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SAARMSTE's role in building and connecting Early Grade Mathematics research: A review of SAARMSTE Proceedings 2003–2022

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This paper focuses on the Southern African Association for Research in Mathematics, Science and Technology Education's (SAARMSTE's) role as a platform supporting research dissemination and connecting researchers in early grades mathematics (EGM) in the Southern African region. A review of the Long Papers in SAARMSTE over the last 20 years supports the finding of the other review papers in this Special Issue: that there has been substantial growth of attention to EGM since 2013. However, two distinctions are marked when looking at conference papers rather than journal papers. Firstly, there is a particularly large expansion of work in the last 5 years, with a broadening base of participation in this work. Second, looking across all the formats of conference presentations indicates SAARMSTE's role in supporting and building EGM as a key focus of research attention, and bringing together regional and international groups with interests in this area. Given that conference proceedings usually offer a broader picture of emerging interests than journal papers, we reflect on the range of foci of attention within EGM in the SAARMSTE Proceedings, and trends within this. These trends also help us to point to areas that are likely to be of key interest in the next decade.

Keywords: *Early Grade Mathematics; Southern Africa; review of; foundation phase; primary mathematics research*

Introduction

While journal articles remain the high 'status' publications that detail research growth in the education field, key established conferences are acknowledged as spaces that usually allow for a broader range of emerging research interests and findings to be disseminated and discussed (e.g. see Somerhof et al.'s (2015) review of argumentation and proof research in PME proceedings). Such conferences offer important interface platforms where communities engage with each other in real time and grapple jointly with pertinent issues that can shape the way research in an area moves forward, and thus offer spaces for research that is grounded and responsive in its formulations. This is particularly important in national and regional conferences, where audiences are predominantly drawn from the local ground, with awareness of the conditions and cultures of schooling and education. Unfamiliarity with these conditions and cultures has been noted as a feature that, at times, makes it harder for work from marginalised populations to get heard and get published in the larger international conference and journal outlets (Mesa & Wagner, 2019; Jorgensen & Graven, 2022).

In this paper, we offer a review of early grades mathematics (EGM)-related work published in the Southern African Association for Research in Mathematics, Science and Technology Education

(SAARMSTE) annual conference proceedings over the last 20 years (2003–2022). While the other review in this Special Issue focused predominantly on journal papers, our focus is on the SAARMSTE conference papers as a key platform in which work on EGM has been disseminated. Further, SAARMSTE is a regional organisation that mostly represents and features work from the Southern African region. This regional base allows us to consider the representation of EGM work from across the region rather than looking in national terms at South African research in regional and international journal publications as Morrison et al.'s (this issue) review does.

Our restriction to a focus on SAARMSTE conferences is both pragmatic and personal. At the pragmatic level, we are aware that a wide range of EGM work has been shared in SAARMSTE conferences across this period. On the personal level, as authors, both of us have long histories with the SAARMSTE community, having played roles in its institutional structures for much of the period of this review (including both of us serving as presidents in the past). Given this, a key focus of this paper, alongside offering a review of the foci and trends of EGM work presented at SAARMSTE across the coming-of-age period, with a zoom into the last decade, is also a reflection on SAARMSTE's institutional role in supporting research and development in the area of EGM.

As such, this paper offers a more reflective view on the key findings of the Morrison et al. review (this issue) of *South African* articles published in the field of EGM in key national and international journals (they did not include published peer reviewed conference proceedings). Their systematic review of this literature found key clusters of work focused on teachers and teaching, learners and learning, language issues and multilingualism, and assessment. The authors also noted a substantial increase in the volume of South African EGM-related papers in the second decade.

Looking at conference proceedings, as noted, offers a route to considering the processes of emergence of fields. Such explorations can go beyond consideration of outputs. SAARMSTE runs an annual conference that is hosted each year by different institutions across the various member countries. Approximately 250–550 delegates from multiple Southern African and other countries each year attend and present in the programme. Long paper submissions are fully double-blind peer reviewed and, if accepted, are published in the conference proceedings and available online to SAARMSTE members.

Given that Morrison et al. (ibid) point to EGM as an area with a strong emergent trajectory, understanding the breadth of in-process EGM research seen in the SAARMSTE Conference Proceedings space offers a way of understanding the mechanisms through which EGM has been brought to the fore of research activity in Southern Africa, and the trajectories of ideas and issues across this period. The questions guiding our review are therefore:

- To what extent is research in EGM present in SAARMSTE proceedings over the 2003–2022 period? What regions are represented? Has this shifted over time?
- What emergences and connecting threads can be seen across the two decades of research in EGM, and what key clusters of research topics and theories/methodologies have been established in the EGM research through this trajectory in the SAARMSTE proceedings?
- What do the outcomes suggest in relation to conferences in Southern Africa as platforms for supporting the emergence of new fields?

Motivating this paper and the broader focus on EGM is a growing acceptance that unless language and mathematics outcomes improve in the initial years of schooling, the chances of later interventions achieving substantive learning remain constrained (Spaull & Kotze, 2015), while also becoming increasingly expensive. Adler et al.'s broader (2017) review of mathematics education research noted expansions in research focused on primary mathematics education between 2007 and 2015, in comparison with the findings of an earlier review covering the 2000–2006 period (Venkat et al., 2009). We were also interested, following the critique in Deacon et al.'s (2009) review of educational research covering 1995–2006 that most research reviewed was small-scale, in whether the same critique could be directed at EGM research in the SAARMSTE proceedings. This was important given that recent publications have reflected growth of interest in the EGM phase specifically and particularly in interventions within this phase (Venkat & Roberts, 2022; Spaull & Taylor, 2022). In this article we focus on interrogating this growth within the SAARMSTE proceedings, with attention to the trajectories of development and clusters of foci within the growing EGM research base.

We begin with a methodological overview of our approach to reviewing the research presented in the SAARMSTE proceedings, before going into quantitative summaries that lead into our answers to the above research questions.

Methodology

The scope of this review is 20 years of SAARMSTE proceedings with emphasis on the long papers (which are the full independent peer-reviewed research outputs in the proceedings). Our finding of substantial increases in EGM outputs in the last decade (2013–2022)—which mirrored those found in Morrison et al.'s review (this issue)—led us into a broader examination of EGM related work across the other presentation formats in the conferences in this decade. These broader formats take in the focus of short papers (which are commonly used to present emerging work/ postgraduate studies), and round tables, symposia and panel discussions that bring together groups of academics around shared issues. Investigating the extent of attention to EGM across these formats provides a more comprehensive picture of the coming of age of EGM, and of the ways in which SAARMSTE has contributed to this growth.

Our methodological approach to this review was as follows. Using the SAARMSTE website repository of conference proceedings, we began by surveying all the mathematics long paper abstracts in the SAARMSTE Proceedings from 2003–2022, the 20 years of coming to age. Specifically, we looked for whether the abstracts indicated a focus on mathematics in the early grades (foundation phase Grades R–3 in South Africa, and broadly parallel grades in research emanating from other countries). We also kept counts of the numbers of papers that focused on the higher remaining grades of primary school or focused generically on the primary grades without any specific attention to EGM. In similar ways, we kept a count of the 'other maths' long papers outside of these two primary (lower and upper/ general) level categories. The 'other maths' category included papers focused on secondary or tertiary mathematics, as well as papers with a more generic methodological or theoretical focus. Where necessary, we read through the paper if we were uncertain of the phase-level focus from the abstract. In terms of procedure, all EGM papers were placed into a spreadsheet gathering the following information:

- date;
- authors;
- affiliation;
- country or countries (of the research);
- title;
- abstract;
- data gathering methods;
- sample size.

This process provided us with a record—for each of the 20 years—of the total numbers of:

- EGM long papers;
- primary mathematics long papers (by combining the EGM and other primary grades/generic primary numbers);
- mathematics long papers (combining the last total with the remaining mathematics long papers).

This enabled us to see the proportional representation of EGM in relation to *primary* mathematics and mathematics papers *across all levels*. This was important given that the total raw numbers per year do not always provide a sensible picture of growth or decline as the location of the conference has tended to affect the number of delegates and presentations—for example, conferences held in larger cities or places where travel costs are cheaper have tended to attract more delegates and papers. We also made a decision on the overarching inclusion criterion for counting a paper within the EGM category:

- papers focused on EGM-related issues (i.e. issues or implications directly pertinent to Grades R–3 in South Africa, or on equivalent years of primary school in other countries).

This wording allowed us to include papers with an empirical base in the later grades of primary schooling if they dealt with issues or presented implications that were directly relevant to EGM—examples of this were papers focused on early number sense and on the use of translanguaging in teaching. We thus only excluded papers with an upper primary empirical base if they did not speak also to EGM-related issues.

While a focus on EGM long papers drawn from the SAARMSTE proceedings in the given time period seems a relatively clear-cut exercise, we note that we worked with the limitations of availability via the SAARMSTE website, and also with shifts in SAARMSTE policies around paper formats over time, and changes in South African accreditation regimes for academic articles. These meant that for some years, long papers, short papers and snapshot submissions were not explicitly marked as such online, leading us to work with a '6 pages or more' dividing line to demarcate long from short papers to align with what we saw in the proceedings in years where these demarcations had been made. Policy shifts over time in accreditation arrangements in South Africa led to a directive that long papers could not be extended into journal papers unless there was overt evidence of expansion in the paper, in contrast with the international terrain where extension of conference long papers into journal articles is the norm. This policy played through into short paper formats being shorter in part of the second decade.

This initial survey of the 2003–2022 proceedings yielded 46 EGM long papers. Our full sample is included in the references. Where page numbers are omitted it is because these were not available in the format in which papers are available on the SAARMSTE website. We go on now to our analyses of emerging foci and longitudinal connections in these over time. We decided to break the 20-year time period into four 5-year blocks as this allowed us to focus on trends over time in ways that ameliorated the year-to-year fluctuations in numbers due to conference locations and travel costs.

Findings and discussion

> RQ1: To what extent is research in EGM present in SAARMSTE proceedings over the 2003–2022 period? What regions are represented? Has this shifted over time?

Using the four 5 year blocks, we begin with an overview of the numbers of EGM long papers published over time in the SAARMSTE Proceedings between 2003 and 2022 (see Table 1), in comparison with the overall numbers of primary mathematics and all mathematics-focused long papers.

There are several patterns of interest in Table 1. First, a marked double rate of increase in EGM papers in the third 5 year block is almost maintained in the fourth 5 year block. This leads to a more than three-fold increase in the numbers of EGM papers in the second decade in comparison with the first decade. While there were increases in the numbers of primary papers *not* related to EGM across the two decades, this increase was much more modest (from 11 + 5 = 16 papers in the first decade to 12 + 9 = 21 papers in the second decade). These two increases could also be contrasted with a drop in the number of long papers falling outside of the primary mathematics remit (44 + 82 = 126 papers in the first decade to 53 + 25 = 78 papers in the second decade). Another way to consider the relative increase in EGM visibility and primary mathematics visibility more generally is to consider the proportions of EGM papers within the primary maths basket and within the overall

Table 1. Early grades mathematics (EGM) long papers in the Southern African Association for Research in Mathematics, Science and Technology Education (SAARMSTE) proceedings between 2003 and 2022

	EGM	Non EGM primary	All primary	Maths other	All Maths
2003–2007	5	11	16	44	60
2008–2012	6	5	11	82	93
2013–2017	13	12	25	53	78
2018–2022	22	9	31	25	56

Table 2. EGM prevalence within the primary and mathematics long paper categories; primary mathematics prevalence with the mathematics long paper category

	EGM/primary	Primary/mathematics	EGM/mathematics
2003–2007	5/16 (31%)	16/59 (27%)	5/59 (8%)
2008–2012	6/11 (55%)	11/93 (12%)	6/93 (6%)
2013–2017	13/25 (52%)	25/78 (32%)	11/78 (14%)
2018–2022	22/31 (71%)	31/56 (55%)	22/56 (39%)

mathematics basket, and primary mathematics papers within the overall mathematics basket. This analysis produces the results in Table 2.

This analysis highlights substantial growth in the proportion of long papers focused on primary mathematics in the second decade. EGM featured as the major player in primary mathematics research in the last 5 year period in particular, with more than two-thirds of the primary mathematics long papers focused on the early grades, and more than one-third of all mathematics papers also focused on this phase.

In terms of country representation of lead authors of the EGM papers, South Africa tends to dominate the long papers (34/46 = 74%) followed by Malawi (4/46 = 9%) and Lesotho (3/46 = 7%). Zimbabwe contributes a single paper (1/46 = 2%). Lead authors from other countries, not in the Southern African region, also contribute occasional papers and the countries represented include Norway, New Zealand and Mexico. In the case of Norway and Mexico, these papers are linked with broader collaborations with academics in the Southern African region: with Mercy Kazima's Malawi-based project in the case of Norway and Mellony Graven's Numeracy Chair project in the case of Mexico. Authors from Portugal and Australia have also contributed to single papers.

While in the first two periods South African papers made up just over a half (6/11) and two-thirds (4/6) of the EGM papers in the latter two periods, this increases to (11/13) 85% and (17/22) 77%, respectively, indicating particular growth in EGM research in South Africa in the past decade. This resonates with the Morrison et al. (this issue) finding that shows a substantive growth in the number of journal articles on EGM by South African authors over the past decade (discussed further below) and probably reflects the nexus of multiple longitudinal research and development projects focused on EGM (for example, Henning's Integrated Early Learning Chair at the University of Johannesburg, Numeracy Chairs at Wits and Rhodes, and the Initial Teacher Education Research Project and Primary Teacher Education project (PrimTEd)) as well as policy emphasis on the primary grades (e.g. the Foundations for Learning policy and the Annual National Assessments, ANAs). Similarly, while only one Malawian paper on EGM is present in the first decade, Malawi contributes three EGM papers in the most recent 5 year period, indicating growth in this field in Malawi, and linked to Mercy Kazima's research and development project. So, looking across Southern Africa, it is South Africa and Malawi where the EGM growth is located rather than being broad-based across the region.

Methods and sample sizes were more difficult to accurately count as many papers stated that they used multiple data gathering methods while the paper then only focused on a single source of data and a small sub sample of participants. What was clear was that the vast majority of papers relied on qualitative research methods and most reported on small to medium sample sizes with larger sample sizes coming from assessments of pre-service teachers' (PSTs') knowledge or learner knowledge/learner dispositions. Teacher and learner knowledge assessments were a popular data gathering method for several papers while teacher and learner interviews and questionnaires were also used. Documentary analysis—including curricular and assessment texts—also featured within a cluster of papers in our sample.

The substantial increase in numbers and proportions of EGM work since 2013 pointed us in the direction of looking in more depth at the second decade to understand the work, authors and institutions that have contributed to this growth. We noted too that this growth, while marked in itself, tended to underplay the actual visibility of EGM within the conference in the second decade, when

Table 3. Short papers: EGM and primary prevalence

Years	EGM focus	Non-EGM primary	Total primary	Maths other	Total maths	EGM as a percentage of all primary	Primary as a percentage of all maths	EGM as a percentage of all maths
2013–2017	27	33	60	164	224	45%	27%	12%
2018–2022	56	25	81	105	186	69%	44%	30%
Decade total	83	58	141	269	410	59%	34%	20%

looking across the other presentation formats at the conference: short papers, snapshots, panels, round tables and symposia amongst these. We include quantitative summaries of this data below (short paper numbers are given in Table 3), to note their role in stimulating visibility for EGM within the SAARMSTE Conferences and providing spaces for sharing emerging findings from postgraduate student research. We focus on the second decade given the near absence of EGM short papers in the first decade—by way of example, there were only the EGM short papers in the 5 year block of 2003–2007 out of 13 primary papers in total and 98 maths short papers in total.

Thus, as with the long papers the percentage of short papers focused on EGM as a percentage of primary mathematics and total mathematics papers respectively increased from period 3 to period 4 (45–69% of all primary maths papers and 12–30% of all maths papers). Similar to the EGM long paper contribution of 39% of all mathematics long papers in the most recent 5 year period, EGM short papers make up a substantive proportion of all maths papers (30%). This visibility fits within an overall expansion in the extent of short papers focused on primary mathematics out of all maths papers—rising from 60/224 = 27% between 2013 and 2017 to 81/186 = 44% between 2018 and 2022. This points to substantial growth of attention to primary phase mathematics in the research presented at SAARMSTE.

What is also notable in the past decade is the much larger number of short papers in comparison with long papers (83:34). Underlying the large number of short papers is a point we return to later—a much greater regional spread of representation of EGM work in the short papers compared with what is seen in the long papers. The limited spread in long papers is further noted at the end of the analysis of papers across each given time period when responding to RQ2 below.

> RQ2: What emergences and connecting threads can be seen across the two decades of research in EGM, and what key clusters of research topics and theories/methodologies have been established in the EGM research through this trajectory in the SAARMSTE proceedings?

There were a number of options available to us in terms of how to look for key clusters of research topics or of theories/methodologies over the 20 year period of the review. In the Morrison et al. review, this work involved classifying all the papers falling within the inclusion criteria on the basis of their empirical field, sample, key topic/s, etc. Given the smaller number of long papers falling within the EGM remit in this paper, we began with an eye towards emergences and consolidations in the field. This approach is informed by the finding from the aforementioned review of education research in South Africa by Deacon et al. (2009). This review suggested a lack of building up of educational knowledge base from a research base. Given that our review of EGM research in SAARMSTE, like Morrison et al.'s review, suggested a strong expansive trend in terms of numbers and visibility, we were interested in whether this expansion simply reflected 'more' of the kinds of diffuse, small-scale research noted in Deacon et al.'s (2009) review, or whether instead there was any evidence of an EGM field coming together around shared research problems, with some building around earlier findings in subsequent studies.

Given this concern, we approached the question of key clusters more qualitatively. This involved a full reading of all the EGM long papers identified in our initial search, noting the problems they were

interested in, the empirical base, the literature bases they were drawing from and the methodological and theoretical approaches they were using, and the findings emanating from their work. Working in this way, starting from the first 5 year block, we were able to see emergences and connecting threads that fed into larger clusters of research that went beyond a simple shared focus on, say teaching, or language, into deeper inter-connections that we feel have resulted—at this stage—in a field with strong networks and collaborations that reflect shared interests and multi-faceted lenses linked to key shared concerns.

In presenting our case for this claim, we work chronologically across the 5 year blocks, noting examples of the ways in which research published in later blocks has drawn on earlier approaches and/or findings. In each of the blocks below, we begin with a listing of the EGM-oriented long papers within that period, prior to offering an overview commentary on interconnections within that set, and in the case of subsequent blocks, between the blocks.

This approach led us into key clusters of research that, by the end of the 20 year period, have a longitudinal evidence base, with multiple empirical bases and sub-facets having been studied. These clusters of substantial research attention are listed here, and we detail and comment on each of these collated evidence bases in the second analysis section. Note that while some papers could be placed into more than one theme as they addressed issues across themes in order to maintain the count of 46 papers, we selected the theme we identified as most central to the paper's contribution. In our concluding section, we note the importance of these extended bodies of evidence for furthering the track record of intervention studies in EGM in the next two decades:

- Theme 1—teacher knowledge & teaching practices, 18 papers;
- Theme 2—interventions (learner, teachers and PSTs), 8 papers;
- Theme 3—learner and teacher beliefs, dispositions, identities, experiences and attitudes, 8 papers;
- Theme 4—assessment of learners, 4 papers;
- Theme 5—language and communication, 4 papers;
- Other (research tensions, self-regulation strategies, learning difficulties, probabilistic reasoning), 4 papers.

In Table 4, we list the EGM long papers in the 2003–2007 block and go on to overview their foci and interconnections.

There are five papers in this 5 year block. The two 2005 South Africa papers are linked to the same project. The Cranfield et al. (2005) paper presents findings that pre-date a long trajectory of writing in South Africa that has pointed to counting in ones as a key strategy used by children to solve arithmetical problems, with a relatively large empirical base underlying this work ($n = 222$ Grade 1; $n = 257$ Grade 2; $n = 240$ Grade 3 learners), all drawn from one South Africa province.

The Maher (2004), Cranfield et al. (2005) and Kühne et al. (2005) papers in this set are focused on early number learning. Of interest are the bodies of prior work leaned on in these studies, with the New

Table 4. 2003–2007 SAARMSTE EGM long papers

Year	Author countries	Author/s: title
2003	Lesotho	Polaki: A research-based description of Basotho Elementary and middle school students' probabilistic thinking
2004	New Zealand	Maher: Junior primary mathematics given a helping hand
	Zimbabwe	Mutemeri & Dube: A study on the extent to which mathematics instructional practices in the infant school relate or make use of children's experiences
2005	South Africa/The Netherlands	Cranfield et al.: How Grade 1 to 3 children learn, understand and solve early number problems.
	South Africa/The Netherlands	Kühne et al.: A learning pathway for number as a guide to Instructional programme design

Table 5. 2008–2012 SAARMSTE EGM long papers

Year	Author countries	Author/s: title
2009	South Africa	Lombard & McAuliffe: Teaching numeracy teachers to teach numeracy: A comparative review of curriculum in terms of content, practical application and methodologies
	Lesotho	Mpalami & Harries: Exploring student teachers" understanding of mathematical representations—A preliminary study with first year student teachers enrolled for Diploma in Education Primary at Lesotho College of Education
2012	Malawi	Chitera & Kufaine: Mathematics teaching in a classroom where a local language is the language of learning and teaching: The formal and informal mathematical language
	South Africa	Jooste: 'I've never given the value of zero much thought': Teachers' understanding of the concept of zero
	South Africa	Graven & Stott: Design issues for mathematics clubs for early grade learners
	South Africa	Venkat: Analysing classroom talk in a Grade 2 numeracy lesson

Zealand work drawing on the Mathematics Remediation work of Bob Wright, and the Kuhne et al. paper including a key writer in the Realistic Mathematics Education tradition (see Van den Heuvel-Panhuizen & Drijvers, 2020) amongst its author group, and drawing on the mathematical trajectory writing developed in that work. The models, frameworks and approaches in both of these sources (Wright 1994; Van den Heuvel-Panhuizen & Drijvers, 2020) have continued to be drawn on and adapted in later studies in EGM within our current survey.

Polaki's (2003) paper is the only paper in the reviewed set focused on probability in the early grades, and—as subsequent sections show—one of a minority that look beyond whole number work. Mutemeri and Dube's (2004) paper on teaching in Grade 2 is similarly 'stand-alone', although in its attention to the ways in which teachers build on children's explanations, reflects the widespread attention around that time in Southern Africa curricula to the key tenets of learner centred education (e.g. Vavrus et al., 2011). The five papers thus come from institutions based across four countries, three of these in the Southern African region. The regional and international connections within this small group are an important part of the SAARMSTE network and orientation.

In Table 5, we list the EGM long papers in the 2008–2012 block. Here we overview their foci and interconnections. Within this group of six long papers, five of the studies are focused on teachers and teaching (Lombard & McAuliffe, 2009; Chitera & Kufaine, 2012; Mpalami & Harries, 2009; Jooste, 2012; Venkat, 2012), with the latter three attending to early number emphases. The Mpalami and Harries (2009) paper points to a lack of fluency among student teachers in their own work with number lines and other structured representations; Jooste points to poor understanding among teachers of multiplication and division by zero; and Venkat's paper notes the lack of connection in teachers' work that underlies the repeated reversion to unit counting. These fundamentally mathematical interests contrast with the more 'generic' focus on pedagogy in EGM classrooms in the earlier Mutemeri and Dube (2004) paper in the first block, which reflects a trend noted in the broader South African writing in the early 2000s, drawing from a sociological perspective as noted in Venkat and Sapire (2022). These papers also point to problems with the ways in which EGM teachers understand and work with mathematics—a focus that has remained a core problem for research in primary mathematics throughout the 20 year period. The Lombard and McAuliffe (2009), Mpalami and Harries (2009) and Jooste (2012) papers all include pre-service teachers, and while all of these are small-scale studies, this focus on initial teacher education foreshadows growing attention to initial teacher education in the second decade.

The Graven and Stott (2012) paper discusses design issues involved in setting up the Maths Clubs intervention model in the South African Numeracy Chair project at Rhodes. This paper and the Venkat (2012) paper are the first in a lineage of SAARMSTE writing that came from the Numeracy Chairs and a range of other EGM initiatives between 2010 and 2020. Chitera and Kufaine's (2012) paper on language use in early grade mathematics classrooms notes the lack of bridging between informal/formal talk. The focus on informal/formal talk tends to be 'generic'

Table 6. 2013–2017 SAARMSTE EGM long papers

Year	Author countries	Author/s: title
2013	Norway and Portugal	Jacobsen & Ribeiro: Teachers' reflections on nonstandard students' work
	South Africa	Stott & Graven: Procedural spectrums: translating qualitative data into visual summaries
	South Africa	Pausigere & Graven: On the constituents of primary maths teacher identity: Towards a model.
2014	South Africa and Israel	Graven & Heyd-Metzuyanim: Primary learner descriptions of a successful maths learner
	South Africa	Pausigere: On South African primary mathematics learner identity: A Bernsteinian illumination
	Lesotho	Mpalami: Learning to teach mathematics by means of concrete representations
2015	South Africa	Graven et al.: Identifying stages of numeracy proficiency to enable remediation of foundational knowledge using the learning framework in number
	South Africa	Hewana & Graven: Exploring frameworks for identifying learning dispositions: The story of Saki
	South Africa	Kgalushi & Kakoma: Teachers' pedagogical content knowledge in the teaching of Grade 3 mathematics concerning equivalent fractions in some rural schools of Limpopo Province
	South Africa	Jojo: Representation of the equal relationship in the development of mathematical thinking: A case of Grade One's
2016	South Africa	Roberts & Barmby: Analysing Annual National Assessments to improve both teaching and assessment practices
	South Africa	Long & Graven: Documentary analysis of learning dispositions promoted within the transition between Grade R and Grade 1 in the South African Curriculum and Assessment Policy
	South Africa	Graven: Teacher perceptions of the successes and challenges of a mathematics homework drive for primary learners

in its mathematical focus, rather than content specific—a point that we return to in later sections. In this period we see a growing presence of South African research in EGM, with four of the six papers emanating from South Africa.

In Table 6, we list the EGM long papers in the 2013–2017 block. Here we overview their foci and interconnections. The attention to early number continues in this 5 year block with a focus on the nuances of number teaching presented from international perspectives in the paper by Jacobsen and Ribeiro (2013), and the set of papers documenting aspects of number learning seen in intervention studies (Stott & Graven, 2013; Graven et al., 2015).

A substantively 'new' insertion in this block is the focus on teacher identities (Pausigere & Graven, 2013; Pausigere, 2014; Long & Graven, 2016) and learner dispositions (Graven & Heyd-Metzuyanim, 2014; Hewana & Graven, 2015) in the work of Graven's Numeracy Chair group. This focus tended to shift the ground from the earlier attention to learning from observational and assessment standpoints, rather than the more subjective positions embodied in the work on identities and dispositions. This body of work leans on international writing outside the field of mathematics education (e.g. Wenger, 1998; Carr & Claxton, 2002; Gee, 2000). Of interest within this group is the evidence of some interventions starting to draw on the evidence gathered—for example, Graven (2016) notes that a key rationale for the homework drive intervention is the need for greater attention to independent sense-making and agency, with evidence of limitations in both of these aspects marked in the earlier dispositions research base. Curriculum analyses with a focus on promoted institutional identities within these are also informed by these findings (Long & Graven, 2016; Pausigere, 2014). There is therefore a connective tissue here across multiple studies, where a problem identified in one study or set of studies leads to further investigations and interventions in other studies.

Table 7. 2018–2022 SAARMSTE EGM long papers

Year	Author countries	Author/s: title
2019	South Africa	Bezuidenhout et al.: Early mathematics vocabulary and number concept development
	Mexico/ Australia/ South Africa	Cortina et al.: Instructional design in pursuing equity: The case of the 'fraction as measure' sequence
2020	South Africa	Alex et al: Mathematics assessment (in Isixhosa and in English) of entry level mathematics education students in a rural university
	South Africa	Chikiwa et al: What mathematics content knowledge do pre-service teachers bring to their foundation phase post graduate certificate in education studies?
	Malawi	Gobede: Analysis of a Grade 2 teacher's use of artifacts and inscriptions when introducing addition of whole numbers
	South Africa	Hokonya et al.: Exploring an analytic framework for mathematical identities of learners in landscapes of mathematical practice
	South Africa	Jaffer: Assessment of number in Foundation Phase initial teacher education programmes in four South African Universities
	South Africa	Roberts: Maths Intensive: First design trial in response to PrimTEd mathematics assessment
	South Africa	Venketsamy & Wilson: Voices from the classrooms: Early grade teachers' experience in the use of digital technology in mathematics teaching
2021	South Africa	Brown: Module and assessment design to develop the mathematical thinking of preservice primary school education students
	South Africa	Chikiwa et al: Pre-service teachers' levels of reflection on mathematics lessons: A review and adaptation of frameworks
	Norway	Fauskanger & Bjuland; Learning to notice learners' mathematical thinking while co-enacting instruction
	South Africa	Morrison: A multiplicative reasoning intervention in Grade 2
	Malawi	Mwadzaangati & Kazima: Self-regulation strategies used by female student teachers in primary mathematics teacher education
	South Africa	Roberts & Moloi: Jumpstart programme impact on mathematics learning outcomes: A cross-sectional quasi experiment using the early grade mathematics assessment
	South Africa	Westaway & Vale: Preservice teachers' noticing of children's addition calculation strategies
	South Africa	Venketsamy et al.: Exploring challenges experienced by teachers teaching number sense in the Foundation Phase
2022	South Africa	Robertson & Graven: Mathematical meaning-making: It's not just all talk
	South Africa	Chikiwa & Graven: Exploring the efficacy of the six-lens framework in developing pre-service mathematics teachers' reflective practice
	Malawi	Gobede: Multiple mediatory roles of artefacts in large classes: A Grade 1 teacher's orchestration of artefacts when introducing the concept of addition
	South Africa	Long & Graven; Grade R teachers' institutional identities proposed in policy and narrated in interviews of a teacher's experiences
	South Africa	Willemse et al.: Support teachers need to assist learners experiencing mathematical learning difficulties

The Roberts and Barmby (2016) paper analyses ANA Grade 3 data and offers openings for how this data might usefully be presented to impact feedback into the education system. In this sense, this paper too is quite overtly intervention oriented. This period of long papers is dominated by authors in South African institutions other than the paper by Mpalami (2014) that is conducted in Lesotho and focuses on the use of concrete representations in the context of teaching money.

In Table 7, we list the EGM long papers in the 2018–2022 block. Here we overview their foci and interconnections. Initial teacher education is writ large in this 5 year block, with nine papers dealing

with this focus (Alex et al., 2020; Chikiwa et al., 2020; Chikiwa & Graven, 2021, 2022; Jaffer, 2020; Roberts, 2020; Brown, 2021; Mwadzaangati & Kazima, 2021; Westaway & Vale, 2021). Many South African studies in this set are linked to the rollout of the PrimTEd study, while the Mwadzaangati and Kazima paper, with its gendered focus in the Malawian system, is more stand-alone.

Early number continues as the key content area in focus across a number of these papers, though with more focus on teaching (Westaway & Vale, 2021; Venketsamy et al., 2021; Gobede, 2022) than on learning (Bezuidenhout et al., 2019; Roberts & Moloi, 2021), and represented as a focus of intervention studies (Morrison, 2021) and in studies of the teacher education curriculum (Jaffer, 2020). Within this set, there is evidence of cross-pollination with Gobede making use of the mediating primary mathematics framework (Venkat & Askew, 2018), which, in turn, developed out of classroom observation findings including the earlier Venkat (2012) study, and Jaffer's paper citing several earlier works emanating from the PrimTEd study.

Language and discourse appear in three papers in this large group (Bezuidenhout et al., 2019; Alex et al., 2020; Robertson & Graven, 2022). Of interest in this group is that language is now dealt with in conjunction with attention to number concept as in the Bezuidenhout et al. paper, or in teacher assessment as in the Alex et al. paper. In this cluster, there is a sense of language moving from being a stand-alone focus to a focus that is connected with other issues at play in the EGM space. While this period sees continued dominance of papers from South Africa, the three papers from Malawi contribute 14% of the papers in this period.

We now comment on the substantial research themes emerging from this longitudinal analysis. We have ordered these in terms of those with the greatest number of papers, i.e. teacher knowledge and teaching practices (18) to those with the least (assessment of learners and language with four papers each)

Theme 1: Teacher knowledge and teaching practices (18)

Given the consistent evidence of gaps in primary teachers' mathematical knowledge in Southern Africa, a focus on teacher (pre- and in-service) knowledge and teaching practices (Mutimeri & Dube, 2005; Venkat, 2012; Mpalami, 2014; Jojo, 2015; Kgalushe & Kakoma, 2015; Gobede, 2020, 2022; Venketsamy et al., 2021) is unsurprising in our EGM review dataset. There are additional papers focused on teaching that have taken a lens focused on other issues like language/communication that are counted elsewhere, but add to the illustrations of EGM teacher knowledge and pedagogy in Southern Africa. We have pointed to the growth of attention to initial teacher education, with work across observational studies (Mpalami & Harries, 2009), assessment-oriented studies (Alex et al., 2020; Chikiwa et al., 2020; Westaway & Vale, 2021), theory and framework-oriented studies (Chikiwa & Graven, 2021) and intervention studies (Roberts, 2020; Brown, 2021; Chikiwa & Graven, 2022). In this latter group, there are opportunities to take up Mosvold's (2022) challenge to consider how to make a difference in teachers' work with the knowledge demands of teaching in Southern Africa. There are also a small number of international studies represented in this set (Jakobsen & Ribeiro, 2013; Fauskanger & Bjuland, 2021).

Once again, in this set, what we see is a body of work that has emerged out of recognition and building on earlier findings, and interactions in SAARMSTE symposia and other formats. Given that many of these groups have kicked off intervention projects in the last few years, EGM and primary mathematics teacher education are likely to continue to have a strong showing in years to come.

In some ways, the strong focus on pre-service teacher education has somewhat eclipsed the attention to in-service teacher education, although these are represented in some of the smaller scale studies focused on noticing (Fauskanger & Bjuland, 2021) and larger scale studies such as the Morrison's (2021) paper on intervention working via district subject advisers.

Theme 2: Interventions (learners, teachers and PSTs) (8)

Interventions in EGM have formed an important and highly visible part of educational research in South Africa in the last decade (see Spaull & Taylor, 2022), so we were not surprised to see a cluster of papers in this category. The vast majority of these papers have been published in the

most recent 5 year block. At the schooling level, a number of the papers in this cluster detailed interventions seeking to improve early number teaching and learning (e.g. Maher, 2004; Morrison, 2021; Graven & Stott, 2012), building on earlier writing on problems within both the teaching and learning of early numbers as seen in classroom observation and learning assessment studies. Cortina et al.'s (2019) paper discusses design research focused on the topic of fractions. Roberts and Moloi's (2021) evaluation of the impact of a number of interventions run by the non-governmental organization Jumpstart is one of a small number of larger scale studies in our sample, working with four years of cross-sectional data ($n = 5724$ learners).

The Maths Clubs initiative is an intervention that is well represented in this review, with two papers focused on design aspects (Graven & Stott, 2012) and outcomes (Graven et al., 2015). Intervention studies are starting to emerge from the PrimTEd project, looking at initial teacher education (Roberts, 2020; Brown, 2021), with these papers following observation/assessment focused studies (e.g. Alex et al., 2020; Chikiwa et al., 2020; Westaway & Vale, 2021) that worked to detail the existing landscape of pre-service EGM teacher knowledge, understanding, noticing and reflection skills, prior to intervening to develop this ground.

Theme 3: Learner and teacher experiences, beliefs, dispositions, identities and attitudes (8)

Eight long papers gather data on early grade teacher experiences and beliefs linked to specific aspects of teaching such as technology or giving homework (e.g. Venkatsamy & Wilson, 2020; Graven, 2016 respectively), and identities of teachers of Grade R learners (Long & Graven, 2022) or teachers of the transition Grades 3 and 4 (e.g. Pausigere & Graven, 2013; Pausigere, 2014). These studies predominantly use questionnaires and interviews to gather data. The studies tend to point to both challenges and learning opportunities that teachers face in their teaching and in their participation in Professional Development (PD) learning opportunities. Similarly, several long papers gather learner data on mathematical learning dispositions (e.g. Graven & Heyd-Metzuyanim, 2014; Hewana & Graven, 2015) or identities as early grade mathematical learners through questionnaires, narrative written stories and interviews (Hokonya et al., 2020).

All the studies in this cluster are qualitative studies with medium sample sizes other than the study by Graven and Heyd-Metzuyanim (2014) that investigated the written mathematical learning dispositions of 1208 Grade 3–4 learners. The learner studies in this cluster point to the importance of interventions that support shifting negative and passive mathematics learning dispositions and identities towards more positive fully participating, resilient, persevering and confident learning dispositions/identities.

Theme 4: Assessment of learners (4)

Another theme of SAARMSTE long papers in EGM relates to the assessment of learners. The papers on learner assessments focus on gathering information on the mathematics knowledge of early grade learners often in the context of assessing an intervention. For example, in the context of after school mathematics clubs using Wright et al.'s Learning Framework in Number assessment and recovery framework. Graven et al. (2015) suggest this as a useful way of assessing learner progression that provides detailed feedback to inform intervention as opposed to the ANAs that were summative and failed to provide useful information for planning teaching. On the other hand, focusing on Grade 3 learner performance in the later abandoned ANAs, Roberts and Barmby (2016) argued that analysis of learner methods and performance across these has the potential to be used in ways that can inform the planning of teaching. Learner assessments also feature prominently in the evaluation of larger scale intervention programmes discussed under interventions above (e.g. the Roberts & Moloi, 2021 study that used Early Grade Mathematics Assessment (EGMA) assessments to evaluate the impact of the jumpstart programme).

Kühne et al. (2005) draw on the Learning Pathways in Number literature to address the assessment of learner progression. The same team (Cranfield et al., 2005) analysed the nature of learner problem solving through analysis of their written assessments and found that most learners were unable to solve straight calculations and most used counting all and counting on strategies and their analysis

across the grades indicated almost no progression from Grade 1 methods to solve problems across the foundation phase Grades 2 and 3. This finding is taken up by the Mental Starters Intervention programme that began in 2016 and partially at least, began in response to teacher dissatisfaction with the ANAs' ability to inform their teaching.

The work of the Grade 3 Mental Starters Assessment Project led by the two Numeracy Chairs (Graven and Venkat) has been presented as a plenary panel (in 2017) and a symposium (in 2022) rather than as long papers. This work focuses on the use of timed pre- and post-diagnostic assessments that look to assess learning in relation to the development of fluencies and strategies required for Grade 3 mental calculations.

It is worth noting that in this theme we see EGM papers drawing on larger sample sizes and/or relying on quantitative analysis. For example the Cranfield et al. study included 719 Grade 1–3 learners while the Roberts and Barmby (2016) study uses Rasch analysis on two classes of Grade 3 learners. Note that assessment related to pre-service teacher knowledge is also a prevalent theme but this was discussed and included under the first theme that addressed knowledge of teachers.

Theme 5: Language and communication (4)

As with assessment of learners, a small cluster of four long papers focused on language issues in EGM. Of interest, all South African papers in this cluster appear in the last 5 year period (Alex et al., 2022; Robertson & Graven, 2022; Bezuidenhout et al., 2019) while the paper from Malawi appears in 2012 (Chitera & Kufaine, 2012). Each of the papers highlights different aspects of language and communication in foundation phase classroom teaching of mathematics.

Chitera and Kufaine (2012) focus on how mathematics teachers distinguish formal and informal mathematics talk and mediate between these. Chichewa was the home language of the learners and the language of learning and teaching. They argue that when the language of learning and teaching is a local language, learners are able to use informal mathematics language to support their learning of more formalised mathematical language.

Alex et al. (2020), working with foundation phase PSTs tested whether PSTs in a rural university could trans-language between English and an African language for mathematical sense making. They had half their PST group write the national Primary Teacher Education mathematics test in English and then in isiXhosa (and vice versa for the other half). Their findings showed significantly poorer performance when writing the test in isiXhosa, highlighting concern for foundation phase PSTs' teaching of mathematics in African languages. Bezuidenhout et al. draw on a translanguaging perspective and argue that mathematics vocabulary and logical reasoning are important skills for early number development. They describe how Grade R learners can access different languages to support communication.

Robertson and Graven (2022) share micro-ethnographic data to illustrate some of the ways in which mathematical meaning was co-constructed in the course of an after-school mathematics club session between Grade 3 learners and the club facilitator. They highlight that, while most verbal input came from the facilitator, other modes of communication, particularly gestures, enabled learners to produce and communicate a solution to the mathematical challenge set before them. The paper argues for the importance of paying attention to multi-modality in mathematical meaning-making, especially when learners lack confidence in verbal engagement.

We note that several papers noted under other themes link with or raise key language issues in their writing even while not focused on the issue of language (e.g. Alex et al.'s 2020 paper focused on assessment of mathematics knowledge of foundation phase PSTs looks at this across the English and IsiXhosa language). While not a long paper, the 2019 symposium titled 'The language use debate—translanguaging or code-switching in the Foundation Phase', led by Ingrid Sapire of Bala Wande, is also noteworthy as an example of the growing visibility to language issues in EGM within SAARMSTE.

Since language and mathematics education is a growing field regionally, particularly in Malawi, Kenya and South Africa with much attention given to this in leading journals both international (e.g.

Kazima, 2007; Phakeng & Moskowitch, 2013) and regional (Setati et al., 2009; Essien, 2018), the relatively low number of long papers focused on language in our review is expected to grow over time.

Adding further to the EGM visibility, there were substantial numbers of panel sessions and symposiums focused on EGM in the past decade. Between 2013 and 2017, there were four EGM-focused symposia/panels out of a total of seven mathematics focused symposia/panels (57%). Between 2018 and 2022, there were seven EGM focused symposia/panels out of a total of 17 mathematics focused symposia/panels (41%). Over the course of the second decade, close to half of all the symposia/panels (46%) were therefore focused on EGM. A number of the larger primary project 'hubs' in the region (the South African projects mentioned above and Kazima et al.'s Malawi-based project and the more recent South African Bala Wande project) and also the South African Department of Basic Education feature in these presentation formats. By design, these formats include cross-collaborations—for example, the 2022 Mental Starters Assessment project symposium involved researchers, provincial coordinators and DBE personnel, all offering perspectives and sharing evidence on the rollout of this mental mathematics initiative in South African schools.

Conclusions

We began this paper by noting a key critique of education research as being too small scale and diffuse in its foci to have impact. The work on EGM represented in this review and in the other review papers in this issue tends to refute this claim. Whilst the majority of studies are qualitative and smaller scale, we have pointed to a significant degree of inter-connection and building on prior work. Bodies of work built around projects have been important within these interconnections. Graven's Chair project includes several inter-connected papers in this review, as does Mercy Kazima's Malawi-based EGM project and the PrimTEd project. The work linked to both the Venkat and Graven Numeracy Chairs and other projects has also been presented across several of the SAARMSTE presentation formats—long papers, short papers, panels and symposia. The extended timeframes of such projects appear to have allowed a leveraging of the range of platforms at the SAARMSTE conference, with early student work presented more often in short paper formats, and more mature work being discussed and shared across the other formats.

We have provided some illustrations of the interconnected nature of this work. Perhaps somewhat less in focus are the connections between this work and the broader EGM field and trends. Space limitations make this difficult to do, but we have noted that the expansion of focus in EGM in South Africa and Malawi, in particular, have been discussed in several other recent publications.

The expansions in South Africa and Malawi point to a flip side—that there is limited work in EGM across the rest of the Southern African region. It is worth noting on this that a much broader regional representation was present when looking at the short papers. However, it would appear that these studies are not building, over time, into studies that feature in long papers. Our sense (and reflected in the Morrison et al.'s (this issue) review) is that there is limited representation of this broader regional work in journal articles too. Given the evidence of EGM being critical for subsequent access and success in mathematics, we would argue that some of what SAARMSTE needs to support, through its network of regional chapters, is the establishment of research and development hubs focused on EGM across the region. The rising proportion of EGM visibility at the SAARMSTE conference, in long papers and other formats, indicates not only a success story in terms of SAARMSTE's key role in supporting this growth, but also that this might be an opportune time to establish wider regional representation in EGM across Southern Africa.

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