User-centered applications: Use of mobile information technologies to promote sustainable school healthcare services

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ABSTRACT

The youth, especially school going children, are the future of any society. It is therefore important that children should receive adequate healthcare support at an early age in order to strive to preserve and ensure better education and welfare of the children and continuity in societal success. Despite the strategic initiatives that aim at improving the general health of school going children, such as South Africa's Integrated School Health Policy, there still exist challenges in support programmes meant to alleviate the barriers to effective healthcare towards improved education for the school children. Advances in ICT enable a fundamental redesign of healthcare processes based on the use and integration of electronic communication at all levels. New communication technologies can support a transition from institution centric to user-centric applications. This paper defines key principles and challenges for designers, policy makers, and evaluators of user-centred technologies for healthcare in schools. The paper employs the User Experience Management Model (UXM^2) to review the current and emerging trends, and highlights challenges related to the design of a typical m-ICT application that supports delivery of healthcare in schools. The paper reaches conclusions for next steps that will advance the domain.

KEYWORDS: Healthcare, m-ICTs, school health assessment, user experience, user-centred, user experience management, education institutions, change management.

CATEGORIES:
H.5.1 [**Information interfaces and presentation**]: Multimedia information systems—*evaluation/methodology*
H.5.2 [**User interfaces**]: Evaluation/methodology, theory & methods—*design science research, design-based research*
K.6.1 [**Management of computing and information systems**]: System development, training—*change management, sustainable long-term user experience*

ARTICLE HISTORY

Received 25 February 2015
Accepted 8 April 2015

1 INTRODUCTION

A robust education and health system is of critical importance to the sustainability of the economy of any society. South Africa, just like many of the African countries, is faced with challenges caused by poor healthcare service delivery, which leads to increased infant and maternal mortality and poor educational performance. The impact of poor healthcare and underperformance in education system on global and national development is overwhelming. This has resounding effects on individuals, families, communities and nations, and represents a formidable barrier to sustainable social and economic emancipation and development.

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It was in this light that improving the quality of healthcare and education featured as cardinal points in the Millennium Development Goals (MDGs). Provision of quality healthcare is important especially for school children. The youth are the future of any society hence it is important that they should get good education and healthcare. This has been far from being accomplished in most rural areas in South Africa. The Department of Health of South Africa instituted the Integrated School Health Policy, which aims at improving the health of school going children [1].

The use of Information and Communication Technologies (ICTs) has been put forward as an enabling tool to support healthcare services in schools. In order to effectively deliver healthcare services in schools, this paper look at the development process of the School Health Assessment App, which is a mobile ICT healthcare application that supports the health assessment

activities performed by school nurses, in schools. This article presents a User Experience Management Model (UXM^2), which emphasizes on considering the needs of the users when developing applications. The model act as a guide that provides steps that has to be followed in order to produce a product that promotes a sustainable, long-term, positive user experience. The proposed UXM^2 was used during the development and implementation of the School Health Assessment mobile application.

Section 2 of this paper provides background information and sets the scene on school healthcare, in context of typical rural areas in South Africa. The research design and methodology are presented in Section 3, and the synthesis of UXM^2 is explained in Section 4 and 5 respectively. Section 6 discusses the application and results of the UXM^2 in the development of the School Health Assessment mobile application followed by discussion of the results in Section 7 and the conclusion in Section 8.

2 BACKGROUND

It is critical that school-going children should be healthy in order for them to benefit from educational programs. When school-going children are healthy, one can expect that their performance in education as well as other socio-economic activities will improve [2]. The provision of healthcare services in schools ensures better educational outcomes, achieves greater social equity, and increases the efficacy of other investments in child development [3]. Since children spend most of their time at school, it becomes important that they should be provided with extensive healthcare support while they are still at school. Such interventions, at a young age, have the potential to support a healthy youth force that can be influential change champions for good health practices in the societies.

In 2012, South Africa's National Department of Basic Education in collaboration with the National Department of Health formulated the Integrated School Health Policy-2012 (ISHP), as a mechanism to improve the general health of school-going children and to address health barriers to learning, in order to improve education outcomes [1, 4]. The context in which the ISHP is implemented poses many challenges and in many parts of South Africa, school health services are not functioning at all.

During a review by the research team in 2013 regarding the implementation of the policy, nurses identified a number of issues that impact on the provision of quality services. These issues include:

- Insufficient staff and infrequent visits to schools, limiting their ability to give children the time and attention that they need;
- Lack or insufficient basic equipment such as scales to weigh children;
- Lack of a conducive environment in classrooms for assessment and examining children properly, including mental health assessment due to the lack of privacy;

Following this premise and identified inadequacies, the former Minister of Science and Technology, Mr Derek Hanekom, launched the Technology for Rural Education Development (TECH4RED) project in joint efforts with the Department of Basic Education and the Eastern Cape Department of Education in 2012. The project was initiated in the Cofimvaba district schools. The objective of TECH4RED was to use technology-led innovations to improve teaching and learning in rural schools [5]. The project initially focuses on 26 schools in the Nciba Circuit, which falls within the Intsika Yethu Local Municipality in rural Eastern Cape. These schools serve as a "testing ground" to evaluate different ways in which a range of technology-intensive interventions could enhance the teaching and learning of maths, science and technology.

Since the quality of teaching and learning is influenced by a range of environmental factors such as school health, an eHealth Working Group was appointed to demonstrate the use of mobile devices with specific mobile applications to improve access to school healthcare and health education. The approach taken was a holistic one and included technology interventions in the education sector as well as ICTs, nutrition, health, water, sanitation and energy. Various "Working Groups" were responsible for the aforementioned sectors. A School Health Assessment mobile application was developed in pioneering this research.

The success of projects such as those in the context of TECH4RED requires a user-centered design approach that aims at promoting development of products that provide a sustainable long-term positive user experience.

2.1 Purpose of present research

The purpose of the present research is to introduce mobile technologies as enabling tools for the re-institutionalisation of the school healthcare system. The role players in the school healthcare system consist of school nurses, who are facilitating and implementing the system at school level, as well as the schoolchildren who are the recipients of such healthcare services. The aim of using technology is thus to enable school nurses to expedite school healthcare in such a manner that all school-going children could benefit from it. This research seeks to develop mobile applications that address the needs of the target users through adoption of the UXM^2, which advocates for a comprehensive user-centered design approach.

Section 2.2 following, demonstrates the need for effective user-centered instead of institution-centric approaches for mobile healthcare services in education schools. To address the purpose of this research a model, UXM^2, is proposed to guide the development of a typical mobile healthcare application in order to promote sustainable long-term positive user experience. The applicability of the model is then demonstrated by applying it in the development of a school health assessment mobile application to be used in a typical rural context in South Africa. This article relates mainly to the development of the school health screen appli-

cation, but also illustrates importance of the UXM^2 towards guiding the development of user-centered ICT products providing a sustainable long-term positive user experience.

2.2 The need for a user-centred approach

The introduction of new technologies does not only has an impact on business processes but also results in a lifestyle change of the people using the technologies [6]. A user-centered design seeks to consider the needs of the people and address those by providing a product that is fit for use and fit for purpose for the target users [7]. Such an approach also requires that the change in the user experience of the people should be managed in order to promote a sustainable long-term positive user experience [8]. A user-centred approach ensures that the needs, capabilities and expectations of the target users are met. Furthermore involving users from the early stages of the designs brings a sense of belonging to the users of the product and promotes brand loyalty and long-term positive user experience [8]. A user-centred approach promotes a product to be accepted and to be used by the target users, the approach reduces the likelihood of resistance towards product adoption [9].

Most ICT applications have been aimed at only satisfying the business objectives of the institutions disregarding the needs of the target end users. Furthermore, the current user-centred design approaches are mostly focused on the product development lifecycle. They are inadequate in addressing a variety of factors that influence the use of the product outside its features. They also fail to acknowledge that user experience evolves over time or the need for a sustainable long-term user experience. It is because of these inadequacies that the researchers opted to develop the UXM^2 and to implement it in the designing of the School Health Assessment App.

The next section describes this research process.

3 RESEARCH DESIGN AND METHODOLOGY

The research methodology followed in this research is two-fold. The first part borrows aspects of design science to develop an artifact in the form of a model, the UXM^2. Secondly, a Living Lab methodology's emphasis on needs-driven solutions and co-creation, where technology designs would follow reiterate cycles, lead by the users' needs and expectations.

The research was conducted in the Cofimvaba Living Lab. Cofimvaba is one of the Siyadala Living Labs (an umbrella body for a number of Living Labs) in the Centre for Community Technologies (CCT) of the Nelson Mandela Metropolitan University.

4 DESIGNING THE USER EXPERIENCE MANAGEMENT MODEL (UXM^2)

The UXM^2 was developed following the phases of a generic procedure for developing a model illustrated in Fig. 1. This generic procedure for developing a model is an adaptation of various approaches used to develop models [10, 11, 12, 13]

The generic development procedure commences with problem identification followed by the identification of requirements that are needed for the model. After this, a strategy for developing the model is determined, and thereafter the model is built. Building the model entails scoping the focus areas that the model is intended to solve, designing the model by articulating the target users of the model, and populating the components of the model into a domain component diagram. The model is then evaluated for its validity, relevance and rigor. Upon satisfaction, it is presented to the target users and finally, the model is applied for use in the relevant context and maintained to address any arising situations. The application of the proposed generic procedure for developing a model, the UXM^2, is discussed next.

4.1 Phase 1: Problem definition

The problem that has been identified in this study is that there is a need for comprehensive user-centred approach for designing mobile ICT applications in order to promote sustainable school healthcare services. This has been attributed to a lack of a user-centred criteria for managing user experience in order to promote a sustainable long-term positive user experience.

4.2 Phase 2: Requirements identification

The development of a product that provides a sustainable long-term positive user experience, requires the determination of the various factors that influence user experience and product design methodologies, that promote the acceptance of the product as well as measures that ensure a lasting positive user experience. This involves preparing the target users, implementing the product, sustaining the user experience, and monitoring and evaluation [8].

4.3 Phase 3: Determination of the strategy to develop the UXM^2

As mentioned earlier, the introduction of new ICT brings changes in the lifestyles of the people that have to use it as well as the business processes. The UXM^2 makes use of concepts from user experience and change management. Hence, the strategy employed is to combine aspects from existing models in change management and user experience in the development lifecycle of a product. Components of models from change management are transferred and used in developing ICT products for sustainable long-term positive user experience.

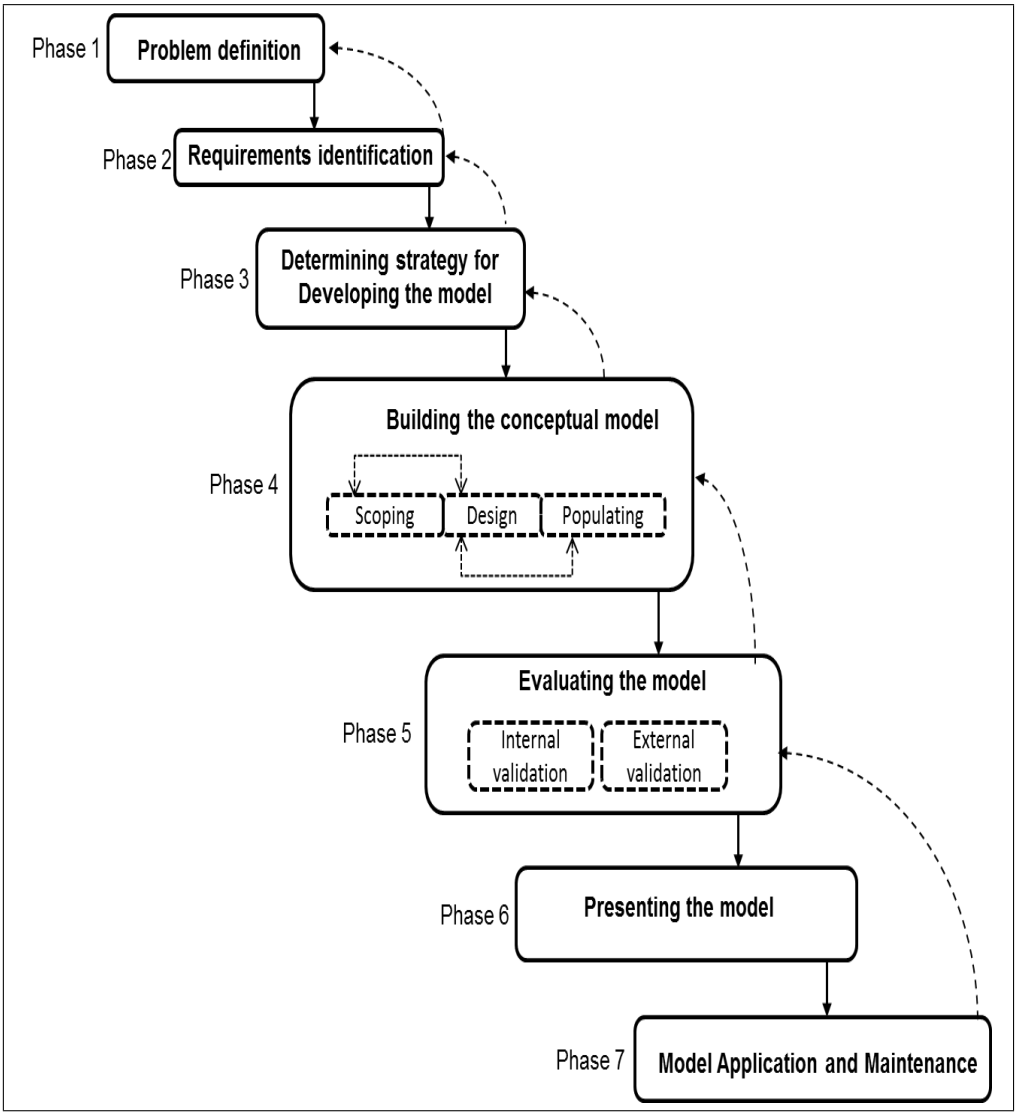

Figure 1: Generic procedure for developing a model

4.4 Phase 4: Building the model

The UXM^2 was constructed following the steps of the generic procedure for developing a model in conjunction with the main phases of developing a model proposed by De Bruin et al. [13] as follows:

Step 1 (Scoping): The purpose of the UXM^2 is to provide a comprehensive guide on how to develop and introduce ICT products in a manner that promotes a sustainable long-term positive user experience to the people using interactive products.

Step 2 (Designing): These steps entail identifying the target users of the model, how they will use the model and what they will achieve from using the model. The target users of the proposed UXM^2 are user experience practitioners and product designers. The model is aimed at guiding user experience practitioners to manage user experience by directing the design of products for positive user experience. For product designers, the UXM^2 serves to provide user-centred design directions for the designing of products for positive user experience.

Step 3 (Populating): Populating involves bringing together the domain components that make up the model. The proposed model consists of factors impacting user experience, requirements for managing the identified factors, and techniques for implementing the requirements to manage the factors. The constructs of the model are from the user experience domain, from which the factors that impact on user experience are identified as from the change management domain, from which it incorporates the requirements for managing user experience presented in the User Experience Management Requirements (UXMR) Framework [8].

4.5 Phase 5: Model evaluation

The model should be tested for its internal and external validity. The evaluation seeks to determine the rigor and relevance of the model. The model has not yet gone through evaluation at the time of writing this paper. The model shall be evaluated by means of interviewing subject domain experts. These interviews will be conducted based on scenarios that simulate the

real use cases of the model. The experts will then be asked to evaluate the applicability and relevance of the model, based on the scenario.

4.6 Phase 6: Presenting the model

The UXM^2 will be presented to academic audiences at internationally recognised conferences and journals in Health Informatics, Human Computer Interaction and User Experience, with the objective of contributing to the body of knowledge in the respective domains.

4.7 Phase 7: Model application and maintenance

The applicability of the model has been demonstrated through the development of the school heath assessment application described in section 6. The proposed model is discussed next.

5 USER EXPERIENCE MANAGEMENT MODEL (UXM^2)

The UXM^2 is a comprehensive artefact that brings an extensive approach to user-centered design. The comprehensive nature of the model lies in the fact that it delves from institutional-centric approach of developing products to user-centric approach. Furthermore, the UXM^2 goes beyond the traditional user-centered design approach, which only focuses on the product development lifecycle. The UXM^2 acknowledges that there are a variety of factors outside the use of the product that influence the user experience of a product. These factors should be investigated and addressed prior to developing the product. Secondly, the model is based on the understanding that user experience evolves over time, hence the transitions in user experience have to be managed in order to attain a sustainable long-term positive user experience. Another novel characteristic of the model is that it provides a user-centric approach by considering the long-term user experience, contrary to the traditional user-centered design approach that measures user experience as episodes of interaction and not as cumulative feelings, hence the model advocates for the inclusion of impact assessment.

The UXM^2 consists of six phases as illustrated in Fig. 2. The phases are iterative and there is a process of monitoring and evaluation at each phase.

The components of these phases are discussed next.

5.1 Phase 1: Research and discovery

The first phase of the UXM^2 requires researching and discovering the factors that influence user experience. This involves determining who the users are, what tasks they perform as well, as when and where they interact with the product. It also entails identifying why and how the users would want to use the product. Other profile characteristics of the users such as social status, cultural values, technological perceptions, etc.—which do not directly relate to the features of the product—should also be investigated.

Techniques like context inquiry, interviewing the users, survey, expert inspection methods, user observations, user testing and document analysis are used during research and discovery. The expected output of the research and discovery phase is a list of factors that influence user experience.

5.2 Phase 2: Establishing the concept and strategy

Phase 2 deals with establishing the concepts and formulating the strategy for developing products for a sustainable long-term positive user experience. The strategy for developing products for positive user experience is formulated based on the factors that were derived from Phase 1.

Formulating a strategy involves gathering a guiding team as identified in change management [14, 15]. The purpose of the guiding team is to sponsor and support the user experience management initiative. The team should consist of people who are trusted, respected leaders in a community, thus people who have power to influence others in order to have buy-in from others. The techniques for gathering a guiding team include key-role mapping.

Once the guiding team has been established, the next step is to recruit a cross-sectional representation of stakeholders in the community to participate in the project. A cross-sectional representation of stakeholders ensures that the product will satisfy the needs of almost everyone who will be users of the product. The role of the user experience practitioner is to be the mediating party among the rest of the stakeholders and to ensure that all parties are satisfied with the product. The mediation process includes requirements specification, user experience evaluation, and managing the change in user experience.

Step 3 involves formulating the strategy for implementing the process of managing user experience. This strategy is formulated through steering committee meetings and brainstorming sessions with stakeholders. The implementation strategy entails planning what has to be done and at what stage, and defining the responsibilities of the team members as well as the expected timeline for each activity. The goals of user experience management and the metrics for assessing the desired user experience objectives have to be defined during planning. The implementation plan also specifies the criteria for assessing the impact of the process of managing user experience.

The strategy is formulated through key-role mapping to identify the guiding team and stakeholders in order to derive at the most applicable plan for managing user experience.

The output of this phase is a user experience management strategy.

5.3 Phase 3: Implementation

The ADKAR model as put forward by Hiatt [16] informs this phase through Awareness, Desire, Knowledge, Ability, Reinforcement. The implementation

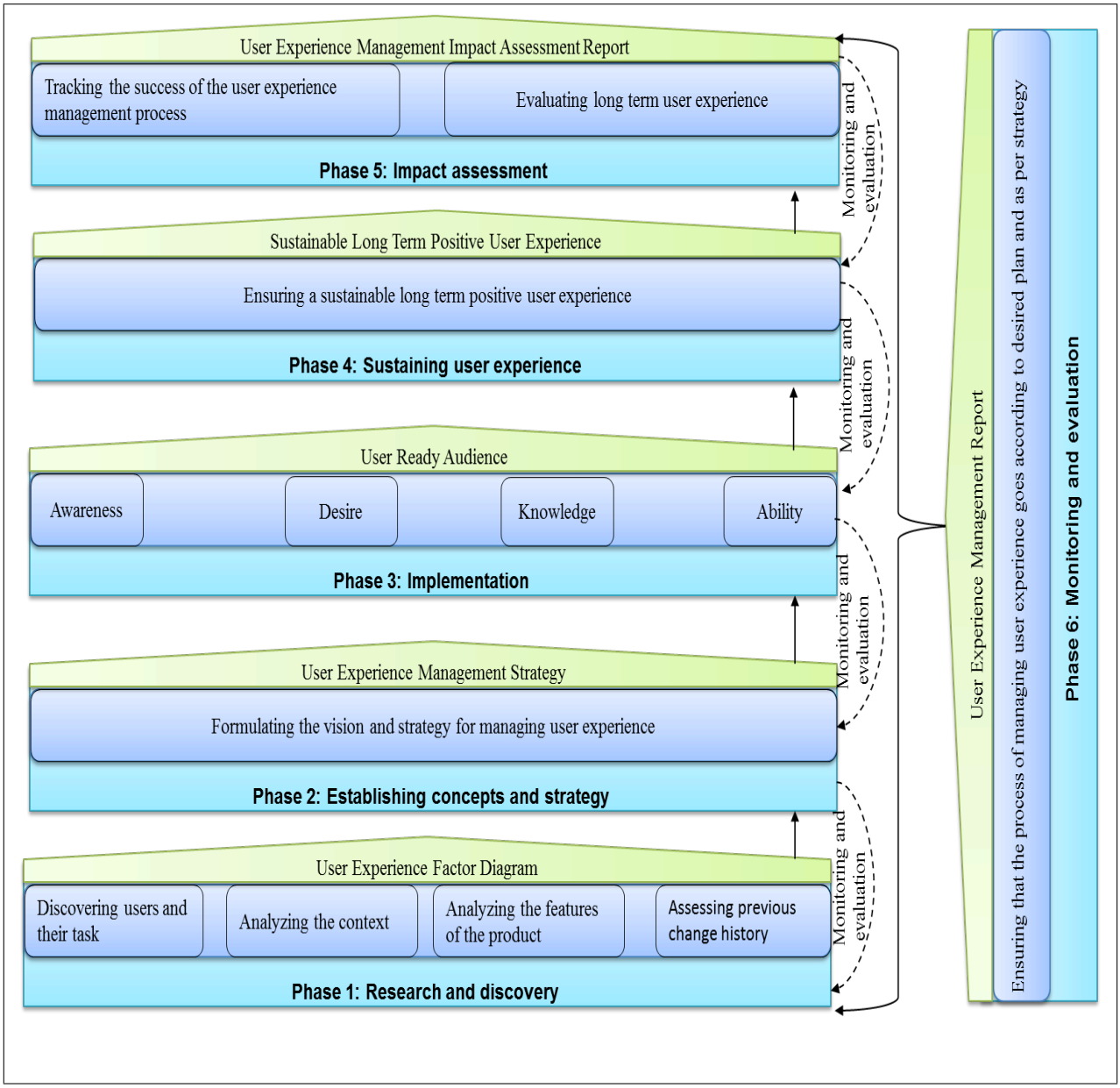

Figure 2: User experience management model (UXM^2)

phase involves putting the strategy that was formulated in Phase 2 into action in order to achieve a sustainable long-term positive user experience. The chosen requirements, activities and techniques for developing a product for positive user experience should be amalgamated and utilised to follow a defined strategy for successful positive user experience.

During the implementation phase the users have to be made *aware* of the product, its features, and the benefits of using the product. If the product is already in existence, it is important to make the users aware of any changes introduced as well as of the benefits of the changes. The techniques for bringing awareness include advertising, promotions, workshops and meetings.

After awareness creation, it is important to cultivate a *desire* to adopt and use the product. People may be aware of the product, but may lack the willingness to accept and use it. Hence there is a need to promote a desire to use the product. User education, use of change champions, participatory design, and designing for persuasion, as well as emotion and trust, all help to cultivate a desire in users to embrace the product for a long-lasting positive user experience.

A desire to interact with the product does not necessarily convert to product adoption and usage. Users need to have the *knowledge* to use the product. They need training, support and coaching, so that they become conversant with the product and its features. Thereafter, it is important that the users demonstrate that they are able (*ability*) to translate their knowledge into action while interacting with the product. Ability is demonstrated through continuous hands-on usage of the product and users may be assessed for their effectiveness and efficiency through user testing.

The expected outcome of successfully implementing the strategy for managing user experience is a user-ready audience. User readiness refers to positive receptiveness of the product by the users. Once a pos-

itive user experience is attained, the next step is to sustain it continuously.

5.4 Phase 4: Sustaining user experience

Once the users have shown an affinity to accept the product and have demonstrated some positive user experience, the positive user experience has to be reinforced to make it stick. Sustaining the user experience ensures that the users become loyal to the product or brand despite the changes that may have been introduced or might be introduced in the future. The users will then not switch to another product offering the same functionality or service.

The activities of sustaining user experience include continuous research and improvement of user experience. The techniques for making user experience stick include persuasive, emotional and trust research, and agile design processes for user experience. This also involves sharing success stories on how the product proved to be efficient, effective and satisfactory. Such techniques aim to keep the users captivated by the product with which they interact, and to nurture permanent free-will behavioural changes by appealing to the social influence factors of the people.

The expected outcome from sustaining user experience is a sustainable long-term positive user experience.

5.5 Phase 5: Impact assessment

The purpose of impact assessment is to determine more broadly whether the process of developing the products for positive user experience yielded the desired effects on individuals, and whether those observed effects are attributable to the intervention. The desired outcome (that is, long-term positive user experience) is evaluated based on the baseline that has to be established before the intervention, as well as after the intervention. Impact assessment further determines whether or not the noted improvement in user experience is as a result of the user-centered design process criteria.

Counter-factual scenarios of a control group and a treatment group have to be set to determine if the observed improvement in user experience has resulted from the intervention or not. The treatment group is the selected sample to be subjected to undergo the user experience management process. Qualitative, quantitative and participatory impact assessment methods, together with long-term user experience management methods, have to be used as techniques to assess the impact of the process of managing user experience. An impact assessment report regarding managing user experience during an intervention is produced at this phase.

5.6 Phase 6: Monitoring and evaluation

During monitoring and evaluation, user experience is measured and any deviations from the planned strategy are noted. This provides feedback on how to improve the process of managing user experience in the subsequent steps as well as during other projects. Monitoring and evaluation occurs throughout the whole process of managing user experience to ensure that it is executed according to plan.

Monitoring and evaluating entails determining whether the factors that influence user experience are fully explored, ensuring that the strategy for managing user experience is adhered to, and making sure that the user experience is sufficiently sustained. Corrective measures are taken based on what may have gone wrong, and lessons are consolidated on how to improve the process in similar projects, aimed at developing products for positive user experience. The output from monitoring and evaluation phase is a user experience management progress report.

The model was implemented in the designing of the School Health Assessment App and is discussed next.

6 THE SCHOOL HEALTH ASSESSMENT APP

The School Health Assessment App is a project to demonstrate the use of technology to improve School Healthcare [17]. The primary objective of this project is to make use of mobile devices with specific mobile applications to improve access to school healthcare and health education based on the needs of the schools in rural Eastern Cape. The project runs under the scope of TECH4RED, institutionalised under South Africa's Integrated School Health Policy.

The target users of the School Health Assessment App are school nurses who assess the health conditions of school-going children in close collaboration with teachers. The app allows the nurses to screen the children for a number of common physical conditions. Hearing and vision tests are two of the most frequent evaluations, because abnormalities of these senses are often subtle, and neither parents nor teachers nor children may recognize that a problem exists. It is important that these conditions should be detected prior to the child enrolling for school and should be continuously assessed as some may have been missed while others might develop later. Such conditions may be difficult to identify if they are mild for example, a child who has difficulty reading the blackboard may not know that she or he is seeing differently from anyone else. Nevertheless, even mild anomalies can significantly affect a child's ability to learn.

The first functional prototype of the School Health Assessment App was released for evaluation in August 2014. The app was installed on Android tablets and uses store and forward technology, which allow users to create electronic learner health profiles whilst off-line and send the data to a central repository when connectivity becomes available. This feature is extremely useful as connectivity in remote areas is unreliable and data-transfer costs are high. Another user-friendly feature of the application is the checklist-layout of the screens. This minimizes the amount of text to be

entered by the user, limiting errors and misinterpretations.

In addition to the health-assessment application, 'WhatsApp', a cross-platform mobile messaging application, was installed on all devices to allow the nurses to send messages without having to pay for the service, as it uses the same Internet data plan as the Android tablets. User-groups were created that put the school nurses in contact with one another when support was needed and contact with the clinics was not possible.

7 APPLICATION OF UXM^2 TO DEVELOPMENT OF THE SCHOOL HEALTH ASSESSMENT APP

This section describes how the UXM^2 was employed to develop the School Health Assessment App's user experience management process.

7.1 Phase 1: Research and discovery

In this phase the researchers set the scene by determining the needs of the nurses, the schools and the Cofimvaba community to contextualize the research and understand the social and cultural characteristics of the target community. The issues covered in the research and discovery phase were the geographical mapping of the schools in relation to the clinics and the clinics in relation to the district hospital.

School nurses, who are the intended users of the app, were profiled to understand their familiarity with technology, what technology were used on a daily basis and to determine the work processes followed during health assessment at the schools. The majority of the nurses lacked prior experience in using computers. On the initial contact the people exhibited to have some fears of using the technology. The users were novice level, especially to touch screen devices. They are all from a cultural background that values education, willing to learn and they are very receptive to change.

7.2 Phase 2: Establishing the concepts and strategy

The app was developed in collaboration with the users. The users were constantly consulted during the development phases from requirements gathering, conceptual design and project implementation. Business processes were translated into user requirements, which informed the development of the app. Each development cycle was reviewed and tested with the users until a function prototype was ready to be tested in the field.

7.3 Phase 3: Implementation

Using the UXM^2, users were made aware of potential benefits of using technology to enable them to work smarter, not harder. The environment they worked in, called for innovative solutions and the School Health Assessment App was seen as just that.

The users were part of each development cycle, which created a desire to participate, as their voices were being heard in the development of a solution that would address their needs. Suitable equipment, such as Snellen Charts for vision testing, electronic hearing testing devices, electronic scales and audiometers to weigh and measure the height of a child, etc. were provided to enable accurate readings during health assessment. This also contributed to create desire amongst the users.

Once the prototype was ready for field-testing, users were trained on the devices and the application. Some users were less proficient in the use of touch-screen devices than others, but this was overcome with regular usage of the devices. Importantly, it was communicated to the users that the technology was not aimed at replacing the users but to complement their tasks and make them more efficient.

7.4 Phase 4: Sustaining user experience

In order to establish a peer-to-peer support network, WhatsApp groups were created on each device. This enabled the users to communicate with each other should they experience any difficulties. The research team undertook monthly visits to Cofimvaba, accompanied by the developer himself, to immediately resolve any issues that cropped up and to implement updates to the system. Problems that occurred outside these monthly visits were addressed immediately, which strengthened the trust relationship between the research team and the users.

7.5 Phase 5: Impact assessment

Impact assessment is a critical component of the research. It measures the impact the intervention has on all role players, whether it is positive or negative. The first positive impact was measurable only eight weeks after the first prototype was deployed for testing.

Table 1 depicts the impact per participating clinic including the sub-district.

Table 1: Conventional assessment methods vs. mobile assessment application

Name of clinic	Number of children screened per day	
	Conventional assessment	Mobile assessment app
Qamata Clinic	20	60
Banzi Clinic	20	20
Ntshingeni Clinic	20	20
Sabalela Clinic	40	91
St Marks Clinic	20	60
sub-district	20	20

Clinics Qamata, St Marks and Sabalela reported significant increases in the number of pupils screened per day. They used to screen only 20 children per day but since the introduction of the app and appropriate equipment, the number increased to 60 children per day. Sabalelo Clinic reported an increase from 40 to 91 children screened per day. The school nurses

at Banzi and Ntshingeni Clinics as well as the sub-district were still not proficient in using the tablet PCs and therefore still reverted to using the paper forms during assessment. These records were then captured in electronic format once back at the clinic. They were thus still struggling with using the devices, not using the application, and did not show any increase in the number of children screened. Peer support activities were arranged by the district to assist those users who were still struggling with using the devices.

A number of unintended outcomes were also observed and are listed and discussed below:

- Since the introduction of the devices, the children miraculously lost their 'fear' for the nurses. Where they previously cried during assessment, they were now very intrigued by the technology and seemed to enjoy the assessment activities.
- A significant improvement in the trust relationship between the school nurses and the teachers was evident. Where teachers had to be constantly reminded to bring referred cases to the clinic, they were now proactive and brought referred cases to the clinic without being prompted to do so.
- The use of proper assessment tools allowed the nurse to detect learning problems at an early stage. It also enabled the nurse to differentiate between a learning problem and an underlying problem, such as the wrong medication of incorrect dosing of chronic medication that could reduce a child's ability to concentrate in class.

7.6 Phase 6: Monitoring and evaluation

The participation of the users was a critical step in the development process of the app. Even prior to developing the initial user requirements, it was evident that different processes were followed by each clinic when performing school health assessment. This had to be standardised first before any development work could begin.

There were also elements outside the project scope that influenced the outcomes of the research. Insufficient data-time, lack of transport, absence of qualified staff to stand in if a school nurse was unavailable, hindered progress in more ways than one. Once the concept has been tested and approved on National level, dedicated support will be required from government to remove common barriers experienced by school nurses.

8 CONCLUSION

8.1 Theoretical contribution

The primary purpose of this research was to develop a user-centered School Health Assessment App. To achieve this, a UXM^2 was developed. The UXM^2 serves as a template that provides design direction for a user-centered approach towards the development of mobile ICT healthcare services that promote a sustainable long-term positive user experience. The components of the model were generated from the literature, grounding this work as a theoretical contribution to the bodies of knowledge on m-Health and overly to Human Computer Interaction. The UXM^2 was demonstrated of its applicability through the development of the School Health Assessment App, an m-Health App intended to be used in typical rural communities in South Africa. The paper provided a generic procedure for developing a model that can be adopted in a variety of other domains. The use of this single comprehensive model provides valuable criteria that can be used to improve the development of products that promote a sustainable positive long-term user experience.

8.2 Practical contribution

Most ICT projects are successfully developed but fail to be accepted and used by the target users [18]. The failure to address needs and expectations is one of the leading causes of products that are not accepted by the target users [19]. The UXM^2 sought to bring a solution to this contemporary phenomenon by placing the users at the center of the product design process. The model acknowledges that technology affects the lifestyles of the people and proposes change management methodologies to address the change and alleviate the resistance towards accepting and using the technologies. It is recommended that the UXM^2 be adopted for the development of similar ICT projects to provide for the acceptance of ICT products. ICTs have become ubiquitous and citizens in poor resourced and underserviced communities have the potential of benefiting from access to services and service delivery using ICTs.

This research contributes to society's socio-economic development by supporting the school healthcare services so that school-going children receive the necessary assessments and are referred to appropriate services to keep them healthy. It aims at ultimately supporting a healthy and educated youth force that will actively participate in the national development of a country. In addition to the socio-economic development, the data collected through the health assessment tool, is used and can in future be used to determine trends in different regions, as well as report on specific health indicators. It also paves the way for the creation of electronic health records for learners that can allow for the integration of data collected by the Departments of Basic Education and Health.

8.3 Future work

The current research study promotes quality delivery of healthcare services in the education environment in low-resourced areas in South Africa. In this regard, the UXM^2 outlined challenges and provided key underpinning principles for designers, policy makers, and evaluators of the School Health Assessment App, as a mobile technology-enhanced healthcare applications that can be used in the education contexts

The UXM^2 has not been evaluated for external and internal validity in order to explicitly improve on the model. Future work will involve evaluating the model using subject domain experts.

Just as UXM^2 was built to guide the development of the School Health Assessment App, the researchers advocate the use of the model for the creation of similar healthcare services. Furthermore the model can be applied to guide the development of mobile applications in other domains.

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