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Children doing mathematics with confidence in the early grades by 2030: What will it take?

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Abstract

In this chapter, we draw together the early grade mathematics (EGM) work reported on in this volume and in Volume 3, offering a bird's-eye view of what we know. Pulling together the emerging themes that cut across the mathematics chapters and the factors identified as impeding progress, we reflect on what it will take to have South African children doing mathematics with confidence in the early grades by 2030. We note through this analysis that in the decade from 2010 to 2020, rates of curriculum coverage have improved, but teachers' knowledge and their access to learning mathematics remain serious concerns. We have identified the following priorities for improving outcomes in mathematics learning: 1) mathematics-focused teacher-development programmes, 2) university-level capacity for mathematics-focused initial teacher education programmes, 3) school–university–government partnerships for research design hubs, 4) more flexible working with the National Curriculum and Assessment Policy Statement (CAPS) and language policy, and 5) building capacity for school-based instructional leadership.

KEYWORDS
early grade mathematics, South Africa, CAPS, assessment, mathematical knowledge

1 Introduction

The chapters in this volume and in Spaull and Taylor (2022) point to a vibrant range of work in EGM. This range of work brings together EGM studies across the mathematics education, policy, educational development, and assessment fields. This type of cross-field collaboration represents an area of useful growth in EGM in the last decade. There is also variety in methodological and developmental foci. Some studies are focused on policy and policy development, for example, in relation to language use and the roll-out of workbooks. Others focus more specifically on detailing mathematical gains in depth over time, for example, the studies emanating from the Numeracy Chairs (Venkat, Askew & Graven, this volume; Graven et al., this volume), the Magic Classroom Collective (MCC) (Porteus, this volume), and the NumberSense interventions (Brombacher & Roberts 2022; Moloi et al. 2022). There are findings from larger-scale studies, such as the provincial R-Maths programme (Spencer-Smith et al. 2022) and the national Mental Starters Assessment Project (MSAP) (Venkat & Graven 2022), and medium-scale studies such as the NumberSense, JumpStart and Bala Wande (Sapire et al. 2022) projects. Research linked to these intervention projects includes experimental and longitudinal impact designs. The former often involves treatment and parallel control schools; the latter more often measures impact in terms of shifts in scores on mathematics assessments over time.

In this concluding chapter, we draw on the preceding chapters, firstly, to reflect more broadly on what we know at this stage in relation to EGM, and secondly, to suggest key areas in which answers are not yet known and that we feel are priorities, based on the current evidence. Across both of these sections, we pull together the evidence under key headings which now have an accumulated body of evidence to support the themes we have selected as priorities.

2 What we know

In this section, we highlight what has emerged as key foci of attention in the 2010–2020 decade, and summarise what has been learned from studies on these. We note also the national constraints at the systemic level that impede improvements in learning outcomes for mathematics, and that require national attention and intervention.

2.1 Emerging foci

In terms of the foci for research and development emerging in EGM, we have noted the following:

- An emphasis on number sense as a core foundation for learning mathematics,
- Emerging flexibility in how the curriculum can be worked with, with repackaged and reformulated models coming into play,
- Growing attention to Grade R,
- Growing work in out-of-school and community settings for supporting EGM,

- Emerging evidence on how subject advisors and teaching assistants may be used to support teaching and learning of EGM, and
- Emerging attention to mathematics teacher education at tertiary level, and collaboration.

2.1.1 An emphasis on number sense

Several of the design hub projects that feature as chapters in this volume have focused their attention on early number learning and number sense rather than on the whole curriculum. Larger-scale mathematics interventions that began earlier in the decade tended to be bound by the need for full coverage of the CAPS curriculum – the Gauteng Primary Language and Mathematics Strategy, the Programme to Improve Learning Outcomes, and the National Education Collaboration Trust programme are all examples of this. However, the interventions launched by the Numeracy Chairs and Brombacher's NumberSense project have focused their attention on number topics. All of the latter projects have documented gains related to early number learning in the context of their interventions. The MSAP project (Venkat & Graven 2022), focusing on mental mathematics, is an example of a model that has now been incorporated into national policy.

The careful mathematical development of materials, with the inclusion of key representations such as part–part–whole models and number lines for supporting the teaching and learning of number sense have been common features of all of these projects. In the early grade mathematics community there is a consensus building around the need for focus on smaller numbers of key representations for particular mathematical topics. The Wits Maths Connect-Primary project chapter (Venkat et al., this volume) describes key 'structured' representations that they have used for addition and subtraction, and this point is noted too by Porteus (this volume) and Brombacher and Roberts (2022).

These studies have shown that it *is* possible to make inroads into improving the outcomes of early number learning. However, the disruptions caused by Covid-19 have set back the access to learning. It is important now to bring these groups together to look at the best ways in which number teaching and learning in schools in EGM may be strengthened by looking at intervention models and materials that can be used in schools and to refocus on the need for solid attention to strong foundations in number sense. The ways in which the Bala Wande project's materials have 'repackaged' the CAPS curriculum, with greater emphasis on number topics in Grade 1, provides a recent example that has drawn on the work of the MCC project. Drawing in the development of online support materials for number teaching and learning – such as those developed within OLICO (Bowie et al., this volume) and MSAP projects – is likely to prove useful in offering out-of-school support for in-school learning.

2.1.2 Emerging flexibility in how the curriculum can be worked with

Coupled with the growing emphasis on number teaching and learning is a growing flexibility in how the curriculum can be worked with in interventions. Interventions that began earlier in the decade skirted the prescriptions imposed by the requirement

to cover the official curriculum, by focusing on its 'mental starter' section (in the case of the Wits Maths Connect-Primary project), and by working in after-school club settings (in the case of the Rhodes SA Numeracy Chair project). Porteus (this volume) notes that the pressure for full curriculum coverage was associated with lower comparative gains in their Magic Classroom Collective project, and this led to their development of carefully sequenced and paced materials that tended to diverge from the CAPS stipulations.

In this latter project, as in the Bala Wande project (Sapire et al. 2022), we notice an increasing willingness among provincial and national education partners to consider more flexible options for implementing the curriculum. These options have evolved from carefully constructed research and development studies. The outcomes of these modifications are yet to be studied, but the designs provide openings for approaches that are geared towards bridging the gap between actual learning and the curriculum targets for achievement better; this gap is entrenched by the end of Grade 1 (see Spaull et al., this volume), and noted as a feature in other developing countries too (Pritchett & Beatty 2015).

2.1.3 Growing attention to Grade R

There have been vast extensions of access to Grade R in schools, from 300,000 learners enrolled in Grade R in 2003 to just over 800,000 enrolled in 2016 (Ashley-Cooper et al. 2018). While some studies earlier in the last decade pointed to limited, if any, gains related to Grade R access in learning outcomes for learners within the no-fee schooling sector (Van der Berg 2013), subsequent interventions have pointed to positive, albeit small, effects on subject advisors' and lead teachers' knowledge (Spencer-Smith et al. 2022). There has been scaling-up here too, with work done in the Western Cape's Education Department on the R-Maths programme, currently (2022) being adapted and implemented in Gauteng.

In the second half of the decade, there has been increasing interest in examining existing provision of preschools and their possible impacts, and political interest via the National Development Plan in exploring broader access to preschools. Early evaluations of interventions suggest promising effect sizes, based on recently-developed assessments such as the Early Learning Outcomes Measure, which includes an Emergent Numeracy and Mathematics component (Van der Berg 2021).

2.1.4 Growing work in out-of-school and community settings for supporting EGM

Several projects have worked with after-school maths clubs for primary-age learners, following the initial work of the Rhodes Numeracy Chair project, which showed the feasibility and scalability of this model, and of related community-based Family Maths Days (Graven & Jorgensen 2018). The OLICO Youth NGO has recently rolled out a provincially-supported after-school mathematics programme with primary schools in the Western Cape. Both of these projects have, or are, collecting assessment data to understand the impacts on learning, and how this learning can support children's learning in mathematics at school.

2.1.5 Developing subject advisors and teaching assistants to support the teaching and learning of EGM

Fleisch's (2018) writing has pointed to the potential of what he describes as the 'triple cocktail' model of intervention, involving materials, training, and support from coaches. However, the additional costs of coaches have rendered that part of the model unsustainable in both the Gauteng Primary Language and Mathematics Strategy and in the Bala Wande project. The findings emerging from the Limpopo arm of Bala Wande (Ardington & Henry 2021), coupled with the evaluations conducted for projects in the Jumpstart projects – both of which worked with qualified, but out-of-education and out-of-work school-leavers employed as teaching assistants – point to cautious promise with the latter model. However, the actual mechanisms through which improved performance is being achieved remain unclear at this stage, beyond the time savings that come through having an additional adult in classrooms to set up activities, and to support and mark individual learners' work. Interim presentations from the qualitative analysis of the Bala Wande implementation have noted that teachers have welcomed the support offered by the teaching assistants they are working with.

The MSAP and Wits Maths Connect-Projects have similarly shown cautious promise in interventions that have been mediated for teachers by district subject advisors, following training from the intervention developers. In both of these projects, there is emerging evidence of learning gains in scaled-up models involving subject advisors (see Askew et al. 2022, in relation to MSAP, and Venkat & Askew 2021, for WMC-P project intervention).

2.1.6 Emerging attention to collaboration in mathematics pre-service teacher education at tertiary level

Recent studies have increasingly focused on pre-service teacher education, and pointed to similar problems as those seen among in-service teachers, regarding their knowledge of mathematical content (Fonseca et al. 2018). More seriously, these studies have also flagged concerns with the seemingly low levels of development of content knowledge across four-year BEd programmes (Bowie et al. 2019; Alex & Roberts 2019). While some in-service teacher-development programmes have shown stronger gains than are indicated in the pre-service studies (using overlapping item sets in their pre- and post-testing) (Venkat et al. 2016), final mean levels of performance still fall short of what might be considered satisfactory levels of conceptual understanding for teaching primary mathematics.

In the wake of these findings, a small number of pre-service initiatives are under way and aim to focus lecturers' attention on developing pre-service primary teachers' mathematical content knowledge. The Mathematics Intensive programme was first piloted at the University of Johannesburg with first-year students, and showed promising improvements in teachers' knowledge (Roberts 2020). It was then extended to the Cape Peninsula University of Technology and repeated at the University of Johannesburg – again showing promising improvement in learning outcomes (Roberts & Maseko 2022). Flowing from this initial design work, the Maths4Primary Teaching programme was collaboratively developed and is currently trialling a first-year module in six universities (see Roberts, McAuliffe & Porteus, in process). In addition, the

recently-launched Mental Maths – Work Integrated Learning project builds on the MSAP's national roll-out by the DBE in Grade 3 in 2022, and aims to prepare pre-service teachers to understand and work with the MSAP materials during their practicum periods in BEd/PGCE programmes.

2.2 Impeding factors

On the impediments side, the following continue to challenge the potential for interventions to make an impact:

- EGM teachers' fragile mathematical knowledge and their poorly-connected instructional narratives,
- misalignment between curriculum expectations and learning,
- monolingual orientations to home-language use in classrooms, that poorly reflect South African learners' multilingual language repertoires, and
- limited assessment data in EGM.

These issues are coupled with evidence of increases in class sizes (Spaull et al., this volume). In this chapter we reflect on the bodies of evidence on each of the above, and what further research and development may need to do to address these constraints.

2.2.1 Problems with teachers' mathematical knowledge and their instructional narratives in African languages and in English

Teachers' mathematical knowledge has been highlighted as a problem across in- and pre-service levels. The recent decade has extended and added nuance to the awareness we already had a decade ago of gaps in primary teachers' mathematical knowledge. On the nuanced side, studies have pointed to particular problems for teachers in working with multiplicative reasoning (Venkat & Spaull 2015), mirroring the ongoing evidence of poor learner performance in topics with a multiplicative base – fractions, percentages, ratio among these (Herholdt & Sapire 2014; Bowie et al. 2022). In the early grades, qualitative studies have also pointed to problems with *how* mathematics is known, as well as *what* mathematics is known, with evidence of problems with connections and instructional explanations (Mathews 2021).

At this point, limited headway has been made on larger-scale improvements in terms of both knowledge and more coherent instructional narratives. However, a number of current interventions are seeking to develop better methods of instruction, with the issue of content knowledge increasingly coming into focus in the context of pre-service teacher education – as noted above. The development of instructional narratives is being supported in a range of ways across different projects. Lesson plans coupled with learners' materials are a part of several projects: MCC, Bala Wande, PILO and the National Education Collaboration Trust (NECT). In Bala Wande and MSAP, the instructional materials are linked with exemplar video clips that illustrate tasks being played out, again aiming to support coherent narratives alongside aspects like pacing and interactive and responsive teaching. Increasingly, these projects are producing instructional materials in many, or all, South African languages – building support for home-language and translanguaging instruction, supported by materials designed

around the key representations, as mentioned earlier. Translanguaging, as explained earlier in this volume, refers to the fluid incorporation of multiple languages and mathematical representation to support learning. Roberts et al. (this volume) call for greater attention to using storytelling in early grade mathematics, and argue for more attention to mathematical talk (in English and African languages), in initial teacher education programmes.

Kanjee et al. (2022) have focused on more generic formative assessment practices to improve the quality of pedagogy in EGM. This project has had a positive impact on teachers' knowledge of formative assessment and its uses, as well as greater participation and talk by learners. While there is potential for these generic practices to improve what McKay and Spaull (2022) describe as the "grammar of teaching", our sense is that gaps in teachers' mathematical content knowledge put a cap on the effectiveness of these types of intervention. It is critical to address these gaps in knowledge in order to leverage the power such interventions have to improve formative assessment.

2.2.2 Curriculum and learning misalignment

The findings from Spaull et al. (this volume) concur with those of Fritz et al. (2020) in providing evidence that, even in Grade 1, the CAPS mathematics curriculum outpaces where South African children actually are. Some studies have suggested that the tightly prescribed one-size-fits-all model of pacing and progression works against efforts to support teachers with 'teaching at the right level' (see Brombacher et al. in Volume 3). The Teaching Mathematics for Understanding framework (DBE 2018) offered a repackaging of curriculum content in the early grades, although some elements of the content in this curriculum went in different directions from the number-sense literature that grounds some of the other interventions. Subsequently, the Bala Wande project has worked with an adapted curriculum coverage in their learner activity books. What is urgently clear, in any case, is that teachers need to be better trained to mediate curricular content in responsive and progressive ways to learners. Further, this applies across pre- and in-service teacher education – and is a core priority for the coming decade.

Kanjee's work points to teachers needing support to effectively use assessment data to identify learning gaps and once they have identified these, to address the particular learning needs of their learners. At a modest level, this means making use of assessment data to inform teaching interventions (see Graven & Venkat 2022). Kanjee et al's (2022) integrated reading and mathematics intervention follows this approach.

With teachers' fragile mathematical knowledge of the teaching of EGM, caution is needed before advocating a differentiated curriculum, as considerable skill is required to manage well-differentiated lessons. In the context of South Africa's history of inequitable access, there are dangers that such approaches may lower expectations for learners who are identified as 'less capable'. Rather, the evidence suggests that modest moves towards including more differentiated learners' work may be possible, supported by provision of differentiated materials (as in the NumberSense booklets model described in Brombacher & Roberts 2022).

2.2.3 Language in mathematics education

While South Africa's Language in Education Policy has remained static over the last 20 years, there is increasing advocacy and implementation of translanguaging approaches, in which free and fluid movement between languages and between mathematical representations is promoted and encouraged (see Feza et al., Roberts et al., Sapire et al., this volume). The MCC was in the early wave of projects that placed home-language use squarely at the centre of their intervention work in the rural Eastern Cape (Porteus, this volume). Sapire's (2021) ongoing attention to language across a range of materials-development projects has culminated in the fully bilingual model of presenting languages seen in the Bala Wande materials. This aligns with her critique of what she describes as the "multiple monolingual" orientation of South African policy that is reflected in the DBE Workbooks (in which, while a diversity of languages is recognised, only one language is used at any one time). While South Africa now has a relatively substantial source of African-language texts (albeit translated from English mathematics texts), the quality and consistency of the translations, in the absence of well-developed mathematics terminology in each African language, remains a concern (Feza et al., this volume).

Current problems in the language policy and the ways in which it plays out on the ground relate to a number of issues. Firstly, we note concerns with how materials in the different languages are constructed. There have not yet been sufficient investments in systematic development of mathematics terminology in African languages, and into how to support the instructional narrative in any particular African language (see Porteus, this volume). This is a concern, given the known problems with how early grade mathematics texts are translated from English (see Feza et al., this volume). Translations are often done directly from English, without considering what particular African languages may offer in terms of mathematical expression, nor how they are constrained (see Mostert 2019 as an example). Secondly, English-to-African-language translations of mathematical texts are predominantly undertaken in an uncoordinated way (with multiple translation agencies, without systematic collaboration between mathematicians and linguists, and at the behest of a particular intervention). A national investment into more coordinated creation, development and translanguaging of 'Mathematics in English' into 'Mathematics in African languages' is likely to be necessary for this enterprise. A useful early outcome would be exemplar texts, arrived at by consensus, on appropriate and responsive spoken language (coupled with manipulatives, diagrams and written inscriptions) that can be used in the teaching of particular topics in EGM. Available multilingual dictionaries can function as a useful base for developing these resources. The evidence suggests that diagrams and video-clip illustrations of how mathematical content can be worked with in sensitive and responsive ways in different South African languages may be useful within this. Such work is likely to require collaboration between language and mathematics specialists alongside expert home-language EGM teachers.

There is increasing provision of instructional materials in several South African languages, but in materials for professional development (teacher guides, initial teacher education, and professional development programmes), English remains dominant. Given the evidence of widespread differences in the mathematics courses offered in BEd programmes (Bowie & Reed 2016) and the limited development of

content knowledge in tertiary institutions in these programmes, capacity for the education of mathematics teachers needs to be developed.

2.2.4 Limited assessment data in EGM

An ideal national assessment system, according to Nuga Deliwe and Van der Berg (this volume), comprises a combination of sample-based assessments and universal assessments. Such an assessment system is not yet in place for EGM in South Africa, but we do see the growth of EGM assessment tools. Being able to track learners' outcomes – using reliable assessment instruments over time – is an important part of assessing improvement. Several of the projects reporting on EGM learning outcomes in the context of interventions across Volumes 2 and 3 have used and/or developed assessments suitable for use in the Foundation Phase (FP), where substantial evidence points to low levels of reading proficiency – making traditional written tests unsuitable for use. The EGM assessment (EGMA) is used by several design hubs – the MCC, JumpStart, Shikaya, and Bala Wande. The Wits Maths Connect-Primary project and the Rhodes SA Numeracy Chair project have both made use of the more detailed individual interview-based assessments developed by Bob Wright and colleagues (Wright et al. 2005). A critical part of what these studies have offered is a method for tracking learning over time – longitudinally or quasi-longitudinally.

2.3 Aspects of the South African EGM landscape that are missing in this volume

There are a few important aspects of EGM in South Africa that are missing from this volume and are worth highlighting.

There is no detailed analysis of the FP mathematics curriculum, and McKay and Spaull (2022) note the lack of a large-scale evaluation of the impact of roll-out of the DBE's mathematics workbooks. Further work on both the curriculum and the workbooks is likely to be important in the interests of having greater flexibility in curriculum implementation models, and in the need to understand their contribution to improving teaching and learning.

There are large-scale interventions coordinated by the NECT, which use learner workbooks, teacher guides and trackers of curriculum coverage that are not described in this volume. The NECT work – and its related design hubs at provincial and/or district level – has been a major feature of the EGM landscape in South Africa, and it has sought to work at a large scale almost from the outset. We look forward to seeing more peer-reviewed research from the NECT interventions, detailing the impact on EGM learning outcomes.

While we have reflected on professional development courses for teachers in school, little attention has been paid to initial teacher education. There has been some progress in early teacher education, with the development of the Primary Teacher Education (PrimTEd) standards of knowledge and practice for mathematics. Related design interventions to support the implementation of the agreed standards are in their infancy.

3 Priorities for effecting improvements in EGM teaching and learning

This brings us to our concluding reflections on what we see as the priorities if we are to make improvements in EGM happen in the coming decade. These reflections are linked to the categories we have identified above, and we focus, in particular, on some of the systemic supports likely to be necessary if we are to make headway in each of the categories above.

3.1 Priority 1: invest in and support design and implementation of well-researched teacher-development programmes

Primary teachers' mathematical knowledge has continued to be seen as a binding constraint in South Africa's education system for over two decades. Thus far though, there is very limited evidence of success, at any large scale, with improving in-service primary teachers' levels of mathematical knowledge. There are small-scale examples of professional development courses that focus explicitly on mathematical knowledge and EGM teaching development, mathematical dispositions and reflective practice emerging from the design hubs. Some of these require additional design and investment to allow for working at a large scale.

There are clear lessons emerging about the features and areas to focus on in EGM teacher development.

Firstly, carefully designed and well-structured learners' workbooks need to be deliberately used as a vehicle for professional development. Porteus (this volume) reports on the MCC learner workbooks' inclusion of language signposting to help carry the instructional narrative of mathematics lessons in isiXhosa. Brombacher and Roberts (2022) refer to the simplicity of the NumberSense workbook design – with a limited number of representations and a simple 'counting–calculating–problem-solving' page-a-day structure. The Bala Wande (Sapire et al. 2022) and Mental Starters Assessment projects (Venkat & Graven 2022) include teachers' guides with short video clips that accompany the learning materials, and that can be accessed via mobile phones.

Secondly, with the majority of FP teachers teaching mathematics in an African language, shifting to English in Grade 4, attention to multilingual working within in-service teacher-development programmes is critical. It would also signal, support and model bilingual practices in EGM in ways that can support teaching. However, making this approach possible will require extensive work to develop high-quality texts in African languages for EGM and its teaching, and for use in teachers' education.

Thirdly, attention to ways of rigorously studying the impact of in-service teacher-development, and the related limitations and costs, is needed in order to start accumulating knowledge about the features of programmes that can contribute to larger-scale improvements in teaching.

3.2 Priority 2: invest in and support university-level capacity for design and implementation of high-quality initial primary maths teacher-education programmes

Very predictably, the lens has turned critically to pre-service teacher education as a key site for effecting improvements through the future teachers who enter the profession. This has led to a decade-long commitment from the Department of Higher Education and Training to support projects that focus on language and mathematics teacher education in the primary grades. A constraint that is increasingly being raised as a possible hindrance to change in pre-service teacher education is the varying, but generally limited time allocations for mathematics and its pedagogy across programmes. Thus, there are growing calls to increase the credits given to mathematics and language in primary pre-service programmes to 100 of the 480 credits allocated currently (Taylor & Mawoyo 2022).

On the pre-service side too, it will be important to attend to and promote translanguaging practices supported by materials. It will also be important to understand the impact of interventions to improve mathematical content knowledge, pedagogic content knowledge, and classroom practice, with awareness of what is left aside in these approaches.

3.3 Priority 3: incubate and continue to support design hubs that work closely with government structures

The success of design hubs (partnerships between universities and/or NGOs and a group of ten or more schools in a particular district or province, that include working relationships with government structures) in contributing to the EGM knowledge base is clear in this volume. They have contributed with trials and refinements of scalable models of improvement in mathematics learning outcomes. Increasing the number of design hubs and enlarging the emphasis on interventions that have potential to go to larger scale is a priority in the coming decade. Further, we need platforms through which provincial departments can critically engage with researchers on interventions that serve their goals.

The design hubs have, in most cases, used assessments to monitor learning outcomes in their studies. Critical discussions of the ways in which the assessments used across different studies overlap and differ can be a useful route to developing assessment literacy and assessment design skills. We are not calling here for the standardising of mathematics assessments across studies. Different assessments often offer different windows into the kinds of mathematical learning that interventions are producing. However, attending to the nature and range of mathematical assessment tasks is important if one wants to understand their impact on learning outcomes.

3.4 Priority 4: encourage more flexible working with the CAPS curriculum and language policies

Emerging evidence points to greater successes when more flexible approaches to working with the CAPS EGM specifications have been incorporated (e.g. through the MCC and Bala Wande projects). Initiatives such as the Teaching for Mathematical Understanding project have helped to make these adjustments in curriculum coverage possible within intervention projects. A second strand of flexibility is seen in approaches focused on differentiated offerings: some interventions are promoting differentiated workbooks (NumberSense) while others are exploring differentiated responsive feedback (Assessment for Learning).

Several interventions have also shown success with working with a carefully selected range of representations for early number learning, with a sharp focus on number structure and place value. These foci have fed into the more recent interventions of the decade, for example, the Bala Wande study and the pre-service Maths4Primary Teaching project.

As we have stated in the preceding notes on priorities, we suggest that this more flexible approach is extended to the Language in Education Policy. The emerging evidence (and the literature base) shows that fluid moves between languages and representations serve 'learning-with-understanding' better than dogmatic monolingualism in classrooms. Given that improving mathematical learning outcomes is the key priority, flexibility in language policy would better support teachers in their use of translanguaging. Both the FP mathematics curriculum and the DBE learner workbooks provide a rich repository of translated text in all our indigenous languages. Taken together, this is a valuable trove that could be an important contributor to the development of the terminology for mathematics in African languages. These texts ought to be important springboards for research and improvement in the envisaged design hubs that are organised to support our linguistic typology.

3.5 Priority 5: build capacity to offer school-based instructional leadership in EGM

Building the capacity to support the learning of EGM within the schooling system is critical if we are to meaningfully shift teaching praxis at a significant scale. The design hubs in this chapter have all worked to design and improve mathematics intervention models which can be scaled up. In two interventions – MSAP and R-Maths – we see the adoption of a 'modified cascade model', in which subject advisors are trained, mentored and supported to conduct district- and school-based training and mentoring. Supporting more efficient and effective use of personnel within the schooling system has also been a priority for one of the NECT interventions (PILO). The increasing use of teaching assistants to support work in classrooms brings another layer of personnel into the system who are also likely to need instructional support. Developing interventions that can build the expertise of the layer of subject advisors

so that they can offer useful support to heads of FP mathematics and to EGM teachers, and understanding what is achieved through these models is therefore a priority.

4 Concluding remarks

Common across the categories of the current evidence base and the priority areas for change, we see increasing levels of collaboration between players and sectors in the EGM field. Several multi-institutional collaborations are under way, and there are strong links between researchers from different fields, government, the education donor field and the NGO sector. Collaboration though, is only a precursor to the possibilities for supporting large-scale improvement, and the appetite and capacity for this work remain unknown. What is abundantly clear across the projects reported in this volume and Volume 3 is that effecting change in the system at any scale is labour- and time-intensive: several projects have noted that waves of curriculum reform and the extensive production and provision of materials and curricula on their own do not work to effect change.

While not loudly proclaimed across the chapters in this series, the role of the Association for Mathematics Educators of South Africa (AMESA) and the South African Association for Research in Mathematics, Science and Technology Education (SAARMSTE) is noteworthy for having provided platforms for dissemination and collaboration in the EGM education community. Almost all of the EGM interventions in the focus of this book and Volume 3 in this series (Spaull & Taylor 2022) have presented interim findings and workshops at these bodies' annual conferences. They are key contributors to the collegiality evident across the chapters in this volume.

We think that these are the major EGM priorities if we are to get South African children doing mathematics with confidence:

1. Invest in and support design and implementation of well-researched teacher-development programmes;
2. Invest in and support university-level capacity for design and implementation of high-quality initial primary maths teacher-education programmes;
3. Incubate and continue to support design hubs that work closely with government structures;
4. Encourage more flexible working with the CAPS curriculum and language policies; and
5. Build capacity to offer school-based instructional leadership in EGM.

A decade ago, the framing of the problem in education was in terms of 'physical access but not epistemic access'. Greater prescription of coverage and pacing was advocated as being what was needed to address the problem of inadequate coverage in the context of poor content knowledge. We now have evidence that the rates of curriculum coverage have improved, but our concerns about teachers' knowledge and teaching, and epistemic access to mathematics for learners, remain. We concur with the growing body of research that a medium- to long-term commitment to improving teachers' understanding of mathematics is the only way. But within this, we also argue for less dramatisation of the problems of knowledge and pedagogic practice, and more patient

documenting of where things stand and how they move forward, even if this change is slow in coming forth – as we know it is likely to be. The important thing is to be taking this endeavour forward, and developing the capacity for this work along the way.

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