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# An integrated model for teacher continuing professional learning in Zimbabwean primary schools

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**Background:** Rapid changes in the classroom and out-of-school life characteristics of this knowledge society make continuing professional learning for teachers an imperative. But what kind of continuing training model could be effective in diverse work situations such as under-resourced rural school environments?

**Aim:** The aim of the project was to capacitate primary school teachers in their teaching of mathematics to encompass numeracy learning outcomes among their pupils.

**Setting:** This article describes an intervention service-*cum*-research project undertaken in three rural school districts of Zimbabwe.

**Method:** Underpinned by the notion of change and lifelong learning, the intervention project deployed a modified cascade action research design to train 70 teacher leader mentors and 35 community leader mentors as drivers of the change in the three districts. Twelve of the 70 teacher leader mentors were further developed into expert status on numeracy pedagogy for continuity and sustainability of the change.

**Results:** The service dimension of the project succeeded in infusing numeracy pedagogy in the schools' instructional repertoires at the level of cultural practice within communities of practice.

**Conclusion:** The main challenges faced in trying to implement pedagogy intended to foster mathematical numeracy are those related to costs, sustainability and continuity, some if not all of which can be dealt with through collaboration between experts, teachers and community.

**Contribution:** The research dimension resulted in revealing a potentially powerful model of teacher continuing professional development characterised by fusing centre (district), school and community elements while retaining the cascade format. This model is worth exploring in similar and diverse school environments elsewhere.

**Keywords:** Models of continuing professional development; teacher peer learning; mathematics lesson study; teaching numeracy; teaching mathematics literacy; teaching mathematics in rural districts; integrated centre–school–community training.

## Research problem and its setting

In Zimbabwe, access to education for all has been on the increase, as indicated by enrolment rates at all levels of schooling in public and private institutions. However, learning outcomes, as measured by learner achievements in national examinations at various levels such as Grade 7 in the primary cycle and the school-leaving certificate at the secondary cycle, highlight large differences in pass rates, with mathematics generally registering lower rates (Gadzirayi et al. 2016; Roberts et al. 2019). As is often the case in developing countries, including Zimbabwe, rural school environments tend to be more under-resourced than their urban or peri-urban counterparts, especially if they are government or community managed as opposed to private trust managed. Among challenges that rural school teachers experience are reduced opportunities for peer network–driven continuing professional learning (CPL), due in part to a sense of isolation, whether real or imagined. The sense of isolation arises in part from the typically large physical distances between schools and poor provisions of Internet connectivity infrastructure such as Wi-Fi.

Such challenges to CPL of the teachers may contribute directly or indirectly to unsatisfactory learning outcomes of schoolchildren in mathematics. The outcomes are unsatisfactory, not only in terms of academic mathematical knowledge, as indicated through performance in school examinations, but also in terms of functional quantitative proficiency in everyday out-of-school

life. This kind of proficiency – also known as numeracy or mathematical literacy – is supposed to be cultivated as well during regular classroom mathematics learning, yet low levels of it characterise many primary school drop-outs and graduates alike in typical Zimbabwean rural school communities (Vere et al. 2017).

Nearly all primary school teachers in Zimbabwe, including those in rural districts, are initially formally trained in teacher colleges of education for 3 years. But like professional practitioners elsewhere, they still require continued professional learning. Indeed, some of these primary school teachers do engage in further studies, often on a part-time basis, for a Bachelor of Education (primary) degree in the country's universities. Pursuing the degree after obtaining a diploma in education from initial training at a college of education is typically considered a pathway to enhancing chances for promotion – often to administrative responsibilities – in their educational environments. It is not certain, however, that possession of a degree qualification in and of itself amplifies quality of learning outcomes of the children in terms of academic school mathematics and numeracy. Hence, a need remains for CPL by the teachers while on location in their schools, alongside parallel initiatives such as studying for higher qualifications – the Bachelor of Education degree, in this case. It is against such a background that an intervention action research–style project was conceptualised. The main aim was to contribute to schoolteachers' CPL by enhancing their capacity to teach for higher attainments in school academic mathematics and numeracy. The following research questions were addressed in order to achieve the study's aim:

- How does the integrated centre–school–community (ICSC) intervention model foster mathematical numeracy pedagogy in under-resourced primary rural school settings?
- What challenges are faced when implementing the ICSC model?

This article reports on one such intervention with primary school teachers in the three rural districts of Matobo, Mbire and Rushinga in Zimbabwe during the period 2014–2018. The article first contextualises the intervention research project as a mode of teacher CPL, then describes the design and process of the intervention and ends with a discussion of assessments on the impact of the intervention.

# Theoretical considerations

## Teaching mathematics for numeracy

Although the notion of numeracy is understood with slight variations depending on place and context, and no single formulation of the definition is likely to capture all nuances of the concept, common strands and elements can be abstracted from the various formulations. Mathematical numeracy is described as the interpretation of computations and the understanding of the relationship between numbers and the manipulation of material components of the real world (Kus 2018:59). While this description lays thrust on the skills dimension, there are other dimensions associated with numeracy, such as knowledge, behaviours and dispositions, as suggested in the Australian Curriculum (Australian curriculum n.d.). The National Numeracy Programme (United Kingdom) adds the dimension of confidence in working with numerical information in a variety of contexts in everyday life (National Numeracy n.d.). Lloyd and Frith (2013) refer to numeracy as 'quantitative literacy' and emphasise that it is mainly concerned with 'mathematics and statistics used in context' and add that it requires competencies that include 'logical and critical thinking', among others, and that the phenomenon demands ability by the incumbent to 'respond appropriately to quantitative information in text and communicating quantitative ideas' (p. 19). Emphasising the element of critical thinking disposition, these authors argue that while quantitative literate behaviour consists of the components of 'application of mathematical concepts in context, critical reasoning, and communication', it is the **awareness and inclination** to connect mathematics with the real-life world and to respond appropriately to and reason with quantitative information that lies at the core of numeracy (p. 20). There is again a similar view of numeracy as described earlier: the view that it is a capacity that is simultaneously cognitive (concepts and skills) and affective (beliefs, habits and attitudes). Overall, then, most expressions of numeracy tend to portray numeracy in terms of its desirable goal of enhancing the functionality of an individual as an active participant and productive citizen of modern society.

Clearly, there is a close relationship between numeracy and mathematics. While numeracy can be regarded as mathematics-in-application in real-life situations – and indeed many may use the term 'mathematics literacy' for numeracy – mathematics would be taken to mean 'mathematising within laboratory or mathematical situations'. School mathematics then lies in the intersection of numeracy and mathematics (National Numeracy n.d.).

The primary goal of the project was thus to positively influence the development of numeracy-*cum*-mathematical literacy competencies of learners in the three selected districts through enhancing the capacity of their teachers to teach mathematics for numeracy in their classrooms.

## Models of continuing professional learning

Literature is replete with descriptions of many teacher professional development models, some associated with specific contexts while others can be applied to wider contexts. It is not essential for the purposes here to give an overview of this literature. The project, however, drew on specific elements from some of the models where those elements informed the specific intervention adopted for the project.

Ideas of: (1) continuing education as opposed to deficit instruction, (2) curriculum-*cum*-staff development and (3) teacher personal growth (Neil 1986) appeared useful for the project. In the project, there was interaction with participant teachers within a framework that encouraged

them to view themselves as engaging in a lifelong developmental process (as opposed to filling in their knowledge gaps per se). This was effected through learning activities that integrated curriculum reform with their own professional learning (a praxis), thereby contributing to their overall personal growth as individuals and professionals.

The project also drew from and fused elements of the standardised teacher professional development model, the site-based model and the self-directed model as described by Gaible and Burns (2005:25), cited in Mary Hoover (The Global e-Schools and Communities Initiative [GESCI] n.d.). This intervention brought together lead school cluster teachers to a district learning resource centre for the purpose of enriching them with fresh instructional ideas which were expected to cascade down to the classroom teacher via cluster-level CPL enrichment activities facilitated by the trained lead teachers. This conforms to the standardised model.

A feature of the site-based model is reflected in the cascade strategy that increasingly locates the learning site within the local environment, is facilitated by local resource persons and often involves small groups of collaborating teachers learning together – the notion of the community of practice. In this vein, where the opportunity arises and practicalities permit, there may also be occasional support of the in-service classroom teacher through coaching the teacher as he or she grapples with applying his or her newly gained instructional ideas.

In the self-directed model, the teacher initiates and develops his or her own learning path, looking for resources and assistance per need, and often from more knowledgeable colleagues. This is the idea of the teacher as an *autonomous professional and lifelong learner*. The CPL intervention for the mathematics teachers in the project districts was underlined by and stimulated with this conception of CPL.

Finally, there is the notion of teacher professional learning being largely an issue of 'management of change in relation to teacher identity', which is what Marcelo (2009:3) calls the implicit model of teacher professional learning. The project drew from this model in the way the intervention sought and expected the teachers involved to embrace changes in their understanding of the meaning of mathematical literacy (numeracy) and imprinting that change onto their identities as teachers of young children. This again is a matter of interplay and fusion between competencies on and beliefs about mathematics, teaching and themselves as teacher professionals.

While acknowledging the critical place of beliefs in teacher professional learning, the intervention, however, focused on the teachers' change in their content knowledge (Marcelo 2009:15) relating to numeracy at the primary school level. Content knowledge (or subject matter knowledge) refers to grasp of the domain concepts and competency in associated skills. In this case, the main concepts and skills are those typically covered in the primary school mathematics curriculum. Pedagogic content knowledge includes the capacity to transform mathematical concepts and skills into forms that are comprehensible to learners using a variety of mathematically appropriate representations, in addition to the teacher's knowledge of the curriculum, the learners and the learning context. The research-*cum*-service project had its thrust on enhancing the teachers' capacity in content knowledge and aspects of pedagogic content knowledge relating to transforming and communicating the concepts and skills for their learners. But any programme of learning for teachers, however, has to show sensitivity to adult styles of learning.

Like children, adults have their own peculiar ways of and preferences for learning. While adults are generally (though not always) self-directed and internally motivated, they are also known to require their learning to draw from their real life experiences and in ways that make them see immediate application of what they are learning (Service Employees International Union [SEIU] n.d.). Other principles of learning characteristic of adults are that:

- Adults demand to know upfront the relevance of content, method and goal of the learning provided.
- Adults prefer active rather than passive learning.
- Adults prefer learning activities that integrate problem-solving and meaning-making in them.
- Adults like to be accorded autonomy and be treated with respect (Centers for Disease Control and Prevention [CDC] n.d.).

Adults are also known to prefer learning by doing; use of varied activities and approaches; and theory-generative rather than re-productive learning (Boy Scouts of America: Monmouth Council n.d.).

The approach adopted by the project, which can best be described as an ICSC model, has two distinctive features. Firstly, rather than treating school- and centre-based trainings as separate phases of a continuum of training, the ICSC model integrates and blends them into an inseparable unitary format, as will become apparent in the description of the design of the intervention in the next section. That gives the approach a holistic orientation. Secondly, the ICSC brings in the community component as an equal partner in teacher learning activities, thereby making the CPL of the teacher a whole community (teacher, child-learner, school, parent or guardian) development that is consonant with the idea of community of practice, on numeracy in this case. The powerful notion of community of practice, developed by Jean Lave and Etienne Wenger (1998), and subsequently elaborated by many others, gives the approach adopted by the project a cast of authentic learning.

# Research methodology

## Design of the intervention

The design of the intervention project was underpinned by three beliefs held by the research team. Firstly, the team believed that because the desired change in the teaching

practices had to be school-wide and enduring, it had to be embraced from the initial teacher preparation phase to retirement phase of teachers. Hence, the design had to take on a collaborative element with as wide a spectrum of stakeholders as possible. For that reason, the research team of six consisted of three educators from one university and three from three colleges that prepared primary school teachers, including a majority of those who served in the three project districts.

Secondly, the team believed that the desired change had to be holistic rather than componential. This means the school community in its wider sense, that is, inclusive of administrators (school-based and district office–based) and the immediate community that supplies learners to the school, had to be transformed into a community of practice in numeracy instruction, learning and application. For that reason, there was an attempt to bring all components (teachers, administrators [school and district office], community [parents] and facilitators [project team]) together and conjointly and interactively develop fresh insights on mathematical competencies and related meanings and values.

Thirdly, the team believed that for change to be enduring, it had to be consummated at a cultural practice and value level. This is to say participants had to see the proposed intervention within a context of learning as enculturation into a community of practice rather than as acquisition of additional isolated competencies.

The project then adopted an action research design, meaning that expected outcomes had both theoretical and practical dimensions. For the practical dimension, the goal was a transformation of the school teachers' pedagogical practices into those commensurate with teaching for numeracy, while the focus of the theoretical dimension was on testing the robustness of the intervention as a training model, thereby contributing to knowledge on teacher continuing professional development (CPD). Figure 1 summarises the design of the intervention.

Notes relating to Figure 1:

- District-level training was executed by the project team as consultants.
- A total of 70 teacher leader mentors and 35 community leader mentors[1] formed the initial cohort for training at the centre (district) level.
- The results of baseline study were used to locate an entry point for the intervention and develop facilitating instructional and learning activities – with a following activity building on a preceding one – for the entire 4 years the project lasted.
- School-based trainings were executed by the lead teacher experts (those trained at the district level and also called teacher leader mentors) and peer teachers trained at the school cluster level by the lead teacher experts.
- Assessments of learning as classroom teachers of numeracy or as facilitators of peer trainings were continuous and interwoven with learning activities from beginning to end, mostly during feedback loops but also from independent reports of district school inspectors, parents and external stakeholders, for example, the funders of the project.
- Consolidation and feedback loops were used to consolidate and extend learning based on real field experiences in trainings and practice on the ground at school cluster forums and regular school classrooms.
- In the final year of the project, some school-based trainings were executed by the lead teacher experts and community mentors under direct supervision by project team consultants.

## The continuing professional learning training and learning activities

There were four main training and learning activities. The overall problem of the intervention was that of strengthening teaching mathematical literacy (numeracy) within the context of school mathematics and community life. The problem was teased out into subthemes such as values, problem-posing and -solving, applications in everyday life, questioning and so on. Treatment of each subtheme would generally begin with an overview – often in a combined whole group or small group format – where the issue is *problematised for and by all participants*.

A second training and learning activity involved what might be called observation peer-learner lessons, which were conducted at district-, cluster- or school-level sessions. In these sessions, participant teachers, typically lead teacher mentors, conducted planned lessons with live learners under observation by all other participants (project team, community leaders or mentors, school administrators, school district officers [school inspectorate] and other peer teachers). Observation peer-leaner lessons would be followed by lesson study, a learning strategy developed to perfection in Japan (Sato 2000; Shuilleabhain & Seery 2017; Tsukui et al. 2017). This is a reflective and re-constructive dissection and analysis of the lesson by both observer and observed. Insights that emerged from there were mapped onto theoretical or practical issues raised during subtheme overviews mentioned for the first activity and then used to craft and refine pathways towards desirable characteristics and the goals of teaching for and learning mathematical literacy.

A third training and learning activity came in the form of participant teacher–designed instructional and learning materials for own use. Twelve selected lead teacher mentors were initiated by the project team into developing instructional pamphlets and learner worksheets on mathematical literacy on the various topics covered in the official primary school mathematics syllabus. They were to carry out that writing activity in interdistrict writer groups for topics they distributed among themselves, with

1.Teacher leader mentors and community leader mentors (*or alternatively referred to as lead teacher mentors and lead community members, respectively*) were the teachers and community leaders selected by the district school systems to undergo initial district-level capacity building and be subsequently developed during the course of the project to attain expert knowledge level in the numeracy learning and teaching theme espoused by the project.

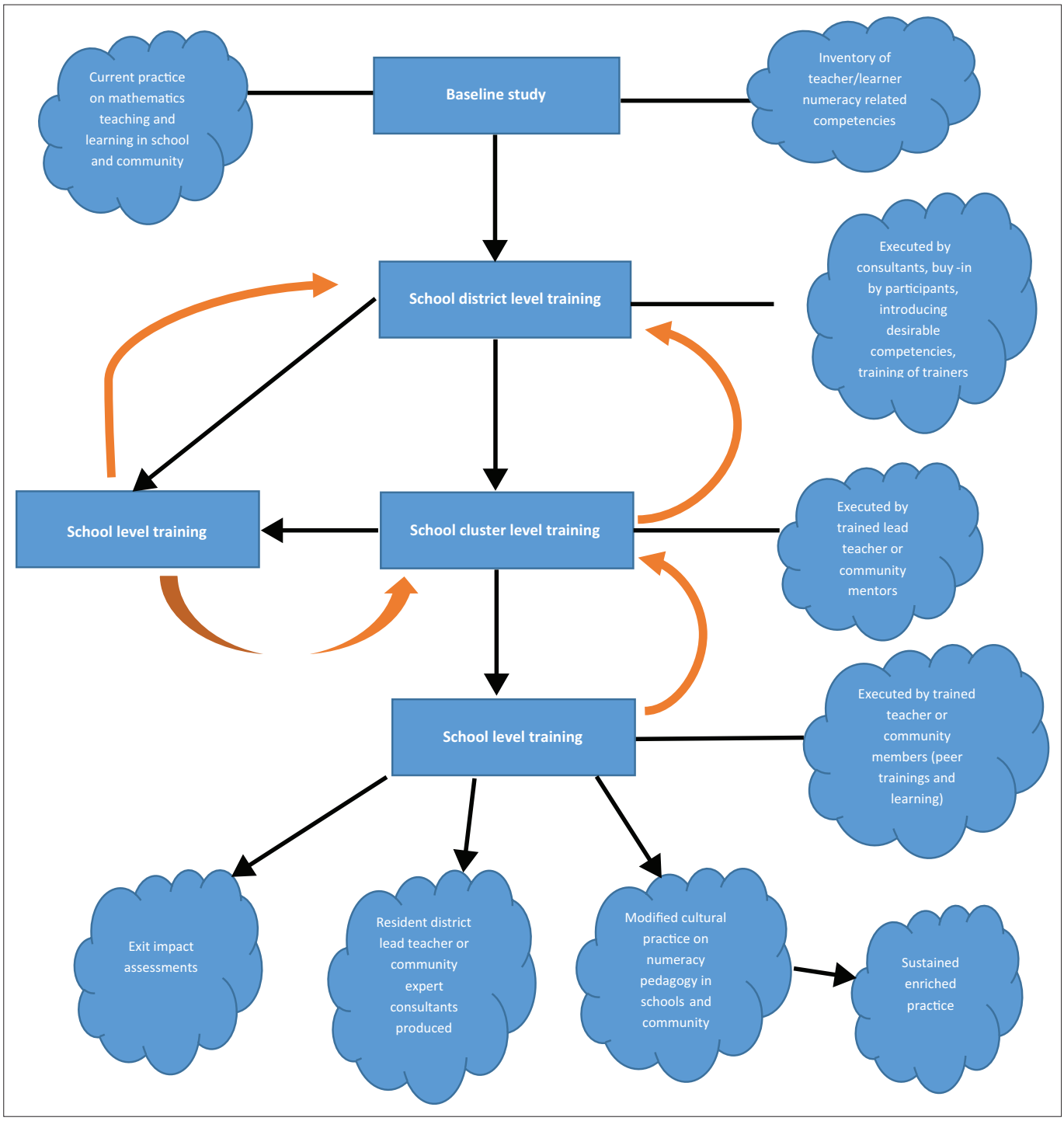


**FIGURE 1:** Structure of the intervention.

community leader mentors contributing as much as possible as resource persons, especially on community life contexts for formulating mathematical problem situations. When completed, these teacher-developed materials could be shared with other peer teachers in the three districts initially, but in the whole country eventually. A strong motivation for using this training and learning activity lies in its potential in considerably raising both expertise and confidence in the teacher leaders or mentors (the material developers) in numeracy pedagogy, while at the same time making them less dependent on their standard school textbooks.

Finally, the project included a module on facilitation as another training and learning activity. This was meant to help participants develop skills for facilitating peer learning, such as running training workshops for fellow teachers. The module mainly covered conceptualising, planning, executing and assessing workshop activity in consultation and collaboration with relevant stakeholders, including school and district administrators and community leaders. When they became adequately competent, the teacher leader mentors could also help peer teachers to develop into facilitators as well, hence becoming trainers of trainers.

## Data generation

Data for learning about the behaviour of the CPL model were gathered throughout the intervention in line with action research design. Data were generated through interviewing during and after implementing the ICSC model. Data were also in the form of video recorded lessons on numeracy. Presented next is an elaboration of the data collection process. The baseline study used classroom observations of live classroom teaching action by teacher participants selected by the school district system to be trained as lead teacher experts or mentors in numeracy pedagogy. With considerations of the number of school clusters in a district, Matobo district presented 38 teacher participants and 19 community leader participants; Mbire district 12 and 6; and Rushinga 20 and 10, respectively. Observations were complemented by a combination of task sheet and interview that aimed at apprehending the teacher participants' pedagogic content knowledge. An equivalent set of instruments was used at the end to assess exit-level learning outcomes on their pedagogic content knowledge.

In between the baseline and exit-level studies, data were gathered through observations, self-reports (oral and written) from participant teachers themselves and other collaborating participants (district office officials, school administrators and community leaders). All these data were captured in structured and informal interactions during trainings at all levels (district, cluster and school). Some of the data were recorded as video clips of action moments or as case study reports or in questionnaire format. The video clips, including those of all live demonstration lesson trainings, lesson study sessions and whole group discussion sessions, were compiled, edited and stored on flash disks and deposited at the school district offices to be used as resources for supporting continuing training and practice of numeracy pedagogy in the school communities. Finally, some data were generated and recorded as instructional and learning materials (book pamphlets, project brochures and posters, training manuals produced by the project team or lead teacher experts or mentors).

## Data analysis

Content analysis of qualitative data (field notes from lesson observations, video recordings and interviews) was used to carefully and systematically examine text to determine exit impact effects from the intervention project (Berg 2009; Corbin & Strauss 2008). *In vivo* codes in the form of actual narrations by informants were used to support inferences made about the kinds of challenges that characterised implementation of the CPL model.

The conclusions offered at the end of this article about the model of teacher CPD exemplified through this project are abstracted from this massive set of data that was generated in multiple formats from multiple sources.

# Results and discussion

The project realised five main outcomes. Firstly, it produced a cohort of human resources in the form of teacher lead mentors who became adequately expert in numeracy pedagogy. From the 70 teacher leaders produced by the project in the three districts, four per district were given advanced training to enable them to attain expert status in numeracy pedagogy. This cohort of 12 teacher lead mentors became designated as resident numeracy expert teachers (RNETs). They would continue to be regular teachers in their schools but would also serve as consultants and drivers of the change in mathematics instruction in their districts. The imperative of the teacher lead mentors of having to develop themselves into facilitators of peer learning provided an added impetus for them to learn and understand related pedagogic content knowledge sufficiently for them to function as mentors for their peers. From the perspective of the project team, production of the RNETs was a deliberate strategy for increasing the continuity and sustainability of the practice advocated by the intervention in these project districts. All the school district officers endorsed the potency of this strategy, with school inspector Morris Mawonya putting it in this way:

> 'The project is excellent. Teachers say they are benefitting from the training they are receiving, and that children's mathematics performance is improving. On our school inspection rounds, we are noting serious attempts by teachers to implement the numeracy approach. I feel we are making some headway. However, the cascade teacher training approach needs careful monitoring and we will do our best to do that, and give the necessary support. We will also look into identifying a focal person for the project at each school in the district.' (Interview with participant informant, Rushinga District)

Secondly, there was production of teachers' own instructional resources. Apart from making physical and conceptual resources for teaching and learning mathematical literacy in the districts' schools available among the teachers, writing skills gained by these RNET mentors were transformative with long-term impacts – at least on the RNET mentors themselves – in terms of strengthening the practice of teaching for numeracy in the three districts. An RNET lead mentor, Raymond Mugota,[2] admitted:

> 'I feel my participation in the project has had a significant, positive impact on my career as a teacher. I improved in my teaching of mathematics. Learner performance has increased and they are more interested. Even slow learners sometimes request for homework. Other teachers appreciate the approach at our school. 11 teachers from the school have participated in PSCNEP [*Primary School Children Numeracy Enhancement Project*] workshops at the cluster level. So far, we have held 4 cluster level workshops. The main challenge of spreading awareness about teaching for numeracy and developing the skills needed has been lack of funding. I think the involvement of heads is a very positive development with long term impact in sustaining the project. I feel good about being selected as an RNET member. I am looking forward to being a role model in teaching for numeracy.' (Interview with participant informant, Rushinga District)

Thirdly, a resource library was created at the school district office. All training sessions where the project team was involved, whether at the district, cluster or school level, were video recorded, edited and stored on flash disks. The recordings included overviews on subtheme issues,

2.See Appendix 1 for the transcript of interview with informant, Raymond Mugota.

observations of peer-learner lessons and lesson studies. This resulted in over 80 h of electronic resource materials at each district office available to whole districts for reference. Indeed, some teachers copied extracts from these materials on their laptops and used them in their peer group or individual learning or teaching at their schools. The project team also produced two print publications: one on peer group learning facilitation (Mtetwa 2017) and the other on strategies for teaching for numeracy (Vere et al. 2017). These publications were distributed, 1–2 copies per school, in the three districts – courtesy of the benefactors of the project. Hence, it can be said the project was resource output–rich.

A fourth outcome was incidental and in the form of the forging of teacher networks, some physical and others electronic, among teachers in the three districts. For example, RNET mentors who engaged in the interdistrict collaborative authoring of instructional materials described above automatically constituted a functional network. Needless to emphasise, networking is a powerful mechanism for enhancing CPL of teachers.

Finally, the action research dimension of the project produced some insights on teacher CPD in the form of a potentially effective model which the project team dubbed ICSC and whose essential features are described in the next section. In this way, it can be said the research experiences from this project coalesced into knowledge contribution, while the pragmatics dimension (changes in perspectives on the practice of teaching) became quite inspiring to naturally motivated teacher participants. For example, in the words of one RNET lead mentor, Siqabukhile Dube:

> 'The project has contributed immensely for the good. This is through its methodology. Personally, it has made me a better, well equipped and confident teacher ready to produce articulate mathematicians. Pupils are also showing enthusiasm in the subject and using it as a tool in everyday life.' (Interview with participant informant, Matobo District)

Thus, a number of the lead teachers experienced the impact of the intervention as a new vision, almost like a revelation, with some of them being propelled to enrol, on a part-time basis, for a bachelor's degree at a university institution. All the teacher participants were qualified education diploma holders who had been teaching in the schools prior to the intervention. Even community leader mentors were not spared the intervention's impact. As Jesca Mawite[3] remarked:

> 'I feel more empowered to go back to my village and spread the Project's message, now that I have a better understanding of the project, and am armed with copies of the Project's poster and brochure. Some learn mainly through hearing, others mainly through seeing. The poster and brochure will be useful tools in convincing our communities about the value of the PSCNEP project.' (Interview with participant informant, Mbire District)

3.See Appendix 1 for the transcript of interview with informant, Jesca Mawite.

# Concluding remarks and looking ahead

## Fostering mathematical numeracy pedagogy

The motivation for calling this professional learning model ICSC has been explained earlier. As a model, its main features are:

- It is inclusive of all elements in the context. This is one way of accepting the reality of rural school environments where the teacher is also an integral part of the community; the school survives symbiotically with the surrounding community; and the school and district administrators are the conduits for any activity that involves the teacher and the learner. Hence, for any well-meaningful developmental act to have any chance of effect in rural school environments, the act has to be embracing in this manner from start to finish. Excluding one component kills the act in one way or another.
- The entry point of the ICSC in beginning the intervention is an inventory analysis and evaluation of participant beliefs and conceptions *vis-à-vis* a clearly defined goal that is problematised rather than given *a priori* as fact. This process must be participant (i.e. the teacher) driven but facilitator guided. The rest of the intervention emerges from considerations of this initial activity – the intervention should not come in and be presented *a priori* for it to have deep and enduring impacts.
- It has an in-built mechanism for building up and transferring expertise from the external (project team consultants in this case) to the local (resident beneficiary team driver consultants). This is one practical and effective way of institutionalising the intervention for continuity and sustainability.
- Professional recognition of this local driver or consultant team is critical. As teachers who have emerged from a developmental learning process as a valuable resource for the district, they need to be acknowledged as such through material, financial or status embellishments, whichever is practicable for the district. Such recognition nurtures these trained teachers' motivation for them to keep amplifying the positive effects of the intervention in the district. This contributes to making the new practice part of the schools' repertoire of daily functioning.
- Wenger's notion of community of practice is an important consideration in this ICSC model. As has already been highlighted in (1) above, inclusivity of all constituent elements is important. This inclusivity should be more than mere presence, attendance or token participation in the learning and training activities. Intellectual inputs, even from the learners themselves, need to be valued and acknowledged as such, and the discourse engendered should be authentic and not esoteric. In this model, interaction (that is, discourse) needs to be consistent with that characterising a community of practice.

It is quite likely that this ICSC model of teacher CPD is a fresh possibility on the table for the wider educational community to consider.

## Major challenges and suggested remedies

The article has described the main features of an intervention-*cum*-research project on teacher CPD for primary school teachers in rural district settings in the area of mathematics teaching. The main goal of the project was to enhance mathematics teaching and learning in these communities and broaden the teaching to encompass numeracy pedagogy and learning outcomes. Executed over 4 years and involving three rural districts with about 160 primary schools, the project on the whole had a positive impact onto the intended beneficiaries, as described in the preceding section. But like all typical developmental projects of this nature, desirable outcomes do not accrue without challenges.

The main challenges had to do with costs and the well-known watering-down effects inherent in the cascade training design. Typically, many such cascade intervention projects are well funded at the centre (in this case district) level but not so well at the local (in this cluster and school) levels. That is a critical mistake. As was discovered in this project, funding at local levels is essential if the intervention is to produce perceptible impacts. Seed funding for the local levels, with beneficiaries complementing it, is the minimum that a cascade-style project should provide before it winds up. For this project, the beneficiary schools and teachers were highly motivated and willing to contribute with complementary funding for training and learning activities at the cluster and school levels – and in several cases they actually did. It was the depressed socio-economic situation prevailing in the country at the time that militated so strongly against such efforts, despite the modest funding relief availed by the projects' benefactors towards the end of the project (which was rather late).

Another common challenge encountered in change-bearing intervention projects is that of continuity and the sustainability of the change at the end of the project. This particular project minimised the impact of that challenge through integrating in the intervention the immediate community that is foundational to the existence of the school throughout the project period. The production and institutionalisation of resident teacher lead mentors who were developed from among the teacher beneficiaries was another strategy with the same goal of strengthening continuity and sustainability effects. These expert lead mentors took over the guiding role that had been played by external consultants (project team) in the districts.

The combination of resident expert lead mentors and incorporation of the school's nuclear community in the change process raised the possibility that the change was valued by the whole wider community as an additive development in its educational cultural life. Considered as a model of teacher professional learning, and exemplified by what has been described in this article as the ICSC, the project team believes the style of intervention is worth trying out in other related contexts to gauge its robustness.


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## Competing interests

The authors have declared that no competing interest exists.

## Authors' contributions

D.K.J.M. participated in the entire research process from initial conceptualisation of the research problem, development of research instruments, data collection, data analysis and reporting phases. In addition, D.J.K.M. sourced funding of the project from Save the Children.

Z.N. was involved in production of the manuscript beginning from initial thoughts about the research idea, data collection, data analysis and drafting of manuscript.

## Ethical considerations

Ethical clearance to conduct this study was obtained from the Bindura University of Science Education.

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## Data availability

The raw data are in the form of reports from participants of the study. Such raw data can be reproduced if need be.

## Disclaimer

The views and opinions expressed in this article are those of the authors and do not necessarily reflect the official policy or position of any affiliated agency of the authors.


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# Appendix 1

## Transcript of interview with informant, Raymond Mugota (pseudonym)

### Primary school children numeracy enhancement project (pscnep): A case study

**Interviewee's names:** Raymond Mugota
**District or country:** Rushinga, Zimbabwe
**Age:** 27 years
**Gender:** Male

## Current context

Raymond Mugota is a teacher at Chitange Primary School in Rushinga, a district in Mashonaland Central Province.

Chitange School is located in Rushinga East, where the predominant economic activity is subsistence farming, which is typical of Rushinga District as a whole. Farming activities include cattle and goat breeding, poultry and crop production (especially, millet, sorghum, nuts and maize). Chitange has a total enrolment of close to 400 children, with roughly equal representations of boys and girls. Attendance is generally good and dropout, which had been a perennial problem prior to 2015, has been reducing appreciably since then. This welcome change coincides with, and appears to be attributable to, the improved staffing situation at the school, with effect from 2014. Before then, the school was mainly staffed by untrained relief teachers, which probably negatively affected education quality delivery and, in turn, resulted in the high dropout rate. Girls were mainly affected, and many dropped out as early as at the Grade 6 level[4] to get married. These days, dropout appears to be a thing of the past, thanks (it would appear) to the vastly improved staffing situation in the school with effect from 2014.

Chitange has been performing dismally in the Grade 7 examinations over the years, with an average pass rate hovering around 3%. Thus, the 2016 pass rate of 14% has been welcomed by the school and regarded as possible beginning of a positive trend. 2016 also stands out in Chitange's history as the year when a student at the school achieved the highest possible passing grade (Grade 1) in mathematics in the Grade 7 examinations. As far as anyone at the school and its community can remember, this feat never was achieved before, since the introduction of the Grade 7 examination! Thus, there is reason to hope, it would appear.

## His story

Raymond is married, with one child – a boy aged two. He has been teaching at Chitange since September 2014, having graduated from Morgan Zintec College in Harare the year before, with mathematics as his main subject. He considers himself lucky to be at Chitange, where he says he has fitted in well, both professionally and socially. His main hobby is reading, and his current ambition in life is to become a school head.

4.Primary schooling takes 9 years in Zimbabwe, with Early Childhood Development (ECD) 1–2 in the first 2 years, Grades 1–7 in the next seven years.

Raymond first heard about the Primary School Children Numeracy Enhancement Project (PSCNEP) in 2015, when his headmaster informed him he had been selected to attend a workshop on mathematics teaching. He was not quite sure what to expect, but he was 'greatly interested and curious'. So he attended the PSCNEP induction workshop, which was held in Rushinga Town in June 2015. He soon realised, early on the first day, that he was not only expected to get a firm grasp of what teaching for numeracy entailed but also to mentor other teachers on it! However, his initial apprehension was gradually replaced by cautious optimism as the workshop proceeded, Raymond says. He particularly liked, and feels he benefitted most from, the group work session, which involved preparing to teach live lessons through a lively, free exchange of ideas with peers. The lessons, meant to demonstrate teaching for numeracy, were subsequently delivered over a 2-day period to groups of primary school children drawn from classes at a nearby school in Rushinga Town. Raymond was selected by his group to teach one of the lessons and, according to him, the experience helped him to gain more clarity about the idea of teaching for numeracy. Referring to the post-lesson delivery discussion (conducted for each lesson), he says, 'Comments from the PSCNEP team, District officers and fellow teachers were very helpful'.

On returning to Chitange, he requested and received permission from his school head to raise awareness among his colleagues about what he had learnt at the Rushinga workshop. Fortunately, most of them were quite receptive to the idea of teaching for numeracy, according to Raymond, and he has held several follow-up sessions since then. In addition, he has been organising workshops for other teachers in his cluster (Chitange Cluster), as part of the PSCNEP cascading process.[5] He feels the four workshops he has conducted so far have been fairly well received by the teachers, but attendance and participation by parents has been disappointing. Raymond could not be drawn into explaining possible reasons for this, but one suspects it might have something to do with the Chitange community representative's possible lack of drive and enthusiasm.[6] Another challenge, says Raymond, has been the struggle to raise the barest minimum funding needed to run the workshops. This has not deterred him, however, and he has managed to conduct a total of four, fairly well-attended cluster workshops so far, which is about 50% of his initial target.

His efforts have been noticed by the Rushinga District Education Office. Raymond is one of the four PSCNEP mentors selected for Rushinga's Resident Numeracy Expert Team (RNET)[7] membership.

5.A cascading training approach is such that a core team is trained to train others, who in turn train others. Thus, for example, if 20 people are initially trained, and each of them trains 20 other individuals and so on, then by the end of the third layer of training, 8000 will have been trained.

6.Unconfirmed reports so far seem to indicate communities are responding to the PSCNEP idea positively, where their representatives on the project raise awareness among them with enthusiasm for, and understanding of, what the project stands for.

7.The idea behind the RNET is to have in place in each of the PSCNEP supported districts (Rushinga, Matopo and Mbire) a team of teaching-for-numeracy experts, who are able and willing to drive the process of keeping the project's ideals alive as part of a continuous professional development effort. Selection into RNET membership was carried out by the PSCNEP team in close consultation with District Education officials. A workshop whose main purpose was to prepare the selected mentors for their expected RNET roles was held on 15 May 2017. Given the crucial role of school heads in driving education activities, cluster heads were also invited to the workshop, together with the rest of the mentors and selected community representatives. The idea, over and above inducting RNET members, was to raise cluster heads' awareness about teaching for numeracy and the important leadership roles they could play in promoting and sustaining the PSCNEP ideals in Rushinga, with help of the RNET and ordinary mentors.

He says his involvement in the PSCNEP has benefitted him immensely and that he is proud to be a member of the RNET. He also sees the roping in of cluster heads[8] as an important development that is likely to impact positively on maintaining and sustaining the PSNEP's ideals in 2017 and beyond. In his words:

I feel *my participation* in the project has had a significant, positive impact on my career as a teacher. I improved in my teaching of mathematics. Learner performance has increased and they are more interested. Even slow learners sometimes request for homework. Other teachers appreciate the approach at our school. 11 teachers from the school have participated in PSCNEP workshops at the cluster level. So far, we have held 4 cluster level workshops. The main challenge of spreading awareness about teaching for numeracy and developing the skills needed has been lack of funding. I think the involvement of heads is a very positive development with long term impact in sustaining the project. I feel good about being selected as an RNET member. I am looking forward to being a role model in teaching for mathematical numeracy.

## Description of their environment

(Already covered)

8.Cluster heads are school heads selected to play a leadership and coordinating role among the other school heads (around six) in their cluster. They tend to be quite influential.

## Background information

The objective of the PSCNEP is to help children develop an appreciation and enjoyment of mathematics and an ability to apply it solving problems in a wide variety of life contexts, including academic mathematics.

The PSCNEP is trying to address the challenges of teaching mathematics for understanding and real life application; enabling learners to enjoy learning mathematics and to appreciate its central role in solving problems in a wide variety of contexts, especially their everyday lives; enabling and supporting teachers to develop an appreciation of, and ability in, numeracy-focused continuing professional development (CPD). In other words, PSCNEP wishes to increase mathematical literacy among schoolchildren in these districts.

A baseline study was conducted to assess the numeracy competency levels of children in two rural districts (Rushinga and Matopo) in Zimbabwe, and teachers in all three districts reached so far (Rushinga, Matopo and [*more recently*] Mbire).

The results of the project up to this point (end of May 2017) include reaching out (directly and indirectly) to at least six university or college lecturers, 900 primary school teachers, 10 cluster heads and 300 community members.

# Appendix 2

## Interview transcript of Jesca Mawite's (pseudonym) shared experiences of the mathematical numeracy project

### Primary school children numeracy enhancement project (pscnep): A case study

**Interviewee's names:** Jesca Mawite
**Village, district, country:** Karai, Mbire, Zimbabwe
**Age:** 55 years
**Gender:** Female

## Current context

Mrs Jesca Mawite resides in Karai, a village in Mbire District in the north-west of Zimbabwe. She is a widow with one daughter and four sons. All, with the exception of her last-born child (Tatenda), are married and have resettled elsewhere, outside Mbire. Currently she is staying with Tatenda who, having failed his O-Levels last year, is planning to re-sit the examination as soon as possible and to proceed to A-Level if all goes well.

Like many other Mbire residents, Jesca used to get by reasonably well by growing and selling cotton. In recent years, however, this has ceased to be a viable means of earning a living, apparently because of the influx into Zimbabwe of cheaper synthetic fabrics and clothing. The impact appears to have been quite dramatic, with many residents now eking a living through rearing livestock (mostly cattle and goats), which they are occasionally able to sell. With disposable incomes desperately low, sending children to school has become a struggle for many. As Jesca sees it, '… the increasing numbers of children dropping out of school and girls entering into early marriages in our village is alarming, but not surprising …', and, she adds, 'The recent drought has not helped matters'.

## Her story

Jesca was interviewed on 22 June 2016, at the end of the PSCNEP training-of-trainers (ToT) course which took place at Mushumbi Pools in Mbire District from 20 to 22 June 2016.

She appears to be a pillar of strength in her community, devoting a significant proportion of her time to a variety of philanthropic activities, including her work as a:

- member of the Karai School Development Committee (SDC)
- village health worken (VHW)
- member of the local CAMFED[9]-initiated Mothers' Support Group.

Karai School has an enrolment of about 800 children, with a complement of 18 teachers, according to Jesca. She regularly participates in SDC meetings, which are held twice monthly. 'Given the economic hardships faced by Mbire residents, most SDC meetings currently tend to focus on fundraising to keep the school going, as many parents are unable to pay school fees'.

9.Campaign for Female Education.

Jesca is seen at Karai School most days of the school week, preparing meals for pupils together with her colleagues in the Karai Mothers' Support Group. The food is donated by group members, who take turns to prepare the meals. The group is also active in raising funds to support the education of the growing number of vulnerable children, mostly orphans, in Karai Village.

Jesca somehow finds time in her busy schedule to carry out her VHW responsibilities, for which Mondays, Wednesdays and Fridays have been set aside. This mostly involves providing home-based healthcare services where they are needed in Karai Village.

In May of this year, when the Karai School head requested her to travel to Mushumbi Pools to represent the Karai School SDC in a workshop on mathematics teaching and learning, Jesca was naturally a bit apprehensive, being not quite sure what to expect. She nonetheless accepted the invitation and, in the company of Miss Munthali (a Karai School teacher who had also been invited), left home in the morning of 15 May 2016 and arrived at the venue in the evening on the same day. The workshop, which was attended by teachers (mostly) and a few community representatives (like herself), was held the next day, starting in the morning and ending in the evening. By the time she left on Tuesday, 17 May 2016, Jesca felt she had acquired a reasonably adequate understanding of what PSCNEP stood for, its potential benefits to the children in her community and the role she was expected to play. She felt excited and eager to share her experiences with other villagers, she says.

On her return, Jesca immediately swung into action. She approached her local counsellor and briefed him about PSCNEP. Fortunately, he was very receptive and on the same day requested the local headman to call a village meeting at his earliest convenience. The headman complied, and the meeting was duly held within a week. Jesca felt honoured and grateful to be given the floor immediately after the counsellor's remarks. She explained the motivation behind PSCNEP as she understood it, its goals and the expected roles of the various partners involved in the project, including schools and teachers, the community and the district. In closing, Jesca made an impassioned plea, urging fellow villagers '… to value children and their education …' and '… to work together with teachers to help children to learn mathematics, as it a valuable tool in their present and future lives …'. She mentioned such activities as cooking, farming, building and buying and selling as examples of situations where mathematics can be applied in everyday life. To Jesca's dismay, the response was lukewarm, with only a few of the villagers present showing interest. She was, however, pleasantly surprised when, in the subsequent meeting, a few more community members appeared to be warming up to her message. She is not sure what might have led to this apparent change of heart, but she felt encouraged. In that meeting, quite a number of the parents expressed interest in playing their part in supporting their children in mathematics learning. Their main challenge, Jesca noted, appeared to concern their perceived inadequacy in mathematics itself and thus in supporting their children in related homework. As a way forward, some of those present suggested that parents could be provided with mathematics textbooks to enable them to learn or re-learn mathematics concepts and thus be in a position to help their children.[10]

10.The PSCNEP team has noted this apparent misunderstanding and will strategise to come up with a possible solution(s).

As had been promised in the May PSCNEP workshop, a follow-up training and learning activity was conducted over a 3-day period, starting from 20 to 22 June 2016. Jesca enthusiastically had looked forward to it, and she was not disappointed, she says. In her estimation, the workshop's goal – which was to enhance teacher participants' capacity to teach for numeracy and also to help other teachers in their school clusters[11] to do the same – was achieved. She says she feels more empowered to go back to her village and spread the PSCNEP message, now that she has a better understanding of the project and is armed with copies of the PSCNEP poster and brochure.[12] In Jesca's own words: 'Some learn mainly through hearing, others mainly through seeing. The poster and brochure will be useful tools in convincing our communities about the value of the PSCNEP'.

Jesca's enthusiasm and determination is heart-warming, and it gives reason to hope that communities involved in PSCNEP will, slowly but surely, play their expected role effectively as time goes on.

11.In the Zimbabwe education system, schools are organised by clusters, each of which has a total of six schools on average. Mbire district has a total of 35 primary schools, organised around six clusters.

12.Teachers and community representatives who participated in the 20–22 June 2016 training were given copies of the PSCNEP poster and brochure.