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Development of an Interactive Mobile Application for Learning Undergraduate Educational Technology Concepts

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ABSTRACT

Today's schooling which is characterized by over-population, insufficient learning resources and incessant closure due to civic crises and pandemic demands more efficient learning models that allow the deployment of technology for students' active participation in their education. Hence, this study was conducted to develop an interactive mobile application for learning undergraduate educational technology concepts in Nigeria. The ADDIE instructional design model was adopted, and 15 well-structured topics with interactive learning contents and elements were embedded in the developed application built using JavaScript, Html, CSS, Cordova, Articulate 360, Moodle platform, and PHP programming language. The validation of the application was done in three stages and experts involved in the development and validation included educational technology specialists and computer programmers. The mobile application was tested on 30-randomly selected year three undergraduate educational technology students. Findings revealed that exposure to the application improved students' academic achievement (mean gain=27.87), and there was significant difference (df=28, t=19.97, $p<0.05$) between the academic achievement score of students at pre- and post-test in favor of the later. The application is therefore considered suitable for teaching and learning of undergraduate educational technology concepts.

Keywords: ADDIE, development and evaluation, educational technology, mobile learning

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INTRODUCTION

Educational technology is concerned with the development, application and evaluation of systems and techniques involved in the process of human learning. It is the study and ethical practice of facilitating learning and improving performance by creating, using and managing appropriate technological processes and resources (Januszewski & Molenda, 2008). The scope of educational technology encompasses educational objectives, the selection and use of media and methods, the management of resources and evaluation.

The educational technology field emphasizes communication skills and approaches to teaching and learning through the judicious use and integration of diverse media (Chukwuemeka & Iscioglu, 2016; Dey, 2020). Being a pivot to other courses in the field of education, and in order to integrate emerging technologies into teaching and learning, educational technology is being offered as a body of knowledge to students in institutions of higher learning. The programme is aimed at developing competencies and skills needed to systematically apply scientific process and products in educational tasks. Scholars and practitioners in the field examine the uses of innovative media and technologies for education, and seek new and effective ways of organizing the teaching and learning process through the best possible application of technological developments (Chukwuemeka & Iscioglu, 2016; Dey, 2020).

One of the modern technologies that can be integrated into education is mobile technology (Chukwuemeka et al., 2021). Mobile devices are growing faster, and Cisco (2020), in its annual internet report (2018-2023), forecasts that smartphones will have the second fastest growth by the end of 2023. Different mobile operating systems for smartphone devices include Google's Android, Apple's IOS, Microsoft's Windows, Symbian, and Blackberry. However, most of the mobile devices available in market today use android and IOS operating system because of accessibility and affordability in terms of cost and because of their simplicity in usage which make them easily adopted by the new generation of digital natives, the youth, who grew up with access to the internet, mobile devices and social networks. (ALFarsi et al., 2018; Guerrero-Arias et al., 2021; Kocakoyun & Bicen, 2017).

The use of m-learning in the teaching and learning process would be a more natural and effective way of learning for this generation (Dingli & Seychell, 2015). With mobile learning, the teacher creates the

learning content and assessments using an authoring tool on a computer device and uploads the learning content to the cloud. The students access and engage with the learning contents through an interactive mobile application installed on their smartphones, and the contents can also be downloaded and studied by the students on offline mode. Interaction between the students and their colleagues, as well as with the teachers can be made possible and, the teacher can also track learning activities of the students. Mobile technology will enable educational institutions to utilize a set of features such as flexibility, ubiquity, and portability in learning that will be of great benefit to teachers and students in the new digital era (Briz-Ponce et al., 2017; Chukwuemeka et al., 2021). Studies carried out by Amasha et al. (2021), Gezgin (2019), Ketyi (2015), and Oyelere et al. (2018) all revealed that instructional contents embedded in mobile learning applications improved students' academic achievements in education better than students taught using conventional lecture method of instructional presentation.

When developing technologies for learning, there is the need to follow an instructional design approach. Nichols Hess and Greer (2016) refer to instructional design as the principles and procedures by which instructional materials and lessons can be developed in a consistent and reliable manner. One of such effective approach is the ADDIE instructional design model (Chukwuemeka et al., 2020). It is an organized five-step procedure representing analysis, design, development, implementation, and evaluation. This model was adopted in this study as a framework for the development of an interactive mobile application on undergraduate educational technology concepts.

Statement of the Research Problem

Today's classroom which is characterized by over-population and insufficient learning resources demands more efficient learning models that allow deployment of technology for students' active participation in their education. Despite the fact that mobile devices are accessible and affordable by students who are regarded as digital natives and constitute highest proportion of users, the opportunities offered by this technology in education remains untapped by most institutions of higher learning. Even if mobile learning is not fully implemented for all programmes in Nigerian institution, the innovation should have been deployed for undergraduate educational programme being a pivot discipline saddled with the responsibility to train skilled manpower who will develop, evaluate, deploy and carry out research on issue related to technology integration in education.

In order to meaningfully integrate any technology into education, developing the content and platform for deployment become necessary. Therefore, this study was carried out to develop and evaluate an interactive mobile application for learning undergraduate educational technology concepts.

Research Questions

The study provided answers to the following research questions:

1. What are the tools used in the development of interactive mobile application for learning undergraduate educational technology concepts?
2. What are the stages involved in the validation of an interactive mobile application for learning undergraduate educational technology concepts?
3. What are the phases involved in the development of interactive mobile application for learning undergraduate educational technology concepts?
4. What is the difference in the achievement scores of undergraduate students in educational technology concepts before and after exposure to an interactive mobile application?
5. To what extent are the achievement scores of male and female students taught educational technology concepts using an interactive mobile application different?

Research Hypotheses

The following null hypotheses were tested in the study:

1. **Ho_1:** There is no significant difference in the mean achievement scores of students in educational technology before and after exposure to an interactive mobile application.
2. **Ho_2:** There is no significant difference between the achievement of male and female students after being exposed to an interactive mobile application for learning undergraduate educational technology concepts.

METHODOLOGY

The development of the interactive mobile learning application adopted a design-based approach in which the ADDIE instructional design model was sequentially followed. The ADDIE model is a five-phase model formed by combining the first letters of each of the phases (analysis, design, develop, implementation, and evaluation).

The participants of the study included computer programmers, educational technology specialists and students studying to obtain bachelor of education certificate at Federal University of Technology Minna, Nigeria during the 2019/2020 academic session. While the programmers and specialists were involved in the development and validation of the mobile application, 30 randomly selected third year students learnt educational technology concepts for four weeks using the developed mobile application. A 50-item multiple-choice questions on the concept of educational technology treated in the mobile application were administered before (pre-test) and after (post-test) four weeks' exposure to the mobile application content.

The undergraduate curriculum of educational technology as stipulated by the Nigeria's National Universities' Commission minimum benchmark served as guide in selecting the educational technology concepts treated in the mobile application. Topics covering distance education, instructional design, emerging technologies, educational media, and systems' approach were captured in the mobile application.

In order to provide answers to the research questions, narrative report method was used to describe the tools, validation processes and the activities carried out under each of the ADDIE phase of the development process. Moreover, descriptive statistics of mean and standard deviation were used to compute the mean scores of students at pre-test and post-test, as well as the mean scores of male and female students who learnt educational technology concepts through the developed mobile application. However, to test for the null hypotheses, the t-test statistics through the aid of statistical package for social sciences (SPSS) version 23, with significance level for rejection or accepting any hypothesis was fixed at 0.05 alpha level. **Figure 1** shows

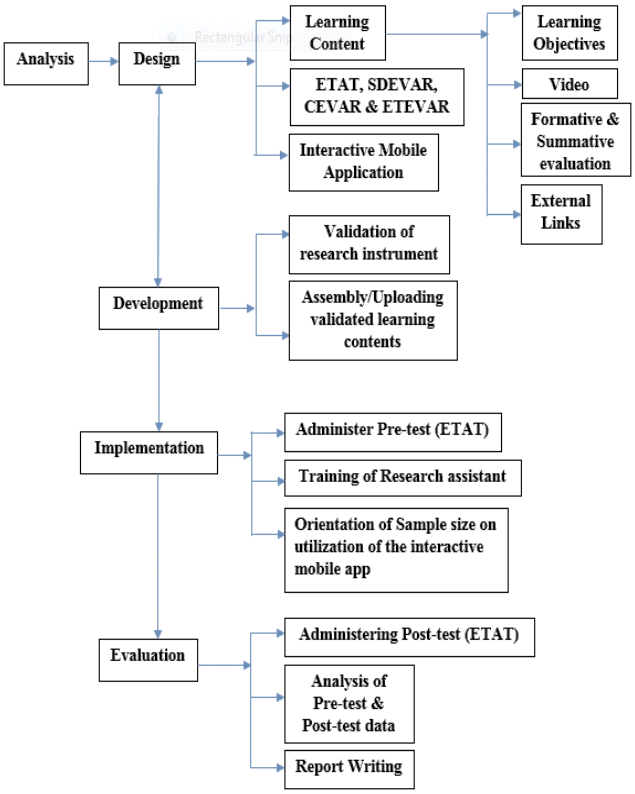

Figure 1. Model derived from the development and evaluation of an interactive mobile application

the model derived from the development and evaluation of an interactive mobile application.

RESULTS

Tools Used in the Development of the Interactive Mobile Application

The interactive mobile application was built using JavaScript, Html, CSS, Cordova, and PHP programming language to create an interactive environment to suit teaching and learning. While the course content was created using Articulate 360, Moodle platform was used to manage the learning content and links from YouTube channels with creative common licenses where deployed for the video tutorials. The entrance menu of the package consisted of student's registration/login page. The dashboard contains four learning materials namely: video tutorial, folders containing text document, final assessment, and external links for further studies. The video section, enables the learner to stream tutorials. The folders provide the learner with text on educational technology concepts. Self-assessment exercises are embedded in each unit to check the level of cognition. Upon successful completion of the self-assessment exercise the learner progresses to the next unit. A poor performance returns the learner to the beginning of the current learning content. Ensuring mastery and attainment of the learning outcomes in the learning content.

Validation of Interactive Mobile Application

The validation of the interactive mobile application for learning undergraduate educational technology concepts was done three times.

First validation

After completion of the initial development of the interactive mobile app, it was validated by five computer programmers, one from MaiTai Technology, Tel-Aviv, Israel, and four from Federal University of Technology, Minna, Nigeria. These experts observed some weaknesses in the package which could affect its suitability and utilization by students in the learning of the selected educational technology contents. They observed that the deploying of the learning content using pdf format was not screen friendly. It was not possible for the text to adjust and fit into smaller phone screens. Hence, they suggested need to improve on text font to make it suitable for learning.

Second validation

Based on experts' suggestion after first validation process, the authoring tool was changed to Articulate 360, and the learning content was deployed using Moodle platform. This enabled the learning content fit into any viewing screen and learners could change the text font to the preferred sizes. The package was thereafter subjected to expert's validation. These experts suggested that the contents in the interactive mobile app should possess formative evaluations that will only allow progress when a student scores 60% and above, and the learning contents should be arranged according to the learning objectives.

Third validation

Based on experts' suggestion during the second validation process, multiple-choice self-assessment exercises were added, introductory page was provided for each unit as well as the learning contents arranged in-line with the stated learning objectives. The experts that were involved in the second validation process were asked to validate the package again. At this point, the interactive mobile application was certified suitable for learning undergraduate educational technology concepts.

Phases Involved in the Development of the Mobile Application

The development of the mobile application was carried out under five phases as discussed, as follows (**Figure 2**).

Analysis phase

At this stage, the researchers identified the need for developing the mobile application. This centers on the need to have well-structured educational technology contents that could be studied at learners' chosen environment and convenient time without necessary attending conventional classroom lectures. Moreover, inadequate classroom space and incessant closure of schools during crises and pandemics necessitated the development of the mobile application. Educational technology practitioners and students agreed that adopting mobile learning for continuous teaching and learning is the major need of students, and developing an interactive mobile application on undergraduate educational technology concepts become imperative as there is no such application in existence to serve same purpose.

Design phase

At this phase, three educational technology experts currently teaching in Nigerian universities, and two distance learning specialists were involved in the compilation and structuring of contents to be integrated in the mobile application. Then topics and sub-topics were organized, structured and organized from simple to complex, known to unknown format. The core contents were developed, diagrams, illustrations were carefully planned, and self-assessment activities were

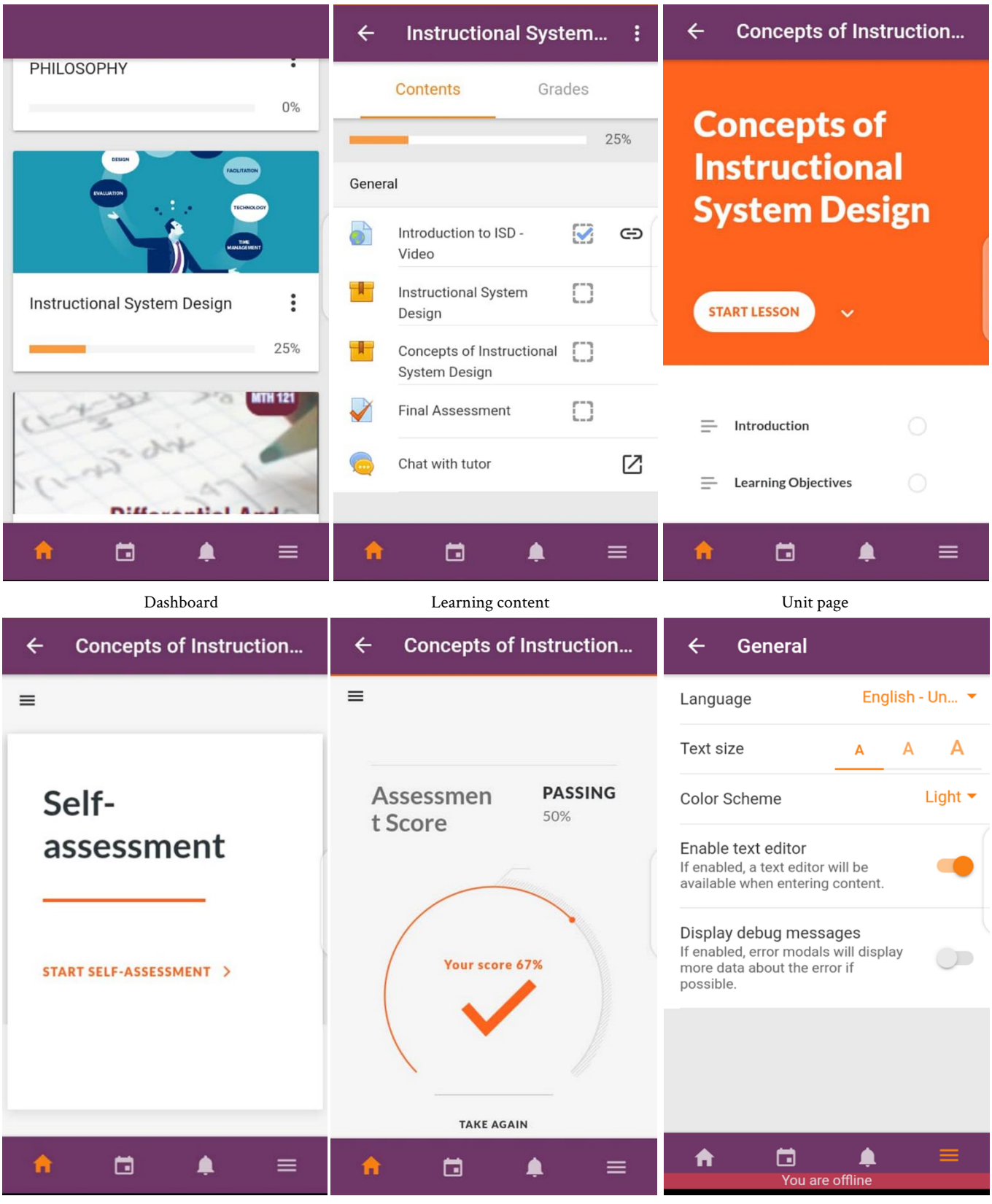

Figure 2. Sampled screenshot of the developed mobile application

added. The contents were organized in such a way that a topic have adequate and sufficient information that a learner can study for minimum of two hours. 15 identified topics were therefore developed, and the experts were also responsible for the development of a 50-item multiple-choice questions used to measure the achievement of students in the treated educational technology concepts.

Table 1. Undergraduate students' achievement scores before and after exposure to an interactive mobile application

Testing	Number of samples	df	Mean	Standard deviation	Mean difference
Pre-test	30	29	44.40	8.92	27.87
Post-test			72.27	4.20	

Table 2. t-test comparison of pre- & post-test achievement scores of undergraduate students after exposure to the interactive mobile application

Testing	Number of samples	df	Mean	Standard deviation	t-value	p-value (2 tailed)
Pre-test	30	29	44.40	8.92	19.97*	0.01
Post-test			72.27	4.20		

Note. *Significant at p<0.05

Table 3. Comparison of post-test achievement scores of male and female undergraduate students after exposure to interactive mobile application

Group	Number of samples	df	Mean	Standard deviation	Mean difference
Male	16	28	70.06	3.42	4.72
Female	14		74.79	3.62	

Development phase

At this stage, the computer programmers developed an interactive mobile application that hosted the educational technology concepts already developed at the design phase. The main menu of the application, installation procedures, dashboard, navigation, sign-up, log-in and user guide were built and the content to be studied were integrated into the application.

Implementation phase

At this phase, the computer programmers, educational technology practitioners and students were involved in the validation of the developed interactive mobile application. The navigation, ease of installation, ease of use, interactivity, suitability, appearance was assessed and scrutinized.

Once the observed corrections were made, the achievement test was administered to the 30 randomly selected students. Thereafter, the application was sent to students for installation and sign up. The students were given four weeks to study the contents on the application, and interact with fellow learners via the application. The achievement test was later administered as posttest on the same students.

Evaluation phase

At this phase, the researchers evaluated the effectiveness of the interactive mobile application by computing the scores of each of the 30 students at both pretest and posttest. The scores of students at both tests, and also based on gender achievement were thereafter compared using mean, standard deviation, and t-test statistics to determine the effectiveness of the mobile application in learning undergraduate educational technology concepts.

Comparison of Students' Achievement in Educational Technology Concepts Before and After Exposure to the Interactive Mobile Application

Table 1 shows the mean and standard deviation of the achievement score of undergraduate students before and after exposure to an interactive mobile application. A total of 30 students made use of the application. A mean of 44.40 and a standard deviation of 8.92 was obtained for the pre-test scores while a mean 72.27 and a standard deviation of 4.20 was obtained for post-test scores with a mean difference of 27.87 in favour of post-test. **Table 1** indicates that there was a difference in the achievement scores of undergraduate students in educational technology concepts before and after exposure to an interactive mobile application.

The t-test statistics was used to determine if the difference observed in the mean scores at pre-test and post-test were significant as shown in **Table 2**. **Table 2** shows the paired sample t-test results of the achievement score of undergraduate students before and after exposure to an interactive mobile application. A total of 30 students made use of the application. From **Table 2**, t=19.97, df=29, p<0.05. Hence, the hypothesis one was rejected. This indicates that there is a significant difference in the mean achievement scores of students in educational technology before and after exposure to an interactive mobile application.

Comparison of Male and Female Students' Achievement in Educational Technology Concepts After Exposure to the Interactive Mobile Application

Table 3 shows the mean and standard deviation of the achievement score of male and female students after exposure to an interactive mobile application. A total of 30 students made use of the application. A mean of 70.06 and a standard deviation of 3.42 was obtained for the male students while a mean 74.79 and a standard deviation of 3.62 was obtained for the female students with a mean difference of 4.72 in favour of the female gender. **Table 3** indicates that there was a difference in the achievement scores of male and female students in educational technology concepts after exposure to an interactive mobile application. The t-test statistics was used to determine if the observed difference between male and female is significant.

Table 4 shows the independent sample t-test results of the achievement score of male and female students after exposure to an interactive mobile application. A total of 30 students made use of the application. From **Table 4**, t=3.68, df=28, p≤0.005. Hence, the hypothesis two was rejected. This indicates that there is a significant difference between the achievement of male and female students after being exposed to an interactive mobile application for learning undergraduate educational technology concepts in favour of the female students.

DISCUSSION

The adoption of the five phases of the ADDIE model resulted to the developed interactive mobile learning application that focuses on learning outcomes relevant to students, meet students' needs and facilitate active learning of undergraduate educational technology concept.

Table 4. t-test comparison of post-test mean achievement scores for male and female undergraduate students after exposure to an interactive mobile application

Group	Number of samples	df	Mean	Standard deviation	t-value	p-value (2 tailed)
Male	16	28	70.06	3.42	3.68*	0.001
Female	14		74.79	3.62		

Note. *Significant at p<0.05

The findings of this study on the effectiveness of the developed mobile application reveals that students' achievement in educational technology was greatly improved after exposure the application. This is in agreement with the earlier findings of Ketyi (2015) who found that mobile learning had positive influence on undergraduates' learning achievement; Oyelere et al. (2018) who found that learning performance of students exposed to mobile learning applications was significantly better than that of their counterparts in the control group; Gezgin (2019) who found that mobile learning positively affected students' academic achievement; and Amasha et al. (2021) who found that mobile applications were more effective than traditional teaching methods. However, the previous finding of Chu (2014) who found that a significant difference was found in the learning achievements of students exposed to mobile learning application and traditional method in favour of the latter contradicts this present finding.

With respect to gender difference in students' achievement when exposed to mobile learning application, this present finding which reveals gender difference in students' achievement is in agreement with the previous findings of Daud et al. (2021) and Ketyi (2015) whose studies showed that the impact of mobile application on students' learning outcomes differ according to gender. This however is not in agreement with the finding of Hilao and Wichadee (2017) whose study revealed that male and female students did not differ in their learning performance after exposure to mobile learning application.

CONCLUSION

This study identified the need to develop a mobile learning application on Nigerian undergraduate educational technology concepts. Experts, tools, contents, and students' participants were carefully chosen and involved in the analysis, design, development, implementation and evaluation in line with the ADDIE instructional design model. A suitable interactive mobile learning application was developed and found effective, and students' academic achievement would be greatly improved if deployed for teaching and learning of educational technology.

Recommendations

Being an indigenous product, the developed interactive mobile application should be promoted and adopted for teaching and learning of educational technology in Nigerian Universities. This will promote students' ubiquitous learning and improve their academic achievements.

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Data availability: Data generated or analysed during this study are available from the corresponding author on request.

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