School-based professional development in a developing context: Lessons learnt from a case study in Zambia

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Abstract

This paper reports on the development and outcomes of the second phase of OER4Schools, a school-based professional development programme supporting interactive forms of subject teaching in conjunction with Open Educational Resources (OER) and technology in Zambian primary schools. We worked with partners to identify the needs of school-based continuing professional development (CPD) adapted to the local context; the programme was based on participatory, collaborative and inquiry-based pedagogies for both classroom learning and teacher development. We worked over a 1-year period with four experienced teachers in two basic (primary) schools serving disadvantaged communities. Data were collected from observations, interviews, surveys, lesson planning / review meetings and team workshops. All participants integrated OER and technology into mathematics and science lessons and developed more interactive practices, including collaborative learning. Professional dialogue, quality conversations, reflective practice, cultural sensitivity, peer learning and co-operation were pivotal mechanisms through which teachers shifted their focus from teaching (and teacher exposition) to student learning. Seeing students as capable individuals, teachers raised their expectations, and developed insight into interactive practices such as group work, providing meaningful opportunities for student collaboration and active learning by all.

1. Introduction

If teachers are to become reflective practitioners who use active learning approaches in their classrooms, where students learn through problem solving, critical dialogue, inquiry, and the use of higher-order thinking skills, teachers must learn and improve in professional development programs that not only advocate but also use and model these same methods… The latter approach is more correctly referred to as 'teacher education' or 'teacher professional development' rather than 'teacher training.' The critical difference between the two concepts [. . .] is defined by their dissenting views of teachers—as incapable of acting as professionals and requiring scripted practice or as responsible professionals who

*will perform well in an atmosphere of trust and support. (*Leu & Price-Rom, 2006, p. 7*)*

This paper reports on the development and evaluation of a programme of school-based professional development in basic (primary) schools in Zambia. The OER4Schools[i] programme supported more interactive forms of subject pedagogy, particularly focused on teaching and learning of mathematics and science. We also explored the feasibility of introducing digital technologies and high quality Open Educational Resources (OER) where other resources are scarce. The professional development programme was participatively developed through a North-South partnership between the Cambridge team and institutions in Zambia (see Acknowledgements).

The quote above by Leu and Price-Rom (2006) sets the scene by portraying our respectful approach to professional learning: it offers new strategies and together with key stakeholders adapts them for – and assesses their value within – the particular cultural context, described below. Evidence is emerging that the strongest school-level determinant of pupil achievement in developing countries is the *quality of teaching* (Adekola, 2007; Schwille & Dembélé, 2007); this is more significant than levels of experience or qualification (Moon & Dladla, 2013, p. 12). Improving quality includes a pedagogical shift towards teachers becoming facilitators of learning instead of transmitters of facts – or 'moving from telling to listening' (Suurtamm & Vézina, 2010, p. 1). This requires effective professional development and African teachers urgently need access to opportunities for such ongoing support (Thakrar, Zinn, & Wolfenden, 2009). However, the literature on issues around such access in developing country contexts is presently very limited. Further empirical research is needed to determine what support is needed to make school-based teacher development effective (Schwille & Dembélé, 2007).

The aims of this paper are to share and reflect on our experiences of supporting Zambian teachers, to characterise pedagogical change, to identify effective forms of support and issues arising in its provision, and thereby to elicit a set of guidelines for in-school professional development in Zambia and other, similar contexts.

1.1. Educational context in Zambia

There is on average one classroom teacher for every 62.6 students in Zambian primary schools, but class sizes vary enormously and rural schools have fewer teachers per head (World Bank, 2011). As in other sub-Saharan African (SSA) countries, Zambia has many under-qualified teachers working in classrooms that lack basic resources. Despite encouragement for interactive teaching through government policy, teachers tend to focus on subject teaching rather than students' understandings and thinking (e.g. Carroll, 1996), perpetuating the same methods by which they were taught. Teachers often measure learning only through testing (Pryor & Westbrook, 2013). Research in six African countries by Akyeampong et al. (2011) confirms that this approach reflects the emphasis of teacher education. College courses offer limited opportunities for teaching practice to help teachers learn to deal with classroom realities (Pryor & Westbrook, 2013). This may contribute to the fact that 70% of children do not achieve basic numeracy after six years of schooling in some SSA countries, e.g. Malawi, Namibia, Zambia (Education For All, 2010, p. 106).

While our focus is on teachers' pedagogy, a number of cultural and school-level factors are equally important. The school organisation influences the ease with which a CPD programme can be implemented, and the head teacher plays a crucial role. In our studies, head teacher endorsement for interactive teaching (and appropriate time commitment) was viewed as essential by everybody involved. Several infrastructural and cultural factors influenced our approach, including the physical facilities, low resources in schools, and difficult working conditions for teachers, especially low and irregular pay. High staff turnover and absenteeism are common. Motivation can derive from professional pride, and experiencing successful teaching, as well as from access to technology and developing technical skills.

2. Interactive pedagogy and the role of professional development

2.1 Interactive teaching and collaborative learning

An interactive learning environment is one where teachers create and take up opportunities to facilitate a two-way discussion with learners, promote hands-on activities and open-ended questioning, and engage students as active participants in the learning process. An established body of research shows that learners can gain valuable insights from peers' perspectives when required to express and explain their ideas to other learners who may disagree, requiring further thinking by all as they formulate, articulate, explain and self-evaluate their responses (e.g. Cramer, Beauregard, & Sharma, 2009; Looi, Chen, & Ng, 2010; Nussbaum et al., 2009). Such an approach is rarely observed in sub-Saharan Africa (Moon & Dladla, 2013). Educational technology initiatives are common, and they likewise have the most positive impacts on children's learning when they foster interactivity and collaboration (Barak, Lipson, & Lerman, 2006; Bebell & O'Dwyer, 2010; Becta, 2004; de Jong, 2006). A key aim of OER4Schools was to support teachers in using technology in these ways, through a tailored professional development programme.

2.2 Sustained professional dialogue, reflective practice and quality conversations

Previous research demonstrates that reflective dialogue as a deliberate professional learning strategy is a significant catalyst for improved classroom practice (e.g. Nehring, Laboy, & Catarius, 2010; Twining, Raffaghelli, Albion, & Knezek, 2013). Specifically, regular group reflection on the alignment of intent and practice is a more powerful facilitator of change than reliance on individual reflection. Reflective professional dialogue needs to be meaningfully contextualised and sustained over time. The typical provision of one-off workshops – whether focused on new technology or not – is of limited value in sustaining transformation of practice (Glazer & Hannafin, 2006; Muijs & Lindsay, 2008). Classroom implementation is highly challenging for teachers. CPD work aimed at developing primary South African teachers' mathematics practice showed that even a series of workshops where teachers successfully developed awareness and confidence in alternative conceptualisations of teaching, and devised and practised new methods, led to little actual change in practice without ongoing support (Goldstein, Mnisi, & Rodwell, 1999). Teachers lacked the confidence to challenge existing structures and they returned to established patterns at the chalk front.

Recent research indicates a promising approach to be a CPD programme that draws on teachers' local networks, encourages peer learning, includes concrete, experiential tasks, and focuses on immediate teaching needs and everyday, first-hand classroom experiences (OECD, 1998; Twining, et al., 2013; Wells, 2007). In these professional learning communities, teachers identify their own starting points (Cordingley, Rundell, Temperey, & McGregor, 2004), engage in sense making, problem posing and solving (Wallace, 2003), that is, in *inquiry*. Collegiality does not, *per se*, ensure quality, though; a *critical* stance is also needed (Manouchehri, 2001), whereby teachers ask fundamental questions about what learners understand, and challenge their own underlying assumptions and those of curriculum or professional learning materials (Cochran-Smith & Lytle, 1999). Teachers may modify or dismantle existing practices as they develop and trial new ones, hence developing new insights into pedagogy (Suurtamm & Vézina, 2010; Wells, 2007; Zwart, Wubbels, Bergen, & Bolhuis, 2007). We argue that developing such a critical inquiry outlook may require deliberately challenging, yet supportive, questioning strategies that model the questions that teachers might ask themselves.

This methodology necessitates structured time for teachers to work together in planning forthcoming lessons, observing each other's classrooms, and sharing feedback. Such a school culture is correlated with a wider repertoire of pedagogical practices, more positive teacher-student relations and higher student achievement (OECD, 2009). To support effective professional learning, teachers also appear to need opportunities to engage with other sources of ideas within and beyond the school, plus collaborations which have well-defined missions, offer psychological safety, respect and trust between collaborators, include suitable practical support for the collaboration, incorporate fruitful conversations, and build in a readiness for teacher learning (Perkins, 2003).

Where teachers are supported by working with external researchers, the structure of the dialogue between them, and the environment in which it takes place, strongly influence outcomes. Successful initiatives promote an open, dynamic, and safe environment in which teachers can freely share experiences and ideas, explore or critique; they present suggestions for teaching strategies rather than formulae or inflexible directions to be followed (Butler, Lauscher, Jarvis-Selinger, & Beckingham, 2004; Hennessy et al., 2010; Suurtamm & Vézina, 2010). Overall, the literature points to the process of formally opening up a professional dialogue both with peers and external researchers, offering teachers opportunities to develop new and better theories-in-use (Perkins, 2003) as well as to develop their practices.

One of our strategies was thus to find ways to promote 'quality conversations' (Wallace, 2003, pp. 11-12) focused on the specifics of teaching and structured to provide concrete support and scaffolding. Such opportunities for dialogue enable teachers to find meanings that best serve their unique needs (ibid.). Other key facets of such conversations are critical reflection, and clear, guiding questions that clarify teachers' ideas, and push thinking in new directions.

Design and implementation of our own programme of CPD attempted to provide the opportunities for teachers recommended in the literature reviewed above.

3. Groundwork

This paper reports on Phase 2 of the OER4Schools project. The (pilot) Phase 1 assessed the feasibility of supporting interactive forms of subject teaching in conjunction with providing Open Educational Resources (OER) to computer- and Internet-equipped primary schools in Zambia (Hassler, Hennessy, & Lubasi, 2011; Hennessy, Hassler, & Mwewa, 2012) . The project was initiated in response to a project led by our NGO partner iSchool, implementing technology in Zambian schools but involving limited pedagogical support. Our aim was to identify and respond to the needs of school-based professional development adapted to the local context, as identified by iSchool and their school partners, by designing an appropriate support programme. A key feature of the work was to use technology and OER to support interactive pedagogies.

In Phase 1 we worked over a 6-month period (January - June 2010) with eight experienced teachers in three basic (primary) schools in Lusaka province, all serving under-privileged communities (see Participants). The teachers were selected on the headteachers' recommendations, comprising those who were interested in participating in a technology project, regardless of their levels of teaching/technology experience. Two schools had Internet access (through the iSchool programme), the third had no technology facilities or Internet connection of its own; an arrangement was made for teachers to use facilities at an adjacent teacher college. Two workshops introduced teachers to the notion of interactive teaching and learning, to the technology equipment and some digital resources, and to the research methodology. School visits, some undertaken by a part-time researcher recruited from the University of Zambia, then supported the teachers through developing lesson plans, observing and feeding back on lessons. Teachers reported back by emailing us brief post-lesson surveys, although not all returned these systematically.

All participants ultimately integrated some use of digital tools and OER resources into lessons and developed more interactive practices, including more collaborative group work, practical work, student presentations to peers, and greater acceptance of classroom 'noise' during discussions. Teachers began to shift towards open-ended questioning to some degree. The pilot provoked a very enthusiastic response from participating teachers, schools, iSchool and the Ministry of Education, all of whom wanted us to continue the work. Hence Phase 2 (October 2010 - October 2011) was conceived.

The current study also benefited from the parallel *Appropriate New Technologies to Support Interactive Teaching in Zambian schools* project (ANTSIT, October 2010 – April 2011, funded by the UK Department for International Development; Haßler et al., 2011). The research explored what kinds of mobile devices and innovative uses can create an environment supportive of learning through active participation in under-resourced school communities. The project provided a small number of mobile devices and non-digital resources. The same equipment remained available for OER4Schools Phase 2, reported here.

Throughout the various project phases, the teachers in our studies were coming to grips with novel technologies and learning resources, and they were still in the process of developing an interactive teaching approach, thus we inevitably needed to provide substantial support. Our conclusion was that under these conditions some engaging and pedagogically interactive lessons can take place, although quality of the final outcome could vary. We know that teacher learning proceeds gradually and hesitantly as horizons of understanding expand, rather than through

sudden leaps of insight (Wallace, 2003). Our findings confirmed that CPD opportunities are essential for teachers to become familiar with new technologies and to make creative use of them. However, teachers reported that typically CPD is not readily available to them. In the community school, no CPD was available at all, while in the government school, the in-service training coordinator attends some CPD sessions and relays the content to colleagues.

4. Research questions and approach

This paper reports on Phase 2 of the OER4Schools project in which we designed, implemented, and evaluated a CPD programme.[ii] The deliberately practical approach taken included joint planning of lesson activities and whole lessons, followed by classroom-based trialling to experiment and refine. To evaluate the programme and inform future iterations, we posed the following questions:

- ≅ What are the most effective strategies to encourage and develop new methods of interactive classroom teaching in SSA?
- ≅ What level of external support is required to implement an effective CPD programme?

Our experience is that genuine participation is key to ownership, sustainability, and replication. Tillman's (2006) account of culturally sensitive research (with African-American teachers) informed our investigation and understanding of Zambian classrooms, helpfully elaborating the open-minded and participatory nature of our approach:

> When research is approached from a culturally sensitive perspective the complexity of an ethnic group's culture, as well as its varied historical and contemporary representations, is acknowledged (Tillman, 2006, p. 266). … Researchers rely on participants' perspectives and cultural understandings of the phenomena under study to establish connections between espoused theory and reality and then to generate theory based on these… perspectives (p.271).

This perspective helped us to gather some insights from our teacher participants into their local culture – namely the shared knowledge, practices, experiences, values, and ways of thinking.

To mitigate the risk of forcing an intervention in an environment where it may not be appropriate, decision making was as collaborative as possible; for example subject topics were negotiated, and the initial technology choices had been directly informed by teachers' suggestions. Lesson planning was a joint process with the end goal of equipping teachers to work independently, through responding to their own ideas concerning both teaching strategies and technology use, detailed in 5.1.1.

4.1 Overview of CPD process and research strategy
The programme evaluation was intricately linked with the CPD process itself; for example, video records were used for research, and to document (changes in) practices, both for participants to comment on and for the subsequent benefit of other teachers. Lesson planning and review meetings were critical elements of the CPD process and audio records of meetings were primary

data sources. Evaluation was ongoing throughout the programme as we collected evidence to demonstrate proof of concept (InfoDev, 2005, p. 13) and also encouraged teachers to monitor their own progress informally. They engaged in a process of continual self-evaluation and refinement (Unwin & Day, 2005). Thus the CPD programme structure and its evaluation are first summarised holistically here, then elaborated in subsequent sections.

Our Phase 2 work (detailed in this paper) involved only two of the original schools for capacity reasons, and comprised three stages. The **first stage** of Phase 2 involved preparation in the UK and remote communication with the teachers. Our attempts during Phase 1 to recruit staff locally for research and teacher support in our absence had met with mixed success, and we were unable to recruit anyone suitably qualified for Phase 2 (see Hennessy, et al., 2012 for more information about inter-cultural research partnership issues). The goal was to support teachers in developing interactive pedagogy.

The **second stage** comprised two weeks of intensive field work – observing and video recording lessons in action, conducting interviews, joint post-lesson reviews and lesson planning. Additionally, a joint workshop was held for teachers from the two schools to strengthen our support network. The outcomes of this stage included the iterative co-construction of (a) concrete lesson plans that promoted interaction and collaboration supported by technology use, (b) a generic lesson template and (c) guidelines for a collaboration process for creating future lesson plans.

The **third stage** of Phase 2 capitalised on these outcomes. We returned to Zambia with a professional film producer to record two lessons each with three teachers. We also recorded a short general interview with each participant, asking them to reflect on progress made throughout the programme. Again there was a 3-month period of attempted remote communication beforehand, and then in-depth joint lesson planning and review immediately before and after the filmed lessons. Our ultimate aim during this stage was to create a professional learning resource, followed by Phase 3, as elaborated under 'Follow-up and Outlook'.

4.2 Participants

To obtain the widest picture despite such a small sample, we focused on a peri-urban, community school situated in a high density housing compound on the outskirts of Lusaka, with on-site access to electricity and the Internet, and a rural, government school about 50 km from Lusaka, with much larger classes and electricity but no Internet. As in Phase 1, teachers in the latter location could go to the adjacent teacher college to gather digital resources to use offline in lessons. Both schools are mixed sex, are poorly resourced and serve disadvantaged communities. The schools report that many children are orphaned or otherwise vulnerable. In Zambian primary schools teaching takes place mainly in English although local language is used alongside it in the lower grades.

Within these schools we worked in collaboration with four teachers who had taken part in ANTSIT and OER4Schools Phase 1 and were keen to continue. Limited resources led us to select two from each school, on the understanding that they would eventually cascade their knowledge to any interested colleagues, and that the resulting professional development materials would be made available and trialled on a whole school basis.

The four classes involved in the study were Grades 3 and 7: see Table 1. Participation in this study was voluntary for the teachers and students, and explicit written permission to record conversations, film lessons, and gather evidence for the study conclusions was obtained before any work commenced. One female teacher was ill for some weeks, however, and thus unable to participate fully. The teachers' prior involvement in our work meant they already had some experience using technology and we had already begun to develop a shared vision of interactive teaching with technology. We were hence able to short-circuit the process of building rapport and negotiating roles and responsibilities.

Table 1. Participating teachers

School	Teacher	Sex	Grade(s) Taught	Qualifications and Teaching Experience
Chimwemwe Trust School	Eness Chileshe Brian Machiko	F M	Grades 3,4 Grades 7,9	ECCED*; 2 years Teachers Certificate; 6 years
Chalimbana Basic School	Abel Makonga Agness Tembo	M F	Grade 7 Grade 3	Diploma, Teaching cert; 6 years Diploma, Teaching cert; 9 years

*ECCED = Early Childhood Care, Education and Development

Our own research indicates that students in the same classroom often have a varying pace of working, including differing English language competences, making discussion hard to access for some, especially girls (Hassler, et al., 2011). Slow understanding of subject knowledge can be due to language barriers; sex differences (e.g. in mathematics understanding) perceived by teachers or researchers can actually be attributed to differences in English competence (c.f. 5.2.2). Other important factors include 'exposure' (which generally refers to whether a child has encountered a broad range of external influences) and socio-economic status (SES). At Chimwemwe, SES is more uniform but there are differences in prior computer exposure (in or outside school). At Chalimbana, there are differences in SES (e.g. some parents working at the nearby college, some in subsistence farming, others are unemployed), as well as exposure due to various non-economic factors.

Our lesson observations during Phase 1 confirmed that participating schools and teachers initially employed a didactic teaching approach. This approach did not explore what learners knew or understood – before, during or at the end of a lesson – and thus did not tailor teaching according to learners' needs. For example, one teacher whom we asked about what he would do if he found that students had not understood the content of his lesson, responded 'I would repeat the lesson.' We also observed long periods of student inactivity with no work being offered, for

instance while a teacher marked other students' work or while an entire class waited until the last child had finished a task. Differentiation by needs was not observed.

4.3 Implementing the CPD programme

A typical day at school consisted of *observing lessons* in the morning with one of the teachers, followed by joint lesson review and planning (we were participant observers).

Lesson reviews entailed extended conversations with the teachers outside lesson time, collectively reflecting on the relative successes and difficulties of teaching the lesson, including technology use. One objective was to extract effective strategies and generalise them for use in future lessons.

Lesson planning sessions were collaborative. We jointly identified suitable forthcoming curriculum topics within primary mathematics and science and devised activities that exploited the technologies available in each school context. Lesson plans were immediately committed to templates, providing scaffolding to help teachers order their thoughts.

The *day workshops* brought teachers from both schools together to share experiences of interactive teaching, discuss common challenges and suggest strategies.

4.4 Data collection and analysis

Table 2 catalogues the various research data gathered and analysed during the CPD process.

Table 2. Overview of OER4Schools Phase 2 research process

Method (Data Type)	Quantity / Timing	Focus
Lesson observations (field notes, photographs, video recordings)	Seven lessons observed in Feb/March, seven in May/June (lessons lasted 78 mins. on average)	Capturing development and range of interactive pedagogical practices
Post-lesson meetings (audio transcripts)	One meeting per lesson observed (approx. 2 hours / session)	Lesson review, lesson planning, logistics
Semi-structured interviews (audio transcripts)	Ten teacher and three head teacher interviews in total	Participants' experiences and perceived outcomes of the project, opinions about interactive teaching and change in their classrooms/schools
Phone calls from UK to Zambia	On average, one call per teacher per week	Lesson planning and follow-up, logistics
Post-lesson surveys (written/electronic survey forms)	58 forms received (October – March)	Technical issues; learner responses and participation levels in lessons

Day workshops	One involving two Grade 7 teachers from different schools (February), one involving all teachers and other partners (June). Workshops lasted 4-5 hours.	Participants' reports of lessons observed, collective review of lesson video clips, suggestions for further development. Joint planning for filming and production of CPD resource.

Our design was an inductive-deductive research cycle (Teddlie & Tashakkori, 2009) that was both exploratory and confirmatory. Abstraction from the research literature and our prior studies yielded insights into what kinds of professional development support seem to be most useful for this new context; we then sought teachers' responses to it. At the same time we trawled the data for examples of change and examined which forms of support appeared responsible. The cycle involved a process of constant comparison (Glaser & Strauss, 1967) whereby the three researchers independently reviewed research data, noting themes and selecting illustrative examples, finalising outcomes through team discussion.

5. Findings

The findings are split into what types of support proved effective (5.1) and evidence for how teachers shifted their focus towards student learning (5.2).

5.1 Supportive features of our approach

Our strategies and techniques for shifting the focus to learning included engaging teachers in quality conversations, providing support through scaffolding, and creating opportunities for dialogue with colleagues. Any interventions we did make comprised suggestions about new techniques or resources, however it was always left to the teachers to decide for themselves, without pressure, what to include.

5.1.1 Engaging teachers in quality conversations

Using questions to clarify, scaffold and extend

The following extracts are from a Grade 7 lesson on *ratios and areas*, taught using the MobiMaths application for Android tablets. The application overlays a resizable rectangular grid on photographs, allowing measurements to be made by comparing the relative sizes of objects in the picture.[iii] The first extract from the lesson planning conversation illustrates making lesson plans concrete. The teacher initially simply puts forward some fairly general questions for students, which are then refined to be more specific, through targeted researcher (R) questioning (see questions in italics).

> R: We'll need some plenary activity to bring it all together. Get them together to talk about what they've learned, get them to share their findings. *What kind of questions or discussion could we have to wrap it all up?*
> Brian: I think some questions will come – I could ask them how they found the lesson. If you ask them in groups or individually, randomly maybe, what difficulties they had. We could ask a lot of questions.

R: Asking the children how they found the lesson. What helped you understand?
Did you learn anything, and if so, what helped you understand it? Maybe even
before that, it would be good to find out what they learned, what results they
found. Maybe a plenary where they share from each group what they found.
What do you think, is that useful?
Brian: Yes – maybe I could get three types of photos and give them similar
photos and ask the same questions to each. Different items, maybe four.

Example of a more interventionist approach

Inevitably, sometimes our suggestions were not immediately understood as we had intended. In the following excerpt Brian initially interpreted the notions of increasing pupil participation ('involving all children' and 'soliciting learners' own ideas') to mean obtaining feedback in turn from every pupil. A much more direct intervention than usual was consequently made.

R: A couple of times when you were asking them questions about the gradations on the tape, you asked a question and one of them gave an answer. Then you asked all the children and they all gave the same answer (I think it was 39.5). I was just wondering why after two or three had given the answer, you went round asking all the others as well?

Brian: I just wanted them to participate also, because some of them feel out of place if they're not picked. I wanted all of them to have a turn.

R: Yes I can see that point [but] sometimes they copy each other... and once you've gone around half the class nobody's going to say anything other than 39.5 because they know that's the consensus view. I think it's a really good strategy to get them all to participate and have a turn, but I would perhaps suggest using different questions so that maybe one answers that question and you see if they all agree – and if not, why. Then the next question goes to another table. So they all get a turn but they don't just copy, because otherwise it's too easy for them... [nevertheless] they were all very engaged in the lesson. They were all actively participating.

Using reflection to stimulate new strategies

Post-lesson review always began with open questions gauging the teachers' own impressions of their lesson and whether/where they thought it might need modification: for example, 'how do you think it went?', 'what would you like to do differently?' almost always brought up the issues already observed. This method of reflection engendered ownership of the lesson planning process, and modelled desired classroom strategies. In the next example a teacher draws on evidence from a previous lesson and accordingly develops new strategies herself that adapt to different students' pace of working (see italics below). The conversation had been about group work, and the researcher asks about group formation.

R: How will you make those groups?

Eness: The one [lesson] that you filmed last time, I observed that the slow learners were not moving at the same pace as the fast learners, so I thought of grouping the slow learners alone and the fast learners separately, so that when it comes to preparing questions and swapping, maybe slow learners will prepare easy questions and the fast learners will prepare hard questions. When I tried this lesson, when I reached the point of swapping questions I found that the [fast learner] group would prepare a question – they would look for a bigger number and then give it to their friends, and they would say 'oh this is hard' so the next time they would also [prepare] a hard question. So I discovered that it wasn't fair for the slower learners because they would just sit and watch. *So according to their level, everyone can contribute.* If someone comes up with a question like 10 divided by 2, at least that person will be able to count, even using their fingers and find the answer. If they are given a large number, they will all be stuck, and they won't say anything. So I thought of grouping them according to the understanding they've reached.
[. . .] I will have 2 groups for fast learners and 2 for slow learners. I'll make sure that the slow learners prepare questions for the other slow learners. [. . .] When it comes to reporting, they have to know the answer. So they won't prepare a hard question to which they don't know the answer.

Eness realised that it was important for the children to know the answers to the problems that they were posing, demonstrating thoughtful lesson planning and insight into productive collaboration.

Quality conversation with positive outcomes

The following conversation illustrates our approach of introducing strategies in concrete settings. Agness had noticed that a small group of students, mostly high-performing males, was usually the first to volunteer, and thus dominated the discussion of the entire class. In response the researcher suggested a new strategy, 'no hands up'. Agness took this up and later reflected on the outcome in a wider workshop:

When I asked questions, you could find that some pupils would raise their hands, others didn't. So in the next lesson, I had to change the methodology. I discouraged raising hands because I had seen that others could have the answers but could not speak up. So I was just pointing to random pupils and that really helped the pupils participate fully. . . I think you should try to discourage hands up when they know the answer – I will just point by random. By so doing, you are encouraging each and every one to think. Because if you always point to those who are raising their hands, the others think they don't have to think.

Again, this demonstrates insight into making lessons more productive and increasing learning outcomes for all children.

5.1.2 Creating opportunities for learning from and with peers

Another key strategy within our programme was to create opportunities for peer learning, allowing teachers to interact with each other, rather than just with professional development leaders. There are obvious benefits in collaboration, for instance where teachers plan how to teach specific topics. However, often such opportunities do not exist:

> Zambian teachers rarely find time to discuss as members of staff. The discussions that we were doing where teachers were bringing their own ideas, could be happening in schools. The obstacle there is that teachers work as an island; this teacher does not want to sit down with another teacher. [Yoram, professional development leader and teacher]

We specifically sought to create such opportunities. Teachers were initially reluctant to comment on another teacher's style or lesson, feeling that they were not in a position to make useful suggestions. However, as teachers discovered that they could learn from each other, this reluctance diminished.

One of the issues that came up in the same wider workshop was Eness' difficulty in teaching long division. Agness offered a solution – to use real-world objects in the children's lives such as sweets to relate more abstract and complex ideas like long division. Eness later reflected on this:

> I usually find it difficult when I'm teaching long division. But just after we had that discussion when we were in groups… there's this idea that I got from Agness [that] I thought of trying today, and I think it has really helped me because from what I observed, out of all the pupils who were present today, I think only 3 or 2 had problems.

Building support networks is essential and desired by teachers. Teachers themselves suggested that they should work more with teachers at other schools.

5.2 Teachers shifting their focus from teaching to student learning

The strategies and forms of support described throughout Section 5.1 were all oriented towards increasing the teachers' focus on learning. In this section we now chart the actual process describing the observed and reported changes in practice and outlook. Awareness seemed to develop in two stages: first, there was a shift towards focusing on learning generally (5.2.1). Teachers' understanding that pupils' learning is a joint teacher/learner responsibility, that peer learning (of pupils) is powerful, and that learning needs and progress require constant teacher assessment to *adapt* the teaching accordingly, was clearly evolving. In 5.2.2 onwards we outline the second stage, in which teachers became aware that they needed to find ways to engage *all* students in the class, through being aware of and responding to specific learning needs.

5.2.1 Using an interactive teaching approach to shift the focus

Abel's reflection below emphasises the perceived advantages ('benefits') of the 'shift from telling to listening' (Suurtamm & Vézina, 2010, p. 1) and the changing roles in the classroom as interactive teaching became more ingrained:

I decided to try interactive teaching because . . .the benefits that I saw and that I'm seeing are that a teacher doesn't talk too much [when giving instructions to the whole class]. *A lot of work is done by the pupils themselves. They teach themselves.* You are only there to coordinate, or maybe to consolidate what they know, and also to guide them. I've seen that pupils, as long as you tell them to be interactive, they learn a lot from their friends, which is very very good. I've seen myself teaching interactively without maybe repeating the same lesson time and again because a lesson, or something taught by a peer is sometimes not forgotten very fast. So pupils keep remembering, *'so my friends say this, that one also, and also the teacher supported that. That's a good idea.'*

Abel mentioned, however, that the interactive approach, especially using digital technology, has some potential drawbacks and requires careful planning and control.

It is good but it also consumes a lot of time … and sometimes as a teacher, if you are not following whatever is happening in class, that noise tends to be commotion … disturbing other classes. . .You need to guide them here and there. By doing that, you're controlling the situation . . . Also, they are seeing that [the teacher] is not only asking us things. He's also trying to understand and get something from us. I equally learn a lot.

5.2.2 Focusing on learning of all students – grouping strategies

The second stage of teachers' evolving awareness was that they needed to engage **all** students in the class, not just the majority. One teacher recognized that the previous desk arrangement of rows facing the teacher '*limited the participation of the children*'. By rearranging into small groups of mixed pace learners, the teacher found that *'[students] will discuss their assignment. If they've got a problem they will ask and . . . you explain in a group, not as individuals.'*

Teachers also realised that interactive approaches can also benefit particular students and involve more students, as in the following quote:

Group work really helps the slow learners because there are some pupils who are just too quiet. They don't want to say anything, not until you point at them – now when they are in a group, they are forced to say something. (Eness)

A related, important aspect of group work is that it can help to bridge language barriers and free discussion, as students tend to use local languages, rather than English.

Ideally all students will participate in ways that move their thinking on. This was manifest in our encouragement to teachers to ask for contributions that no-one else has yet offered, as in the brainstorm at the start of Eness' lesson on the classification of animals[iv]. The lesson started with children naming animals in turn (without repetition), which were later classified according to a variety of criteria.

Team discussion of pace grouping and Agness's classroom experience.

The following excerpt (also from the above workshop) builds on the earlier description of lesson planning with Eness where she suggested trying out mixed pace groups. In this discussion, the advantages and disadvantages of pace work, such as 'coasting', are debated and techniques for avoiding copying are shared with peers. This is a 'quality conversation' between peers – from two different schools; the focus is on learning as they share their own classroom strategies. Agness had described a 'fun addition using a number tree' activity where students had to find the long number by subtracting numbers in the branches and then check it by adding.

> Agness: Most of them got everything. It was only three or four pupils in Banana Group, they didn't do well [. . .] The only part which, using the calculator, the Banana Group, they could press the numbers and then when they pressed on minus… It is not shown so they continued pressing on that.
>
> Maud: Oh 'Banana Group'! Isn't that where you put all your slow learners...?
>
> Agness: Yes, we have put them according to pace group [. . .] because they say maybe if a dull person is mixed with those very intelligent they won't participate the same. So, it's better you have them on their own…
>
> Brian: Do you find any from that pace group joining another group?
>
> Agness: They do! Every time when you come in [they've moved]: 'Go back to your places.' They change.
>
> Brian: Why can't you allow them to remain there instead of...
>
> Agness: No. The rule is that those slow learners should be nearer the teacher . . . because if you get a slow learner and you put him at the back, truly it will be difficult for you to monitor that pupil every time.
>
> [...]
>
> Ivy: Sometimes maybe mixing slow learners and fast learners [is good] but the thing is slow learners will copy from their friends… so it's better slow learners are in their own group.
>
> Agness: But in… the interactive way, yes, copy[ing] it's there but it depends also on the teacher. I remember in my lesson, one said 'Teacher! This one is not doing anything. She just wants to see what we're doing.' I went there and physically said 'Can you give the calculator to her? Tell her what is your lesson? [. . .] They are all there teaching the writing to their friend. So it depends [on] you as a teacher. If you just direct them, truly, they'll copy.
>
> I remember. . . the science lesson on the rocks weathering. . . I gave them the [mini] whiteboard. 'Can you draw what you learnt in the last lesson?' One [child] drew the sun very fast and he said 'Teacher! I am finished!' So I noticed that [others then drew the same] and [next time] I said 'when you are finished don't show me, put it [face] down. That's what they did.
>
> Only two drew the river, the rest drew the sun. So, I thought, ok, they're copying, fine. 'When you find the answer, put your whiteboard upside down'. And they are

there, struggling. And most of them were able to find the answers. I said 'Can I see?' and all of them did this [held up the boards at the same time]. So that's what I am saying: you as the teacher should have different methods. You should vary.

Brian: We don't talk about copying [in my classroom]. If one is copying, you wait and [ask them] 'Show me or show the class'.

Further suggestions were subsequently made (by teachers and researchers), which were then tried out by the teachers. Agness devised a lesson plan based around mixed pace groups and activities requiring students to explain a concept to each other, groups to set problems for each other and to mark each other's responses. Post-lesson feedback indicated that teachers developed their understanding of group formation for different purposes and the benefits of mixed pace grouping.

5.2.3 Focusing on learning of all *students – responding to learning needs*

Likewise, teachers demonstrated that they could assess and respond to learning needs. A number of video clips from one of the lessons we filmed illustrate this. Students investigated whether two rectangles that have the same perimeter also have the same area. A vote was taken at the beginning of the class, indicating that most of the students thought that this would be the case.

The first clip[v] shows Abel giving instructions for the interactive task, followed by some work with one of the groups, clarifying the concepts of area and perimeter, as well as how to use GeoGebra, an Open Source geometry and algebra software. However, the group is still stuck. Rather than simply repeating the instructions, Abel has realised that his way of explaining the task is not helping the students. At this point Abel solicits help from other students, asking them to explain to this group. The teacher acting in a facilitatory role, making moment-by-moment decisions as to how to support student learning, is highly unusual in the Zambian context. Overall, teachers gained insight into the value of peer interaction among students.

The next excerpt from a debrief with Abel also illustrates how he adjusted his strategy *during* the lesson when he found that students were not initially grasping the notions of area and perimeter:

> During the lesson, I changed a few things. I knew for them to understand perimeter and differentiate area, I had to simplify the two formulas so that they really understand what we are talking about. So that they actually see where the 'l' [length] and 'w' [width] were coming from – and where the '2' was coming from.

He engaged students in a way that helped them to actually understand. In a second clip[vi] later in the same GeoGebra lesson, a group of students now independently investigate together. The teacher is allowing space for students' own investigations, rather than giving step-by-step instructions.

5.2.4 Focusing on learning of all students – raising expectations

Teachers were sometimes adamant that a particular lesson idea would not work in practice because the 'students were not capable'. This may mask the view that the teachers themselves felt challenged by the new approach; it may also have reflected their lack of practice in assessing learning needs. We diplomatically challenged these low expectations (e.g. 'How about if you try

it out and see how far they get?'). When the lesson was conducted, teachers were generally surprised by the level of student achievement, and the depth of the student questions raised.

In sum, teachers began to move towards viewing learners as capable participants who need to be challenged. 'Challenging all learners' was a particular phrase we used quite often in our discussions, relating it to teachers tuning into students' views and needs – a phrase that teachers themselves adopted over time. They became more reflective about this, as evidenced in the following debriefing excerpt where Abel felt that a lesson was too easy and had not engaged students. It demonstrates the teacher's awareness of the need for a new strategy next time.

> I realised I was wasting time – what I needed was to maybe improve on the questioning. (Abel)

6. Conclusions

The professional development programme presented here was designed to offer African teachers new opportunities for peer learning through sustained, reflective dialogue and supported classroom trialling, adapting the principles of effective CPD (c.f. our literature review) to a new context. It has been built and refined throughout our work with the teachers in previous project phases, and we have seen slow but continual change in practice. Teachers were ultimately able to teach interactive lessons, including a degree of improvisation to address challenges. In sum, the findings suggest that the approach used to build school-based professional development adapted to a developing country context can have an impact on practice and thinking.

We arrive at the following **guiding principles for in-school professional development** to support more interactive pedagogical thinking and practice in other, similar contexts:

- Reflective dialogue through post-lesson review and planning explicitly encourages a cycle of reflective practice and critical inquiry, and supports ongoing, deep change (Jaworski & Wood, 1999).
- Teachers are construed as professionals, capable of critiquing and developing their practice.
- The programme is practical and practice-focussed through immediate development of concrete teaching plans.
- Dialogue poses sensitive and structured challenges, focussing on students' learning needs, and raising expectations of their capabilities.
- Face-to-face opportunities support learning from and with mentors and colleagues.
- Concerns and constraints of teachers and the school environment are taken into account, offering appropriate and sustained development opportunities.

It took some time to establish this new form of CPD, and for the teacher participants to become comfortable with their roles, but after several iterations they became much more involved and saw the benefits of an interactive approach in their own development as teachers. The in-depth

process of critical reflection on practice during the post-lesson reviews corroborates Guskey's argument that when teachers see that an innovation works well in their classrooms, especially when they gain feedback or evidence for student involvement, learning and motivation, change in their attitudes and beliefs will follow (Guskey, 2002, pp. 387-388).

7. Follow-up and outlook

This study provided an account of a process of teacher change that is relevant to different educational contexts. As an outcome of the work described here, we created an OER for professional development.[vii] This multimedia resource[viii] supports interactive teaching and collaborative learning through using digital technology, OER and Open Source software – as appropriate for teachers' own purposes and settings. High quality video clips of mathematics and science teaching (similar to, and including, the clips referred to above) form a stimulus for discussion as teachers compare their own experiences, views and ideas. Critically, the videos show that the new practices depicted can be effective in the Zambian context, despite (cultural and practical) constraints. They are accompanied by: reference texts explaining the pedagogical principles and purposes; discussion, reflection and practical classroom activities; links to digital resources and other materials. They also include podcasts and quotes from the participating teachers about their experiences. Sessions cover various aspects of group work and questioning, whole class dialogue, Assessment for Learning, and inquiry-based learning. The resource builds on previous research and CPD materials devised in the UK and elsewhere, and on an established process for teacher-led discussion, trialling new ideas, peer observation and joint reflection (Hennessy, et al., 2010).

Our subsequent work (Phase 3, 2012) focussed on a trial with half of the teaching staff in one school (Chalimbana Basic), where we formalised and extended our programme initially to 12 teachers (Grades 4-6). Abel stepped into the leadership role, to facilitate the programme for his colleagues, and Agness assisted. The outcomes are detailed in a forthcoming publication. For the current school year (2013), all of the 40-strong staff at the school were reportedly keen to participate, and we extended a further revised version of the programme to the whole school.

We are aware that a barrier to sustainable and long-term building of interactive teaching communities is the potential for creating a dependence on (impermanent) external agents in terms of new ideas or resources, encouragement, and evaluation (Butler, et al., 2004). The most sustainable element that we aimed to embed was a culture of knowledge sharing and collaboration around effective pedagogy and technology use (by both teachers and students) that is enduring and to some extent replicating. Currently, two parallel teacher groups are facilitated by more expert colleagues, while we have gradually withdrawn our support.

Looking to the future, engagement at the teacher level remains pivotal, while top-down change is problematic. Sometimes new government materials (e.g. school curriculum/policy handbooks) are not even available at schools. Funding permitting, we hope to trial the materials in different school and tertiary education contexts. We aim to provide school-centred, college-based and distance learning forms of adaptable professional development, itself supported by new technology (offline or online).

*It has been a challenge and being amongst the first group in the project in Zambia –
I represent Zambia. I would say that I think the new style of teaching is the only
thing that you should do. If all the schools had the opportunity that we have, I think
we can better the country. (Brian)*

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i
       http://www.educ.cam.ac.uk/centres/cce/initiatives/projects/ictzambia/

ii
       The focus of this paper is on the CPD aspects of our programme, rather than on infrastructure and ICTs (covered in more depth in a forthcoming technical report).

iii
       A clip from this lesson showing a teacher talking through a ratio exercise on the tablets using the Visual Mapping tool is available here: http://sms.cam.ac.uk/media/1165259.

iv
       http://orbit.educ.cam.ac.uk/wiki/Video/Eness_Vertebrates

v
       http://orbit.educ.cam.ac.uk/wiki/Video/New_Abel_Clip_4.m4v

vi
       http://orbit.educ.cam.ac.uk/wiki/Video/Geogebra-group-interaction.m4v. More clips from the lesson (http://orbit.educ.cam.ac.uk/wiki/Video/Abel_rectangles) provide additional context.

vii
       http://www.oer4schools.org

viii
       Note that schools without internet access (or electricity) can use an offline (or print) version of the resource, although a media player is needed for playing the videos. A solar-powered technology solution is an option.