Mathematics Education Research in South Africa 2007–2015: Review and Reflection

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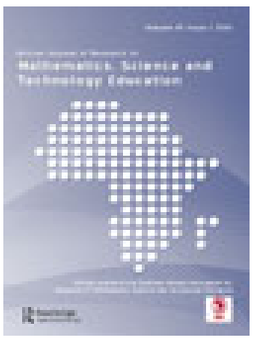

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Mathematics Education Research in South Africa 2007–2015: Review and Reflection[1]

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This article reports a review of research in mathematics education in South Africa published in local and international journals in the period 2007–2015. The purpose of the review was to describe the landscape of mathematics education research in the country over the past (almost) decade. Findings indicate that the mathematics education research community has become more established, expanding quantitatively, with the number of articles identified being nearly double, in absolute terms, that in a similar review of research from 2000 to 2006. Trends identified in the earlier review persist, with a dominance of publications in local journals and on small-scale qualitative studies on secondary teaching and learning. There is, importantly, an increase in research on primary mathematics. The review includes critical reflection on these findings, opportunities and threats, new and old, and what these mean for the future of research in this field.

Keywords: *research review; mathematics education; South Africa*

Introduction

In 2009, a review of research in mathematics education published in the years 2000–2006 was reported in this journal (Venkat, Adler, Rollnick, Setati, & Vhurumuku, 2009). The review identified 150 research papers published across national and international journals. The driving interest in the review was to explore the relationship between the published research and policy and practice in mathematics education, and the extent to which the spread of research was inter-connected and so accumulating. The review (science was included but is not in focus here) identified themes emerging across the research and described evident connections across these strands, and links with educational policy and on-the-ground practices. The conclusions reached were that there was an established, albeit relatively young and also fragile, field of mathematics education research in the country, with biases towards small qualitative studies at the secondary level, and a relatively small number of articles in international journals in the field.

This article reports on a similar review of published research in mathematics education in South Africa, now focused on the subsequent years 2007–2015. Almost a decade has passed, so it is an appropriate moment to look again at the current state and status of research in mathematics education in South Africa. We thus begin the article by summarising the methodology and findings of the 2000–2006 review.

The 2000–2006 Review in Overview

As noted above, the concern of the 2000–2006 review (Venkat et al., 2009) was to establish the state and status of published research in mathematics (and science) education, and specifically to

investigate the research–policy–practice relation. As it was undertaken at the time of significant socio-political change in the country, the study also aimed to identify the role of the researchers and teacher educators in (re)building mathematics (and science) education in post-apartheid South Africa.

All reviews are inevitably selective. This review was limited to research articles dealing with mathematics education in South Africa, and published in peer-reviewed local and international journals specialising in mathematics education research, and/or in local but general education journals. This scope led to the following journals being searched for such research papers:

- Local journals – *Pythagoras, African Journal of Research in Mathematics, Science & Technology (AJRMSTE), Journal of Education, Perspectives in Education, South African Journal of Education and South African Journal of Higher Education*.
- International journals – *Educational Studies in Mathematics, For the Learning of Mathematics, Journal for Research in Mathematics Education, Journal of Mathematics Teacher Education, Mathematics Education Research Journal, Journal of Curriculum Studies and Journal of Education for Teaching.*

We note here, and return to this point later in the article, that the focus on journal articles indicates the privileging of peer-reviewed published research in this review. Of course there is other research relevant to mathematics education in South Africa in reports from both government and non-government agencies, as well as in books and book chapters.

A total of 150 refereed articles were identified (see Figure 1), with 125 of these (i.e. more than 80%) published in local journals; half of these in *Pythagoras* (63 papers) and a relatively small number of papers (25) in international journals. Each paper was summarised in a template where the author, their location, the title of the paper, its problem, the research method, and the topic and various aspects of the focus were recorded.

From these individual paper summaries, it was possible to identify research trends. The 150 papers clustered around three main themes: (a) curriculum reform and implementation with focus on relevance in mathematics and learner centred practices; (b) teacher education with a focus on mathematical knowledge for teaching and teacher learning; and (c) learning and teaching in multilingual classrooms. Within these themes there was a dominance of qualitative research, at the secondary level, and in urban settings. These biases, while unsurprising at the time, nevertheless raised questions. The bias towards small-scale qualitative studies, while important for in-depth and detailed study of specific issues (e.g. learners using their main language as a resource in the mathematics classroom), signalled a gap in large-scale quantitative research that could speak in different ways to policy (whether such practices in multilingual classrooms evidenced greater mathematics learner attainment than, for example, in 'English-only' settings). The lack of research at the primary level and in rural settings was particularly worrying given the increasing 'mismatches between learners' levels of understanding

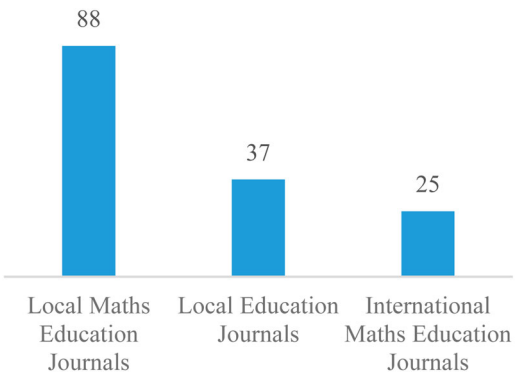

Figure 1. Number of papers reviewed 2006 (total=150)

and curriculum specifications by the late primary and early secondary stages' (Venkat et al., 2009, p. 19).

It is important to contextualise the 2000–2006 review. It is somewhat obvious to note that, in the decade 1995–2005, the state embarked on the project of undoing the ravages and inequities of apartheid education, working to open access and create conditions for greater equity. Curriculum reform went ahead apace, in schooling and in teacher education, complemented by new policies including language in education policy that endorsed and valued multilingual classroom practices. It is thus not surprising that curriculum implementation, curriculum reform, teacher education and language emerged as focused clusters of research in the review, and each is explored in depth in separate papers published in the same issue (see *AJRMSTE*, 2009, special issue). Moreover, as Venkat et al. (2009) argued, concern with access and equity wove its way through much of the reported research.

Noting strengths and notwithstanding gaps in the research, the researchers concluded that the mathematics education research community was an established, thriving and connected community with concerns for access and equity and impact on policy and practice. In discussing who was doing the research, and noting that various prominent researchers had shifted in this period into positions of university management, the authors also warned of the fragility of the community. These findings of the review and the warning of the community fragility provide the backdrop to the elaboration of the current review to which we now turn.

2007–2015 Review: Focus, Context and Process

The Focus

Building from the 2000–2006 review, we ask:

> (1) Has the mathematics education research community continued to grow? In what ways? Is it still 'fragile'?
>
> (2) Have the foci changed? In what ways? What is the same/different?
>
> (3) How do we interpret both shifts and stasis? What new and old opportunities and threats currently shape the field?

The Context

If the context of 1995–2006 could be described as one focused on curriculum reform with a transformation agenda, then the following decade can be described by a shift to a focus on performance and quality across the system coupled with increased attention to teachers' knowledge. In contrast to concern with implementation of a transformatory curriculum, this period is shaped by the introduction of Curriculum and Assessment Statements—a curriculum that is more specified in terms of what is to be taught and when. What can be inferred here is a national acknowledgment of the criticism of the curriculum and policy of Outcomes-Based-Education (e.g. Jansen, 1998), and the implementation of recommendations of the national curriculum review process (see Chisholm, 2005). An equity agenda prevails, particularly given the persistent poor performance of learners in mathematics in the Grade 12 NSC examinations, and more recently the Grades 1–9 Annual National Assessment results.

Alongside these shifting foci, and critical to the work of researchers in mathematics education, is an increasingly financially constrained higher education context, given explicit form in the continuing *#feesmustfall* campaign across the country. Student intake has increased without corresponding financial commitments from the state. Researchers face increasing demands on their teaching time. At the same time, pressure to publish has intensified. These conditions are not unique to higher education in South Africa, opening up a space internationally for predatory publishing (see http://scholarlyoa.com/2015/01/02/bealls-list-of-predatory-publishers-2015/), a phenomenon that has recently captured attention within and across universities and appears to be rapidly expanding. University research web pages contain information about the various publishers across the academic terrain, with lists of

journals accredited by the Department of Higher Education and Training, and warning lists of journals that are considered to have questionable practices.[2]

The Process

Identifying data

A four-member team in the Wits Maths Connect Secondary project undertook the review, focusing as before (we took the processes and results of the 2000–2006 review as our starting point) on articles published in refereed international and local journals in the period 2007–2015. We were aware of journals not included in the 2000–2006 review, both international and local, either because they were not yet in existence, or because they did not contain papers on mathematics education research in South Africa. Table 1 contains the full spread of journals reviewed in both 2000–2006 (150 articles over a 7-year period), and 2007–2015 (285 articles over a 9-year period), indicating the new/additional journals.

We searched the databases of each of the journals for papers where research was about South African mathematics education and/or done by South African researchers. This enabled our inclusion of non-South African researchers in the international terrain with interests in South African mathematics education, and so contributing to the local landscape. Typically, such researchers were working in collaboration on South African projects. The only additional local journal we reviewed was *Education as Change*, which while not new, had attracted publications in mathematics education in the review period.

With respect to international journals, in addition to the international journals in the earlier review, we searched the *International Journal of Science and Mathematics Education* and *Research in Mathematics Education*, two new mathematics education journals we were aware of, and *ZDM: Mathematics Education*, which while not new, now contained papers relevant to the review. Going beyond journals

Table 1. Journals and number of articles in the research review (compared with 2006)

	Number of articles	
Publication title	2000–2006	2007–2015
International mathematics education		
Educational Studies in Mathematics	10	9
For the Learning of Mathematics	9	8
International Journal of Educational Development[a,b]	—[a]	7
ZDM[a]	—[a]	6
International Journal of Science and Mathematics Education[a]	—[a]	5
Mathematics Education Research Journal	1	5
Journal of Mathematics Teacher Education	2	4
Journal for Research in Mathematics Education	3	1
Research in Mathematics Education[a]	—[a]	1
Total 1	25	46
National regional maths/science education and general education		
Pythagoras[c]	63	98
AJRMSTE[c]	25	65
Education as Change[a]	—[a]	22
South African Journal of Education	13	17
Perspectives in Education	11	18
Journal of Education, Natal	5	10
South African Journal of Higher Education	8	9
Total 2	125	239
Grand total	**150**	**285**

[a] New journals—were not in 2000–2006 review

[b] The only international journal that is not specific about mathematics education.

[c] Mathematics education journals.

dedicated to mathematics education, we also selected and searched the *International Journal of Education Development*. We were interested to see whether there was research published in mathematics education in South Africa located in the field of education development. Of course, this selection excludes other international educational journals where research on mathematics education might be published (e.g. *Curriculum Inquiry*, *Teaching and Teacher Education*).

As in the 2006 review, this is a selection of peer-reviewed articles only. Most reviews of research are purposeful, with selection guided by the questions being pursued and the resources available (see, e.g. Sztajn, Borko & Smith, 2016, for an interesting discussion of the process of their review of research on professional development in mathematics education). While we do not report on individual researchers below, given the relatively small community of mathematics education research in the country, we were satisfied by a scan of the data. We considered this a reasonable representation of current research in the country, albeit incomplete, particularly as the range of authors and their institutions had spread (see below).

Whilst the review was in process, two special issues (on Mathematics Teacher Education and on Communication and Language(s) in Teaching and Learning Mathematics) were published in the *International Journal of Educational Sciences* (*IJES*) and the *Journal of Communication* (*JoC*), respectively. These were brought to our attention through different mathematics education email lists. Aware as we were of the contentions around predatory publishing practices, we turned to the web pages of each journal. It was immediately apparent that there were numerous articles published about South African education, a considerable number of which were on mathematics education. Across only two years – 2014 and 2015 – we identified 35 relevant papers in *IJES*, and nine in the *JoC* special issue. We noted firstly that these are only some of the published papers in these two journals as both are general education journals. Given the spread of the other 285 papers across various journals, including specialist mathematics education journals, we were surprised by the appearance of 35 papers over only two years in one journal that was not dedicated to mathematics. This peaked our interest in the publishing practices of the journal. We thus looked further into both journals and their publisher. They come from the same publishing house, and of particular interest and concern to us was the rapid expansion of journal issues per volume or year, and the number of papers accepted per issue in the *IJES*. This journal now publishes one issue a month, and so 12 per volume, with up to 20 papers in a single issue. A rapid turnaround time from submission to review to publication is promised and appears to be met. Authors nominate their reviewers, and the role of the editors is not apparent. Each of these practices raises questions about the quality of the review process. It was thus not surprising to find both journals and their publisher on Beall's list of 'Potential, possible, or probable predatory scholarly open-access publishers'. We were surprised to find both journals on the IBSS list (International Bibliography of the Social Sciences), and thus 'accredited' by the Department of Higher Education and Training in South Africa.

Time constraints did not permit us a full review of the 44 papers. It is thus beyond the scope of this review to deal with the issue of 'possible' or 'probable' suspect journals in any depth, and whether and how these factor into reviews such as this. We hope that, by flagging the issue up here, we invite further debate and reflection on this phenomenon in our and other fields. We return to this issue when we consider opportunities and threats going forward.

Data capturing

Data capturing was done in a spreadsheet, re-presented as Figure 2. With respect to authors and their affiliations (i.e. *who were the researchers and where were they institutionally located*), we were interested to see whether the spread of authors now extended beyond those active in the previous survey. We obviously captured the title of the paper and year of publication, the research problem pursued in the paper, the methods used and the results (i.e. *the what and how of the particular study*). These would alert us to relations with policy implementation, concerns with practice, as well as the qualitative/quantitative methodology used. We were also interested in what we loosely called the research 'participants' (i.e. *who and what were the object of research: teachers, learners, other non-human, e.g. textbook*); and the level of education in focus *(*i.e. *primary, secondary, tertiary).* Given the

#	Name of Journal	Author(s)	co-authoring	Affiliation	Year
Volume		Issue	Title	Problem	Result
Participants		Teachers			
		Preservice		In-service	
Humans	resources	Primary	Secondary	Primary	Secondary
Learners		Curriculum			
Primary	Secondary	Tertiary	Selection	Pedagogy	Assessment
Maths Topic					
Calculus	Number	Algebra	Geometry	Probability & Stats	Mathematical Literacy	NO Maths Topic	Trigonometry	undergraduate mathematics
Methodology					
Empirical				Theoretical	Advocacy
Quantitative		Qualitative	Mix		
Small Scale	Large scale	Small Scale			

Figure 2. Template used for categorising and summarising papers included in the review

current context and concerns with teachers' knowledge and practice, we included a categorisation of research on teachers/teaching identifying whether the focus was on knowledge, practice and/or identity, and whether the knowledge focus was subject matter knowledge (SMK) or pedagogic content knowledge (PCK). We further included a categorisation of the mathematical topic—an aspect not in focus in the previous review.

In general, for each article, we read the abstract first and used this to populate the spreadsheet with basic information or the general categories such as title of the journal, names of authors, affiliation, and so on. We then scanned the paper for other information such as whether the paper was about teachers and what grade, secondary or primary, the methodology and the main results. Working with a spreadsheet then enabled us to 'filter' elements of the review such as teachers as participants. Given the scope and spread of articles, we did not select any subsample to read in depth. We return to reflect on the consequences of this decision in the discussion of the results.

2007–2015 Review: The Findings

Enlargement of the Mathematics Education Community

One main result of the 2015 review is the quantitative expansion of the South African mathematics education community. We thus begin our description of our results detailing and dissecting this enlargement.

Increase in number of publications

The search we did resulted, after some 'sifting', in the 285 papers presented in Table 1, and so nearly *double, in absolute terms*, the number in the 2000–2006 review. The papers excluded were those that were either not located in South Africa (e.g. a student from Lesotho who was studying in South Africa, and whose research was located in Lesotho), or were not on South African education (e.g. work done by Adler in and on England). The increase from 150 to 285 papers, notwithstanding that it included two additional years, was the first indicator of the quantitative growth of the field of research and researchers in South African mathematics education.

We noted a similar trend to the 2006 review in that the majority of publications identified were from local journals, comprising over 80% of the total publications in both reviews. Within these local journals, *Pythagoras* and *AJRMSTE* are the main target for researchers in mathematics education (59% of papers were published in them in the 2006 review and 57% in the 2015 review). Interestingly, both of these journals increased their number of issues a year, and published special issues during the current review period.

Authorship and collaboration

Affiliations: as reflected in Table 2, more institutions are represented in the current review than in 2006, providing evidence of active mathematics education researchers across many more institutions. This suggests a growing and more widely distributed mathematics research community across universities.

Table 2. Number of papers from South African universities in the review

South African universities	Number of papers 2000–2006 First author	Number of papers 2007–2015 First author[a]	Number of papers 2007–2015 Total[b]
University of the Witwatersrand	37	68	79
University of KwaZulu–Natal	22	56	61
University of Pretoria	15	24	31
University of South Africa	6	17	23
Stellenbosch University		16	21
Rhodes University		16	20
University of Cape Town	25	14	20
North-West University		8	11
Nelson Mandela Metropolitan University		8	10
Cape Peninsula University of Technology		6	10
Tshwane University of Technology		4	7
University of Johannesburg		5	5
University of the Free State		5	5
Durban University of Technology		2	5
University of the Western Cape	8	1	5
Central University of Technology		4	4
University of Zululand		2	2
University of Fort Hare		0	1
Walter Sisulu University		0	1

[a] First author refers to number of publications with the leading author is from that university.
[b] The total number here presents the number of publications where the name of the university appeared.

In overview, we see that, while researchers are spread across more universities, 'traditional universities' (as in the previous review) are still dominant in comparison with comprehensive universities and universities of technology.[3] It is important to note that the two universities with the greatest output both have large mathematics education departments and undergraduate teacher education programmes. There are more academic staff in mathematics education and thus a larger pool of researchers. It is also of interest that, amidst the general increase, there are a few universities where output has decreased over time.

Accompanying the wider range of institutions is also evidence of greater collaboration between researchers. We examined the publications reviewed where there were multiple collaborating authors. Figure 3 shows that more collaboration has been established, especially between two and three authors, within and across institutions, including institutions outside of South Africa. The valuing of individual publishing, however, is evident in both reviews.

International publications and collaborations

We looked at the ratio of local:international articles and noted its similarity to the 2006 review. In the current review there are 46 papers published in international journals (out of 285) compared with 25 (out of 150) articles in 2006. Thus while there are more papers in international journals, they are still a small percentage of all the papers.

We also looked at collaboration between local researchers and international colleagues. Figure 4 shows that international collaboration spreads across continents, with most being with researchers in Europe, particularly the UK, and North America. While there is some collaboration with researchers in other African countries, like the 2000–2006 review, international collaboration was mostly outside Africa, or as we suggest, looking north.

These various aspects of expansion (the quantity of papers, spread of authorship and collaborations), are collectively signs of a growing and strengthening research community.

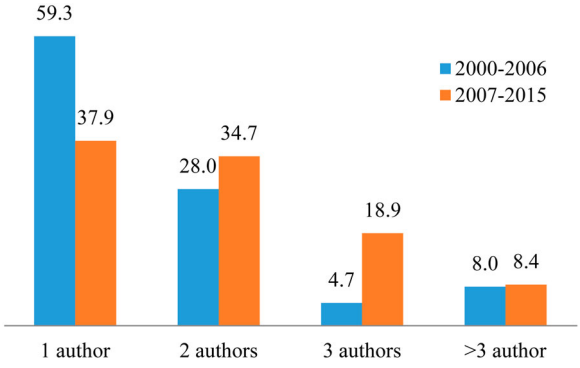

Figure 3. Collaboration in the mathematics education community (%)

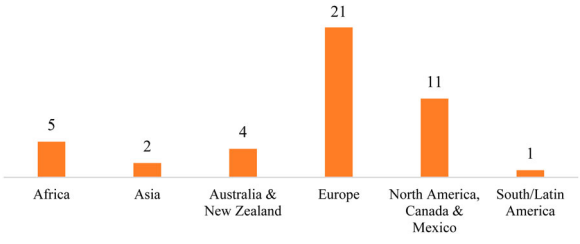

Figure 4. International collaboration—looking north

From Expansion to the Research Foci and so Shifts and Stasis

Teachers and learners in secondary and primary research

The 2000–2006 review stressed the paucity of research targeting primary education and called for the need for more research on that area. The current review shows the response to that call. Fifty-three papers targeted primary education (including primary and secondary papers) with 14 published in international journals. As noted above, there were 46 such papers in all, with a third of these articles focused on the primary level for both teachers and learners, and a further four papers targeted both primary and secondary teachers, as shown in Figure 5. Research on primary mathematics in South Africa is now visible through its outputs. Moreover, primary mathematics education research in the country has established an international presence. That said, the bias towards secondary research (whether focused on teachers or learners) remains in the current review.

Qualitative and quantitative research

The 2000–2006 review also lamented the paucity of large-scale studies. Unlike the growth of primary mathematics research, qualitative methodologies and small-scale research remain the dominant approach across reviewed studies. Nearly half (49%) of the papers employed qualitative methods with small research samples. Amongst the remaining papers, roughly 45 (or 15%) were not empirical studies, 19% reported use of mixed-methods and 17% reported quantitative methods.

Of course, on their own, large-scale quantitative studies cannot provide detailed descriptions of related teaching–learning practices nor explain the enduring problems related to poor performance, hence the importance of qualitative research. However, it remains unclear whether and how small-scale studies, including those using mixed and quantitative methods, accumulate and complement each other, and are thus able to exert influence on policy. We are reminded of previous reviews of research reporting on the relationship between mathematics performance and English language improvement, which surfaced 'conflicting results' across small-scale qualitative and quantitative research (Essien & Setati, 2007, p. 222).

Teachers as participants—the 'subjects' of the research

In the 2000–2006 review, 30 of the 150 papers focused specifically on teacher education with different foci such as teacher knowledge, attitudes and beliefs, and teacher learning, and these were the focus of a more detailed and specific review (Adler, Pournara, Taylor, Thorne, & Moletsane, 2009). In the current review, we did not separate out studies in or on teacher education *per se*, but rather looked at all papers with teachers as subjects (participants) of the research.

Across the 285 articles most were focused either on teachers (39%) or learners (29%) or both (6%) (Figure 6). The remaining papers focused on other 'human' participants such as university students or parents; or on 'non-human' participants such as textbooks or curriculum and policy documents.

Given the large amount of research focused on teachers and/or teaching, we looked in more detail at these papers, categorising them in three ways, two of which are indicated in Figure 7. We identified whether the research related to teachers' knowledge (K), identity (I) or teaching (T), and alongside

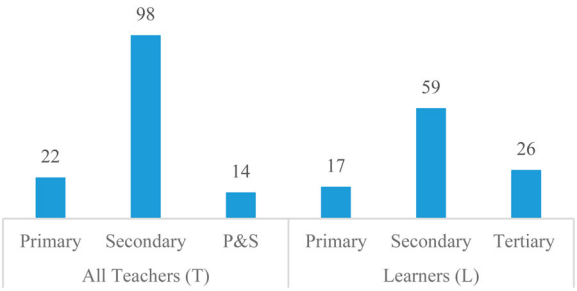

Figure 5. Number of research across educational level

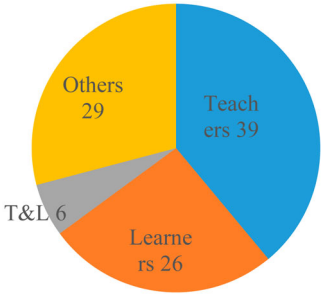

Figure 6. Participants in the reviewed papers (%)

each of these whether we could discern whether the focus was on PCK, SMK or both (PCK/SMK). We also categorised whether papers with teacher participants were focused on pre- or in-service education or professional development.

The research targeting teachers paints a picture on its own. The description of the context at the beginning of the paper as reflecting a concern with performance and teachers' knowledge is reflected in the predominance of papers on mathematics knowledge for teaching, for in-service teachers at the secondary level. What is interesting, however, is the focus on PCK. It was when we examined the mathematical topics (see below) within the studies targeting teachers that the relatively large number of papers overall without a specific mathematics topic focus made more sense. Typically, studies related to PCK were not topic specific.

Mathematical topics in focus

As noted earlier, we were interested to see whether different areas or topics of mathematics were in focus, and thus whether there was accumulating knowledge of teaching and learning in the country in particular domains. We anticipated that there would be such foci, given the shift of attention to learner performance and teachers' knowledge. We were surprised to observe that the largest category of papers did not focus on a specific mathematical topic (Figure 8). It is interesting to see that algebra and number predominated in the papers where a mathematics topic was in focus. This is not surprising. On the international terrain, while there is research across topics in the school curriculum, there is a wealth of work on number and algebra. Indeed research work in the field of early schooling focused on these domains.

Answering our Focus Questions

We set out to see whether the mathematics education research community has grown, and in particular whether it is still 'fragile'. We also asked whether the foci of research have changed over time, and how such shifts and continuities might be interpreted. We have shown firstly that the community has indeed grown. Research output has increased. Moreover, there is also a wider spread of authors

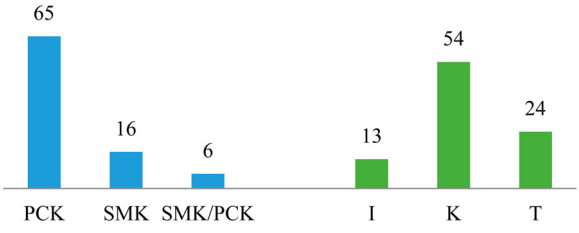

Figure 7. Focus on teachers in published papers (%)

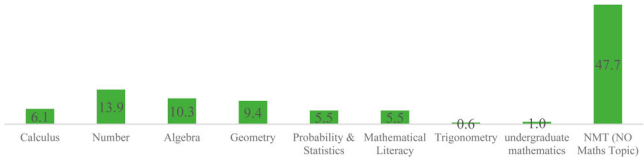

Figure 8. Mathematical topics in the review

and institutions than previously. The community does not appear fragile, but rather as strengthening. The perceived threat, therefore, of established researchers moving into management in higher education in the past decade, and so weakening the community in terms of output and induction of new researchers, has not materialised. In addition to a larger and stronger community, we have shown the increase in research at the primary level. Aside from this shift, there are continuities in biases towards qualitative small-scale studies, published in local journals. One consequence pointed to here is that this limits impact on policy. Another is in the impact of the work internationally. In addition, while teachers/teaching (and more so at the secondary level) continue to be the subjects of a significant portion of the research, this review revealed that there was a strong focus with respect to teacher knowledge on PCK. In line with this latter point, a significant amount of research in the field does not appear to have a specific domain focus.

Interpreting and Accounting for Shifts and Continuities

More Journals and Additional Issues

One obvious reason for more publications in the current review is that it includes more journals both international (e.g. *ZDM*) and local/national (e.g. *Education as Change*), and then beyond mathematics education (e.g. *International Journal of Educational Development*). However, of greater significance is the increase in the number of issues per year in both *Pythagoras* and *AJRMSTE*, the two journals containing the majority of mathematics education research papers in the review and so on South Africa. These additional issues of each journal, as well as the inclusion of the new international journals, account for much of the increased output in the review period, and thus show the importance of expanding opportunity and places for researchers to publish their work. While extended avenues for publication is perhaps necessary, it is not sufficient to account for the enlargement. The research community itself had to have grown, in terms of the number of researchers and institutions supporting mathematics education research in the country (which we have shown), together with new or extended areas of research.

New Initiatives: The South African Numeracy Chairs

It is interesting to reflect briefly on the research at the primary level. In 2010, and thus relatively recently, two new Chairs in Primary Mathematics (the South African Numeracy Chairs at Wits and Rhodes universities) were appointed, with the mandate and resources to conduct research and development projects in selected primary schools, and to develop and promote such research. A considerable portion of the primary focused research in this review is from researchers in these two projects. We learn from this that, if research in new or under-developed areas is needed, and dedicated and focused investments are made in this domain, knowledge and outputs follow. Thus, too, we can predict the corollary: if investments are not made, it is less likely that there will be such focused development. It would be interesting to explore in more depth the who, what and how of primary mathematics education research and development in the country, thus providing further insight into new growth areas.

The Continuing Bias Towards Secondary Foci and Small-scale Qualitative Research

As shown, secondary level and qualitative studies remain the focus in a majority of studies. Together with the large number of studies on teachers' knowledge and practice and in pre- and in-service

teacher education, and as argued in Venkat et al. (2009), this coincides with the location of researchers in mathematics education in universities, typically in schools of education, where their work is in teacher education. All are under pressure to publish research, if they are to advance within their institution. While restructuring of higher education in early 2000s saw primary teacher education colleges being merged into universities, employment practices, together with the career trajectories of primary teachers, has largely resulted in the recruitment of secondary-trained teachers into teacher education positions, and thus with teaching expertise and research interests not necessarily located in primary mathematics.

Contextual Responsiveness

One final comment that is relevant for interpretation of the findings of the 2007–2015 review relates to the dynamic, changing educational context in South Africa. As discussed earlier, the recent past has seen a shift in the government and policy domain from what we might describe as concerns with access and quantity (how many more learners are in school, overall pass rates) and curriculum reform, to concerns with performance and the quality of teaching and learning. This shift has brought with it a focus on teachers' knowledge and practice. The enlargement of this research domain in the current review reflects researchers' responsiveness to the changing context. While teaching and teacher education were in focus in the earlier review, the current prevalence of papers on teachers' knowledge reflects changing contextual conditions. While much of the public discourse focuses on subject matter knowledge, it is interesting that the bias in mathematics educational research appears to be towards pedagogic content knowledge and without domain-specific attention. As an aside, it is interesting to note the emergence of topic specific PCK studies in science education (e.g. Mavhunga, 2014).

Our categorising in the current review did not produce a clear set of themes across the research, hence our focus, instead, on what stood out as we investigated the patterns in the spreadsheet of data. We thus move now to conclude the paper by attending to the final part of our focus questions: what new and old opportunities and threats currently shape the field?

Concluding Reflections

The review presented has established that the field has grown: thus, the threat of fragility was just that. In research in South Africa in general, there is a concern with an aging professoriate, and thus retirement of established researchers before a new generation has adequately developed. In the field of mathematics education, while key researchers moved into and have remained in leadership positions in higher education institutions, most have continued to contribute to the field, and a relatively small number are heading for retirement.

We also noted the opportunity for expanding research outputs provided by new journals and additional issues in existing journals. However, we flagged up earlier that some journals with rapidly increasing additional issues in our midst could also be a threat. Currently in mathematics education, the turn-around time for reviews of papers in the leading journals is slow, with experience of up to a two-year lag between initial submission and final acceptance and then publication. Job security and promotion can thus be seriously thwarted. Again, our experience is that the review processes in leading journals, and this includes international and local journals, does enhance quality, and indeed offers learning processes for the authors. A journal with short turn-around review processes, where reviewers can be nominated by authors, and without active academic editors, lacks such processes and thus threatens quality. In addressing this relation between quality and quantity, we were immediately challenged by the following question: what criteria do we use to address this relation? Who decides research quality?

These questions cannot be answered here, particularly as we chose not to review even a subset of papers in depth. However, as a community and field, these are critical questions for us and our practice. Firstly, what is the purpose of our research? South African mathematics education faces significant challenges, particularly with respect to learners' performances at all levels, and teachers'

specialised mathematical knowledge (Carnoy, Chisholm, & Chilisa, 2012). How can and does our research lead to better understanding of the reasons behind such challenges, possible interventions and their successes/failures? Moving towards solutions requires time commitments. At the same time the pressure to publish is very real. Predator conferences and publishers are on the increase. How do we manage these competing 'values'? Most significantly, how might we turn the threats of predatory practices into opportunities for influencing our field and wider research and publishing practices? And so back to the questions: *what is the purpose of our research?* We hold the view that our purpose is to influence policy and practice through rigorous, credible research and also influence the national and international terrain. How then do we work to not become victims of predatory practices, but rather agents in improving our field?

The above discussion points to a limitation of this review. As we said at the outset, all reviews are necessarily selective. We chose here to work across all 285 papers and faced a wide range of topics, levels and participants, and as a result the review could not move beyond what we have described in this paper, to consider themes, whether and how the research accumulates and thus interpretations of quality. We offer this review in the hope and with the recommendation that it stimulates further in-depth analyses of various aspects of our terrain.

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No potential conflict of interest was reported by the authors.

Notes

1. A first version of this paper was presented at the 2016 SAARMSTE Conference, Tshwane University of Technology, Pretoria, South Africa (12–15 January 2016).
2. See for example http://collections.nwu.ac.za/dbtw-wpd/textbases/accredited-journals.html, where there are links on the page to a 'List of questionable, scholarly open-access journals'.
3. For description of the different universities in South Africa, see http://web.archive.org/web/20050301015907/http://www.sauvca.org.za/highered/

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