Original Contribution

Mobile Application Development through Design-based Investigation

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Designing culturally responsive mobile learning courses will be made easier as a result of this study. Design-based research will be made easier as a result of this study. The outcomes of this study were based on the observations of a small sample of potential consumers. The objective of this paper is to demonstrate the development and testing of an innovative mobile application through the use of design-based research methods and techniques. This study describes the process of digitizing existing printed course material using design-based research, where design, research, and practice were all applied simultaneously. One session each from BSc Nursing, Pharmacy, and Medical Laboratory Sciences was chosen for this transition. The major research question was formulated in the first step. OUSL MLearn, a mobile learning application, was conceived and built in phase 2. In the third phase, this application was evaluated by five groups of stakeholders: content experts to validate content, educational technologists to align technical and pedagogical features, novice users to assess overall effectiveness, developers to assess ease of use, and researchers to assess impact. These stakeholders were closely involved throughout the four-month project. The outcomes of this phase were analyzed and used to improve the product. The findings have implications for the design of interactive mobile applications that are culturally responsive. It was discovered that the built mobile application was easy to use, visually appealing, and pedagogically beneficial for its target audience. Optimization, development time, technical and organizational concerns, the workload of academics, and production expenses, on the other hand, were regarded as the most significant obstacles.

INTRODUCTION

Higher education institutions had to be reconstructed in the twenty-first century to keep up with the increasing global competition, the increasing demand for higher education, the changing nature of information, the rapid development of Information and Communication Technologies (ICT), and the varying expectations and demographic characteristics of learners (Kukulska-Hulme, 2005a). The changes in the dynamics of information and communications technology (ICT), institutions, and learners have an impact on the academics working in higher education institutions, causing them to adapt their teaching approaches and strategies. Mobile technology is an extremely fast-growing industry that is directly linked to our job and day-to-day lives. It is also a field that is always evolving. Every day, new developments contribute to its expansion, with new patterns of usage arising that have both positive and bad effects (Pasupuleti, 2016).

However, despite the fact that these technologies are widely available (ubiquitous) and offer immense promise in meeting the needs of

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individual learners due to their unique characteristics, we have not seen a significant uptake in the education sector as a result. Furthermore, as a result of the rapid developments in mobile technologies, including devices and communication technologies, new research opportunities have been created, and the focus of research has even shifted (Parsons, 2014). According to Krull and Duart (2017), mobile learning is a burgeoning subject of research in higher education, as indicated by an analysis of journal papers between 2011 and 2015. In particular, the most extensively explored issue was m-learning apps and systems, which included both quantitative and qualitative studies and was focused at students, according to the key findings of their study. Because faculty and student adoption are critical to the success of mobile learning initiatives, the authors urge that future research examine the implications of mobile learning initiatives for both faculty and students.

Research articles on mobile learning, as well as methodological frameworks for building long-term mobile learning activities, are, on the other hand, in short supply (Nouri et al., 2016). Accordingly, the objective of this investigation was to close this gap by employing design-based research in the development of a mobile learning solution for undergraduates at the Faculty of Health Sciences at the Open University of Sri Lanka (OUSL). It presents the outcomes of the testing phase of the mobile solution conducted by five groups of stakeholders: content experts, educational technologists, developers, beginner users, and researchers, all of whom participated prior to the delivery of the first cycle of the solution.

METHODOLOGY

The design-based research model proposed by Ma and Harmon (2009) was utilized as the framework for this study because it clearly outlined the procedures that took place. Following Reeves' approach, the first phase is characterized by the "analysis of practical problems." The identification of a practical problem and the review of relevant literature about the practical problem are carried out during this phase. This phase is concerned with the "development of solutions" for the practical problem identified in the first phase, which includes conceptualizing a solution within a theoretical framework, identifying the research purpose and development method, and developing a prototype that serves to address the problem identified in the first phase. The third phase is characterized by the

"assessment and testing of solutions in the field." During the last phase, which is called "documentation and reflection," design principles are developed and recorded in order to serve as a guide for practitioners and researchers interested in undertaking design-based research.

It was also influenced by the design-based action research approach proposed by Keskin and Kuzu (2015), which describes phase 3 as an iterative cycle rather than a linear procedure, and which was used in this work. During this phase, problems associated with the prototype are identified, and action plans are devised to address them. During the implementation phase, these plans are put into action, and the repercussions of the action are assessed and reflected on in detail. This procedure is repeated until all issues have been resolved. Due to the fact that design-based research is a multi-phase study, the current study included five different groups of stakeholders in total (Pasupuleti, 2015c). In this study, researchers took the initiative and were involved from the beginning of the design process, working alongside the developer, content experts/practitioners, and educational technologists to create a successful outcome. All of these parties were actively involved throughout the entire process, which took place over a four-month period. For the formative evaluation, four content experts, four educational technologists, six novice users, four researchers, and one developer took part in the study.

ANALYSIS OF A PRACTICAL PROBLEM

A practical problem is identified and solved. A practical problem is identified and analyzed by researchers and practitioners in the first phase of this design-based research project. Several of the researchers in this study are also practicing professionals: two are instructors of zoology and health courses, while the other two are responsible for training academic staff in online learning and educational technology. They have been confronted with the same practical dilemma that the OUSL has been dealing with for many years: the difficulty in delivering timely printed course materials for OUSL students as the number of students continues to grow. OUSL students as well as the university are equally concerned with this practical problem (OUSL). As a result, the researchers took the initiative to conduct this research study using design-based research because they believed the problem was important to the OUSL learning community and wanted to address it. Moreover, they anticipate that the

findings will provide information to guide decision makers on the viability of giving students with a tablet computer loaded with the content, allowing them to make data-driven decisions rather than ad hoc ones (Adusumalli, 2016a).

Examining the literature in order to determine the significance of the problem is the first step. Prior research conducted with students at the British Open University revealed that the majority favored e-books as a complementing technology, but that they still preferred to get printed course materials in the mail (Kukulska-Hulme, 2005b, p. 130). A further finding of the study was that learners had difficulty downloading e-books, acquiring adequate page and font sizes, as well as navigation and cursor control, among other things. Despite several technical improvements over the years, students continue to believe that printed books are easier to read, understand, and navigate, and that they provide longer-term access, despite the fact that digital texts are becoming more affordable (Baglione and Sullivan, 2016). In order to compare the effects of digital reading (for example, reading a word document or PDF file on screen) and print reading, comparative studies have been conducted; however, little research has been done into examining learners' reading behaviors and the educational benefits of recent, more flexible visually presented texts (Rha, 2014, p. 51). In her study (2018, p. 48), Rogers-Estable claimed that many staff members expressed their dissatisfaction with electronic textbooks (eTexts), stating that if they are merely PDF files (or glorified PDFs), there is no benefit to using them with students.

After conducting a literature review, the research team decided that rather than providing learners with a digitalized text in the form of a PDF (or a glorified PDF) (as an e-book), they should instead provide them with a mobile learning application that contains an enhanced version of the already existing print material that includes additional pedagogical, technological (interactive), contextual, and social interactive attributes associated with mobile learning that are supported by innovative strategies and tools. The social interactive characteristics inherent to mobile learning were utilized; however, less emphasis was placed on the design of peer/tutor interactions in this mobile application because it was designed as a stand-alone package to be studied offline, taking into consideration the specific requirements of the target group, which is health professionals under intense time constraints. Learners, on the other hand, have the option of using the mobile application whether they are online or offline. If they desire to collaborate socially, they can also discuss the information through other channels such as e-mail and social media.

DEVELOPMENT OF A SOLUTION

The present print course materials were originally developed in accordance with teaching and learning ideas such as Guided didactic conversation in online education and other similar theories (Holmberg, 1983). While current printed course material can be converted into digitized information, extra study into mobile learning is required, such as producing content with built-in interactive elements for mobile devices, among other things (Adusumalli, 2016b). Furthermore, learning takes place in a certain location and environment. As a result, design-based research was used in conjunction with numerous revisions of the mobile application to apply research and practice at the same time. Developing a solution inside a theoretical framework is a difficult task. After that, a mobile learning application titled "OUSL mobile learning" (OUSL MLearn) was conceived and developed specifically for Android mobile devices in order to address the primary research question within the conceptual framework.

Methods of development are being identified. Due to the fact that this mobile application was built on existing content from printed materials, the design and development of the mobile application were severely restricted. As a result, the first step was to create a prototype that was appropriate for the intended use. The construction of a mobile application was chosen after reviewing the literature on various types of prototypes. This was done since the vast majority of learners are visual learners, and an icon-based prototype was chosen (Rha, 2014). Identifying the function that research will play in the development of a solution. Following the conceptualization of the solution, the following phase was to determine whether or not further study should be undertaken while constructing the answer. Research was an integral part of this study because the solution was to develop a mobile application through several iterations. Relevant research studies with respect to the needs and requirements of the stakeholders (teachers and students), learning preferences of students, and cultural propensities were considered when designing the user-interface, developing content, and developing the technical design of the system.

Creating a prototype that meets the needs of the research project. In order to construct the mobile application, the first meeting was held with the content developers, educational technologists, researchers, and the developer, during which the overall objectives of the project were discussed and the overall design of the application was decided. One session per degree program) of the existing print materials were turned over to the developer, who then highlighted the needs, provided relevant information, and provided gadgets to aid in the development process (tablet computers). The developer was given complete flexibility to choose the technologies and tools that would be most appropriate for developing the mobile application that would be used with the specified tablet computer. For the purpose of minimizing technical difficulties, it was decided that the OUSL would give standard tablet computers to all of its learners rather than requiring them to purchase or use their own tablet devices. HTML was the primary tool utilized in the development process, with additional tools being employed to increase the capabilities of the final mobile application.

These instructional aspects have been carried over into the mobile version as well. Examples include the advance organizer at the beginning of each session and the summary at the end of each session, both of which were developed in accordance with the pedagogical elements of the original print course materials. As demonstrated by Ausubel (1960), an advance organizer serves as a schema for the learner, allowing him or her to associate new concepts with previously learned concepts and to make meaningful connections between them. In contrast, a summary (post organizer) provides a synopsis that allows the learner to gain a comprehensive picture of the concepts learned during the session. Additionally, advance organizers provide assistance to a variety of learners, particularly FD and FI learners, respectively. The findings of research investigations have showed that FD learners are holistic in nature and require external guidance to solve problems, whereas FI learners are serialistic in nature and solve problems using their own clues (Witkin et al., 1977). Because OUSL students come from a variety of backgrounds, course materials must accommodate both of these groups in order for them to understand the topic without the assistance of the teacher. According to Sweller's (2011) cognitive load theory, content was re-designed as smaller chunks to fit the mobile screen in order to minimize information overload.

EVALUATION AND TESTING OF THE SOLUTION

Formative assessment, which was an intrinsic aspect of the design technique, was used on a frequent basis during the third phase to ensure that the mobile application matched the requirements. It assisted in identifying the advantages and disadvantages of the innovation while it was still in the development stage, with the goal of rewriting the instruction. As previously stated, the second and third phases were carried out concurrently and could not be separated during the course of the investigation. Several features were introduced as a result of the feedback received from various stakeholders throughout the testing phase of the project.

Identifying research methodologies is important. It was at this phase that the most relevant research methodologies were chosen and that the necessary data was collected and analyzed to provide answers to the research questions. Qualitative methods were employed in the data collection process since the design and development of the innovation necessitated an in-depth examination of the innovation. In order to collect data, a research diary, minutes of committee meetings, observation sheets of users while they were using the tablet, an interview schedule for users, and checklists for error identification were utilized as data collecting methods.

DOCUMENTATION AND REFLECTION

In design-based research, this is a critical phase to complete. The production of design principles and guidelines could not be established without documentation and reflection, and the goal of employing design-based research could not be fully fulfilled without these two steps. According to the findings of the research study, Ma and Harmon (2009) advised that two sets of principles be provided. One set of principles for practitioners to use in order to enhance their practices based on research findings that are directly relevant to instructional innovation, solution, and product. Based on the research methodology, the second set of principles for researchers who are interested in doing design-based research outlines how to conduct design-based research and is intended for researchers who are interested in conducting design-based research (Pasupuleti, 2015b).

It was not only the documentation phase that included reflections in this current study; rather, they were a component of the entire process. For the purpose of generating principles, researchers reflected on their study procedures in all phases, from phases 2 to 4, and went back and forth while documenting the process. Resulting in a continual cycle of design-reflection-design, the outcomes of each development phase were re-examined, reflected on, and utilized for further enrichment at the conclusion of each phase. As a result, formative assessment was incorporated into the testing phase of the design-based research project, and the results were used to modify the system in order to make the training more effective and efficient overall. Phases 2, 3, and 4 were all interconnected in this study and could not be distinguished as different phases as a result.

The current interface of the mobile application, as well as its features, are the result of adjustments made in response to recommendations and reflections received during the formative assessment process for all three phases of the project's development (Pasupuleti, 2015a). Creating a synthesis of design principles for the purpose of generating the recommended solution (mobile application). Following their consideration of the reflections, the researchers concluded that design-based research is extremely appropriate in the design and development of technology-based innovations because user testing is a critical component of the development process itself (Pasupuleti, 2016a). Due to the fact that both researchers and practitioners were involved from the outset, their contributions were extremely valuable in envisioning the solution within a conceptual framework.

CONCLUSION

The design-based research approach built on the concepts of stakeholder centeredness, it was concluded, was effective in the development of mobile learning applications after going through this procedure. Due to the fact that both researchers and practitioners were actively involved throughout the entire process and worked together to create a highly effective mobile application, this was possible. In this study, the assessment and testing of the solution phase were integrated into the development and testing of the solution phase, because these two phases are interconnected and occur concurrently in the framework employed. It was possible to construct an effective mobile solution through numerous

improvements based on existing research and practices because of the iterative cycles of design-based research because of the iterative cycles of design-based research. The establishment of suitable support mechanisms for both teachers and pupils is therefore critical to the long-term viability of these cutting-edge methods of instruction. Additionally, this application will be tested through summative evaluation with actual students to determine the effectiveness of the mobile learning system, which will allow for a comprehensive design of the system to be completed. It is important to consider the target audience, the subject matter, and the organizational culture of the institution while designing and developing instructional materials for any subject matter (context). As a result, the findings of this study may not be applicable to all situations; however, they may provide light on some of the educational, technological, social interaction, and environmental aspects, including cultural dimensions, that must be considered when developing mobile applications. It also includes design concepts for both mobile solutions and design-based research in mobile learning, as well as examples of both types of study.

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