing into teaching styles based on their school experience, however, negative that may have been.

A number of studies on affect focused on low-attaining students. Williams (2008, 2009, 2010) built on her earlier work on optimism (or flow) and used her Engaged to Learn pedagogy in whole-class, small group and individual student projects. Williams found that as a result of creative mathematical activity, students’ experiences of flow situations were of benefit in terms of confidence building, therefore increasing students’ optimism in problem solving situations.

In a pilot study on affect, Ferguson (2009) investigated how teachers’ use of particular mathematical tasks impacted on low-attaining primary students. The study was conducted within the larger Task Types and Mathematics Learning (TTML) project, and participants were two low-attaining Year 5 students. Ferguson reported that through the use of challenging tasks and the TTML pedagogical approach participants were able to maintain positive affective responses.

A study by Sullivan, Clarke, and O’Shea (2010) examined students’ descriptions of their ideal mathematics lesson. Data were derived from a larger survey designed to gather responses on aspects of mathematics lessons and tasks from a cross-section of students in Years 5 to 9 in Victoria. Findings from this study highlighted the similarities between students’ responses and literature on effective pedagogy. Following a two-year longitudinal study which investigated students’ seating arrangements, Ingram (2008a) showed that students’ feelings during mathematics, and how they learn the subject, is related to who they sit near in mathematics classrooms.

**Critique of the Topics/Findings**

In considering the foci and findings of the studies that have been published on the affective dimension of mathematics education in Australasia in the period 2008–2011, we identified some themes and issues that appeared noteworthy. These are briefly outlined and discussed below.

In the previous review (Grootenboer et al., 2008) the authors noted the preponderance of studies that were primarily descriptive, and in general contained a limited amount of theorising. This appears to have changed little in the ensuing four years, although Walshaw (2010) has provided a continued and robust theoretical analysis through a psychoanalytical framework. Others have also engaged in significant theoretical work vis-à-vis their findings (e.g., Goos & Bennison, 2008; Williams, 2008, 2009, 2010) and it is important to note that this has been reported across a number of publications. It seems likely that the avenues for reporting research (e.g., conference papers, journal articles) provide limited space for significant discussion on different theoretical underpinnings or the development of theoretical positions and frameworks, and hence authors are developing this through a program of publication.

There seems to be a reasonable amount of research around the mismatch between stated and enacted beliefs, and interventions for changing teachers’
beliefs. However, there is still scope for studies about how teachers’ beliefs influence mathematical pedagogy, and indeed, how they impact students’ beliefs and other outcomes. Also, given the consistently reported discrepancy between teachers’ beliefs and practice in regards to mathematics education, it is perhaps timely to explore avenues for reconciling these differences by seeing the espoused beliefs as aspirational for practice.

METHODOLOGICAL ISSUES

In this section we have focused on methodological issues because of their importance when researching the affective domain in mathematics education. The reliance on inference, largely based on what people are willing and able to share (Grootenboer et al., 2008), has continued throughout this review period with high proportions of self-reporting data collection methods evident, tempered by a significant increase in studies including observational data.

Attempts to group research papers by methodology in the Australasian literature over the review period was once again difficult because of a multiplicity of descriptors used by researchers, and in some conference papers in particular insufficient or incoherent detail. Philosophical assumptions and methodological frameworks were sometimes absent or only partially developed with just the methods and instruments used described to varying extents. There are many reasons why this may be the case, including the lack of comprehensive theoretical frameworks in the affective domain, but clarity on these issues is essential for the studies to have more than a one-off presentation value.

In the 2008–2011 period, excluding a small number (10) of non-empirical position and review papers, almost 14% of the studies were quantitative (26% in the 2008 review), 67% were qualitative (38% in the 2008 review) and 19% were mixed method studies (36% in the 2008 review) (Grootenboer et al., 2008). The figures suggest a significantly increased focus on qualitative studies and a corresponding decrease in both quantitative and, in particular, mixed methods. This last decrease is in seeming contrast to the growth in mixed methods compared to the review period (2004–2007). However, if research in this domain is seen as lying on a continuum between qualitative and quantitative (Grootenboer et al., 2008), then there are a number of studies in this review period that tend to be more qualitative and are likely to have been categorised as such. The overall number and proportion of studies with a principle focus on affective factors has remained relatively stable over the review period.

The size of samples considered in the studies reflects a feature of qualitative research which frequently focuses on small samples: around 60% of the studies were categorised as small scale with less than 60 respondents (e.g., Ferguson, 2009 [n=3]); around 14% as medium scale with 60 to 100 respondents (e.g., Williams, 2008 [n=86]); and around 25% as large scale with more than 100 respondents (e.g., Carmichael, 2010 [n=425]). However, in the case of a number of the mixed method studies there was a large quantitative survey followed by a smaller qualitative aspect such as interviewing (e.g., Lo & Anderson, 2010 [survey n=152 and interview n=19]).
Of the studies that focused solely on one group of participants, around 45% considered school students; around 20% teachers; and about 33% pre-service student teachers. These figures suggest a more even balance between school students and teachers as the focus of study than in the past two reviews. Of the studies that focused solely on one sector, around 50% considered primary aspects; around 15% secondary; and 15% tertiary/teacher education. Unfortunately, an early childhood aspect is represented in only one study (Beswick & Dole, 2008) evaluating a mathematics course for primary and early childhood pre-service student teachers, which does little to address a glaring gap in the literature.

The lack of studies on tertiary mathematics lecturers continues to be a concern, although mathematics education lecturers and their affective impact on pre-service student teachers has been examined in a series of papers by Klein (2008a, 2008b; Klein & Smith, 2009) and Walshaw (2009, 2010) through the lens of post-structuralism and psychoanalysis.

There was one study (Leder & Forgasz, 2010) examining the wider community’s concerns with mathematics and affectivity that focused on determining parents’ perceptions of gender differences with regard to school mathematics. The paucity of studies in early childhood, tertiary mathematics, and the wider community indicate that little progress has been made in investigating these areas since the last review.

The last four yearly review indicated more student-focused research in primary and secondary classrooms, but queried whether it could be considered classroom-based as there was little observational data evident (Grootenboer et al., 2008). In the current review period, however, there are a number of studies based primarily around observational data (e.g., Mornane, 2009; Sherley, Clark, & Higgins 2008; Williams, 2008, 2010; Wilson, 2009). In addition, there were a similar number (e.g., Ferguson, 2009; Grootenboer & Ballantyne, 2010; Ingram, 2008a, 2008b) which included observational data as one type of data alongside two or three other types. While Jennison and Beswick (2010) used five types of data: (a) survey, (b) pre- and post-test results, (c) pre- and post-interviews, (d) student journals, and (e) video observations. The growth in studies dealing with ‘rich’ data sets including classroom observation is encouraging. A similar number of student-centred studies were done through surveys only (e.g., Bennison & Goos, 2010; Beswick, 2008; Tait-McCutcheon, 2008) and a smaller number used both surveys and interviews (e.g., Norton & Windsor, 2008; Young-Loveridge, 2010). There was also a small group of studies that used interviews only (e.g., Meaney & Lange, 2010) or interviews and focus groups (e.g., Attard, 2010).

The most frequent survey instruments were Likert-scale or open-ended questionnaires, and interviews tended to be semi-structured as in the previous review. Specific methodological techniques were stated in some studies. For example, Bibliotherapy in Wilson and Thornton (2008) and Wilson (2009); Discourse Analysis in Brown and Redmond (2008), and Redmond and Sheehy (2009); Learner’s Perspective Study in Williams (2008, 2010); Multi Levelling Modelling in Martin and Marsh (2008), and Secondary Analysis in McConney and Perry (2010). Some techniques were identified as having specific strengths, such as
the Learners’ Perspective Study methodology which allows the researcher to capture dialogue and actions that may not be captured using other methods.

There have been few advances made to research designs, data collection, and data analysis methods although Sullivan, Clarke, and O’Shea (2010) argued for narrative-based descriptions of behaviours as a way forward in affect research. The issue of attempting to clarify individuals’ understanding and shared understandings of a question and the interpretation of that by researchers (Grootenboer et al., 2008) is still of concern. A pilot study by Sexton (2010) attempted to address this by the use of concept cartoons that typified traditional and constructivist teaching environments. The cartoons gave a detailed description of the two environments reflecting key aspects of each underlying approach to which the respondents reacted rather than relying solely on how individuals perceived the two types of teaching environments. The cartoons were used as a stimulus from which student and teacher participants’ beliefs could be compared. Sexton’s findings indicated that concept cartoons are useful in assessing affect, and further research in this area would be beneficial. One ‘new’ method of analysis used was Rasch measurement models in conjunction with Likert scales. This was used to analyse various elements ‘mathematics teacher knowledge’ (Beswick, Callingham, & Watson, 2011), including teacher’s confidence and beliefs, using a teacher-profiling instrument. The analysis revealed a single underlying ‘knowledge’ construct allowing for a more holistic conceptualisation. The use of Rasch models to explore data sets for underlying constructs, which might combine a number of facets, could be a useful way to search for underlying constructs that ‘unify’ facets currently only treated separately.

In an effort to explore inconsistencies in terminology and measurement of affective factors in the learning of mathematics, Cretchley (2008) conducted a review of research that focused on four sets of research instruments and argued for two distinct broad primary areas of interest: self-concept; and intrinsic motivations for learning mathematics.

The increase in the collection of observational data in situ is encouraging as it allows for social factors. However, observational data on its own is insufficient to create a ‘true’ representation; it needs to be accompanied by other forms of data collection, for example, students’ and/or teachers’ perceptions, to create rich data sets.

There continues to be a relative absence of action research or interventionist type research in this review period. The focus of affect research needs to move beyond reporting and address some of these concerns. Putting our increasing knowledge about the affective domain into practice seems an important strategy for researchers to adopt.

CONCLUDING COMMENTS

Over the last four years, there has been a further increase in the number of research reports (to around 45%) dealing with school student perspectives and a shift toward primary focused studies (around 50%). There is now a predominance of
student focused studies, with a reduction in the number of pre-service teacher and classroom teacher studies. This continues the trends reported in Grootenboer et al. (2008) and may be a response to the call for more research work with primary, although this is not evident for early childhood.

While links between beliefs and practice continue to be of interest, relatively few studies advance any theoretical considerations that might underpin causal relationships between the two. Implications in most of the studies are rarely developed beyond a local frame of reference and indeed the testing or development of theoretical frameworks is still not well represented. The need for theory development to underpin research continues to be a need within Australasian affect research.

Changes in the methodological approaches used have seen an increase in qualitative studies with lesser numbers of quantitative and mixed method studies being represented. However, the reality of this change is difficult to determine with any degree of precision due to the multiplicity of descriptors, the lack of a common terminology and frameworks alongside a lack of detail within some papers. The increase in the number of studies using multiple types of data including observational data to create rich data sets reflects the complexity of the affective domain where many factors may interact and determining causal relationships will always be a challenge. The types of instruments used have remained relatively constant with the main new development being an instrument looking at aspects of affect in statistics.

The trend toward studies containing observational data is an encouraging indicator of a shift of focus to what actually happens in the classroom rather than a reliance on self-report data. In previous review periods the prevalence of self-report data tended to restrict affect research to individual and group perceptions. For belief/practice investigations to move to more fertile ground it is important that observational data of teachers and students in classroom environments continues to be both a focus in itself and an integral part of research projects using multiple types of data.

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