

Learning Design for Multiple Modes of Provision: The Zambian Community School Teacher Development Programme

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Abstract

The use of technology to support learning is ubiquitous. However, technology is more often used to distribute information rather than as a tool to mediate learning. The work presented here on a programme for Zambian community school teachers (non-traditional students) illustrates how learning designs allied to appropriate theoretical concepts make use of technology to mediate learning. The objective of this course was to support Zambian community teachers, with little formal teacher education, to use interactive methods to support their teaching practices. The research makes use of a Constructivist-Hermeneutic-Interpretivist-Qualitative Paradigm to critically evaluate the learning designs by experts. However, it is necessary to first describe social constructivist theoretical frameworks for learning design and technology mediation that were used to create and evaluate the learning resources. The work presented here illustrates how a distance education paper-based course design is enhanced by the use of contemporary learning theory and digital technology models good classroom practice and the use of interactive methods.

Keywords: learning design; technology; mediation

Introduction

The work reported here is about the creation of learning materials that make use of video to support the professional development of Zambian community teachers. Much of Zambian primary and secondary school education is dependent on community supported teaching by unqualified teachers. The objective of the project was to model good teaching practice to support the professional development of community teachers with little supervision and we suggest that the most appropriate way to model good teaching practices is through the use of contemporary learning designs that include the use of videos as part of learning activities. First we explore a theoretical framework to

support the design of the learning materials. This framework is allied to Cultural Historical Activity Theory (Bozalek et al., 2014; Engeström, 1999; Leont'ev, 1978; Vygotsky, 1933). Thereafter new use the framework to create and evaluate the learning resources. The design and evaluation of technology, based on concepts of tool mediation (Kaptelinin, 1996, 2005; Nardi, 2005; Wertsch, 2007) are then presented.

Theoretical framework: Teacher student relationships and use of technology

Fig 1

Bates (2005) argues that there are significant differences associated with the concepts of open learning, flexible learning and distance learning. Open learning is primarily about access to learning (removing unnecessary barriers to learning such as the need for prior qualification); it is flexible, scalable and makes use of technology that is available to everyone. Distance education allows students to study anywhere and at any time and requires technology (for example, printed learning materials, radio, video, and internet access). Flexible learning is designed to support students in different geographical areas, social environments and with time constraints. Flexible learning might include face-to-face and/or distance learning methods. Aligning these concepts to those of e-learning, blended learning and distributed learning results in a continuum of technology-based learning. This could be described in terms of the geographical distribution of students and the use of technology (from no digital support to fully online) (Fig. 1).

However, the geographical distribution of teachers and students, and the use of technology, do not speak to learning designs that are affected by a number of factors including ontology (ways of understanding reality and how things work) and epistemology (the origin, nature, and limits of human knowledge) (Hodgkinson-

Williams, 2006), teaching ideology (instructivism versus constructivism) (Amory, 2007), and concepts of learning (Hinostroza, Labbé, Brun, & Matamala, 2011).

Theoretical framework: Instruction versus mediation

Teachers who integrate technology in a passive and teacher-centred manner replicate the traditional instructivist approach (Dutton, Cheong & Park, 2004; Blin & Munro, 2008), focus on technical issues (Dutton et al, 2004), emphasise remediation ICT and drill-and-practice applications (Smeets, 2005), and believe that information is more important than the learning process (Paulsen, 2003). This can be described as a learning teaching pedagogy *from* technology approach (Jonassen & Reeves, 1996).

Noor-Ul-Amin (2013) posited that while educational technology has fundamentally changed processes and practices associated with business and government, only small changes are apparent in education, mainly related to supporting a more student-centred learning setting. The works of educational theorists and practitioners of the past century (including Dewey, Piaget, Vygotsky, Bruner, Freire, Papert, Resnick, Seely Brown and Lave) all argue that the learner must be an active agent in the process of learning (Laurillard, 2012). Achievement of learning outcomes appears to be dependent on social interactions (Noor-Ul-Amin, 2013; Kožuh et al., 2015) and collaboration between students and between teachers and students (Báez, Hennig, & Segovia, 2013; Gu, Chen, Zhu, & Lin, 2015). Recent social network analysis research shows that participation in learning communities improves academic performance (Gašević, Zouaq, & Janzen, 2013; Rizzuto, LeDoux, & Hatala, 2009), persistence (Thomas, 2000), retention (Eckles & Stradley, 2012) and creativity (Dawson, Tan, & McWilliam, 2011; Perry-Smith & Shalley, 2003). Pittman and Gaines (2015) argue that the use of sociocultural learning theories allied to the appropriate integration of educational technology can support learning. For example, a

constructivist problem-based learning approach supports the development of socially connected groups of students (Baturay & Bay, 2010) and develops learner autonomy and motivation (Barber, King & Buchanan, 2015). Situated learning environments that include authentic contexts, activities, expert performances and integrated assessment improve student performance (Pérez-Sanagustín, Muñoz-Merino, Alario-Hoyos, Soldani, & Kloos, 2015). Therefore, constructivist approaches to the use of educational technology in teaching and learning emphasise the use of technology as a cognitive, or “mindtool” (Jonassen, 1994). This could be referred to as a learning *with* technology approach (Jonassen & Reeves, 1996).

However, technology can also act as a tool to mediate knowledge construction: a social constructivist view. Vygotsky (1933) described tools from two perspectives: the physical tools (such as pencils and technological artefacts), and the psychological signs and symbols (especially language). Tools are oriented to material activity, while signs and symbols are part of social and intrapersonal interaction used to solve problems (that is, part of higher cognitive functions). But, dependent on the context, a material tool can function as a tool, a sign or both. All tools can therefore be seen as both material and conceptual: they are parts of our world and shaped by human activity (Cole, 1998).

Fig 2

Therefore, depending on ideological positions, technological tools can be used in different ways in teaching and learning. Technological tools can be used for instruction (learning from technology), or as a mindtool to support either cognition or to mediate individual transformation (learning with technology) (Fig. 2).

Theoretical framework: Outcomes

Fig 3

The geographical distribution of students and teachers, and the ways in which educational technology is used, also does not fully describe learning outcomes. Therefore, to evaluate the impact, if any, of the use of ICT in teaching and learning designs, it is necessary to include a dependant variable. Bloom's taxonomy, developed in the 1950's, includes categorised cognitive skills and objectives from lower- to higher order. This was revised by Anderson et al., (2001) to use categories for forms of thinking with associated key verbs: Remembering (recognising, listing, describing, identifying, retrieving, naming, locating, finding), Understanding (interpreting, summarising, inferring, paraphrasing, classifying, comparing, explaining, exemplifying), Applying (implementing, carrying out, using, executing), Analysing (comparing, organising, deconstructing, attributing, outlining, finding, structuring, integrating), Evaluating (checking, hypothesising, critiquing, experimenting, judging, testing, detecting, monitoring) and Creating (designing, constructing, planning, producing, inventing, devising, making) (Fig. 3).

The four vectors (Geographical disposition, use of technology, use of technology in education, and Bloom's modified taxonomy) comprise a conceptual framework, which is incomplete, as it does not describe ways learning activities might be conceived or created

Theoretical framework: Authentic learning tasks

Amory (2014) argued that authentic learning tasks (Brown, Collins, & Duguid, 1989; Reeves, Herrington, & Oliver, 2004; Herrington, Reeves, & Oliver, 2014; Smeets, 2005) is an appropriate design approach to support effective learning. Authentic tasks are based on concepts of situated cognitive apprenticeships, problem solving and collaboration (Brown et al., 1989), the use of complex problems in authentic environments (Means & Olson, 1994) and situated cognition (Brown et al., 1989). A

more abstract description of authentic learning is Herrington et al. (2009) than the original formulation by Reeves et al. (2004) who posited that authentic learning tasks have real-world relevance, are ill-defined and complex, provide opportunities to examine from different perspectives, provide opportunity for collaboration, provide opportunity for reflection, are integrated across different subject areas, are integrated with assessment, yield polished products and allow for competing solutions and outcomes.

Research design

Reeves & Hedberg (2003) suggest that Constructivist-Hermeneutic Interpretivist- Qualitative research approach is a paradigm that does not make use of quantitative methods to evaluate of teaching and learning. Furthermore, we subscribe to this paradigm as it aligns closely to our theoretical frameworks that supports the notion that human knowledge is collectively and individually construct. This research is concerned with an analysis of the curriculum (hermeneutic), the analyses undertaken are context specific (interpretivists) and make use of expert qualitative methods of analysis.

The developed framework was used to design four modules to support the professional development of Zambian community teachers. Each module included five weeks of work with a varying number of learning activities per week. The development of the four modules is described. Thereafter, selected module activities are evaluated using an instrument based on the framework in order to highlight the learning design and associated interactions. However, as these learning activities make use of a number of artefacts, including videos, Zambian curriculum documents, worksheets and African Storybooks (www.africanstorybook.org), it was necessary to provide a technical solution (an Android app) to integrate the learning designs and digital assets. The development of this app is documented and thereafter evaluated using a heuristic based

on (Kaptelinin, 2015) analysis of mediation related to human computer interaction research.

Use of the framework to design and evaluate teacher professional development modules

Many national education frameworks in sub-Saharan Africa, including the Zambian National Curriculum Framework (2013), emphasise classroom pedagogy as a way of improving the quality of education and highlight the importance of learners being actively involved in the learning process. O’Sullivan (2010) and Stutchbury and Woodward (2017) state that teacher education courses (both pre-service and in-service) are often not fit for purpose: they are too long, they do not model participatory pedagogy, are highly theoretical, and fail to address important questions about the ‘how’ of learner-centred education in a particular cultural context. New models of teacher education are required, which operate at scale, are consistent with policy aspirations and reflect current social trends, such as available and affordable mobile technologies.

This section presents an overview and evaluation a school-based CPD interactive methods course for Zambian Community School teachers. The course makes use of video for two purposes, first, authentic, locally made videos provide teachers with contextually relevant examples of interactive learning and teaching methods using the language of instruction in community schools. Second, the teachers participating in the course are encouraged to take videos of each other adapting and implementing the learning activities seen in the videos, with their own classes (mediation). These videos are then watched and discussed in the school-based study groups, providing an opportunity for reflection on what worked well and what may still need to be

strengthened.

The use of tablets with a purpose-designed app (iAct) used to implement the course is also examined. To ensure access in rural areas, the course activities and videos were copied onto secure digital memory cards (SD cards) allowing the course to be accessed off line. Where necessary, schools were provided with small solar generators to charge the tablets.

Course design

Key principles that inform the course design include:

- School-based CPD implemented as supported independent study using a digital format on a tablet with a purpose-designed course application to deliver the course.
- Learning design for multiple modes of provision – the course is made available on a tablet for each school-based study group (comprising between 2-5 teachers). Additionally, each teacher is provided with a print-based copy of the course – the study guide. The tablet is used for watching the videos and for individual teachers to complete the weekly key learning points self-assessment test, but for ease of access to activities, readings and templates each teacher has their own study guide.
- An activity-based approach – teachers learn by doing authentic tasks.
- Collaborative learning – teachers work through the course together in school-based study groups (peer learning).
- New methods are modelled - interactive and collaborative learning and teaching methods are modelled in authentic videos made in Zambian community schools.

- The course is designed around a routine weekly learning strategy that includes a teaching challenge, reflection on their own context and experience, video or challenge, authentic task, implementation of this activity in the classroom, reflection and discussion of practice, and consolidation of key learning points.
- Reflective practice is promoted throughout the course – teachers discuss and evaluate the video content and own activities to learn from the implementation process.
- Locally found natural and commercial waste materials are used to make teaching resources.
- Key learning points are consolidated in the individual weekly self-assessment test.
- Teacher agency is promoted by encouraging teachers to take responsibility for their own professional development and encouraging communities of practice.
- Limited external support for the course implementation is to be provided by the Zambian Ministry of General Education Zonal In-Service Coordinators and trainers from partner NGOs.

The course materials

The course materials comprise the videos, cases studies, short readings and extracts from the Zambian 2013 Curriculum and Syllabus for various subjects. A selection of African stories from the African Storybook project are all available as OER. These are also included in iAct in English and in various Zambian local languages for use in language and literacy lessons. Additionally, exemplar activity plans, activity plan templates and guidelines on how to make various teaching aids from locally found resources are also provided.

Course implementation

The 60-notional learning hour course is designed to be implemented over twenty weeks, with teachers expected to spend about three hours per week working collaboratively on the course activities.

The initial phase of the course has been implemented in close collaboration with the Ministry of General Education with the District Resource Centre Coordinators from 18 educational Districts and 19 Zonal In-Service Coordinators trained to support the teachers. During 2017, the course has been implemented in 448 Community Schools across three provinces in Zambia. To date, 1,390 teachers have registered for the course.

Evaluation of two sample activities

Activity 1: Language activity for multi-grade and learners with different reading abilities

The language activity for multi-grade and learners with different reading abilities requires teachers to plan and implement reading and writing activities based on a storybook in a multi-grade or multi-level large classroom. Looked at from one perspective, the pedagogical approach for the CPD embedded in this activity is instructivist. It describes 'model' reading/writing whole class and group activities based on the African Storybook *I Enjoy Doing* (a bilingual English/Chinyanja storybook that gives simple sentences accompanied by pictures of what a child enjoys doing). The instruction also includes how to prepare for each of the activities. The entire process is then modelled in a series of videos – a Zambian teacher demonstrating and talking through the presentation as well as the implementation. The introductory whole class activity shows the teacher reading and discussing the story together, eliciting from the

learners what they enjoy doing using local language for the Grade 1s, but asking for English sentences for Grades 2 and 3 learners.

In the group activities, Grade 1's draw pictures and try to write a word that describes the picture they have drawn; one group of Grade 2/3 learners find letters (cut out from magazines or newspapers) to build words and sentences that go with pictures; a second group cuts up storybooks, and the learners work to match pictures and words; learners in the third group select pictures of activities and write sentences to go with them. The results of the activity are also presented – learners reporting back on their work, the teacher engaging with it, and reinforcing the learning through their different activities. Through instruction and demonstration, in-service teachers are shown how to design and mediate a set of differentiated activities for learners using English as well as the local language, Chinyanja.

What is being demonstrated or modelled is highly mediative teaching. In terms of the criteria, the learning activities provide opportunities for the full range from remembering to creating on Bloom's taxonomy. Learner discussions about what they enjoy, the pictures they draw, and sentences they write constitute complex authentic tasks in which they engage collaboratively. The learners come up with different answers/artefacts (competing solutions), have an opportunity to discuss and reflect on their work in their groups and as a whole class, and demonstrate their work (polished products) in front of the class.

But what about the teacher participants? Are they being asked simply to copy someone else's lessons that have been described and demonstrated to them through video? Is there not a mismatch between the method they are asked to adopt and the way they themselves are encouraged to teach?

Examination of the text of the set of activities for the teacher participants reveals the following. At the beginning of the set of activities, teachers are asked to reflect in their study group on their own experience of multi-grade or multi-level classrooms. This sharing of experience will colour their viewing of the demonstrated lesson, and prepare them either to be more critical or more critically appreciative. When they are asked to watch the video, questions in the module make them focus not only on the steps in the lesson, but the purpose of the activities, and the underlying strategies they represent. This assists the teachers to generalise beyond this specific instance and prepares them to adapt the set of activities or create and implement new activities in their own classrooms. In other words, a model lesson is there simply to scaffold the core task of practising teachers. This core task – adapting someone else’s approach based on an understanding of generalizable strategies - is a key teaching skill. As such, it is an authentic learning activity in a CPD course. It has real world relevance, and is ill-defined and complex.

But the activity goes further. Teachers are required not only to implement their version of the activity, but to video-record and discuss the lesson of one of their own group members. The module helps by giving some of the language teachers might use when they watch and reflect on the video, viz the notion of code-switching and ways of thinking through when to use same ability and when to use mixed ability groups. In this culminating reflective activity, teachers in their groups are asked to discuss the purpose of the activities they have viewed in the video, whether the purpose was achieved, whether there were any surprises, what the challenges were, and what improvements the group can suggest.

Activity 2: Activities related to the topic: Fruits and Seeds, Grade 7, Integrated Science

The focus of this second analysis is a set of video-based activities that promote learning through observation and investigation using resources from the local environment. The first video shows the teacher planning and sequencing learning activities and thinking about the necessary resources. The second video shows how the teacher starts the lesson by recapping what was covered in the previous lesson. He asks the learners questions about the reproductive organs of a flower using a diagram of the cross section of the flower which he has prepared. Although it is the dry season and there are very few flowers around, he managed to find some hibiscus blossoms in the river bed. In class, the learners pass the flowers around and observe the reproductive organs. This activity serves both to recap the “parts of the flower” as well as helping to introduce the topic of fruits and seeds.

In the third video, the teacher asks a number of questions to elicit learners’ existing knowledge of propagation and dispersal. Sitting in groups, the learners are given some fruit, which the teacher has bought at the local market: paw-paws, tomatoes, avocados and oranges. The learners cut them open and observe the seeds inside each type of fruit. The teacher guides the learners to observe the size, colour, number and location of the seeds in each fruit type. After discussing the seeds contained in the fruits, he asks the learners whether they know of any other places where seeds can be found in the natural environment. This leads to the learners talking about seed pods hanging from the trees in the school yard and about grass seeds. In the fourth video, the teacher encourages the learners to go outside to collect as many different kinds of seeds as they can find around the school. Once back in the class, he asks the learners to sort the seeds according to type, to count how many types they have found, to describe what each type

looks like, and where it was located on the plant or tree (in a pod, or at the tip of the branch). He encourages discussion on the location of these seeds as well as on the concepts of propagation and dispersal. In the last video, he asks learners to select one seed, observe it carefully and make a large drawing of it. The lesson ends with a discussion of the key learning points.

The purpose of this series of videos is to model how various interactive teaching methods (probing questioning techniques, observation and simple investigations) can be used to get learners to explore natural phenomena and to construct their own knowledge. The series exemplifies the use of resources, which can be found in the local environment to make interactive learning “do-able” in a resource-constrained context.

The teachers are constantly guided by questions to reflect on the teaching practice and activities, which they are observing in the videos. In the school-based study-groups, they discuss the activities exemplified in the videos and to relate these back to their own experience and practice.

The culminating authentic activity is for the teachers to work collaboratively to plan, prepare and implement a similar observation and investigation lesson for their own classes aligned with the requirements of the Zambian Integrated Sciences syllabus. As in the language activity described above, one teacher’s lesson is videoed. The group then meets to view the video and discuss what worked well, and what aspects of the lesson could be strengthened. The video is being used as a tool that enables teachers to reflect on their own practice.

Evaluation of the two activities

Fig 4

The overall course design (Fig. 4) allows participating teachers to study in the schools where they work (off campus). The course is digital but does not require connectivity and makes use of a human component through study groups (blended). It is mediative, with instructivism used for demonstration, not for application. In terms of Bloom's Taxonomy, teachers apply the methods they have seen demonstrated to create their own lessons in their own classrooms. There are a range of multiple choice and study group activities that require understanding and evaluation. The culminating activity (designing and implementing their own lesson – the core task of teachers) is authentic, ill-defined, and complex. In addition, however, they have the support of their colleagues in planning and evaluating, and engage in video-based reflection on each other's work. The pedagogic approach can therefore be summarised as blended, mediative, with authentic learning tasks using the full range of cognitive skills described in Bloom's taxonomy, as well as considerable collaboration and reflection.

Mobile iAct app design and evaluation

One of the earlier theoretical approaches that supported human computer interface design were those of information process psychology (Card, Newell, & Moran, 1983). However, more contemporary approaches posit that social cultural development approaches, that are part of activity theory (Engeström, 1999; Leont'ev, 1978; Vygotsky, 1933), are better aligned to the ways in which people interact with technology (Kaptelinin, 1996). In particular, two components of activity theory, the object of the activity and tool mediation, are of great importance in the design of technological artefacts (Kaptelinin, 1996, 2005; Nardi, 2005; Wertsch, 2007). In addition, the use of design patterns (Gamma, Helm, Johnson, & Vlissides, 1995) support software developers to solve complex problems and users to more easily learn how to navigate and use software.

The object of activity is understood from two perspectives, either as an object of desire or as an imagined outcome (Nardi, 2005). Technological interfaces should be designed to support imagined outcomes with integrated activities and actions that lead to any number of outcomes. But, each interface component should include a single activity that may result to many outcomes (Amory, 2017).

With respect to mediation, Kaptelinin (2015) identified a number of ways in which interface design should support tool mediation

Kaptelinin (2015) explained technology supported mediation as follows:

- *Me versus the world* – for example, tracker bracelets are designed to form a part, an *extension*, of the individual (“personal technologies”). TV sets are *external objects* “out there in the world”, with which we interact.
- *Coupling between different means* – some activity trackers are designed so that they can be *used independently* from other devices, while other models can only be *used in combination* with a smartphone.
- *Versatility* – a vending machine can be used for one *single purpose* while others, for example, word processors, can be used for a *variety of purposes*.
- *Diversity* – the subject of activity mediated *narrowly defined skill* requirements or is designed to support a *broad range of subjects*
- *Collaboration* – mediation either supports individual or collective activities.
- *Impact* – impact of mediation on actors can either be *short-term*, such as helping to achieve an immediate goal, or *long-term*, such as intentional or unintentional transformation of an individual.
- *Types of objects of interest* – activities orientated to different types of objects of interest.

- *Structure of activity* – activities that take place at several levels mediated by different means.
- *Appropriation* – the status of the same technology as a mediational means depends on whether or not the technology in question is appropriated by its user.
- *Remediation* – new technologies typically substitute existing mediational means, and the adoption of new technologies causes re-mediation – *re-mediation* can be associated with a significant *disruption*.
- *Diversity* – some technologies can be used in the office (e.g. desktop computers) while others (e.g. smartphones) in dynamically changing contexts.

The primary reason for the development of an Android app was to provide a means to integrate video and other text assets into activities. The course includes four modules, each lasting five weeks. Any number of activities are part of the work for each week. Therefore, the app needed to reflect this structure. In addition, as an individual self-test is part of the activities of each week and as the tablet is shared among participants, it was necessary to include a registration process.

Fig 5

Therefore, the landing page of the app (Fig. 5a) included links to an introduction to the course, registration, access to the four modules and work associated with each of the five weeks, acknowledgements (as many resources are CC-BY), and access to a number of African Storybook titles that are used in some of the module activities. Registration required the name, password and identification of participants (Fig. 5b). The work for each week associated with each module is available on the landing page (Fig. 5c). Each week includes a number of activities and the weekly test; includes a progress indicator and allows the user to access the activities associated with any week of that module (Fig. 5d). To take a test the user is required to log in (Fig. 5e). A

progress indicator (number of tests taken) is also visible on the login screen. Each test includes five multiple choice questions that are randomised before display. On completion of the test the user is given their score and opportunity to re-take the test. This design pattern is repeated for each module and every activity looks and functions in a similar manner.

Fig 6

The design of the app was evaluated using the mediation criteria (Kaptelinin, 2015) (Fig. 6):

- While tablets are usually used by individuals (extension of themselves) this project makes use of one tablet shared among up to three participants (me versus the world).
- All the resources are available in the app and therefore can be used independently of any other resource.
- The tablet is used for different actions (interaction, viewing videos, reading stories and other text resources, taking photographs, and filming each other to evaluate their teaching practices).
- Activities are varied and make use of local indigenous materials.
- Groups of participants use a single tablet, which support collaboration.
- With the practice sessions and self- and group-activities, the app should support the long-term transformation of teaching practices.
- Activates range from easy to complex. The complexity of activities increases from the first to the last activity.
- The app is integral to the design of this intervention that should allow the user to appropriate the tablet, not only for their own teacher development, but for other activities.

- It is interesting to note that the app and the learning materials have been reviewed by the Zambian government for adoption throughout the country. This illustrates that well-designed learning activities integrated with technology have the ability to disrupt conventional practices.
- The design of the intervention illustrates that the app can be used in low-bandwidth environments to support individual transformation of their teaching practices.

Discussion

The primary objective of the project reported here was to provide Zambian community teachers with exemplary learning designs that make use of a number of integrated artefacts to mediate learning in order to improve classroom practices. In addition, an Android app was developed to seamlessly integrate videos, Zambian curriculum documents, worksheets and African Storybooks into the learning design. The research presented here posits that good learning design needs to take cognisance of the context of the learning, role of educational technology in learning and an understanding of the learning outcomes. Consequently, a framework for contemporary learning design was developed to guide course development and as an evaluation heuristic of the learning resources. Technology was used primarily to integrate video and other assets in a way that supported the concept of learning *with*, rather than *from*, technology through the use of tool mediation. The HCI mediation criteria (Kaptelinin, 2015) were used both in the design and evaluation of the app.

The framework developed includes a number of components, including the geographical distribution of students (on-campus versus off-campus), access to technology (off-line versus fully online), the use of technology (instructivist versus

mediative) and Bloom's modified taxonomy (remember to create). The principles of authentic learning (Reeves et al., 2004) supported the design of the learning activities.

The Zambian National Curriculum Development Centre has evaluated the course and given its stamp of approval for further roll out. As of January 2018, the course will be implemented in an additional 1,500 community schools reaching approximately 4000 teachers. The course has also been made available to all Teacher Resource Centres nationally. A Teacher Resource Centre's primary function is to support the development and roll out of quality CPD for serving teachers.

In addition, the evaluation of a sample activity yielded an interesting observation about the use of multilingual teachers' familiar languages as a mediating tool through video and group discussion. The unique advantage of the use of video in the design of learning activities, is that while the demonstration in the video makes use of one of the local languages, the professional development activities related to the video are in English. This has two advantages. The first is that implementation of the suggested activities by the teachers in their own classrooms is easier – the activities do not have to be translated back into the language the learners speak before being usable. The second is that new and possibly strange teaching methods are presented in a familiar language (and setting) and potentially increases uptake in the teachers' own classrooms.

Furthermore, the fact that the teachers are grouped around a single tablet and work collaboratively on the activities means that they are free to use all the language resources at their disposal to understand not only the local language video lesson and the English text of the activities, but also each other's insights and experiences.

The design and evaluation of the learning materials and associated app clearly indicate the importance of Vygotsky's tool mediation. The co-constructed inter-subjective interactions between actor (community teacher), object (learning activity)

and mediator (learning and app design) allows the differentiation of three kinds of constructs as the physical object evolves to sign (Yamamoto, 2012). In the first pre-interaction level, the actor uses a physical tool as an extension of their own body for only themselves. No other person plays a role in this action but others can recognize the functions of the tool. In this form the tool is not a mediator. The second kind of interaction is when two actors “interact with a physical object as mediators.” (p. 427) (community teachers working and learning together). Lastly, the third type is the interaction between actors via sign and language. In this instance, there is no physical object acting as mediator but the semiotic sign of the tool becomes the powerful mediator of culture and development. But there are other ways in which tool mediation could be explained, for example, Wertsch (2007) wrote about explicit and implicit mediation.

The purposeful introduction of objects that are obvious and non-transitory into an activity to stimulate the activity is explicit mediation. Here the use of the app, and the embedded assets (especially video) are used as explicit mediators. The use of language, as sign, (implicit mediation) played a very important part on the design of this intervention. Therefore, whether mediation operates through direct intervention, or through language and signs, individual transformation, by necessity, includes both explicit (tools and signs operating on other minds) and implicit (internal tools and signs actions) operating modes of mediation.

For Vygotsky the core of mediation is language. In a multilingual African context, teaching has typically been instructivist, without opportunities for students to use their own linguistic resources for meaning making. This work illustrates how to create opportunities for learning together using all available language resources.

However, these analyses of mediated learning design need a further phase: a study of

how the teachers supported by the app and embedded assets in turn mediate the development of teaching practices for each other and for themselves in their own classrooms.

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Figure captions

Figure 1. The relationship between the distribution of teachers and students and the use of technology in the classroom.

Figure 2. Ways in which ICT can be used in the classroom.

Figure 3. Bloom's modified taxonomy.

Figure 4. Two examples of the use of the framework to design learning activities.

Figure 5. Components of the app user interface (a. Landing page, b. Registration, c. Modules and associated week activities, d. Example of module activity and relationship to other activities and associated weeks, e. Login screen to access test questions, f. Example of a single multiple choice question).

Figure 6. Evaluation of the mediative functions of the app.