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East African teacher educators learning at a distance

Dr Jennie Golding
Associate Professor Mathematics Education UCL IoE

UCL Institute of Education

UNIVERSITY OF LONDON

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Project summary

AIMSSEC (www.aimssec.za) has previously run mixed mode teacher development courses for South Africans from deprived areas, with sustained success (Joubert and Kenny 2018; Golding, 2018). This project aimed to adapt and evaluate the foundation such course for use with mathematics *teacher educators* in East Africa. There are obvious issues of context-specific content and framing, including effective 'low tech' delivery and approaches to overcoming the digital divide. The University of London Centre for Distance Education supported research to focus on the adaptation and efficacy of distance learning resources for this context and purpose.

Introduction

METEA ('Mathematics Education to Empower Africa', a UK-based charity) supported a first mixed-mode 'Mathematical Thinking and IT' (MT) course for East African (Ugandan, Rwandan, Tanzanian, Kenyan) upper primary (and lower secondary) mathematics teacher educators (MTEs), together with mathematics teachers, in January 2019. The course comprised ten days face to face in Kampala plus 3 months supported distance learning via action research as MTEs enacted, evaluated and further developed for their local context, the materials and approaches used, which are developed from those used successfully, and with open access, for the research-based AIMSSEC courses.

Previously in South Africa, the whole has been predicated on a model which in parallel with teacher education, equips participants to lead local teacher development. Within that, developing competencies for harnessing the affordances of IT for teaching and learning mathematics plays a significant role. However, the technology available to East African primary teachers is often limited in terms of devices with sustained online access: distance support therefore needs to be developed to major on asynchronous use of downloadable apps and WhatsApp rather than using online synchronous fora or needing frequent web access. Teachers typically have access to a mobile phone, and might also have one or more desktops in school, with probably intermittent web access. Some Kenyan classrooms, in contrast, have received international funding for a tablet for each child – though often without the teacher expertise to take advantage of that, or web access. We asked, 'How and why should AIMSSEC approaches and materials be adapted for East African teacher educator school system and technology contexts, and what impact can they then have?'; CDE funding supported the deeper development, analysis and evaluation of the associated distance learning, with particular attention to the technological affordances and constraints.

The research in particular probed the student (mathematics teacher educator) experience, progression and achievement, the programme development, technological capability and innovations made, and the dissemination of good practice. It focused on the technological aspects of the development and evaluation of a 'solution study' relating to East African capacity in effective mathematics functioning for the 21st-century. The lead researcher was the author of this report. She was supported by a local researcher and teacher educator, Marjorie Batiibwe, from Makerere University, Uganda, so supporting also the development of local mathematics education research capacity.

Background

African attainment in mathematics is very low in global terms (e.g. Bethell, 2016), and that severely restricts access to economic and personal thriving in a global 21st-century. The researcher had volunteered with the South Africa-based AIMSSEC (www.aimssec.za) for ten years, developing research-based materials and teaching approaches for mathematics teacher in-service courses that build on an intensive 6-10 day face to face foundation with 3 months' supported distance learning as teachers develop, evaluate and adapt the promoted in-class approaches to modern mathematical imperatives. Careful initial selection of applicants as local (maybe potential) leaders in education means they have then successfully used these to impact local provision. METEA is responding to East African community priorities (e.g. the global mathematics education ICMI 'capacity network building project' (CANP) working in East Africa https://www.mathunion.org/icmi/activities/developing-countries-support/capacity-networking-project-canp) to now prioritise the development of East African mathematics *teacher educators,* particularly those working at upper primary and lower secondary levels.

Classroom-based sessions focused on pedagogies and mathematics learn with active participation by learners and focused on meaning- and connection-making. IT sessions built on participants' existing resources and focused on email communications and harnessing of web-based resources for professional purposes, and in particular the materials available via AIMSSEC's open App; also on freely-available subject-specific software important for conceptual development, and in particular, the use of the dynamic geometry package Geogebra. It also addressed word processing freeware, including the embedding of tables, pictures, etc, as might be of most use for professional purposes. The researcher's teacherly role was to lead on METEA's development of the materials and mixed mode approaches for *teacher educators*, so far as possible as an outsider, for East African contexts,

building on other work she had done with teachers and with policymakers in East Africa and elsewhere, and on local documentation and literature (e.g. Halai and Tennant, 2016).

We know that in synchronous webinars mathematics teachers learn mathematical content far more effectively than they do new pedagogical approaches (Golding and Bretscher 2018), so the proposed approach needed very careful design and longitudinal evaluation if it is to be built upon. Further, pedagogical approaches for empowerment need to be very clearly communicated during face to face elements of the course, so as to compensate for the limitations of distance learning for pedagogical change.

The approach

The focus course offered places to ten primary teacher educators from across East Africa (at least two each from Uganda, Tanzania, Rwanda and Kenya), as well as 16 primary teachers and 28 lower secondary teachers, though the reported research focused on the primary teacher educators, some of whom were school-based and some, college based. All participants were fully funded by METEA for all elements of the course, and as part of their post-course learning and formative assessment undertook and reported on action research as they used and adapted the resources and approaches for their own context. All participants were supported on the distance learning part of the course by a tutor: for the teacher educators, this was the lead researcher. The additional funding from CDE allowed her to devote time to more detailed rigorous analysis, synthesis and probing of the outcomes, including via an additional participant survey (as an App) and small number of spaced case study interviews focused on the technological affordances and constraints of the locally available technology, for these purposes – and contributed to the dissemination of those. Primary teacher educators (typically educating teachers of 6-14 year olds in East Africa) are the group whom the East African CANP have identified as having the greater potential for enhanced impact.

Previous attempts at distance synchronous communication with East African teachers have proved challenging (e.g. Golding 2018), but alternative approaches such as surveys are known to typically yield less rich data, especially in a second language, even in the ideal scenario where respondents know the questioner, as they will here. One area discussed with teacher educators face to face, was what technology was best suited for the espoused deep and probing communication as their action research progresses. Importantly, such use of local voice is known to support empowerment and commitment to taking work forward. A relatively low-tech solution such as a telephone call might have been the best way forward, since the vast majority of East Africans employed in education have access to mobile phones (with provider rental at affordable rates well below first world tariffs); however, the involvement of a local teacher educator and researcher enabled face to face

interviews that had the additional advantages of offering a local language medium and local knowledge, and gaining distance from the lead researcher, who had been responsible for much of the materials development and teaching under scrutiny.

Ethics: The study was of course subject to UCL IoE ethical approval: REC 1182. All MTEs gave their permission for their (pseudonymised) communications, surveys, journals, photos and assignments to be available for analysis and use as part of this project; several also offered to participate in more in-depth interviews through the distance element of the course.

Methodology

The design was of quasi-action research, with iterative development of materials in response to each successive data collection event. Course materials, including assignments and the end of course test, had been edited in the light of East African nominal curricula, and were further refined as the course progressed. In-course data collection included lead researcher field notes, and participant reflective journals and end of course test scripts. Following the course, there were assignments to be completed at monthly intervals. The first required participants to apply course materials in their own context, editing them appropriately and then analysing and evaluating their impact. The second required the coordination of a collaborative professional development workshop with local teachers, and again, the analysis and evaluation of that. The third was more open, either further developing an activity similar to that in one of the first two assignments or, more ambitiously, evaluating and editing a wide range of the AIMSSEC open source materials or planning for their own context, or planning a series of local workshops that drew on those materials. MTEs' tutor (the lead researcher) was available for distance support throughout the course and beyond, via email or via the WhatsApp group set up, this being the participants' preferred mode social media mode of communication. Assignments were submitted as attachments to emails, or via a VLE, and tutor responses to those returned by email.

In addition to assignments, and between submissions, MTEs were asked to complete a googlesurvey reflecting on their learning and on the use and impact of the mathematics and pedagogical approaches met during the course, and in particular, their use of IT for such purposes. Surveys, and the final assignment, were iteratively developed in the light of the assignments and professional reflections seen. Timing was as in Table 1 below; whole MTE group data collection was

supplemented by in-depth audio-recorded and transcribed interviews conducted with one school-based MTE.

Findings

Course structure and content:

The intended curricula across East Africa have something in common with one another, but are not well aligned one with another in terms of target year group. However, it was possible to focus on material common to all primary curricula. The approaches used in South Africa were very well received and assignments/reflective journals showed them often interpreted in ways aligned with intentions, although language remained an obstacle through all aspects of the course for Tanzanian participants, who teach in Swahili, and also for Rwandans, only recently transferring from French to English as language of instruction. As in South Africa, *modelling* of the pedagogical intentions so that participants experienced the impact of focus approaches for themselves, appeared to be highly impactful. The grasp of mathematical underpinnings appeared, as in South Africa, to reflect local traditions where rote learning is highly valued, and primary, though not secondary, participants, were judged to have similar mathematical repertoires, ripe for further development. Participants almost universally claimed significant mathematical learning from the learning and environmental approaches adopted.

Technology resources and capacity:

All MTEs had personal mobile 'phones ('cellphones'), and most had smartphones; the preferred social media outlet was WhatsApp, even though three of the East African jurisdictions had recently increased taxes on WhatsApp use. Table 2 shows the range of personal and institutional hardware available to MTE participants. Prior to the course, none claimed to have used social media or email for professional purposes, or the web to identify materials for professional use. During the face to face element, all participants were

enthusiastic about their hands-on IT sessions, and most used lunch breaks and early morning arrival to further develop their skills. None had sent attachments to email, and none had used Geogebra, previously: almost all said they were excited by the possibilities they encountered. Over the distance element of the course, all used the AIMSSEC and course materials that had been provided on a USB and the downloaded AIMSSEC app was regularly used but all felt hampered by unreliable internet access, some extremely so. None had sufficient access to hardware for teaching purposes, that they felt able to use Geogebra with trainee teachers or children, but all other IT learning was applied in some way, though to variable extents, given the local constraints. For most MTEs, the most reliable channel was via their personal 'phones, though data charges are increasing more rapidly than inflation in most East African jurisdictions. Because of the limited access to hardware, and to reliable Internet, almost all IT use remained for professional information, administration, organisation and planning purposes, rather than directly for teaching.

Professional use of software was reported to need significant time to develop, and these MTEs had access to few projectors and/or computers for teaching purposes, though they were able to demonstrate some use of IT to colleagues, and themselves had often progressed to using web-based sources for wider purposes, by the end of the distance phase. All came to submit assignments and deal with supplementary feedback/communications by e-mail with reasonable confidence by the end of the distance phase. However, even for working with small groups of experienced colleagues, these MTEs lacked the experience and immediate support to feel confident about supporting others effectively: Mishra and Koehler (2006) show there is a distinctive pedagogy needed for teaching the use of IT within the curriculum, and these MTEs' only experience with this 'TPACK' (technological pedagogical content knowledge) was as observers in their in-course hands-on IT sessions.

Table 2: MTE study participants, pseudonyms and available technology

Pseudonym	*Professional situation*	*Personal devices*	*Institutional hardware*
Kirabo	School-based	Smartphone	1 computer in school
Fredrick	School-based	Smartphone	1 computer in nearby school
Tony	School-based	Smartphone, own laptop	No computer in school
Ntanbire	School-based	Cellphone (not smart)	1 computer in school
(Fatuma)	College based	Cellphone (not smart)	1 computer in college: left course early
Elizabeth	College based; no primary teaching experience	Smartphone	1 computer in college

David	College based	Smartphone, own laptop	Small suite of computers available in college. Projector bookable.
Sulaiman	College based; no school teaching experience	Smartphone	Small suite of computers available in college
Agnes	College based; no school teaching experience	Smartphone	Small suite of computers available in college. Projector bookable.
Nakimu	College based; no primary teaching experience	Smartphone, own laptop	Several suites of computers available in college. Projectors.

Mathematics capacity:

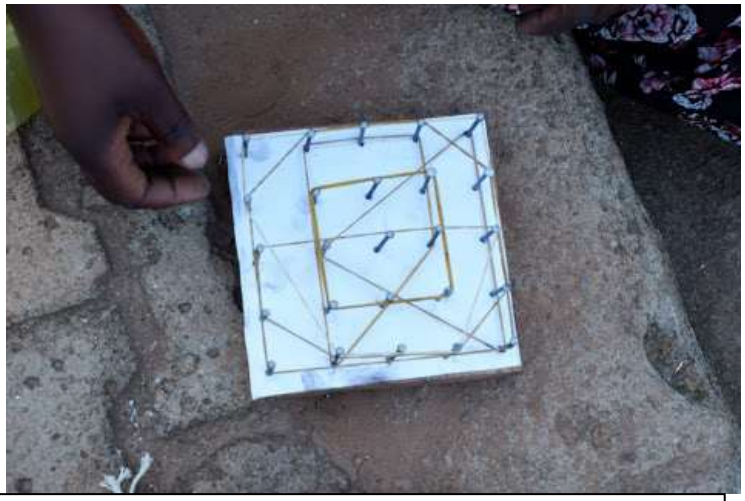
Three MTEs had degrees in mathematics, but not all had taught in primary schools. The end of course test had been edited to better reflect valued course outcomes, so to include

pedagogical issues, and although this was challenging for those with English as a 2nd or 3rd language, the mean MTE mark achieved was 86%, so they were able to perform well on an assessment of course content that was at a fairly basic level. Even so, about half showed limited depth of primary mathematics conceptual grasp, and that was repeated across all assignments. There is of course a tension between post-primary mathematics and deep knowledge of primary mathematics, with primary teacher education in East Africa privileging the former although we know that teaching itself draws primarily on the latter, informed at times by the former (Ball, Thames and Phelps, 2008).

Mathematics and mathematics pedagogy capacity:

Our data show strong evidence for a growth in most participants' active learning for meaning-making, their capacity for replaying-rehearsing and re-envisioning (Hord, 2010) their practice in and for local contexts, and a personal enjoyment and mathematical elucidation expressed. All these mirror outcomes the course is targeting, ultimately for young people in schools. Most participants came increasingly to be able to talk about such issues, and their impact on their learners, whether trainee teachers, practising teachers, or primary learners, but for only about half was this at a sustained and deep level, such as gives confidence in its embedding. Two participants did not

complete the assignments, citing pressure of other work, but neither had shown a deep capacity for transforming course experiences into sustainable local practice for their context. Others showed a variable grasp of related ideas, but sustaining those at a distance and without active local support is challenging, even in better-resourced and -aligned circumstances (e.g. Golding and Bretscher, 2017).



"We now have good ways to make the data meaningful to our learners and it will work very well if I take them outside and use chalk. I did not know what the pie charts meant but the way we have experienced will be even better with a large class"

Capacity for MT pedagogy:

Five MTEs were, from data, able to profoundly re-envisage their contextualized teaching and teacher development to accommodate practices that deeply reflected course-valued approaches, course approaches transferred to planning for learning, and to active, meaning-making collaborative tasks. These participants were able to further develop such capacities between assignments 2 and 3. Where there is an impact on teachers at any stage of their career, there is the possibility for a related impact on primary learners, which is the ultimate goal. Teacher training systems in East Africa do not, though, currently support such approaches and longer-term impact is likely to be diluted unless ways can be found to sustain a supportive community of practice that values those – or a change in policy. East African policymakers, and especially those from Uganda, observed and claimed positive impact from the course, and ways are being sought of following those up: for example, the Ugandan Ministry of Education would like to see the course run for

teacher educators from all their primary training colleges, accompanied by local 'lead teachers' who would support embedding locally, since the serendipitous learning group of teachers mixed with

> ***"It has changed the attitude of my teachers to maths: they are interested and chase me to borrow resources we have made, and they talk enthusiastically about it…. And the children have caught that: they are trying out different methods and getting very excited about maths, now it's hands-on practical and enquiry-based. Children are becoming very inquisitive, and spending time in the library investigating ideas".***

teacher educators was clearly highly productive. The limitations of course include the financial.

Impact on other teachers and on primary learners

An impact on ten MTEs across East Africa is of course a drop in the ocean, yet assignments and other correspondence show strong evidence for wider impact on practicing and training teachers, as well as on large numbers of children in schools. Such activity of course embeds new practices in course participants, as well as spreading it more widely: the challenge, as above, is in sustaining that when it is often counter-cultural, and might not show short-term gain in valued measures. However, some participants, both school-based and college-based via their teacher trainees in school placements, are claiming fairly immediate impact on children's learning, and evidence this derives from both a move to valuing meaning-making, and

to enhancing the environment and using new-found classroom tools to 'dig more deeply' with the related learning – for example, via number lines or 100-squares.

"The teacher trainees feel very excited about the paradigm shift. They say they are ready to implement such practices in their forthcoming school practice in June 2019"

"I've been marking the related assignments and I'm seeing them improving so much. They're getting excited and they are achieving excellent results. And they know they are getting better, so they feel great."

Dissemination

The following presentations, seminars and publications have been undertaken or are committed to:

Ball, D. L., Thames, M. H., & Phelps, G. (2008). Content knowledge for teaching: what makes it special? *Journal of Teacher Education*, *59* (5), 389- 407.

Batiibwe, M.S.K. and Golding, J. (2020) *Capacity to develop: teacher educators attempting mixed mode professional development in East Africa* International Congress of Mathematics Education, Shanghai, 12-19 July 2020

Batiibwe, M.S.K. and Golding, J. (2020) Re-envisaging practice as an East African teacher educator: affordances and constraints of mixed mode approaches *submitted*

Golding, J. (2019) *Mixed mode approaches to teacher educator development in areas with limited access to digital technologies* Presentation at CDE conference, 09 October 2019

Golding, J. and Batiibwe, M.S. (2020) Sustainable mathematics teacher educator development in areas with limited digital access *Pythagoras*, accepted

Golding, J. and Batiibwe, M.S.K. (2019) *Mixed mode approaches to sustainable mathematics teacher educator development in areas with limited access to digital technologies:* paper and presentation, 5th Strathmore International Mathematics Conference, Nairobi, 12-16 August 2019

Golding, J. and Batiibwe, M.S.K. (2019) *Teacher educators re-envisaging practice in East Africa: what is important?* Paper British Society for Research in the Learning of Mathematics, Belfast, 9 November 2019

Golding, J. and Batiibwe, M.S.K. (2019) *Teacher educators re-envisaging practice in East Africa: what is important?* UCL Technology in Education seminar, 5 November 2019

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Joubert, M., & Kenny, S. (2018). Exploring the Perspectives of Participants in Two Mathematics Professional Development Courses in South Africa. *African Journal of Research in Mathematics, Science and Technology Education*, *22*(3), 319- 328.

Mishra, P. & Koehler, M.J. (2006). Technological Pedagogical Content Knowledge: A framework for teacher knowledge. *Teachers College Record, 108*(6), 1017- 1054.