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# Teachers become cocreators through participation in a teacher professional development (TPD) course in a resource constraint environment in South Africa

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## Abstract

The purpose of this paper is to provide insight into how teachers became cocreators by merging their existing knowledge of their subject, context, and new knowledge of using mobile tablets towards enhancing their teaching practices. This was achieved in a specific area in the Eastern Cape Province of South Africa over a period of 3 years. The intentional situating of teachers as cocreators was implementation through a teacher professional development (TPD) course. The course consisted of 10 modules presented and completed over a 1-year period. The TPD course was developed as an artefact using Design Science as a methodology with 3 iterations of implementation to refine it. The development of the course and its iterative implementation and refinement was grounded in the Living Lab open innovation approach with elements of gamification (coopetition), and various stakeholders were incorporated. Structuration theory was applied to indicate the "duality of structure" where structure and agency are related and dependent on each other and agents' actions produce, reproduce, and develop social structures. Technology endowments were integrated as part of the gamification and were dependent on predefined cocreation events. Each event was linked to a badge, and teachers had to provide practice-based evidence of how new knowledge, proficiencies, and skills gained during the TPD sessions was adapted to their own subject and context knowledge and practically implemented in their classrooms. This presents an innovative way to introduce and use tablets in teaching and learning (structure) as teachers (agents) are acknowledged as domain and subject experts, and through exposure to technology and pedagogical strategies in using the technology (resources), they become cocreators of their own new enhanced classroom practice (social structures) and adopted the technology.

**KEYWORDS**

cocreation, innovation, resource constrained, teacher professional development

## 1 | INTRODUCTION

Teacher professional development (TPD) is not frequently associated with the terms cocreation and innovation. These concepts are more related to the process of innovation where the feedback of the user is regarded as significant to provide an improved product, service, process, business models, or policies in an existing context or adapting them from one context to another to achieve desired impact. However, in a recent TPD course that was developed for teachers in a rural context, strong evidence of cocreation, innovation, and an observed enhancement in classroom practice was evident. In this course, teachers were exposed to the use of mobile tablets to support their teaching and learning.

Technology and in this instance mobile tablets are often regarded as the magic wand needed to facilitate technology-enhanced, student-centred teaching environments (Hermans, Tondeur, van Braak, & Valcke, 2008). Hardman (2005) also indicates that Information and Communications Technology (IC) have the ability to act as a catalyst to transform pedagogical practices in classrooms. However, many ICT for education initiatives in South Africa and the rest of the developing world have resulted in failure (Bytheway, Cox, Dumas, & van Zyl, 2012; Ford & Botha, 2010; Were, Rubagiza, & Sutherland, 2011). Teachers in rural areas are willing to use technology to support teaching and learning, but lack pedagogical

and technological knowledge towards integrating it into their teaching activities (Bytheway et al., 2012; Ford & Botha, 2010; Were et al., 2011). They are exposed to training of how to use a device but not how to integrate, internalize, and apply that knowledge in their classroom, often resulting in them avoiding using the technology, and this can result in a resistance to change (technology acceptance model, TAM). In those cases where ICT initiatives in schools do include some kind of training component, the focus might be on computer literacy, rather than how to use the technology as a tool for teaching and learning (Were et al., 2011).

The purpose of this paper is to provide insight into how teachers became cocreators of enhanced practice by integrating new knowledge and skills of using mobile tablet technology to their own expertise towards enriching their teaching practices in a resource-constrained setting in South Africa. This was operationalized through the implementation of a specifically developed TPD course. This course went through 3 iterations of development and refinement towards value of evident cocreation by applying the Design Science research (DSR) process of Peffers et al. (2006).

The research question in this paper is: How can teachers become cocreators and agents of changing structure, through their participation in a TPD course, which made use of mobile tablets to support their teaching and learning in a resource-constrained environment in South Africa?

## 2 | THEORETICAL UNDERPINNING

This notion of training teachers to apply their knowledge and integrate technology to support their teaching is closely related to the structuration theory of Giddens (1984) as both agency (teachers) and structure (established ways of teaching) are addressed in a powerful way to understand the social element. Giddens's theory of structuration notes that social life is more than random individual acts, it is not *merely* a mass of "micro"-level activity, and you cannot study it by only looking for "macro"-level explanations. Instead, Giddens suggests, human agency and social structure are in a relationship with each other, and it is the repetition of the acts of individual agents that reproduces the structure. This means that there is a social structure such as traditions, institutions, moral codes, and established ways of doing things; and it also means that these can be changed when people start to ignore them, replace them, or reproduce them differently (Gauntlett, 2008). For teachers who are trained to use technology, this implies that they, as individuals, produce and adapt their own structure in the school to have actions that reinforce and reproduce a set of expectations—and it is this set of other people's expectations that makes up the "social forces" and "social structures" that sociologists talk about. As Giddens puts it, "[s]ociety only has form, and that form only has effects on people, in so far as structure is produced and reproduced in what people do" (Giddens & Pierson, 1998, p. 77). Thus, as teacher's professional practice improves, it has an effect on them. The teachers, through cocreation, enhance their classroom practice with digital technology and appropriate pedagogy, thus influencing their own structure. This will be highlighted again in Section 8 in this paper.

This paper is furthermore informed by 2 theoretical models. One is the TAM of Davis (1989), and the other is technological pedagogical content knowledge (TPACK) model (Koehler & Mishra, 2009).

Some studies on technology adoption have focused on an individual's characteristics (Davis, Bagozzi, & Warshaw, 1989; Hess, Joshi, & McNab, 2010; Venkatesh, Morris, Davis, & Davis, 2003), technology's characteristics (Davis, 1993; Venkatesh & Davis, 2000), and organizational characteristics (Davis, 1989), as the key factors that determine the acceptance of technologies. Visser, Van Biljon, and Herselman (2013) provided a summary of the most commonly used models to study technology adoption and use. Despite different foci, all the models are based on the same concept—individual end users of technology will have different reactions to using new technology depending on a variety of factors. One of the most popular models is TAM, which was proposed by Davis (1989). The TAM is an information systems theory that models how users come to accept and use a technology. Technology acceptance model is based on the belief that users accept or reject new technologies on the basis of the extent they believe it will help them perform their job better (perceived usefulness) and also on the degree to which they believe that the use of the technology will be free of effort (perceived ease of use). Technology acceptance model is composed of 5 constructs including external variables, perceived ease of use, perceived usefulness, attitude, and intention to use.

1. Perceived usefulness: This was defined by Davis (1989, p. 320) as "the degree to which a person believes that using a particular system would enhance his or her job performance."
2. Perceived ease of use: This was defined by Davis (1989, p. 320) as "the degree to which a person believes that using a particular system would be free from effort."

Perceived usefulness and ease of use of IT technology influence a user's attitude towards the technology and are influenced by external variables (eg, age or gender of user and specific characteristics of the user). Intention of use is also regarded as important for impact. The TAM has been continuously studied and expanded the 2 major upgrades being the TAM 2 (Venkatesh, 2000; Venkatesh & Davis, 2000) and the Unified Theory of Acceptance and Use of Technology (Venkatesh, Thong, & Xu, 2012). Technology acceptance model 3 has also been suggested (Venkatesh & Bala, 2008). For the purpose of this study, only perceived usefulness and ease of use will be the focus, and this will be discussed in Section 8 of this paper.

The TPACK model (Koehler & Mishra, 2009) extends the work of Shulman (1986) and extends his idea of pedagogical content knowledge to pedagogical knowledge, technological knowledge, and content knowledge. The TPACK model (Figure 1) considers technological, pedagogical, and content knowledge and combines them to construct pedagogical content knowledge, technological content knowledge, technological pedagogical knowledge, and finally, TPACK.
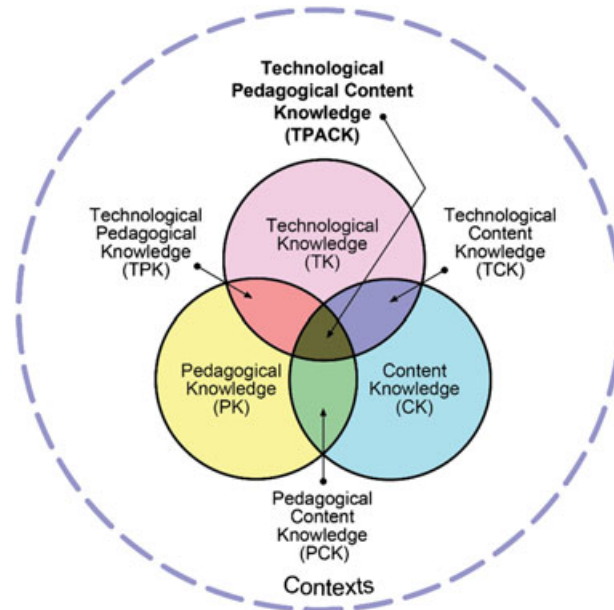
**FIGURE 1** The TPACK model (Koehler & Mishra, 2009). Reproduced by permission of the publisher, © 2012 by tpack.org

Of relevance to this paper is the 4 dimensions of the model that consider technology: the technological knowledge, technological content knowledge, technology pedagogical knowledge, and technology, pedagogy, and content knowledge dimensions. The technological knowledge dimension consists of knowledge about standard technologies (eg, books) in addition to more advanced technologies (eg, data loggers and interactive computer simulations). However, it also includes the skills needed to use particular technologies. On the other hand, the technological content knowledge dimension is aligned to technological knowledge and content knowledge and contains knowledge linked to the reciprocal relationship between content and technology. For example, science teachers need knowledge about not only the content to teach, but also how the content may be influenced by technology. Technology pedagogical knowledge includes knowledge regarding various technologies and their use in the classroom. The dimension includes knowledge regarding the existence of appropriate technology, their components, and their capabilities, in addition to how teaching may be influenced by the use of particular technologies. Finally, TPACK considers the teaching engagement with technology as a whole and is considered the basis of effective teaching using technology. Technological pedagogical content knowledge includes how technology may be used in teaching content in constructive ways, and it will be discussed and applied in this paper in Section 8.

## 3 | LITERATURE REVIEW ON COCREATION AND INNOVATION

Cocreation is a concept that normally refers to any type of user, in this instance teachers, participating in the ideation and further development of solutions. This *user* is thus viewed as a value creator instead of a source of knowledge (Salminen, Konsti-Laakso, Pallot, Trousse, & Senach, 2011). The assigned role of users in the research and development process has gradually evolved from lead user (Von Hippel, 1986, 2005) to user cocreation (Pallot, 2009; Pallot, Trousse, Senach, & Scapin, 2010; Prahalad & Ramaswamy, 2000; Ramaswamy & Gouillart, 2010; Sanders & Stappers, 2008). The more users are involved in this process, the greater the value created. The greater the value created, the higher the maturity level of the product or process. Cocreation is also a term that is often found when describing Living Labs (LLs).

The LL environment is used to create an innovation platform where academia, industry, researchers, government, and other stakeholders can cocreate new ideas and concepts that can support their teaching and learning, as well as improve their skills in a quest to address challenges (Callaghan & Herselman, 2015; De Arias et al., 2014; Guzmán, Fernández del Carpio, Colomo-Palacios, & Velasco de Diego, 2013). It is a concept that refers to a research and development methodology where innovations such as services, products, and application enhancements are created and validated in collaborative, multicontextual empirical real-world settings (Geerts, 2011). Also, it is seen as a new character in the open innovation chain.

Living Labs are thus environments where the aspect of *living* is closely looked at, especially where people/users are involved. Concepts also evident from various definitions of LL are open innovation ecosystems, territorial contexts, concurrent research, and innovation processes where users get to play an active role in the development of new services, products, or processes (Følstad, 2008). This closely links with social innovation where the participation of, and collaboration with relevant stakeholders, cross organizational boundaries (Bason, 2010; Sørensen & Torfing, 2011). This corresponds with the notion of "open innovation" (Von Hippel, 2005, 2007). Relevant stakeholders should be able to bring in their knowledge, information, skills, experiences, and resources. As a result, the produced outcomes of innovation processes are more relevant to them. It can also lead to coopetition where cooperation amongst competitors (like teachers teaching the same subjects) by applying game theory takes place (Brandenburger & Nalebuff, 1997).

Innovation processes require the ability and willingness of the relevant actors to cooperate and to link and share ideas, as well as to exchange vital resources (Von Hippel, 1986, 2005, 2007). However, this open innovation process is an embedded process, which takes place in a specific local and institutional context (Bekkers, Edelenbos, & Steijn, 2011). Recognizing the specific environment in which innovation processes take place is referred to by (Castells, 2011, p. 3) as *innovation milieus*. It can, thus, be argued that innovation processes should be studied from an ecological and context-specific perspective (Bason, 2010; Bekkers & Homburg, 2007; Osborne & Brown, 2011). This presupposes that these stakeholders, given their needs and experiences, are able to cocreate and produce innovations that really matter to them as coproducers of knowledge (Evans, Hills, & Orme, 2012) This can also be related to professional development.

According to Wells (2007), professional development is the way in which organizations deal with the introduction of innovations into their practices. Clarke and Hollingsworth (2002) state that TPD is consist of activities that enable teachers to improve their knowledge, skills, and strategies. Wang and Gu (2014, p. 41) view TPD as the attainment of practical knowledge. "Practical Knowledge is tacit, embedded in the teaching practice, and is concurrent with the individual's thoughts and behaviours." A more expansive outline of TPD is given by Grant (1997). He agrees on the practical nature of the endeavour and further implies that the process goes *beyond* training as an *acquisition* of skills to include the development of new insights into pedagogy and reflection by teachers on their teaching practice and thus changing the structure through applying resources (Giddens, 1984).

# 4 | BACKGROUND TO THE DEVELOPMENT OF THE TPD COURSE

The TPD course was one of the artefacts developed as part of the ICT for Rural Education Development (ICT4RED) initiative. This initiative was part of a large-scale Technology for Rural Education project. This project was initiated by the South African Department of Science and Technology in collaboration with the South African Department of Basic Education, the Eastern Cape Department of Education, and the South African Department of Rural Development and Land Reform. Technology for Rural Education focused on the improvement of rural education via technology-led innovation (Herselman & Botha, 2014; South African Department of Science and Technology, 2013).

The ICT4RED component was implemented by the CSIR, Meraka Institute, and mostly funded by the Department of Science and Technology. It extended to incorporate 26 deep rural schools in the *Nciba Circuit* of the *Cofimvaba School District* in the Eastern Cape Province of South Africa. The district has a population of 35 500, and the schools are scattered over hilly and mountainous terrain and connected by a network of gravel roads (Herselman & Botha, 2014). The ICT4RED initiative involved 270 teachers and 6500 learners. This area can be regarded as a resource-constrained context based on the definition of Anderson, Anderson, Borriello, and Kolko (2012). According to them, a resource-constrained context is an environment where there is low-income communities and low bandwidth. These environments provide unique constraints (eg, cultures) where people are unfamiliar with, or afraid of, technology and/or environments where power and network connectivity are scarce and expensive. In Cofimvaba, the average school size is only 204 learners per school, with an average learner-to-educator ratio of 24. About 72.7% are considered small or very small (less than 250 learners). According to the Eastern Cape EMIS profile of Cofimvaba District for 2015, about 91.6% of the schools in Cofimvaba are either quintile 1 or quintile 2 schools. Approximately 80% of schools have access to water (62% of these get water from a borehole or rainwater collection), and 80% have access to electricity; but fewer than 1% have access to flush toilets (Herselman & Botha, 2014).

The objectives of ICT4RED fall into 3 distinct categories: (i) objectives concerned with discovering the factors that determine implementation success in ICT in education programmes (specifically in rural settings); (ii) objectives concerned with improving the quality of teaching and learning; and (iii) objectives concerned with contributions to knowledge generation and policy formulation.

The implementation model for accomplishing these objectives, and tested through ICT4RED, was the deployment of tablets to learners, teachers, and district officials, in the 26 Nciba Circuit schools, accompanied by supporting programme activities to provide technology infrastructure and connectivity, e-textbooks and other electronic resources, teacher training and school change management, and IT support services.

# 5 | METHODOLOGY

Design Science research methodology (DSRM) was applied to develop the TPD course as a component of the ICT4RED initiative. In DSRM, one can develop ways of understanding and working with socio-technical systems and question existing structures and processes (Pirkkalainen, 2015). Design Science research relates to sustainable development as it similarly addresses wicked problems and measures alignment with innovation and creativity. The DSR process in addition allows for what Open Innovation 2.0 refers to as fail fast and scale fast (Salminen et al., 2011). Because of the iterative nature of the DSR process, an artefact, as solution or innovation, is emergent, and opportunities exist for it to evolve. The artefact as solution is continuously evaluated through successive iterations, adapted, and evolved through implementations and evaluations. The TPD course was thus developed as an artefact by applying the DSRM process of Peffers et al. (2006), and it evolved as it was evaluated and improved through 3 iterations or phases in the ICT4RED initiative.

The TPD course as an artefact was developed and implemented by researchers from Meraka, CSIR, who evaluated it through 3 phases in a resource-constrained environment (as discussed above) in the Eastern Cape province of South Africa. Gregor and Hevner (2013) indicate that evidence should be provided that the artefact is useful and the evidence should address criteria such as validity, utility, quality, and efficacy. A rigorous monitoring and evaluation of the TPD course was done to track impact and improve the artefact. The following diagram illustrates the DRSM process of Peffers et al. (2006) as it was applied to develop, evaluate, and improve the TPD course.

External consultants were brought in to supplement the skills, knowledge, and tools of the internal CSIR, Meraka team; for example, an ethnographer provided short-term support with detailed ethnographic descriptions, another organization assisted with transcriptions and data capturing. An organization, with an already developed school functionality instrument, was contracted to train the Meraka M&E team on the collection of the data and to support the reporting of the data.

The LL approach was applied to develop the TPD course as many stakeholders (with their own knowledge, information, skills, experiences, and resources) were involved. These included the provincial government, teachers as users and cocreators, and district officials, and the CSIR in South Africa as researchers and implementers. The TPD was thus refined and developed on the basis of feedback from teachers in every phase of the DSRM process (Figure 2 and 3). This innovative process of development, implementation, and evaluation to address the needs of the user (teachers) in their context or innovative milieu (Castells, 2011) in Cofimvaba, South Africa. The use of external consultants as well as stakeholders is supporting the research of Tremblay, Hevner, and Berndt (2010) as they have also made use of focus groups to refine and evaluate with the idea of improving their artefact, as Vaishnavi and Kuechler (2015) indicate the process in DSR involves frequent iterations between development and evaluation as evidence has to be collected that shows this artefact can solve real problems. Therefore, the utility and efficacy has to be evaluated as Tremblay et al. (2010) have done in a business environment.
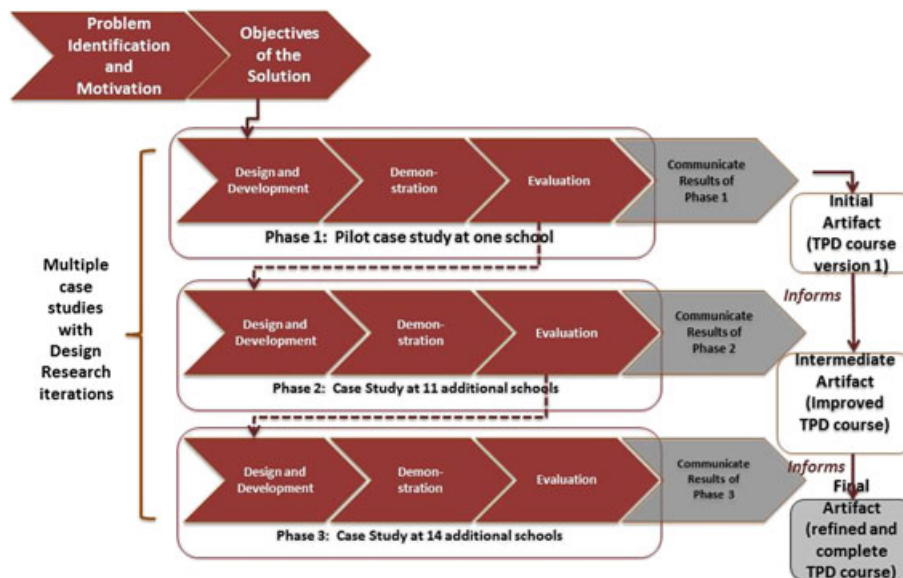
## 6 | TEACHER PROFESSIONAL DEVELOPMENT COURSE

The aim of the TPD course is to support and guide the development of relevant teacher knowledge and proficiency to enable rural classroom practice to portray a 21st century technology enhanced teaching and learning engagement.

The TPD course is intended for classroom practice to change to reflect more of "emerging pedagogy for the information age" (Voogt & Knezek, 2008) through the change in knowledge, beliefs, and attitudes of teachers towards the acquisition of new skills, new concepts, and new processes related to teaching practice (LL approach). The following were also regarded as important:
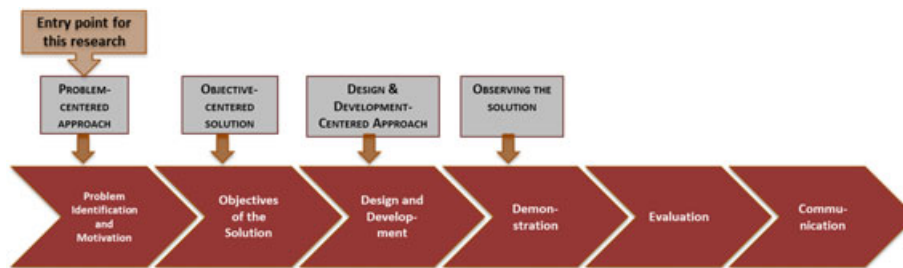


FIGURE 2 Design Science research methodology process of Peffers et al. (2006) as it was adopted to develop the teacher professional development artefact



FIGURE 3 Applying multiple case studies during specific areas of the Design Science research methodology process to refine and develop the teacher professional development (TPD) based on feedback and analysis of data collected

1. To *engender a positive attitude* of teachers towards the adoption and integration of technology is significant to its successful integration.

2. To *mitigate workshop fatigue* through *gamification* as a design strategy to provide a more joyful but focused engagement to create coopetition (Brandenburger & Nalebuff, 1997).

3. To *purposefully support* teachers through collegial, facilitator, and course material to translate integration of ICT.

4. To facilitate the *physical access* to and availability of appropriate technology to integrate into classroom practice. A strategy of *earn as you learn* was adopted, and teachers had to earn the eventual ownership of the technology through the attainment of intermin goals that were given as badges. On completion of all the compulsory badges, ownership of the tablet devices reverted to the individual teachers.

5. To *scaffold sessions* based on the gradual release of responsibility instruction framework (Pearson & Gallagher, 1983). This implies that there is a purposeful shift of cognitive load from the TPD as a facilitated simulation of practice in the training session, to cocreation, towards the independent practice and application by the teacher in their classroom.

6. Each of the 10 modules in the curriculum would be about relevant content, through a teaching strategy using technology to facilitate the teaching and learning interaction. For example, module 1 is about getting to know your tablet, through the jigsaw teaching strategy, using tablet technology. The modules was presented as a learning path (Figure 4) with badges that had to be earned.

In addition, teachers would be exposed to best practice in group work, different assessment strategies, concept of a reflective practitioner, and concepts regarding online learning and additional resources. Each teacher received a 3G enabled 15″ tablet that they could use (which they had to earn). After they had achieved the 13 compulsory badges, the tablet ownership was transferred to the teacher. In addition, teachers received specific technologies such as a cover, SD card, earphones, and a tablet pen as they progressed along the learning path. The ICT4RED TPD course was built in such a way that it could be run offline without having to connect to the internet. If a school provided enough evidence that 80% of the staff have successfully completed the first 5 modules, the school received a data projector and a mobile kit specifically designed to host 20 tablets in a bookcase with the chargers for learners to use. Provision was made for the availability of 1 device per class, 5 devices per class, and 1 to 1 device saturation. This meant that if teachers only have access to one device, they would still be able to integrate the technology into their classroom practice.

## 7 | HOW DID THE TPD COURSE WORK?

The guiding idea of the TPD is that teachers teach the way they are taught. As such, the course is presented by modelling best practice, through the presentation of 10 purposefully chosen teaching strategies in 10 modules. A social constructivist teaching premise was followed that implies teachers learn with and from each other. It is also here where the influence of teachers on each other played an important part to change the social structure as (Giddens, 1984) argue there is always some resources available to humans with which to act in ways that counteract or offset the effect of social pressure (Nyella & Mndeme, 2010).
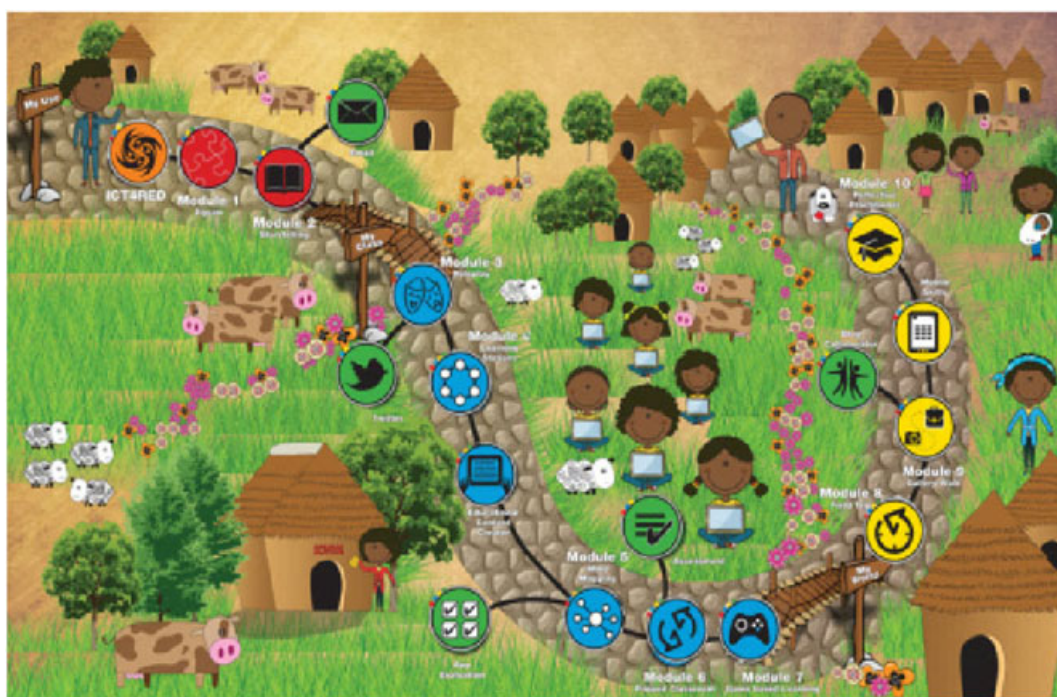


**FIGURE 4** Learning path with badges that had to be earned

The TPD course is presented as a learning path where the teacher moves from a commitment (module 1), to using the tablet for their own personal use (modules 2 and 3), to use for teaching and learning (modules 4 to 7), to use for collaborating and sharing (modules 8 to 10) (Botha, 2014). The learning narrative is presented as a pathway that the teachers follow to graduate and earn their tablet.

Each module runs in the same way as presented in Figure 5 and outlined below:

1. The teaching strategy, skills, and other competencies built into each module are simulated (the facilitator acted as the teacher and the teachers took the role of learners) during the TPD session. This provides an opportunity to experience the strategy, learn more about a topic, and gain technology skills. Each module is linked to at least one badge as learning outcome (see Table 1 and Table 2). There are 13 compulsory badges and 5 challenge badges. The main difference being that the challenge badges are not facilitated. The compulsory badges are the ICT4RED badge, jigsaw, storytelling, role play, learning stations, educational content creator, mind mapping, flipped classroom, game-based learning, filed trips, gallery walk, mobile skills, and reflective practitioner. The optional badges are email, Twitter, app evaluation, assessment, and blog collaborator. Each school had a dedicated facilitator that acted as a mentor and guide.

2. After the TPD session, the teachers have about 3 weeks to apply the strategy for their own content, using technology in their own class. They need to record some evidence as outlined in the badge criteria. This step positions the teachers as a cocreator as they need to incorporate their existing knowledge, expertise, and experience with new pedagogical proficiencies (presented as teaching strategies) and technology skills to enhance their classroom practice. The process is supported by the badge criterion that outlines the expected evidence the teacher needs to present.

3. Table 2 presents the jigsaw badge, linked to module 1. The table outlines the instructions, what the expectation is and what to provide as evidence. The selection of subject content and the navigation of the specific context are considered the teachers contribution (cocreation).

4. A badge facilitator evaluates the evidence provided and either awards the badge or gives meaningful input on possible improvements. In the latter case, the teacher can resubmit at any given time.

5. If there are still modules left, another TPD session will be done, and the process repeats.

Evidence on how the teacher navigated existing and new knowledge skills and proficiencies had to be presented to an external moderator for each of the modules. Each of these modules highlighted various new skills and knowledge that the teacher had to integrate into their frame of reference to complete the course and graduate.

Each module is designed to not exceed 3 hours of training. It is suggested that there is a 3-week interval between each module presentation to allow teachers to integrate the new content and knowledge into existing practice. Taking school terms into consideration, the course would then take about one academic year to complete. The course used tablet technology based on the Android OS as it is open and adaptable, has many free apps, and closely resembled most devices that the teachers owned.



**FIGURE 5**  Teacher professional development course flow

**TABLE 1** Phases through which the teacher professional development course was developed and implemented (Botha, 2014)

| Phase 1 (2012/2013)—1 school | Explore and experience |
|---|---|
| This phase tested the design and enables the initiative to try and test various design constructs, so that the learning and research can be used to enhance the next iteration. | |
| Phase 2 (2013/2014)—1 + 11 schools | Describe and support |
| This phase took into account the learning gained from phase 1 and essentially goes through a redesign process to implement the learning in a new iteration. This iteration is the first attempt to scale the initiative to additional schools, in different contexts (eg, testing the model in junior secondary schools). At this stage, some general findings can be documented, and data and evidence can already be produced that is useful to implementers and policymakers. | |
| Phase 3 (2014/2015)—1 + 11 + 14 schools | Advise and embed in system |
| This phase involved a final redesign, based on the learning from phase 2, and enables the initiative to improve the learning around both process and scaling. It is here where the initiative can make final recommendations, based on data and evidence, as input to implementers and policymakers. | |

**TABLE 2** Example of how the jigsaw badge had to be earned (Botha, 2014)

| Jigsaw Badge Instructions | What to Do | What to Provide |
|---|---|---|
| Use the jigsaw strategy in your classroom by creating at least 4 expert tasks for the learners to do or learn about. At least one of the expert groups must use a mobile device. | You have created at least 4 expert tasks for the learners to complete. You have implemented the jigsaw strategy with your learners. | An electronic copy of your 4 tasks. This can be either a photo of hand written tasks or a word document. A photo of a home group and an expert group doing their tasks. |

## 8 | LINKING THE TPD TO COCREATION, INNOVATION, AND TECHNOLOGY ACCEPTANCE

The process of cocreation was followed to direct or influence the course of action of the teachers. Adapting the view of Allen, Bailetti, and Tanev (2009), cocreation is seen as the active, creative, and social process, based on collaboration between the TPD course facilitators and educators. The cocreation activities are initiated by the ICT4RED initiative to generate value for the teachers and ultimately the school and learners.

To illustrate this, the TPACK (Koehler & Mishra, 2009) was applied. The TPACK was adapted to present an ICT4RED pragmatic TPACK framework. This adaption facilitated the specific aims of the course, highlighting opportunities for cocreation while narrowing and directing the broad understanding of the TPACK towards an application instance. Each module incorporates the following, which allowed the teachers to cocreate (Figure 6):

1. Technology knowledge as suitable technology knowledge related to an Android tablet is used to support the teaching and 21st century learning engagement. It is operationalized as technology skills related to the tablet.

2. Content knowledge is related to words like being, participating, teaching, and learning in a digital world. Teachers are considered the subject domain experts. The TPD enhances their knowledge of skills and strategies to facilitate a 21st century learning environment.

3. Pedagogical knowledge is limited to teaching strategies that would successfully outline the integration of technology into a 21st century learning environment. The choice of strategies was done on its robustness and replicability. Knowledge on own practice was encouraged through reflection on practice towards reflective practitioners.

Teachers are thus equipped with the identified competence or skill, as suggested by the *ICT4RED pragmatic TPACK framework* (mentioned in Section 2), and need to, through cocreation, demonstrate a communicated degree of proficiency in implementing a skill, competence, or teaching strategy into classroom practices. Classroom practice is considered the nexus of the TDP process. Fullan (2007) adds his voice to Bate, Bevan, and Robert (2004), which contends that for people to change, they first need to experience the desire to change. They reason that "he concrete experience of participating … is crucial, meanings and value being formed after the experience not before it." As such, the *change* in classroom practice is seen because of a purposefully planned experience, which ultimately results in action. Change is one very important aspect in the life of a system. It is sometimes characterized by acceptance or resistance.

In the ICT4RED project, it was noted that teachers adopted the technology (TAM, mentioned in Section 2) and found that it enhanced their teaching (perceived usefulness was addressed) and they initially did not believe that using the tablets could be effortless, but as they earned their badges and reached module 10, their beliefs about the perceived ease of use changed together with their attitude independent of their age, and they became more familiar with using the devices to enhance their teaching. The results on teacher participation in the TPD component of the project were consistently high, and this supports the claims made above about TAM. In phase 1, there was a 100% attendance, and in phase 2 of the project, 136 teachers from 11 schools were eligible to participate and attendance was at 96%. Attendance for phase 3 was measured at 91%, and these data illustrate the participation demand and put the high participation in perspective.
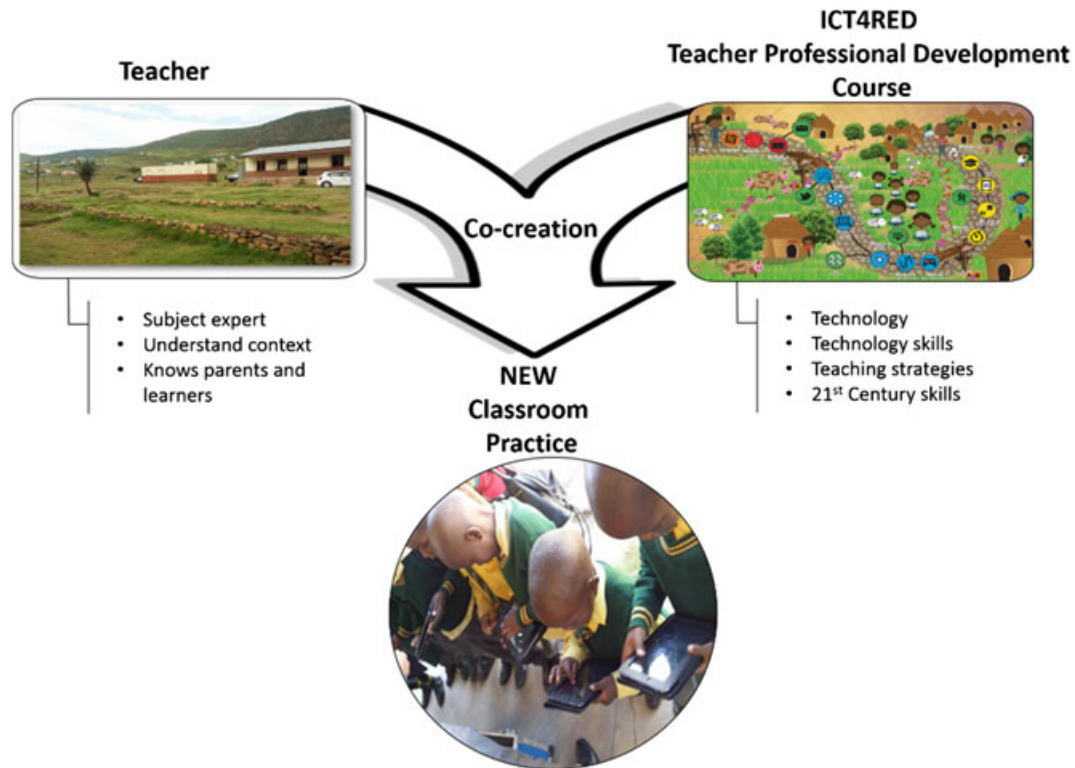
**FIGURE 6** Process of innovation through cocreation

Originally, the thought was to award teachers with Mozilla Open Badges but could not be implemented as the teachers did not have email addresses. This was mitigated through the use of stickers as badges and a physical printed page to show the progress of the teachers. The lack of digital skills impacted the way the course material was distributed. Instead of providing the course as a digital hyperlinked file, the teachers wanted a physical book with space to make notes. As the facilitators then could not add additional resources, a file was used to allow teachers to access the course in a paper format yet allow for the addition of relevant resources. One of the additional resources was *How-to-tutorials*. These were incorporated to provide teachers with a reference for attaining the needed technical skills.

Although the incorporation of game elements was received exceptionally well, it was a challenge to evaluate the large amount of interim goals, and additional resources had to be hired to enable the evaluation. One of the issues that was raised by the teachers was that the role of a teacher within a learner centric class was unfamiliar. It transpired that the teachers were hesitant to integrate technology into their teaching and learning if they had not mastered and integrated it into their personal life. A success factor of the technology hardware introduced was that the teachers felt that they were able to become comfortable with it before they reached a level of competency and confidence to implement it into classroom practice.

The bandwidth challenges in resource-constrained areas are significant. All aspirations to provide an internet experience had to be abandoned, and an *internet-like* experience was used as a substitution. This entailed accessing a local content server containing relevant cached content. Appropriate pedagogies and technologies for ICT integration should incorporate a disconnected or limited connectivity approach that pragmatically attempts to mitigate the realities of so many teachers and learners.

The implementation also indicated that ongoing TPD with ICTs in schools has to be seen as a priority to ensure sustainability and impact of the project especially in resource-constrained environments. Teachers also need to be part of or develop communities of practice where they can share and learn from each other. For this purpose, objectives with ICT integration and implementation should be clear, and measurement of progress should be aligned with an understanding of the path towards success. This requires an integrated strategy that extends beyond technology implementation, and that is translated into a well-supported implementation plan.

The 21st century learning design of the TPD course was evaluated using Microsoft Partners in Learning (2014) rubrics. These rubrics were developed and tested internationally for the Innovative Teaching and Learning Research project, and the evaluation was done by expert reviewers. It represents an important skill that the teachers need to develop and use in their own classroom practice. These skills are collaboration, knowledge building, the use of ICT for learning and skilled communication, self-regulation, and real-world problem-solving and innovation.

Using this rubrics allowed for the a 21st century classroom engagement in which IT-supported pedagogical practices can take place. Teachers therefore became cocreators, mainly because they could (Figure 7 and 8):

1.  apply their newly gained technological knowledge of integrating a mobile tablet to support teaching and learning into their classroom in their subject and at the grade where they taught;
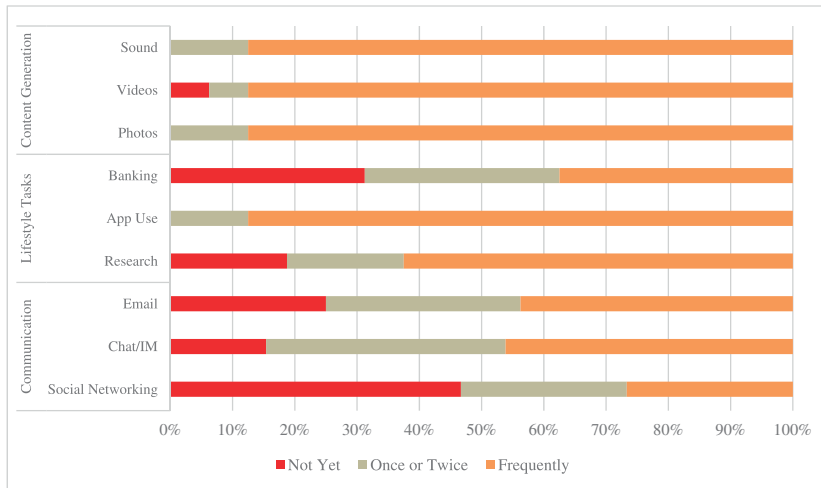
**FIGURE 7** Teacher's personal use of the technology
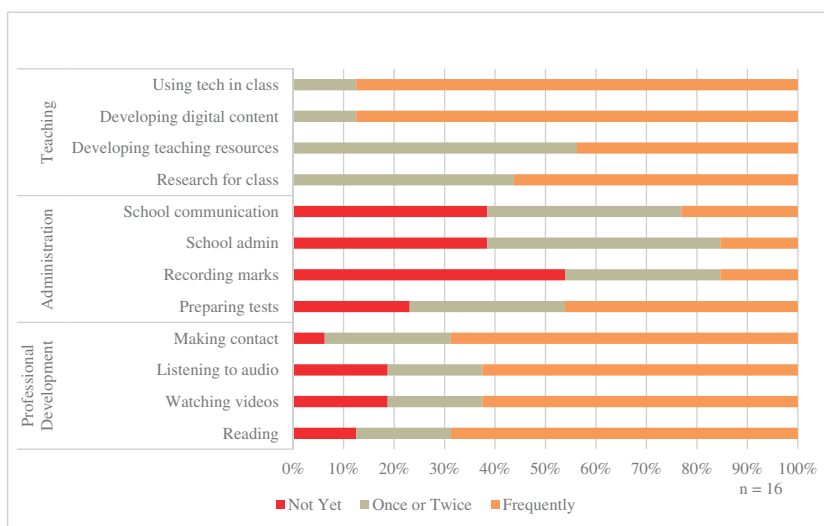


**FIGURE 8** Teacher's professional use of the technology

2. made use of their own content knowledge in a subject and grade level to integrate new teaching strategies (above) as pedagogical knowledge with a tablet to support their teaching; and

3. create new lessons on the basis of old content knowledge to demonstrate competence in applying skills like collaboration, knowledge building, the use of ICT for learning and skilled communication, self-regulation, and real-world problem-solving and innovation using a tablet to support their teaching.

Every phase of development of the course allowed for improvement of the modules. It was soon realized that acknowledgement should in addition be given to teachers interpretation of their own needs and interest in implementing and integrating technology to support teaching and learning. To graduate, teachers had to obtain all compulsory badges (13 for phase 2 and 11 for phase 3), while additional challenge badges could be obtained by completing noncompulsory assignments (up to 15 challenge badges). Of the teachers participating, all obtained the full complement of compulsory badges. Enthusiasm for the training however is reflected in the extent to which noncompulsory assignments were attempted and completed. Only 4% of participants did not obtain challenge badges for noncompulsory assignments, while 75% obtained from 1 to 4 challenge badges.

Data collected from teachers suggest that they have begun using technology routinely in their personal lives. While use is taking hold in all 3 constructs surveyed—communication, lifestyle tasks, and content generation—it is in the latter that use is most apparent.

Teachers' professional use of the technology was investigated by considering 3 constructs: using the technology to support their professional development, using the technology to complete administrative tasks, and using the technology to teach. The data show that teachers are most comfortable using the technology to develop material for the classroom and using the technology in the classroom to teach. Applying the technology in the classroom is emphasized during teacher training, which may account for this result to some extent. It is also apparent that teachers are using the technology to access content that supports their professional development and to communicate with others who could assist their professional development. However, using the technology to complete administrative tasks is reported far less frequently.

Overall, the evidence does suggest that the TPD course has succeeded in instilling routine use of the technology in the personal and professional lives of participating teachers. These results reflect progress towards acquiring 21st century skills—technological proficiency, information handling, communication, problem-solving, collaboration, and metacognitive skills—and allowed teachers to adopt the technology and become cocreators of new knowledge. These findings and results also support the fact that teachers as agents of change became social actors who could account for their reflexivity capacity to routinely observe and understand what they are doing while they are doing it and in the words of Giddens (1984) they could "... possess and apply their knowledge in the production and reproduction of day-to-day social encounters." Teachers used resources like the tablets and their own knowledge and reproduced new knowledge to affect social interactions in their classrooms. This also created coopetition amongst teachers who collaborated as competitors, but they worked together to achieve the same goal. Power struggles amongst teachers were not evident in fact this TPD course allowed for different ranked teachers to collaborate to reach the same goal and to be rewarded through gamification to earn the technology.

## 9 | CONCLUSION

The ICT4RED TPD consists of 10 modules of courseware presented through a gamification strategy. It is innovative as it presents a practical, free, practice-based (3 years and 3 iterations) peer-reviewed course and methodology of how teachers in rural, resource-constrained contexts can be empowered and supported to integrate technology to address 21st century teaching and learning challenges and cocreate new lessons. The significance of game design elements such as simulation and fun, technology endowment in need rather than in case (earn as you learn), adequate scaffolding, a clear learning path with interim learning goals articulated as badges, and relevant ICT-enhanced teaching strategies contributes towards the unique innovativeness.

Technology is not just earned, but teachers become innovative cocreators of content within their own subjects and grades. As the new knowledge, skills, and strategies spill over into classroom practice, teachers become facilitators and reproduced new innovative lessons to lead learners towards creating and evaluating content and information on tablets to enhance their own learning. Teachers as agents developed the "capacity to make a difference" (Giddens, 1984, p. 14). This is also known as transformative capacity and is closely related to power. This influenced the social structure "where relationships are stabilized across time and space" through the use of specific "resources implicated in social reproduction" (Giddens, 1984).

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