Disconnected Electronic Badges in Resource Constrained Environments.

A use case from the rural Nciba district in the Eastern Cape.

A.Botha; C. Salerno; M. Niemand, S. Ouma& I. Makitla

Abstract—This paper outlines the proposed extensions for use of digital badging in a resource constrained environment as part of the Information and Communication Technology for Rural Educational Development (ICT4RED) implementation in the Nciba district in the Eastern Cape, South Africa. The badging forms part of the Teacher Professional Development component that extended to 26 schools and 258 teachers over a 3year period. The initial implementation aimed to use Mozilla open badges. This was problematic as there was limited to no connectivity in the district. In addition the teachers had little or no digital persona and the digital representation of attained skills would have little or no value to them. Alternative methods were explored and are documented here. In conclusion a case is made for an alternative mechanism to include end users in a resource constrained environment.

Keywords—**digital badging, TPD, mobile learning, resource constrained environments, HCI4D**

I. Introduction

The ICT for Rural Education Development (ICT4RED) project is part of a research programme, Technology for Rural Education (TECH4RED), initiated by the South African Department of Science and Technology (DST), in collaboration with the South African Department of Basic Education (DBE), the Eastern Cape Department of Education (ECDoE) and the Department of Rural Development and Land Reform(DRDLR).TECH4RED was initiated with the aim to contribute to the improvement of rural education via technology-led innovation. It is envisaged that the learning from this initiate will enable evidence-based policy development within government. The research programme is expected to continue for at least 3 years and ends in March 2015[2].

Within the TECH4RED the ICT4RED aims to investigate how the application and deployment of new and existing technologies (which include e-textbooks and other electronic resources) at schools in the Cofimvaba district of the Eastern Cape Province can assist to develop a framework which can be replicated and scaled to other provinces and across the rural education system. To this end 12 components were identified that were to be addressed within the project [3]. Each teacher received an Android 10" device and schools were progressively endowed [4]

The *ICT4RED Teacher Professional Development* has been identified as a primary driver within the ICT4RED initiative and aims to guide the development of participating teachers relevant pedagogy and technology knowledge and proficiency to incorporate existing content knowledge to enable classroom practice to portray an 21st century teaching and learning engagement[5].

Figure1:Cofimvaba Education District Schools

The *ICT4RED TPD curriculum* is an instantiation of the Mobile learning curriculum framework[6] and is currently in its final iteration. The first iteration was at a single school, Arthur Mfebe Senior Secondary in 2012, the second phase expanded to 11 schools (137 participants) and the final, third sees the implementation extended to another 14 schools (104 participants)[4]. The initial design of the *ICT4RED TPD curriculum* incorporated some implied game elements. These were loosely incorporated as a design strategy but not explicitly articulated. The early success and uptakein phase 1cannot directly be attributed to any single factor, however, the gamification elements was considered significant enough to motivate a purposeful redesign to incorporate Gamification

A. Botha
CSIR Meraka
University of South Africa, School of Computing
South Africa

C. Salerno; M. Niemand & S. Ouma
Monash South Africa
South Africa

International Journal of Advances in Software Engineering & Research Methodology– IJSERM
Volume 2 : Issue 1   *[ISSN : 2374-1619]*

Publication Date: 30 April, 2015

as a design strategy in the second iteration that would be extended to the additional 11 schools. This purposeful redesign was refined in the third phase and uptake has extended beyond schools to include NGO's and universities.

Having outlined the context of the initiative, the following section briefly touches of Gamification as a design strategy to contextualise the use of badges in general and electronic badges specifically. The decision to incorporation electronic badges, despite the resource constrained environment, presented unique challenges and proposed solutions are articulated in the remainder of the paper.

II.   Gamification

The concept of gamification and the potential to deploy gamified applications is seen as a new line of enquiry for human-computer interaction. Current trends indicate that the use of Gamification as a design strategy to influence interaction design is in the progress of establishing itself as a novel line of enquiry for researchers [7-10]. Deterding, Dixon, Khaled & Nacke [11], make a clear distinction between games and gamified application and argue that the term *Gamification*, "does indeed demarcate a distinct but previously unspecified group of phenomena, namely the complexity of gamefulness, gameful interaction and gameful design, which is different from the more established concepts of playfulness, playful interaction or design for playfulness".

As in any fledgling domain, there is limited agreement on a single understanding of Gamification. The rhetoric surrounding this debate is beyond the scope of this paper and, apart from acknowledging it, the review will concede to usethe term Gamification as defined byDeterding *et al.* [11] and supported by other authors [12, 13]. They argue that *Gamification is the application of game dynamics and mechanics into non-gaming environments[11].*

The goal of using gamification as a design strategy was to make the *ICT4RED TPD curriculum* and resulting course as a non-game environment " more enjoyable and engaging [11]", to "encourages motivation and engagement [14]", while providing for an "engaging experience [9]".

Marache-Francisco and Brangier [10] takes a holistic view and argue that "[i]t is about designing for an experience that drives the user through a journey." This implied journey narrative, supported by game elements, was adopted and implemented. The elements incorporated were purposefully chosen as identified by Costello and Edmonds [15]. They were: creation; exploration; discovery; difficulty; competition; danger; captivation; sensation; sympathy; simulation; fantasy; camaraderie, and subversion. Not all elements were designed to be present in each of the sessions but rather an appropriate combination was strived for in accordance with Juul and Deterding*et al*. [11, 16]. These elements are focused on the experience of the individual as participating user and articulated as "game design patterns and mechanics" by Deterding *et al.* [11] who describes them as "commonly reoccurring parts of the design of a game that concern gameplay".A full discussion on the identification and incorporation of these elements are given in Botha, Herselman & Ford [17].

The principles that guide the *ICT4RED TPD curriculum*implementation as a coursewere identified and adapted from Stott and Neustaedter [18] as: Freedom to fail, Rapid Feedback, Progression and Storytelling.

III.   Badging in the ICT4RED Teacher Professional Development Curriculum

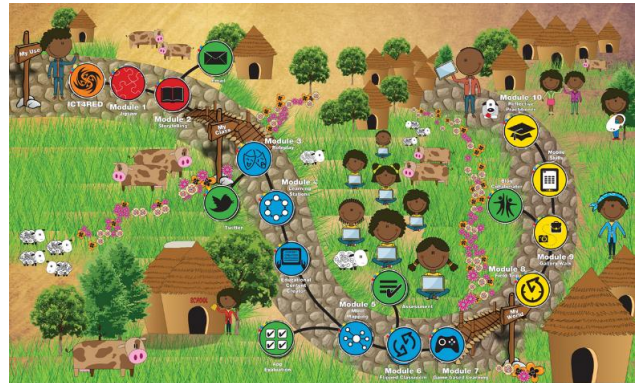The ICT4RED TPD curriculum is an instantiation of the Mobile Learning Curriculum Framework [6].

Figure 2: Sequential Learning Path represented by a road to be followed and badges to be earned.

It consists of 10 modules that are to be presented over a course of approximately 1 year.

The badges that correspond to this journey are outlined below with the articulation of the journey section aim.

Figure 3: Learning path Narrative

Each module is structured to advance technology and pedagogical proficiencyin a resource constrained environment. A resource constraint environment for the purpose of this paper, is best described Anderson, Anderson, Borriello & Kolko [19] as environments where there is low-income communities and low bandwidth. These environments provide unique constraints (e.g., cultures where people are unfamiliar

with or afraid of technology, environments where power and network connectivity are scarce and expensive).
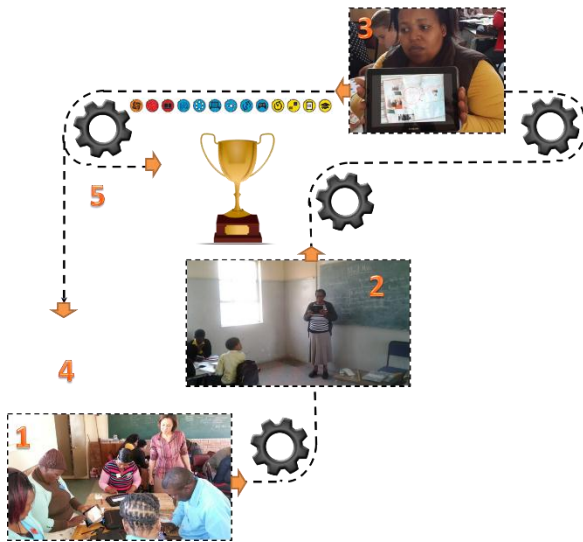

Figure4: ICT4RED TPD course flow

The flow of each module in the course is the same and described as steps below:

1. The learning strategy, skills and other competencies are simulated during the TPD session. This provides an opportunity to experience the strategy, learn about a topic and gain technology skills.

2. Subsequent to the TPD session, the participating teachers have about 3 weeks to apply the strategy using technology in their own class. They need to record some evidence as outlined in the badge criteria.

3. A badge evaluator evaluates the evidence provided and either award the badge or gives meaningful imput on possible improvements. In this case the teacher can resubmit at any given time.

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

5. If all the modules have been presented the participating teacher has the opportunity to graduate should they have achieved the minimum criteria.

With the investment in time, opportunity cost etc. made in the teacher professional development it was imperative that there would be evidence of classroomimplementation of learning beyond the training engagement.The evidence of successful classroom integration would facilitate the drive towards the goals of transforming the teaching and learning engagement and building the teachers personal and professional proficiency. A badge would be issued by an external facilitator to a teacher if they were able to provide evidence of implementing the relevant teaching strategy into their classroom practice

This drive is facilitated by badges that serve a number of functions as outlined below:

- It outlines a clear transparent expectation to the teacher from the project initiators.
- It provides an opportunity for the teacher to demonstrate individual proficiency and competence that is acknowledged.
- It allows teachers to individualize and appropriate learning into practice.
- It acts as a scaffolding environment for achieving the teacher development goal.
- It allows the project initiators to acknowledge individual growth
- Acts as an early warning signal of teachers falling behind
- Allows for timeous investment in further technology needs
- Allows for champions to surface and be acknowledged

Initially the participant is assumed a novice in integrating technology and scaffolded to progress from, being able to use the tablet as a personal device (I can work with a tablet), to use as professional device (I can teach with a tablet), and cumulating in the use of a tablet as a collaborative tool (I can work through the tablet). As such the teacher is encouraged and supportedtowards becoming an online learner and to position them to become lifelong learners and contributors in the digital world. Initially the teachers earned badges that wereissued as paper stickers and displayed on a in a badge backpack book. The idea was to issue these badges online to a Mozilla Open Standards Backpack that was created and hosted at the CSIR, simultaneously.

Figure 5: Progression to online electronic badges

This was not feasible as the Mozilla backpack required thatbadge participants register and access their badges with an email address. The teachers, with exception of a small minority, did not have email addresses. In addition they lacked the technical dexterity and proficiency to create, access, and use email addresses early on in the course.

In the third iteration of the application of the ICT4RED curriculum, an alternative mechanism was sought. This alternative would enable teachers to earn digital badges. This is outlined in the following section.

IV. Digital Open Badges

Digital badges hold many possible advantages for continuous teacher professional development. These advantages are possibly exasperated in a rural context as

International Journal of Advances in Software Engineering & Research Methodology– IJSERM
Volume 2 : Issue 1   *[ISSN : 2374-1619]*

Publication Date: 30 April, 2015

teachers are disconnected and have fewer opportunities to participate in physical communities of practice. Digital badges implies by their very nature an understanding, appreciation and participation in a digital world. The attainment of these ideals was a facilitated process as part of the ICT4RED TPD curriculum and was not realised early on in the course. The appreciation of digital badges was seen as a contributing factor to the eventual participation in a wider online community.

In addition to the technology challenges facing the teachers, similar challenges were experienced with the badge issuers which were pedagogically and content knowledge proficient but not necessarily technologically skilled.

To these ends alternative mechanisms was sought to issue, receive and record badges attained and awarded to participating teachers. These mechanisms needed to be addressed within a resource constrained environment that differs significantly from those in a connected environment [20].

A. *Mozilla Open Badges*

To fully explore the differences,the following sections will overview the awarding of Mozilla Open Badges.

MozillaWiki describes a badge as "a symbol or indicator of an accomplishment, skill, quality or interest"[1]. They make a distinction between digital badges as "an online representation of a skill" and Open Badges that hard code meta-data to the badge image file. As this is based on an open standard, it allows recipients to accumulate badges from various issuers towards a collection that can be representative of attained skills and achievements. MozillaWiki[1] states that Open Badges are

- Free and open allowing for open technical software that any institution can use to create issue and verify digital badges;
- Transferable allowing the collection from various sources;
- Stackable as they can build upon each other; and
- Evidence – based as the image contains hardcoded metadata that links back to the issuer, criteria and evidence.
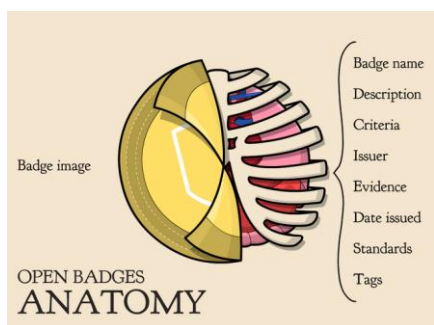

Figure 6: Open Badges Anatomy [1]

The information that is hard coded into the image (badge name, description, criteria, issuer, evidence, date issued, standards and tags) is unique for every recipient. The static hardcoded image is can be created by a suitably skilled individual or by Mozilla's BadgeKit. The BadgeKit Web application facilitates the administration part of a badge issuing system. It includes a Web app for creating, managing, and issuing badges. The BadgeKit was announced in March 2014 and is currently in private beta. The BadgeKit allows, amongst other features, for a badge to be hardcoded with the relevant metadata.

Once created, the static hard coded image is sent via email to the recipient. The recipient then uploads it to a web based backpack that is linked to the specific recipients email address from where it can be shared on various platforms.

With a recipient that has no dedicated email or internet connection the process is problematic.

B. *Disconnected Mozilla Open Badges*

Although teachers as recipients of the badges do not have email addresses in the beginning of the *ICT4RED TPD* course, it is envisaged that they will, not only have email addresses, but have started to explore and participate in an online environment. To this end, the badges that are earned when their online persona and participation is still being developed needs to be accessible and available when the individual presents themselves as ready. This implied that the solution offered needed to be in addition and complementary to the Mozilla structures and should not replace them.

To this end twomobile applications were developed. A *Badge Issuers Application*for badge issuers [21] and a*Trophy Case*[22] for the Teachers receiving badges.

Figure 7: Overview Screen of Badge Issuer Application

The *Badge Issuer Application* will provide a means through which non-ICT confident users can issue electronic badges based on the Open Badges standards to teachers in a resource-constrained environment. The overview screen as shown in Figure 7 provides issuers with a leader board, displaying the top achieving teachers; this can help track the teachers which are contributing the most towards the project and highlight where problem areas exist.

Both the Badge Issuer application and the *Badge Trophy Case*are preloaded with the metadata that makes up a Digital Open Badge. The date issued and badge issuers' remains variables and are added later. The evidence currently not used as none of the evidence is uploaded electronically. This rather shows to a link that outlines what had to be submitted.

When a badge assessor evaluates evidence presented and awards a badge, the *Badge Issuers Application*generates a unique code that incorporates the recipient's name, date of issue and issuer. This code is unique to the recipient and will not unlock any other participant badge or any other badge in the *Trophy Case*.
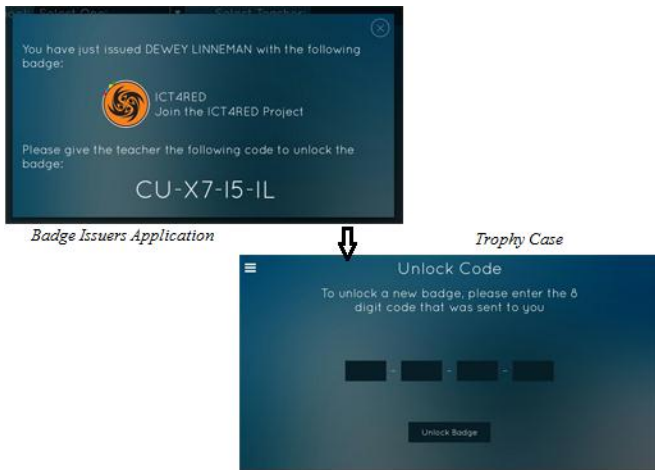

Figure 8: Unique unlock code

The issued badge is then displayed or unlocked and can be viewedin *Trophy Case.* The issued badge is, in addition, added to the teachers name in the Badge Issuers Application to be synced later when connectivity is established. During the Syncing process, all other badge issuers updates are pooled and distributed.

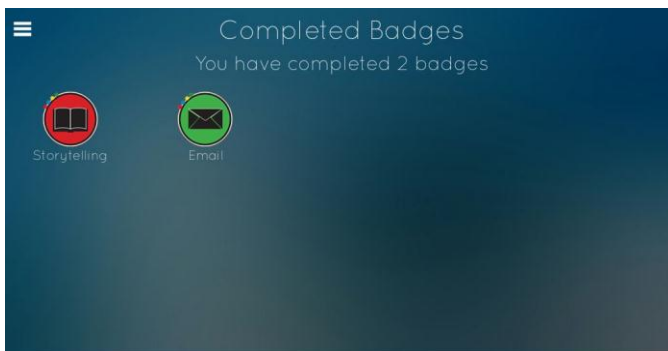Figure 9: Uncompleted Badge View in *Trophy Case*

Figure 10: Issued badges are unlocked as the unlock key is entered in *Trophy Case*

The badge *Trophy Case* will be preloaded with badge information mirroring that found on the BadgeKit Web application. Teachers will thus be able to view the badge requirements on their mobile devices without the need of connectivity [22]. Badges that have not yet been achieved or unlocked will be viewable as seen in Figure 9. Users will have the ability to view a specific badge's information and criteria by long pressing a badge image on the view.

Figure 11: Summary of all badges and achievements in *Trophy Case*

The issued badge is, in addition, added to the teachers name in the Badge Issuers Application to be synced later when connectivity is established. During the Syncing process, all other badge issuer's updates are pooled and distributed.

Figure 12: Teacher statistics screen that has been synced to a central point appears on the *Badge Issuers Application*

The application will,after being synced to a central point,allow the badge issuers to view specific updated information for each teacher within the ICT4RED project; this can be seen in Figure12 above. This page will show the updated ranking of that particular teacher, the school they belong to, as well as the number and type of badges they have earned.

Figure 13: Updated view for each teacher from a central point that will by synced.

Other functionality that the *Badge Issuer Application* will provide is then the ability to monitor the progress of each school and participant. This will be split between primary and secondary schools and the *Badge Issuer Application* will display rankings of each competing school within the project after being synced from a central data base.

When a specific teacher provides evidence that they have managed to create an email address, this will be added to the central data base and the awarded badges will be sent to that teacher, together with instructions to create a profile in on the Mozilla BackPack and to share their badges on social media if they so choose and when they are ready.

v. Conclusion

Of the 137 teachers that took part in the second phase, all of them achieved the compulsory badges and their feedback was overwhelmingly positive. This indicated that they felt they were able to integrate technology meaningful into their classrooms. These teachers are all from predominantly resource constrained environments and have become active participants in the digital world, making technology work for them in their own environment. They can be seen as representative of a much larger base of teachers and individuals that connect from the wrong side of the digital divide and are thus excluded from multiple value adds to their careers and own future betterment. By providing an open badge system that meets them in their context it is hoped that in future, they can also build an accredited skills base and participate on equal footing with their urban colleagues.

References

[1].   MozillaWiki. *Badges*. 2014   [cited 2014 September]; Available from: https://wiki.mozilla.org/Badges.

[2].   DST, *The Cofimvaba Schools District Technology Project: Status Report 2*, 2013, Department of Science and Technology: Pretoria. p. 12.

[3].   Ford, M., A. Botha, and M. Herselman. *ICT4RED 12-Component Implementation Framework: A conceptual framework for integrating mobile technology into resource-constrained rural schools*. in *IST Africa*. 2014. Mauritius.

[4].   Botha, A. and M. Herselman. *Supporting rural teachers 21st century skills development through mobile technology use: A case in Cofimvaba, Eastern Cape, South Africa*. in *ICAST 2013: The Future is Now: Adaptive Science and Technology Unbound*. 2013. Pretoria, South Africa: IEEE.

[5].   Herselman, M. and A. Botha, *ICT4REDResearch Framework: September 2013*, 2013, CSIR Meraka.

[6].   Botha, A., et al. *Towards a Mobile Learning Curriculum*. in *IST-Africa 2012*. 2012. Dar es Salaam, Tanzania: IIMC International Information Management Corporation.

[7].   Reeves, B. and J.L. Read, *Total Engagement: Usiong Games and Virtual Worlds to Change the Way People Work and Businesses Compete*2009: Harvard Business Press.

[8].   McGonigal, J., *Reality is broken: Why games make us better and how they can change the world*2011: Penguin. com.

[9].   Zichermann, G. and C. Cunningham, *Gamification by Design: Implementing game mechanics in web and mobile apps*2011: O'Reilly Media, Inc.

[10].   Marache-Francisco, C. and E. Brangier, *The Gamification Experience: UXD with a Gamification Background*, in *Emerging Research and Trends in Interactivity and the Human-Computer Interface*, K. Blashki and P. Isaias, Editors. 2014, IGI: USA.

[11].   Deterding, S., et al. *From game design elements to gamefulness: defining gamification*. in *Proceedings of the 15th International Academic MindTrek Conference: Envisioning Future Media Environments*. 2011. ACM.

[12].   Kapp, K.M., *The gamification of learning and instruction: game-based methods and strategies for training and education*2012: Wiley. com.

[13].   Domínguez, A., et al., *Gamifying learning experiences: Practical implications and outcomes.* Computers & Education, 2013. **63**: p. 380-392.

[14].   Glover, I., *Play as you learn: gamification as a technique for motivating learners.* 2013.

[15].   Costello, B. and E. Edmonds. *A study in play, pleasure and interaction design*. in *Proceedings of the 2007 conference on Designing pleasurable products and interfaces*. 2007. ACM.

[16].   Juul, J. *The game, the player, the world: looking for a heart of gameness*. in *DIGRA Conf*. 2003.

[17].   Botha, A., M. Herselman, and M. Ford. *Gamification beyond badges*. in *IST Africa*. 2014. Mauritius.

[18].   Stott, A. and C. Neustaedter, *Analysis of Gamification in Education.* 2013.

[19].   Anderson, R.E., et al. *Designing technology for resource-constrained environments: Three approaches to a multidisciplinary capstone sequence*. in *Frontiers in Education Conference (FIE), 2012*. 2012.

[20].   Kam, M., et al. *Designing educational technology for developing regions: Some preliminary hypotheses*. in *Advanced Learning Technologies, 2005. ICALT 2005. Fifth IEEE International Conference on*. 2005. IEEE.

[21].   Salerno, C., *A Model for facilitating the issue of open badges in a resource constrained environment*, in *Proposal for MPhil in CIS*. 2014, Monash South Africa: Unpublished. Pretoria, South Africa.

[22].   Niemand, M.D., *Model for receiving and authenticating open badges in a disconnected environment*, in *Proposal for MPhil in CIS*. 2014, Monash South Africa: Unpublished. Pretoria, South Africa.