

Interventions and Development of Mathematics Education for Primary Schools

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In this presentation I discuss the work of two research and development projects in my country, Malawi, which I coordinated since 2014, and how the work responded to the needs and context of mathematics education in Malawi. For more than two decades, Malawi has been concerned about low learner achievement in mathematics as indicated by national and international assessments. The concerns are similar to other countries in sub-Saharan Africa, where the mathematics achievement of most learners in primary schools is below their grade level. There have been some interventions aimed at addressing this concern by targeting schools, teachers and learners. I share these briefly as part of the background. Then I share the work of ‘my’ two projects called *Improving quality and capacity of mathematics teacher education in Malawi project (2014–2019)* and *Strengthening numeracy in early years of primary school through professional development of teachers project (2017–2022)*. I focus on the research and interventions by the projects - in particular the intervention on counting in the first two grades of primary school. Finally, I discuss the findings and implications to mathematics education research in Malawi and other similar contexts.

It is a great honour to be invited as keynote speaker, many thanks to the MERGA 2024 organising committee. My talk is drawn from my work in Malawi but can apply to other similar contexts. First, I share the context of Malawi and three examples of interventions that have taken place in primary schools within the last decade. Then I discuss the two projects that I coordinated since 2014. I share the motivation for projects, a summary of the work and interventions by projects, focusing on an intervention on counting in the first two grades of primary school. Finally, I highlight the findings and implications to mathematics education research.

Introduction and Background

Malawi Context

Malawi is a small low-income country in southeast Africa with an area of 118,484 square kilometres and population of about 21 million. It is a republic that gained its independence from Britain in 1964. The official language is English and is used in schools from Grade 5 onwards. Grades 1–4 use Chichewa, the national language, or other local language. The school structure has 8 years of primary school and 4 years of secondary school. Primary teacher education takes place in Teacher Training Colleges (TTC) under the Ministry of Education, and the qualification is a Teacher’s Certificate. The duration is two years covering 6 terms; four terms for taught courses at the TTC and two terms for school-based training in form of teaching practice. The initial teacher education programme prepares generalist primary school teachers with no specialisation in terms of teaching subjects or year level. Teacher education for secondary school is offered at universities and has a duration of four years of taught courses and one school term of teaching practice. The university teacher education programmes have specialisations for teaching subjects; often one major and one minor teaching subject (e.g., Mathematics major and Physics minor).

(2024). In J. Višňovská, E. Ross, & S. Getenet (Eds.), *Surfing the waves of mathematics education. Proceedings of the 46th annual conference of the Mathematics Education Research Group of Australasia* (pp. 13–20). Gold Coast: MERGA.

Teaching and Learning Mathematics in Malawi

The teaching and learning of mathematics in Malawi is considered important, hence mathematics is a compulsory subject in primary and secondary schools, and a core subject for all science related programmes in post-secondary education. In primary and secondary schools, mathematics is allocated more time than all other subjects except English, which is also allocated about the same time. For example, 40% of teaching time in Grade 1, 34% in Grade 2 and 31% Grade 3 (Ministry of Education, 2006). While there is all this emphasis on mathematics in schools, the learning seems to be limited as evidenced in low learner achievement. Assessments such as the Early Grade Mathematics Assessment in 2010 and the Monitoring Learning Achievement survey in 2012 reported that more than 50% of the learners achieved below the expectation of the Malawi primary school mathematics curriculum (Brombacher, 2011; Ravishankar et al., 2016). In all the assessments by the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) in 1995, 2000, 2007, and 2013, Malawi was one of the two lowest performing countries in mathematics, with more than 90% of learners performing at or below the basic numeracy level (Milner et al., 2011; Brombacher, 2019).

The concern in low learner achievement in mathematics led the government of Malawi through the Ministry of Education to commission a study to investigate the problem. This was a large-scale study from 2018 to 2019 that investigated what was inhibiting student learning of mathematics. The study focused on the first four grades of primary school and scrutinised the curriculum materials, lesson observations, and the various assessments (Brombacher, 2019). Findings of the study include that the Malawi curriculum had low expectations of learners, for example, it had low number range for calculations (0–9 for Grade 1, 0–99 for Grade 2, and 0–999 for Grade 3); the focus of teaching was on procedures not understanding; and the approach to calculations was the same from Grade 1 to Grade 4. Same single-digit arithmetic using counters and the “combine and count all” strategy was observed. There was no increase in efficiency or development of number range appropriate strategies (Brombacher, 2019). There are other factors that contribute to the learners’ low achievements, including large classes, limited teaching and learning resources, and problems of learning mathematics in English while not competent in the language (Kazima, 2008, 2014).

Interventions in Primary Mathematics

The concerns in teaching and learning mathematics have led to some interventions in primary mathematics. These are mostly small-scale interventions targeting schools, teachers, and learners. Below are three examples, selected for their relatively good impact. The first example is *Unlocking Talent* which focuses on learners, the second is *Numeracy Boost* which focuses on the community, and third is *Japan International Cooperation Agency (JICA) Numeracy* which focused on teachers.

Unlocking Talent Intervention

This is an intervention by an international project aimed at improving numeracy and literacy for marginalised children in various countries (Pitchford, 2018). In Malawi, the intervention started in 2014. It is funded by the Norwegian Embassy and implemented in partnership with the Voluntary Services Overseas, the Malawi Ministry of Education, a non-profit organisation called Onebillion, The United Kingdom’s Department for International Development (DFID), United Nations International Children’s Emergency Fund (UNICEF), and the Scottish Government (Royal Norwegian Embassy, 2017). The intervention offers children in early years of primary school individualised learning using tablets. The tablets are installed with applications that were developed based on the content of the country’s primary school curriculum (Pitchford, 2018). The applications focus on basic numeracy and are designed in

such a way that they do not rely heavily on a quality teacher. This was done to overcome the challenge of limited resources including qualified teachers (Hubber et al., 2016).

Each intervention school has a classroom reserved for tablet use and is provided with 30 tablets. During school time, groups of 29 learners at a time are taken out of their regular class to the tablet class with one supervising teacher. All the applications are in local language, are easy for the learners to use and give feedback to the learner. For example, the tablet can display 10 circles and ask the child to count how many. The tablet would also display some numbers for the child to select the answer by touching the number. Verbal and visual feedback is given to the child before moving to the next item. The supervising teacher only acts as a facilitator and solves technical problems (Pitchford et al., 2019).

The intervention has registered some successes including that it has helped to support development of basic numeracy skills because it allows learners to repeat activities when needed (Outhwaite et al., 2017). Furthermore, it promotes inclusiveness of both boys and girls, and of special needs learners (Pitchford et al., 2019).

Numeracy Boost Intervention

The Numeracy Boost intervention is supported by Save the Children. It started in 2012 in selected rural school communities in one district. The intervention has three components. The first component is community camps which are the core feature of the intervention. The camps are located in the school communities and run by volunteers from the community, referred to as camp facilitators. The camps operate after school and offer a learning through play environment. Some school teachers have the responsibility of camp supervisor which involves suggesting mathematics content areas to be covered at the camp (Mbendera, 2019).

The second component is capacity building of the volunteer camp facilitators and teacher camp supervisors in form of brief training. The intervention works collaboratively with a primary teacher training college, where the mathematics teacher educators are offered training and then participate in developing teaching and learning materials for the camp and training the camp facilitators and supervisors (Mbendera, 2019). The third and final component is learner assessment. The intervention administers baseline and endline assessments each academic year in the intervention schools and some control schools. So far, the intervention schools have registered better achievement than the control schools, and have shown a more positive attitude towards mathematics (Mbendera, 2019).

JICA Numeracy Intervention

This intervention was conducted in 2016 in two schools only and focused on teachers of Grades 1–3. The aim was to equip teachers with knowledge and skills to help learners progress from unit counting to composition and decomposition when adding and subtracting numbers. For example, when addition of numbers crosses a 10 such as $8 + 5$, they should be able to see $8 + 5$ as $(8 + 2) + 3$ and obtain the answer, 13, without unit counting. The teachers were offered three weeks of training before implementing the composition and decomposition strategies in their classrooms. A pre-test and post-test were administered to learners in the classes. It was observed that the learners that used unit counting in the pre-test were able to work out the problems without unit counting during the post-test, indicating that they were able to progress to composition and decomposition strategies of addition and subtraction (Kazima et al., 2022).

Successes and Challenges of the Interventions

Each of the interventions registered some successes which is commendable. However, they also registered some challenges which presented limitations. For example, the Numeracy Boost camps depend on volunteers, which might pose problems if the mathematical knowledge is not at the desired level. The Unlocking Talent takes groups of children out of class for the tablet

sessions, which means the children miss some of the regular learning. A common limitation across many interventions is that there is not much possibility for scaling up. Most start and end with the project life; like small experiments in the schools, then back to usual. The good outcomes are rarely shared widely to apply to others, and possibly there are some bad outcomes for some experimental groups.

Projects I Coordinated

Since 2014, I have coordinated two large projects which I refer to as project 1 and project 2. Both projects were in collaboration with the University of Stavanger, Norway, and with funding from the Norwegian Agency for Development cooperation (Norad).

Project 1: Improving Quality and Capacity of Mathematics Teacher Education in Malawi (2014–2019)

In 2013, prior to the project, we started a collaboration between the University of Malawi (UNIMA) and the University of Stavanger (UiS). We were successful in getting seed funding to develop a 5-year project proposal. Our overall goal was to strengthen the teaching and learning of mathematics in Malawi. We used the seed funding for a baseline study to identify needs that would guide our focus. We identified many needs at different levels; schools, learners, teachers, and teacher education. We decided to focus on teacher education for long term effect. Specifically, we focused on capacity building at the University of Malawi, and in TTCs.

We received a grant of 16.5 Million NOK and we designed a project with five components (Kazima & Jakobsen, 2019) based on the identified needs, as shown in Table 1.

Table 1

Components of Project 1

Component	Needs
PhD programme (developed for UNIMA and offered jointly with UiS)	Capacity building for UNIMA: to have more faculty with PhD, to offer PhD programme, (increase number of well qualified mathematics educators in Malawi)
Master course (developed for UNIMA and offered jointly with UiS)	Capacity building for UNIMA to offer course Target TTC lecturers to strengthen their capacity in preparing primary school teachers Increase number of well qualified mathematics educators in Malawi
Research	To learn from Malawi context and inform professional development Capacity building for UNIMA To increase research in mathematics education in Malawi
Infrastructure development	Capacity building for University of Malawi to offer the new courses (Master & PhD) and improve the existing one (Bachelor)
Professional development	Capacity building: for TTC lecturers to offer better quality mathematics education for UNIMA to offer the PD

Research and Intervention by Project 1

The project intervention was to introduce *Lesson Study* in public TTCs. Lesson Study originated in Japan where teachers worked together to plan, teach, and observe a lesson with the aim of deepening their understanding of how students learn, and how to use that understanding to improve their teaching (Dudley, 2014; Fauskanger et al., 2019). In Malawi, lesson study is relatively new. The project introduced it with the aim for mathematics teacher

educators to learn about their own teaching and their students' learning, to inform improvement in their practice. Research informed the intervention, both prior and during the intervention.

The intervention was carried out from 2016 to 2018 through a series of activities; designing the lesson study programme, conducting workshops with teacher educators before and after the lesson study, and working with teacher educators on their lesson plans for lesson study. Each year, the programme started with a 3-day workshop in May, then lesson study in the TTCs from May to November, and finally another 3-day workshop in November. The intervention was conducted in all eight public primary teacher education colleges and reached all mathematics teacher educators in the colleges, 106 educators at the time. The intervention registered success in terms of mathematics teacher educators' learning and uptake of lesson study as model for their professional development. Challenges include the demand on time of the teacher educators. However, it was observed that advance planning reduced the challenge of time. The project's research and intervention revealed that the mathematics teacher educators need support, suggesting that teacher education should not be ignored as is often the case in many of the interventions.

Project 2: Strengthening Numeracy in Early Years of Primary School Through Professional Development of Teachers (2017–2022)

Midway through project 1, we applied for project 2 to continue the collaboration between UNIMA and UiS. We received a grant of about 15 Million NOK. Through our work with teacher educators in project 1 and our earlier baseline study, we identified the need for professional development of teachers. Thus the project 2 focus was on primary school teachers, and the overall aim was to improve Numeracy in early years of primary school in Malawi (Kazima & Jakobsen, 2021). The project had three main components based on the needs we identified, as shown in Table 2.

Table 2

Components of Project 2

Component	Needs
Research (including Master, PhD, and PostDoc)	To learn from Malawi context and inform professional development Capacity building for UNIMA To increase research in mathematics education in Malawi
Infrastructure development	Capacity building for University of Malawi to offer PD
Professional development	Capacity building: for teachers to strengthen their teaching for UNIMA to offer the PD to provide TTCs with a possible model of working with schools

Research and Intervention by Project 2

In project 2, we planned to introduce an intervention on something teachers already do in their teaching and strengthen it so that they can do it better. Based on our research and observations, we identified counting in the first two grades of primary school as a good focus. Almost all lessons started with counting activities usually through play and song which was motivating and exciting for young learners. However, the counting was all forward counting in ones starting from one. We planned an intervention that would extend the teachers' work of counting to more mathematically meaningful counting activities.

The intervention was conducted in form of professional development for the teachers through lessons study. We adapted the structure of lesson study from project 1 where we started with a 3-day workshop with teachers in May, followed by lesson study in schools from May to

November, then another workshop for 3 days in November. We repeated this from 2019 to 2022, with different schools each year except 2020 due to COVID. We managed to work with a total of 11 schools and all the 136 teachers of grade 1 and 2 in the schools.

Workshop 1

The first workshop included (i) what is teaching and what is learning? (ii) discussion of how the participants teach counting in their classrooms; (iii) counting activities—choral counting and counting collections (Franke et al., 2018)—and why they are important; and (iv) an introduction to lesson study. On the last day, teachers from each school were encouraged to work together to conduct lesson study on counting based on what they learnt during the workshop. Each school drafted their initial ideas then shared with the rest of the group by the end of the workshop. Teachers were also encouraged to use the counting strategies explored during the workshop, specifically counting forwards and backwards, counting in groups, skip counting, counting collections, and choral counting.

Lesson study in schools started with developing draft lesson plans for the research lesson. The focus of the lesson study was for teachers to learn about their students' learning. As such, the research lesson plans needed to make clear what it was about their students' counting that the teachers wanted to learn and how the teachers would observe it. The draft lesson plans were submitted to the project team at UNIMA and UiS. Each draft was reviewed by at least two project team members who provided written feedback to the teachers. The UNIMA project team visited each school to discuss the feedback with the teachers and provide support where needed. The schools revised their lesson plans following the feedback, then identified one of the teachers to teach the research lesson while the others observed. Finally, the teachers reflected on the lesson, discussed their learning from it, and prepared a report to share at workshop 2.

Workshop 2

The second workshop again lasted 3 days, and it covered (i) reports from all schools on their lesson study, what they learned and discussions; (ii) reflections and more lesson plans on counting; (iii) talk moves (Kazemi & Hintz, 2014); and (iv) the mathematics teaching framework (Adler, 2021).

The UNIMA project team visited all schools during the lesson study and later followed up with some of the schools after the second workshop. The findings that follow are from both the lesson observations and reports from the teachers.

Findings and Implications

Findings

I highlight three findings, then discuss their implications to mathematics education research. First, we observed that teachers included more meaningful counting activities in their teaching besides the rote counting through song and play. Teachers adapted skip counting in their play and songs. However, there were reports of challenges in implementation in large classes. Second, almost all the teachers reported surprise at what their learners could do, for example, counting in groups and identifying number patterns on a 100 square or other grid arrangement of numbers. There seemed to be a general underestimation of what grade 1 and 2 learners can do. This supports the argument by Brombacher (2019), that the primary mathematics curriculum has a low expectation of the learners. It seems that the teachers also shared the low expectation. However, it could be argued that the curriculum influenced the teachers' low expectations of their learners. For example, the curriculum's low number range of 0-9 for Grade 1 might have limited teachers' expectation of Grade 1 and 2 learners identifying number patterns. Third, most teachers were able to link counting to mathematical concepts (e.g., linking

counting in groups to multiplication). However, some teachers might have benefited from more workshops and activities to see the mathematical connections.

A general finding from the two projects was that Lesson Study is an effective method of professional development of teacher educators and teachers. However, there was need for support from ‘experts’ in the field, referred to as knowledgeable others in lesson study terms.

Implications For Mathematics Education Research

The findings have implications for teaching, for teacher education, for curriculum development, and others. I focus only on implications for research in mathematics education. One implication is a call for research on implementing the counting strategies in large classes. During the lesson study, some schools split the classes into two so that they could observe all learners easily. While this was a good solution, it is not practical to do so in their everyday teaching. Hence the need for research to inform our practice. Another call for research is on what Malawi children bring to the classroom as they start primary school mathematics and how to use that in teaching. Many children in Malawi do not have access to preschool, and there is no reception class prior to the first grade at age 6. Studies of the curriculum have shown that it has low expectations (Brombacher, 2019), probably because the assumption of what children bring to the classroom was too low. Research to explore this would greatly inform the curriculum and teaching.

Teacher education is another area that needs research to inform practice, specifically research that addresses the knowledge teachers need to teach counting effectively and make mathematical connections with other concepts. What role can initial teacher education play in developing counting skills and teaching strategies? And what role can school-based professional development play?

A general implication is the need for more lesson study with a research component on how to learn from teachers’ own teaching and how to apply their learning in teaching to improve their practice.

We found research within the Malawi context crucial. Research prior and during intervention informs design and ongoing improvements. Research from other contexts informs us better when we understand our own context.

Concluding Remarks

I have shared my work and how interventions can contribute to development. Malawi is an illustrative example, the discussion can apply to other similar contexts. We learnt from project 1 that teacher education needs support and should be included in research and interventions in mathematics education. From project 2, among other things, we learnt that there are many things that the teachers do well within the constraints of the context. Interventions need to acknowledge and strengthen these existing skills while developing new skills. For example, the teachers were good at counting with young learners through songs and play in a motivating way. The intervention needed to strengthen their approach, by keeping the counting songs and extending from the rote counting to more mathematically meaningful counting. There is a lot we can learn from such contexts to complement our understanding of mathematics education that we learn from other ‘more visible’ contexts. There is need for more research and dissemination from different contexts, especially the low-income countries whose work is rarely disseminated beyond their national boundaries. Mathematics Education research associations in the various regions such as MERGA and SAARMSTE have a role to play.

Thank you.

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