

## **Developing mobile teaching practice: A collaborative exploration process**

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### **Abstract**

The goal of this research was to design a process to support the development of mobile teaching practice, embedded within the teaching and research activities in a Faculty of Education at a research-intensive university. Continuous developments in mobile learning create opportunities for teaching and learning, but also present challenges for educators to harness the possibilities of the medium and for the safe and accountable use of new technologies. This article describes the development of a collaborative exploration process by an interdisciplinary group of education researchers in the mobile teaching and learning field. The process was developed within an Education Living Lab, and was based on the knowledge utilisation theory of action that guides collaborating researchers and practitioners. Education researchers and pre-service student teachers participated in the research, described here as the case study of a project, during which the collaborative exploration process was designed and refined. The elements of the resulting collaborative exploration process are: a relevant driver for the project, and the four phases 'explore', 'learn', 'adapt' and 'apply'. The driver is the focus topic of the research, and the phases in the process allow for collaborative activities during which the topic is investigated, while at the same time influencing the teaching, learning and research activities in the Faculty. A Faculty of Education can be a safe space where challenging aspects, such as mobile teaching and learning practices, can be investigated and developed. The proposed process can be applied to the practices of the Faculty, thus formalizing support for educators to explore teaching and learning possibilities; and to promote interdisciplinary collaborative research in the field. Future research can investigate the applicability of this collaborative exploration process for other challenging topics in educational practice and research.

**Keywords:** collaborative exploration; interdisciplinary research; mobile learning; researcher development; teacher development

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## **Abstract**

The goal of this research was to design a process to support the development of mobile teaching practice, embedded within the teaching and research activities in a Faculty of Education at a research-intensive university. Continuous developments in mobile learning create opportunities for teaching and learning, but also present challenges for educators to harness the possibilities of the medium and for the safe and accountable use of new technologies. This article describes the development of a collaborative exploration process by an interdisciplinary group of education researchers in the mobile teaching and learning field. The process was developed within an Education Living Lab, and was based on the knowledge utilisation theory of action that guides collaborating researchers and practitioners. Education researchers and pre-service student teachers participated in the research, described here as the case study of a project, during which the collaborative exploration process was designed and refined. The elements of the resulting collaborative exploration process are: a relevant driver for the project, and the four phases 'explore', 'learn', 'adapt' and 'apply'. The driver is the focus topic of the research, and the phases in the process allow for collaborative activities during which the topic is investigated, while at the same time influencing the teaching, learning and research activities in the Faculty. A Faculty of Education can be a safe space where challenging aspects, such as mobile teaching and learning practices, can be investigated and developed. The proposed process can be applied to the practices of the Faculty, thus formalizing support for educators to explore teaching and learning possibilities; and to promote interdisciplinary collaborative research in the field. Future research can investigate the applicability of this collaborative exploration process for other challenging topics in educational practice and research.

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## **1. Introduction**

The goal of the research described in this article was to design a process to support the development of mobile teaching and learning practice, embedded within the teaching and research activities in a Faculty of Education at a research-intensive university. Pre-service student teachers at the Faculty are prepared for teaching in all the phases and subject-areas in the Basic Education school environment in South Africa. Post graduate qualifications in Education are presented on Honours, Masters and Doctoral levels. Research plays an integral role in under-graduate, post graduate, and academic staff activities at the Faculty, and the broad aim of all research is to investigate and address challenges in the educational environment, and to support educators in their professional development. Research in technology in education (one of the focus areas of the faculty) is situated within a research unit which creates opportunities for interdisciplinary and collaborative research. Mobile teaching practice (as a subset of technology in education) is defined, for the purpose of this research, as the utilization of mobile devices, such as smart phones and tablets, as well as the software and resources on the devices, in the teaching and learning environment.

The challenges experienced in mobile teaching and learning by students and staff, as outlined in this article, are: the availability of numerous resources for mobile teaching and learning; different adoption and utilisation rates of the technologies by educators and students; and the training of educators to recognise and tap into the possibilities created by mobile technology. The research described in this publication investigated the possibilities of collaborative and interdisciplinary educational research in mobile teaching and learning practice development.

The questions that guided this research were:

- *Which phases can be identified during interdisciplinary collaboration in mobile teaching and learning research and practice?*
- *Which collaborative research process can be designed to support mobile teaching and learning practice development?*

The research contributes to discussions on the impact of educational research on educational practice.

## **2. Mobile teaching and learning**

Mobile teaching and learning involves the use of mobile devices in education. The field of information and communication technologies (ICT), and specifically, mobile devices and mobile applications, is developing continuously (Martin 2012). This created opportunities for the field of electronic learning (e-learning) to extend educational interactions beyond physical boundaries into the virtual space (Baran 2014). These continuous developments, however, also create challenges for the safe and accountable use of mobile technology by educators (Traxler 2007; Kukulska-Hulme 2014; Baran 2014). Constant research and rethinking of the integration of mobile technologies in education are required to ensure that the value of mobile teaching and learning can be harnessed with responsibility (Parette and Blum 2013; Bidin and Ziden 2013; Martin 2012).

### **2.1. Opportunities**

Mobile technology is becoming more accessible, which also generates more opportunities for usage in the teaching environment (Jubien 2013; Nikolopoulou 2014; Kalas 2010). Gartner's hype cycle for 2015 also supports this notion, as it includes many of the newer mobile education technologies, such as tablets and smart phones, interactive e-books, open e-resources, and digital assessment tools (Lowendahl 2015) in various stages of the hype cycle. These devices are multi-faceted and each of them can be seen as a mobile tool-kit that potentially may be used by every teacher and every learner (El-Hussein and Cronje 2010). The Educause Center for Analysis and Research (ECAR) reports yearly on the state of undergraduate students and Information Technology (Brooks 2016). According to this study, done amongst 183 different higher education institutions worldwide, student device ownership is continuing to grow. Smartphone ownership, for example, is now at 96%, and 30% of students that did not use smartphones for learning in 2015, were using it for academic purposes in 2016.

Tools such as sound and video recording and playing, cameras, connectivity (social, as well as for information) and a variety of applications for calculators, dictionaries, games, tutorials, simulations and more can now be put into the hands of each participant in education (Jubien 2013; Ifenthaler and Schweinbenz 2013; Gomez et al.

2014). This availability could positively influence the teaching environment in many exciting ways (Traxler 2007; Jeng et al. 2010). Mobile pedagogy could support constructivism, active and interactive teaching (Kukulska-Hulme 2014) and learning strategies, and social learning (Ifenthaler and Schweinbenz 2013; Huang and Chiu 2015). It also is a powerful tool in the quest to develop 21<sup>st</sup>-century skills for teachers and learners alike (Hoffman 2010).

## 2.2. Challenges

Three challenges are presented here, namely the abundance of electronic resources available; rapid developments in ICT; and the preparation of educators in the field of mobile teaching and learning.

E-Resource development results in the continuous development of many proprietary as well as open resources that can be used in tandem with mobile devices and mobile learning (Ally and Samaka 2013; Philip et al. 2013). E-resources refer to a variety of electronic resources, such as different types of e-books (from readers to interactive e-books), documents (worksheets, exam papers, notes), videos, sound clips, podcasts, games, simulations, tutorials, quizzes, generic processing software such as word processors, spread sheet software, paint and other creative software, calculators, and other mobile applications (apps). Mobile apps are, for the purpose of the research, identified as software programmes for mobile devices, and include all the software that drive these e-resources. Educators face the challenge to *source and evaluate resources*, and also to identify application possibilities in mobile teaching and learning.

The rapid development of ICT in the current globalised environment leads to *different adoption rates* of technology. Learners tend to make new technology their own very quickly (Jubien 2013; Ilomäki et al. 2012; Parette and Blum 2013; Khaddage and Knezek 2013), whereas educators often lag in both their willingness and their ability to make successful use of new developments (Sad and Göktas 2014). As a result of this discrepancy in adoption rates, challenges arise in the educational and training environments, which in some cases are viewed by the educators as insurmountable (Ifenthaler 2015). Educators face the challenge of not only utilising mobile devices to their full capacity, but also selecting and using relevant and quality resources that will support interactive and highlevel learning experiences (Kearney and Maher 2013).

*Traditional professional development practices* are not always successful in developing educators' teaching practice to incorporate the possibilities of new technology and resources (Lindsay 2015; A. Walker et al. 2012; Traxler and Vosloo 2014). Therefore, opportunities to use new technology are often shunned or ignored. Given the challenging and changing nature of available technology in teaching, training in the use of this technology for teaching is also challenging and continuously changing. Mobile technology brings many options to the classroom that were not available before, implying endless opportunities for the transformation of teaching practice (Kalas 2010). The need therefore arises for approaches that can map the professional development of the nature of new technology (A. Walker et al. 2012; Traxler 2007; Traxler and Vosloo 2014).

Development in the mobile education environment creates the need for pre-service student teachers, in-service teachers, and education lecturers to face and address these challenges. We propose in our research that collaborative research within a Faculty of Education can provide a way not only to investigate the contributing and inhibiting factors, but also to support the development of the mobile teaching practice of the collaborators.

### **3. Collaborative research in education**

The challenge in qualitative educational research is to ensure that research outcomes can be translated into practice (Penuel et al. 2015), thus impacting on professional development. Collaborative research in academic institutions can bring stakeholders from different disciplines together to investigate common challenges (Bi and Yang 2015) and to ensure that research results are relevant and useful. Participants, or stakeholders, can be from different disciplines within the academic institution, but should also include external stakeholders, carefully selected to ensure the relevance of the innovation to the real market, as well as to national strategic needs. In interdisciplinary innovation research, it is also important that participants focus on a shared goal, which is relevant to all.

The advantages of collaborative research, are not only in the sharing of ideas from different perspectives, but also in the gaining of knowledge and understanding for practice (Kochanek et al. 2015; Bi and Yang 2015). The authors propose such a process that can support collaborative research, which can impact on practice.

#### **3.1. Knowledge utilisation theory of action**

We could not identify empirical studies that focus on collaborative research processes in conjunction with professional development in Education. The knowledge utilization theory of action (KUTA), proposed by Kochanek et al., however, provides a link between research and practice (Kochanek et al. 2015). This theory proposes that collaborative research between researchers and practitioners, which focuses on the shared goal, can develop through the four phases: acquisition, interpretation, sense-making and use. Before research can be applied in practice, it 'must be acquired, interpreted and processed towards making sense within existing practices'. The acquisition phase allows for a decision about the research topic and gathering information about the research focus. During the interpretation phase, the information is disaggregated by both individuals and groups in a process of co-interpretation. Sense-making implies a co-processing phase, focusing on the integration of the information into existing understandings. Lastly, the outcomes of the research are used at different levels – either as is, or to change perspectives, or applied to pre-existing conditions, or to adapt current practice (Kochanek et al. 2015).

Collaborative research was formalised within our research, based on the phases of the KUTA, in an Education Living Lab.

#### **3.2. Living Lab research paradigm**

Collaborative research can be well supported within a Living Lab (LL) research paradigm. An LL creates a research space for interdisciplinary, collaborative, innovation-driven research that aims to address complex

issues by and for the research participants (Evans et al. 2015). An LL approach is focused on innovative solutions to interdisciplinary challenges that usually (but not exclusively) incorporate ICT. As with the knowledge utilisation theory of action, it allows for co-interpretation, co-processing and collaboration between all stakeholders in the environment of the challenge – including researchers, practitioners, industry representatives, policy makers and others.

Research within this paradigm can include the phases ideation, co-creation and venturing, and is supported within the LL environment by a collaborative ICT infrastructure, funding and project management (Katzky 2012). The ideation phase incorporates idea-scouting and mobilisation of participants and processes; during co-creation the research is designed, developed and validated; and during the venturing phase, the results are applied and adapted.

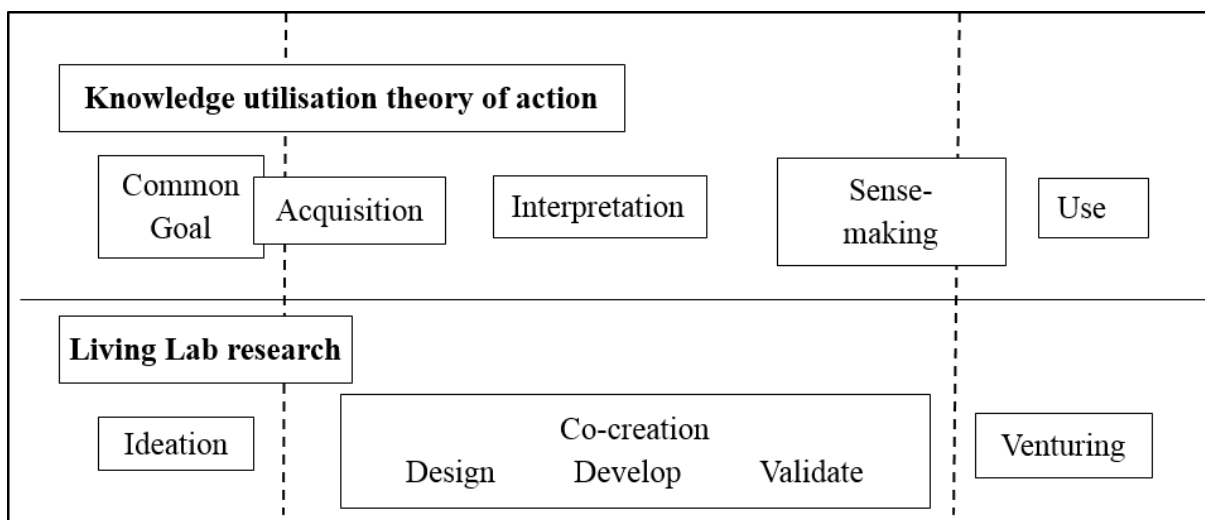
The LL concept can be applied in three dimensions: namely, an LL as a context; a method; and as a conceptualisation. In this research, it is applied within the context of the Education Living Lab research unit at the Faculty of Education, as well as in the collaborative research method applied (Leminen 2015).

### 3.3. Conceptual framework: Collaborative research process

The first research question of this research is

- *Which phases can be identified during collaborative research in mobile teaching and learning practices?*

The KUTA proposes four phases in a collaborative research process, namely acquisition, interpretation, sense-making and use. The LL research paradigm proposes phases of ideation, co-creation and venturing (application). Co-creation is sub-divided into design, develop and validate. In both approaches, it is deemed important that collaborators find a common goal, or driver, for the research process. Figure 1 depicts a summary and our comparison of these phases. This is the conceptual framework for the design research process described in the next section.



**Fig. 1** Collaborative research phases – comparing KUTA and LL

Both processes are initiated by a driver (finding a common goal or an ideation phase). This is followed by a preparation or exploration phase (acquisition or design); a development phase (interpretation or co-creation) and an evaluation phase (sense-making or validation). The last phase focuses on the application of the research in practice (use or venturing).

This depiction addresses the first part of the first research question, gives an indication of phases followed during collaborative research, and proposes a conceptual framework for this study.

#### **4. Methodology**

An educational design research strategy was followed to design and formalize the proposed collaborative research process, as identified in collaborative research projects within a Living Lab research unit at the Faculty of Education. The LL structure in the Faculty supports the ICT infrastructure and the management of projects in collaborative, interdisciplinary research investigating innovative solutions for challenges in teaching and learning. One of the research foci within this LL is mobile learning. The aim of this focus area is to support education lecturers and pre-service student-teachers in developing their mobile teaching practice through applied research (Callaghan and Herselman 2015).

Educational design research supports researchers in investigations into complex problems in educational practice (Plomp 2007). Design research typically follows a cyclic process of designing, developing and evaluating interventions towards addressing complex educational problems. In this research, the intervention designed was the collaborative research process.

In the research described in this manuscript, the challenges in mobile teaching and learning practice were identified, as discussed in sections 1 and 2. Subsequently, research process phases in collaborative research were identified from literature, as presented in Figure 1. After this, the processes followed during mobile teaching and learning research projects were investigated as case studies to identify similar phases followed during each project, as compared to the KUTA and LL research phases identified in literature. This resulted in the development of the collaborative process proposed in this manuscript. The process was applied in further research projects (not described in this manuscript) in the continuation of the design research process.

Data collected during the respective projects (case studies) that fed into the development of the collaborative research process were: various aspects/outcomes/products of activities; reflections of researchers (individual reflections, as well as during reflective group sessions); and surveys completed by students that participated in the various activities during the case studies. Reflections and surveys focused on what worked, what did not work, as well as suggestions for improvement of the research process. Ethical clearance was obtained from the Faculty Ethics committee, and all participants consented to participation in the research.

The following section describes one of the case studies in more detail, to illustrate how the research phases and proposed collaborative research process were identified and designed.

## **5. Case study: Mobile App project**

This section describes the case study of one of the projects during which the collaborative exploration process was developed. It illustrates the design of the process by identifying the various phases in the research.

During reflection on the case studies, it emerged that the collaborative process was driven by a specific focus (common goal or idea). We name this the Driver of the project. The collaborative research process itself developed into four distinct phases, which we named Explore, Learn, Adapt and Apply. The following discussion illustrates and explains these concepts as identified in one of the projects, or case studies, the Mobile App project. The discussion therefore does not focus on the content or research results of the Mobile App project per se, but on the underlying processes followed during the research.

### **5.1. Mobile App project: Driver**

The driver of a project is similar to the common goal mentioned in KUTA and the identification of an idea in the ideation phase of the Living Lab.

The Department of Basic Education in South Africa is investigating and investing in mobile learning possibilities for schools, and a number of public and private schools in the country are also venturing into the mobile learning arena. The ICT4RED (ICT for rural education development) project in the Cofimvaba district in South Africa is an example of such a development (Ford et al. 2014; Botha and Herselman 2013). One of the sub-projects in this initiative focuses on e-resources. The Education LL at the Faculty of Education has secured a project on the sourcing, evaluation and application of free mobile e-resources, and specifically apps that can be used in the South African school curriculum. *This provided two Drivers for the case study: first, the sourcing and evaluation of Apps, and second, the application of the apps in teaching.*

### **5.2. Mobile App project: Participants**

The participants in the Mobile App project are described here to clarify the context of the case study and to illustrate that this project was designed towards interdisciplinary collaboration amongst educators and students in the Faculty of Education.

A team of researchers from the Faculty of Education, together with pre-service student-teachers (744 in the first year and 785 in the second year) and postgraduate students (eight students), participated in the Mobile App research project. The core research team consisted of ten teaching methodology experts in the fields of English, mathematics, physics, chemistry, geography, and mobile learning. Their research focus areas were within these methodologies, as well as in ICT in education. The researchers were also lecturers of the third-year pre-service student-teachers and supervisors of postgraduate students.

Research results were obtained from all the artefacts and processes created during the research. The ten researchers reflected both on their own experiences and the research results throughout this process. Student feedback on their experiences was obtained through online surveys.



### 5.3. Mobile App project: Research process

The research process of this project continued formally for 14 months, which implies that some of the student activities could be repeated and improved on with new groups of students. The final project report and products have already been delivered to the external stakeholder, although the research is still on-going with similar activities, with a new focus on open education resources as one of the current offshoots of this research.

This section describes the research process in terms of the Driver and the four research phases identified. Bear in mind that this discussion does not present the results of the Mobile App project per se, but is focused on the elements of the collaborative research process that emerged. The results of the project will be presented in other publications.

*Driver 1 – App sourcing and evaluation:* Apps were sourced during various activities by the core research team, the methodology students, and all the third-year and postgraduate education students. In most cases, sourcing was similar to an internet search process. A participant would start either with a mobile app that they used before, read about or heard about from other educators, or they would search in the relevant app store with search criteria that narrowed down the topic, school phase, type of app and some technical aspects. The app was then downloaded and used, bearing in mind the basic criteria prescribed by the research project and the guidelines of the specific activity. This process often led to the discovery of another app, or of a developer of apps or a series of apps. The sourced apps were evaluated using an app evaluation tool that was developed during the research. This tool eventually included technical, quality, teaching and learning, and curriculum-specific criteria. The evaluations were peer-reviewed and formally assessed by researchers.

*Driver 2 – Educational application:* A selection of apps was integrated into context-specific interactive teaching and learning interventions. An intervention planning guide was developed to guide this process. Interventions were designed by the researchers, as well as by the methodology students, and were evaluated through peer-evaluation processes. The final planning guide consisted of three sections: the background, a planning section, and a detailed intervention description, including relevant resources.

#### *Research process phases*

Table 1 summarises the collaborative research process according to the headings Driver; Phase; Action; a brief description of the actions; and the product of each phase. During the investigations into the Case Studies of research projects, four phases emerged. These we named Explore, Learn, Adapt and Apply. These phases are described after Table 1.

Table 1 illustrates two iterations of the collaborative research process as it played out in this Case Study, indicated in steps S1 to S8. S1 to S4 links to Driver 1, followed by S5 to S8, linked to Driver 2.

**Table 1 Mobile App project case study: Collaborative exploration process summary**

Driver	Phase	Action	Description	Product
<b>1. App sourcing and evaluation</b>	S1 Explore	Planning an initial app evaluation tool.	The researchers created a template for mobile app evaluation.	Initial mobile app evaluation tool.
	S2 Learn	Applying initial evaluation tool to source apps: Students.	Students used the initial evaluation tool in a variety of activities and groups to source and evaluate mobile apps.	List of 600+ apps – sorted per subject and school phase.
		Applying initial evaluation tool to source apps: Researchers.	Researchers used the initial evaluation tool to source and evaluate mobile apps, also using students’ app list, as well as input from post-graduate students. Focus on mathematics, science, English and geography.	A list of 200+apps – sorted per subject and school phase.
	S3 Adapt	Adapting the evaluation tool: Researchers.	Researchers adapted the evaluation tool for each unique context during workshops, individual and group reflection sessions.	A generic app evaluation tool, adaptable for specific contexts.
	S4 Apply	Evaluating apps in depth: Researchers.	Researchers used the adapted evaluation tool to evaluate a selection of the most appropriate apps in detail.	A list of 40 apps evaluated according to the in-depth evaluation tool.
<b>2. Educational application</b>	S5 Explore	Planning intervention guide: Researchers.	Researchers designed an intervention planning guide during workshops, individual, and group reflection sessions.	Intervention planning guide.
	S6 Learn	Planning interventions: Students.	Students created interactive interventions as part of various activities based on the intervention planning guide.	A variety of intervention plans.
	S7 Adapt	Planning interventions: Researchers.	Researchers planned example interventions, integrating the most relevant apps evaluated, as well as the intervention planning guide, and also building on students’ input.	A set of 40 intervention plans based on the intervention planning guide, incorporating the apps identified.
	S8 Apply	Reflection and planning: Researchers.	Researchers reflected on application possibilities of intervention planning tool in future activities in the methodology modules.	Possible future intervention planning activities.

**5.3.1. Driver 1: App sourcing and evaluation**

*S1 Explore - Initial app evaluation tool:* The core research team of ten researchers planned the first version of the mobile app evaluation tool during several workshops. They explored a host of resources towards the development of the app evaluation tool (Schrock 2013; Sutton 2013; Tolisano 2012; Vincent 2012; H. Walker 2010), some to a greater and some to a lesser extent. Each team member evaluated a few mobile apps, after which the initial version of the mobile app evaluation tool was finalised.

*S2 Learn - Student app sourcing:* The students sourced and evaluated mobile apps for class activities (undergraduate pre-service student-teachers) and research (eight postgraduate students). The outcomes of the assignments differed per activity and student group. However, in all assignments students were exposed to apps and in depth discussions on how apps can be applied in teaching. One of the outcomes was the evaluation of

apps (600 +) on the app evaluation tool in the format of anonymous surveys. This was submitted on the university learning management system, and was collated into a collection of app evaluations per subject and per school phase.

*S2 Learn – Researcher initial app sourcing:* Each researcher used the spreadsheet template of the evaluation tool during their search for appropriate apps. This process included the download and activation of an app, and working (or playing) through the app while reflecting on its aspects in the tool. This activity exposed the researchers to the mobile apps and challenged them to think about the application of apps in education. The selected apps were evaluated on a spreadsheet. The input of all researchers was finally collated into a single document, which was submitted to the project as one of the products of the research.

*S3 Adapt – Final app evaluation tool:* During this stage, each researcher adapted the tool and criteria to customise them for their own specific subject and school phase. Thereafter, the core research team re-worked and expanded the mobile app evaluation tool into a generic format to inform more in-depth evaluation. This process involved reflections on the research process, team workshops, and the in-depth evaluations of a few mobile apps to assess the tool. The tool was eventually submitted to the project as a product of the research.

*S4 Apply - In depth evaluations:* Each researcher selected at least four apps for in- depth evaluation, based on the guidelines of the evaluation tool. This information was also collated into a single document and eventually submitted as a final product of the research. The pre-service student-teacher activities were included as formal assignments in the subsequent two years –although they were adapted each year.

### **5.3.2. Driver 2: Educational application**

*S5 Explore - Intervention planning guide:* During reflections on the first Driver, the researchers recognised the need for guidance in the planning of interactive interventions that integrate mobile apps into the teaching and learning process. An intervention planning guide was therefore developed and piloted.

*S6 Learn – Student planned interventions:* The mathematics, science and English methodology pre-service student-teachers planned interactive interventions that integrated mobile apps into the teaching and learning process. The plans were based on the intervention planning guide.

*S7 Adapt – Researcher planned interventions:* The researchers used the intervention planning guide to develop at least four interventions each, incorporating the Apps sourced for the first Driver. The resulting intervention plans were collated into a single document, linked to the relevant Apps, and sorted by subject and by school phase. The intervention plans were submitted as a final product of the research.

*S8 Apply – Reflections:* The researchers reflected on the intervention planning guide and process, and planned for their future inclusion in the formal activities of the methodology classes. The planning guide and process

were both submitted as a final product of the research. The pre-service student-teacher activities were included as formal assignments in the subsequent two years –although they were adapted each year.

#### **5.4. Participant experience**

The aim of the research described in this manuscript, was to find ways to support mobile teaching and learning practice development. One of the challenges identified focused on the nature of professional development of educators in the rapid developing field of technology and the application possibilities in education. The following discussion is included in the manuscript as an illustration of the experiences of the students and staff in a collaborative research process as well as the impact on the teaching practice of the Faculty of Education.

##### **5.4.1. Student Experience**

Pre-service student-teachers participated in this research in a variety of activities in the subject-methodology (such as science, mathematics and English) modules as well as in the generic education module attended by all third-year education students in mixed groups (school subject and phase). Each of the ten core researchers designed activities for their methodology groups, and in most cases, two iterations of activities were designed. Activities were based on the app evaluation process, the intervention planning process, and other derived activities. These activities were all designed as a result of the research, and are as such an example of the impact on student experience in the faculty, in the application of mobile teaching and learning concepts.

The generic third-year education module focuses on ICT in teaching and learning, and the content and approach of this module changed completely from a lecturer-centred theory-based strategy to an interactive and applied approach during and as a result of this research. Two iterations of this module were designed during the research, and a third was presented after the research. This is a large group of students (800+) and they attend classes in six mixed groups (school phase and subject speciality). The current teaching strategy is interactive, incorporating concepts such as planning for the use of technology in teaching, social and interactive learning, ethical aspects, mobile learning, open education resources, and 21<sup>st</sup>-century skills. Student activities were focused on the integration of technology into teaching. This group also used the app evaluation tool for one activity. A group of 744 students participated in the first iteration, and 785 in the second. They also planned interactive mobile learning interventions that were evaluated through an online peer-evaluation process. This is an example of how the research impacted on the curriculum as well as presentation mode of one of the modules.

Student completed an anonymous online survey at the end of each semester. Questions in the survey focused on their experience, lessons learnt, suggestions for future courses, and challenges experienced. The survey was analysed to identify positive experiences, negative experiences, challenges, lessons learnt and suggestions. These results will be presented in detail in other publications. A few aspects are presented here as an illustration of the results.

Students mentioned the following positive reflections: their own experience during the process, the broadening of their minds, and the value of the activities for their preparation as future teachers. The question

'Share lessons learnt' yielded a wide variety of comments about how to plan for teaching with technology, how to use specific apps, the value of underlying theories and models to support planning, the importance of interactive teaching strategies, the availability of wider networks of educators to learn from, ethical aspects, how to incorporate 21<sup>st</sup>-century skills in the classroom, and more. One student commented: *"I have learnt to go beyond expectations... and to think outside the box"*

One of the challenges mentioned by students was the availability of mobile devices. The class activities were designed so that students could work in groups. The individual assignments could be completed in the computer laboratories in the students' own time, but they still preferred to work on their own mobile devices. This was a dividing factor. However, each year the number of personal mobile devices available to students noticeably increased. Excellent and free WiFi was available in the teaching venues and in most communal areas in the university, which implied that students did not have to pay for data used.

In future, students could be inspired to bring more conscious thought to the activities, although activity submissions demonstrates that many students have already developed a critical eye for choosing and using appropriate teaching material, as is evident in the artefacts submitted.

#### **5.4.2. Researcher experiences**

The researchers had to work through many mobile apps to find relevant, usable apps to evaluate (including those found by the students) and incorporate in mobile learning interventions. However, immersion in this research for such an extended period, and such detailed work on the sourcing, evaluation and application of apps, inevitably affected the researchers' views and practice. Teaching strategies, course content and activities in the modules were thus changed as the research evolved. Even though many frustrations were encountered, all of the researchers commented on the impact that the experience had on their practice, both as educators and as researchers.

The researchers found it difficult to become accustomed to mobile learning as a teaching strategy. The main reason they provided for this, was the changing possibilities that a mobile device in the hands of each student brings to teaching and learning. During this research, and in the redesign of their own courses, they were gradually applying more mobile teaching and learning principles. Another challenge identified, was that the creating an understanding of useful apps implied full involvement in using these apps, which took time and was not always stimulating. All of the researchers also commented on intrusive and/or unsavoury advertisements, gaps and challenges in some apps, and the fact that not all app content was scientifically correct. They also mentioned issues that might arise regarding young children's development in relation to the use of technology; access to information; their vulnerability, health, and participation in society; geographic, cultural, and socio-economic factors; and 21<sup>st</sup>-century requirements. These factors have also been echoed by other researchers in the field (Nikolopoulou 2014).

The researchers found identification of Bloom's taxonomy levels in the apps fairly problematic, as they indicated that the contexts in which these apps would be used would also have an effect on the level of the taxonomy applied in teaching and learning. It was clear from their reflections and subsequent workshop discussions that different dimensions of Bloom's taxonomy would have to be incorporated in the app evaluations (Krathwohl 2002). The adapted taxonomy was therefore used for the final version of the app evaluation tool. This is another example of how the research impacted on the researchers' development as mobile teaching practitioners.

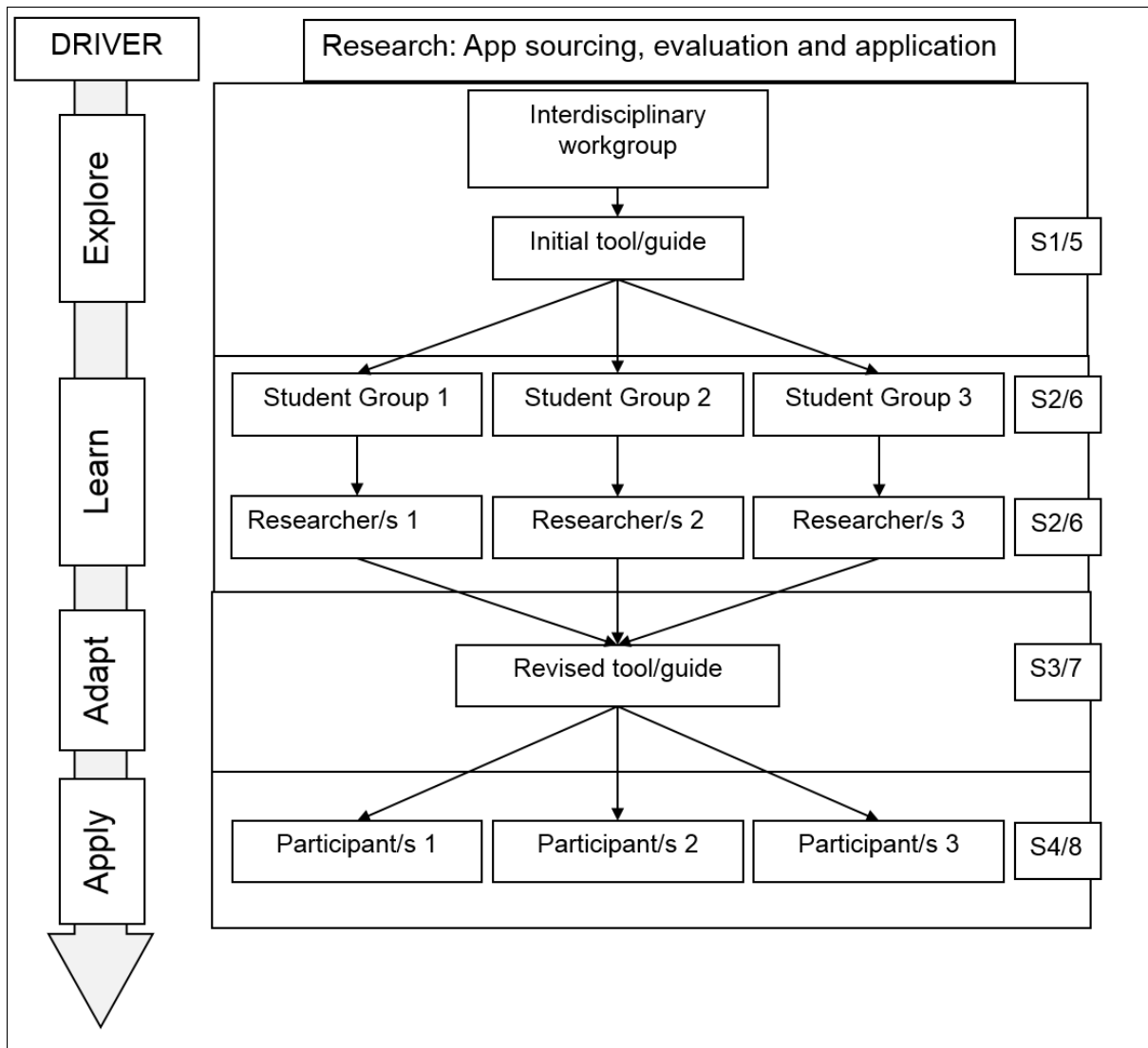
Awareness was created regarding a field of resources and possible applications in teaching, and the research helped researchers to 'test the waters'. The researchers found the investigation into the possibilities and challenges of mobile learning in their school phases and in digital literacy meaningful. They were excited about the possible applications in the classroom, and identified the need to educate students and teachers about the use of apps.

The researchers concluded that mobile learning can provide additional exercises, promote proficiency, provide encouragement, and give different perspectives on content. It can provide support where the classroom setup is dysfunctional. It creates possibilities of connections to international communities, and thus broadens horizons for both teachers and learners. It can counter slavish adherence to textbooks. Planning for mobile learning lifted lesson planning to a different level. The digital divide is addressed between lecturer/teacher and students/learners, as well as in access to technology. The research created an awareness of the advantages and disadvantages of mobile learning, even in poorly resourced schools.

This process rejuvenated the research, as it was about the fun aspects of teaching. The researchers were amazed at other researchers' discoveries. Most of the researchers found working with other researchers in other disciplines stimulating.

### **5.5. Case study summary**

Figure 2 illustrates the case study as it applied the phases of the collaborative research process. The phases identified in the case study are depicted on the left hand side. The two cycles of the research are combined into the four phases in the figure – S1/5; S2/6; S3/7; and S4/8.



**Fig. 2** Illustration of the collaborative exploration process

Figure 2 also illustrates the developmental nature of the exploration process. The Driver is the energiser of the process. The Drivers of the process in the case study, namely the explorative research on the sourcing, evaluation and application of mobile apps, were of paramount importance. The Driver topic was current, relevant to all departments in the Faculty, challenging, and interesting.

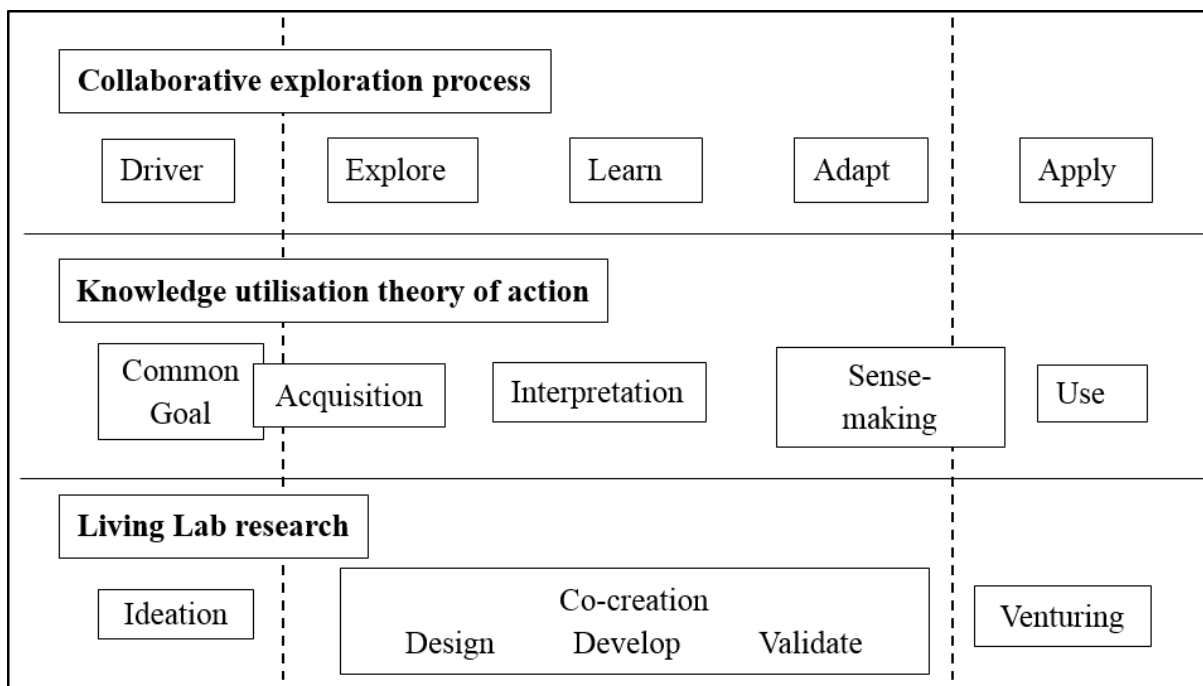
The phases, explore, learn, adapt and apply, are depicted in an arrow on the left-hand side of the Figure to indicate the dependency of each phase on the previous one. The process as it played out in this case study is illustrated on the right-hand side as applied in Table 1.

The process commenced with the exploration phase (S1/5) in the interdisciplinary work group, culminating in an initial product. The learn phase (S2/6) featured collaborative work of different groups of participants and researchers. During the learn phase, this product was applied in a variety of activities - not only applying the actual product, but also co-interpreting it for practice. The results of the learn phase were collated and adapted

in the adapt phase (S3/7), to co-process a revised product. This was incorporated into practice in the apply phase (S4/8). The phase focused on the application or use of the product in different settings and on different levels as is, or to change perspectives, or applied to pre-existing conditions, or to adapt current practice (Kochanek et al. 2015).

## 6. Proposed collaborative exploration process

The preceding case study illustrates the research process designed for interdisciplinary and collaborative research in education. We present it here as a *collaborative exploration process*. Figure 3 depicts this process as compared to the KUTA and LL processes in Figure 1. The dotted lines divides the processes into three main phases, namely a phase of initiation, a co-creation phase, and a phase of application.



**Fig. 3** Collaborative exploration processes

The following discussion unpacks Figure 3. It describes how the proposed collaborative exploration process links to the KUTA and LL phases. It also presents more generic discussions on each phase, participants, products, impact and challenges.

### 6.1.1. Driver

The common goal referred to in KUTA and the ideation phase in the LL approaches is translated into the Driver in our projects. In KUTA this decision is included in the initial stages of the acquisition phase. This is typically initialised by a research request from external stakeholders, or a challenging area in practice, or an identified research focus area within the Education environment. During this phase, preliminary information is gathered to inform a decision to continue with the research (or not). Possible stakeholders are also identified and informed about the research.



In our research projects, we found that the Driver was of paramount importance. The research was based in formal research for an external stakeholder. The collaborative exploration process went through two cycles during this research. The first Driver was linked to mobile app sourcing and evaluation, and the second to educational application of these resources. Both Drivers were perceived as current, relevant to all departments in the Faculty, challenging, and interesting. The expectation that a product had to be delivered to an external stakeholder also created a sense of urgency.

The *challenges* in this part of the research were in finding appropriate, challenging, relevant interdisciplinary drivers, in identifying stakeholders, and in managing the initial phases of the research.

### 6.1.2. Process phases

The collaborative exploration process itself developed into four distinct phases. This is a brief summative reflection on each phase, referring to the activities in the case study, products, participants, impact and challenges of each phase. The phases repeated again as part of ongoing research in the case study.

- *Explore*: The latter stages of the acquisition phase in the KUTA, and the develop phase in co-creation in a LL, are translated to the explore phase in our collaborative exploration process. ‘Explore’ indicates the openness of the initial phase, where input from other sources as well as our own experiences can feed into the development of the research with as little restriction as possible. We found that this was one of the key aspects in the collaborative research process, which possibly distinguishes it from other traditional research processes. This is also the reason why we propose the name of the process as a Collaborative Exploration Process, rather than a Collaborative Research Process.

In our case study, activities consisted of interdisciplinary workshops focusing on the design of a preliminary *product* (a tool / guide / template / process – depending on the project). *Participants* in this phase were interdisciplinary groups of education researchers from different departments in the Faculty. The *impact* of this phase was in the new experience (for most participants) of working in an interdisciplinary collaborative research group with a common goal, as well as in awareness of the specific Driver topics.

The biggest *challenge* in this phase was to focus the research within the desired project, but also to create an open environment conducive to innovation. Managing participants and initial activities were also challenging, mainly due to the open nature of the research.

- *Learn*: The interpretation phase in the KUTA, and the development phase (within co-creation) in the LL paradigm, is translated into the learn phase in our collaborative exploration process. In KUTA, this implies the disaggregation and co-interpretation of information as individuals and as groups. In the LL, this implies development of new ideas or adaptation and integration of existing ideas.

During this phase in our case study, numerous activities were designed to test and use the product/s of the explore phase. *Participants* included different groupings of pre-service student-teachers, postgraduate education students, and the group of education researchers and other education lecturers. This phase was at the core of the process, as all participants had the opportunity to be innovative and to

experiment with the product, in the process constructing their own learning within the specific Driver topic. The activities were designed to foster a robust and very open learning process. The purpose of researcher participation in this phase was to reflect on and formalise the learning processes to feed into the researchers' own teaching and research, as well as into the next collaborative exploration phase. The *product* of this phase was a collection of different types of artefacts (depending on the product used) created by both pre-service student-teachers and researchers.

The *impact* of this phase was in the development of mobile teaching practice for all participants. Both undergraduate student-teachers and postgraduate education students were exposed to mobile teaching practice, and they could find, evaluate and create resources and plan for applications in their own specialised fields. Students also valued the opportunity to participate in real-life research projects during their studies. Researchers designed and experimented with mobile teaching approaches in their own practice as educators.

The *challenges* in this phase were mainly in keeping track of all the activities, collating data and artefacts, and ensuring that all were still within the focus of, and related to, the expected outcome of the research, as well as being of a sufficiently open nature to inspire innovation. Where large groups of students were involved in activities, the administration and management of these activities and artefacts proved time-consuming. Keeping track of the learning processes was inspiring, but also a daunting task, as this needed to be transferred into the next phase of the research.

- *Adapt*: The adapt phase in the collaborative exploration process corresponds to sense-making in the KUTA and to validation in the co-creating phase of the LL paradigm. This implies co-processing, interpreting and integrating the experiences and outcomes of the previous phase into existing understandings, while at the same time in the process developing new perspectives.

The *participants*, a group of education researchers and postgraduate education students, adapted the *product* (tool / guide / template / process) developed and implemented by, and also based on the artefacts created by, the experiences and feedback of the participants in the learn phase.

The *impact* of this phase was seen in the experiences of researchers of working in a collaborative and interdisciplinary way with these tools / guides / templates / processes, as well as on plans to apply these experiences to the formal teaching and research activities in the Faculty.

The *challenges* in this phase were in the complex nature of sense-making during co-processing. Decisions about which results are usable, and which are not, were also not easy. Reflection was important throughout all phases, but this phase in particular relied heavily on the reflections of researchers to ensure that well-grounded decisions are taken for future teaching and research practice. Products also had to be prepared as deliverables for the formal projects that guided the case study, which was a time-consuming task.

- *Apply*: According to the KUTA process, the last phase is the use phase. Outcomes of research can be used at different levels: either as they are; or to change perspectives; or applied to pre-existing conditions; or to adapt current practice. The last phase in the LL paradigm, is venturing, during which the product, or result of the research, is disseminated and implemented.

In our research, the final phase, apply, implied the dissemination of the research and the release of the tool / guide / template / process for use by other educators, as well as the incorporation of the *final products* into the formal teaching and/or research activities of the Faculty. The *participants* are the project manager of the project was responsible for the former, and education researchers for the latter. The *impact* of this phase was seen, where tools / guides / templates / processes were accepted, on the mobile learning teaching practices of the education researchers as well as on the experiences of pre-service student-teachers. In both case studies, the activities incorporated during the learn phase were incorporated into different education subjects as formal assignments.

The *challenge* in this phase was to ensure that the collaborative exploration process does not stop here, and that teaching and research practice utilising these products evolves continuously in conjunction with the changing field of mobile learning.

## 7. Conclusion

The guiding questions of this research were:

- *Which phases can be identified during collaborative research in mobile teaching and learning practices?*
- *Which collaborative research process can be designed to support mobile teaching and learning practice development?*

This research proposes a collaborative exploration process that can foster teacher professional development in the research and implementation of mobile and other new technology in teaching and learning in a Faculty of Education. The proposed process is initiated by a Driver, followed by the phases explore, plan, adapt and apply, as illustrated in Figure 2. The process was developed through projects generated in a Living Lab for innovative teaching research at a Faculty of Education. The interdisciplinary and collaborative nature of the Living Lab research approach and the Knowledge Utilisation Theory of Action provided the theoretical underpinnings for the eventual process proposed. The nature and structure of the Living Lab provides the management and technical support for the process, and also creates the interdisciplinary collaborative environment.

Challenges during this process was discussed in the descriptions of phases. The biggest challenges of the collaborative exploration process lie in the complex nature of interdisciplinary research and the availability of appropriate drivers.

The strength of the collaborative exploration process lies in its interdisciplinary and open nature, exposure to and experimentation possibilities for students and lecturers with new technology in a safe environment, and in the usability of the products for future teaching and learning activities. The integration of teaching and research activities, as well as the collaborative nature of the process, are also beneficial, especially to inexperienced teachers and researchers.

The collaborative exploration process is proposed for groups of educators and pre-service student-teachers who are addressing the challenges of incorporating new technology and other developments in education into their

teaching practice and research. Embedding such a process in both the teaching and the research activities in the Faculty can integrate the professional development of student-teachers; lecturers; and researchers.

The process was applied in another research project at the Faculty Living Lab. The Driver is the design of open education resources for an open school system. The process is currently in the adapt phase. This will be presented in future publications. Future investigations will need to explore if/how this process can be replicated in, and adapted to, other educational research initiatives. The processes and tools designed during the case study described in this research will also be presented in other research papers.

We hope that the collaborative exploration process will positively influence the development of teaching and research practice of lecturers and pre-service student-teachers. The words of one of the student best encapsulates the impact of the process on her professional development:

*“The theme has opened new ways of teaching for me. I have never been a great fan of technology in the classroom. However, after this theme I was able to discover how effective and creative it can be. I have learned that technology in the classroom does not take away the importance of the teacher, but gives the learner more responsibility in the classroom to create his/her own knowledge and be able to express it in a way that he/she understands best.”*

A Faculty of Education should be a safe space where challenging aspects, such as mobile teaching and learning practices, can be investigated and developed. The proposed process can be applied to the practices of the Faculty, thus formalizing support for educators to explore teaching and learning possibilities; and to promote interdisciplinary collaborative research in the field. Future research can investigate the applicability of this collaborative exploration process for other challenging topics in educational practice and research.

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