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Investigating the Learning Attitude of Undergraduate Students by Analyzing the Effectiveness of User Interfaces for M-learning

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Abstract

While Mobile learning referred to as M-learning has mounted to prominence in higher education and has directed exponential growth in research areas, there seems to be insufficient empirical evidence from wide experimental findings to vouch for its learning effectiveness. This concern is addressed in this article by steering randomized experimentation on undergraduate students. This study examines the effectiveness of various user interfaces of mobile devices on the M-learning attitude and perception of undergraduates registered in a graphic design course at a public learning institution. Students took part in three consecutive study sessions. A session comprising a demonstration of the perception of M-learning and an outline of associated mobile applications with their primary course of graphic technologies was organized delineating the scope and functionality for Mobile learning in the line of instruction of 2D and 3D Design at the university level. It was assumed that M-learning with iPad could lead to identical learning attitudes and perceptions among students as that by using an Android tablet, but students were found to have an enhanced learning attitude towards M-learning with iPad as compared to a tablet. M-learning can lead to the modeling and progression of mobile-based instructive curricula. This article aimed to provide several recommendations regarding improving the usability of the applications and enhancing readers' knowledge to enable future researchers to identify the emerging practices of mobile learning.

Keywords

M-learning, usability, effectiveness, device compatibility, user interface

INTRODUCTION

M-learning scientists endeavor to expand the utility of mobile technologies in higher learning establishments while retaining the educational mission. In the existing literature, specialists have defined M-learning from separate viewpoints. M-learning is the education that is exercised using miniature computing mobile devices [1]. The definition comprises of smartphones and small handheld gadgets. M-learning can be described as a specific theme that has emerged from distance learning [2]; M-learning can be considered as the next generation of E-learning using mobile technology [3]. More elaborately, M-learning is the expertise that alters the method in which the students connect, interact, and work out with each other and their experiences [4]. In addition, it was supported that M-learning accelerates knowledge sharing among learners and educators in interaction with each other [5]. M-learning is not only the erudition that is grounded on the application of mobile devices but also the erudition that is reconciled across multiple contexts handled by portable mobile gadgets [6]. Briefly, M-learning benefits learners and educators to operate their daily chores in a limited period using miniature technological gadgets (tablets or smartphones) in an anytime anywhere environment. A need for an extensive user requirement analysis was investigated to explain the functionality and scope of the M-learning applications used with the capability to enhance the learning perception within the Bachelor of Arts cohort in the 'Studio Art' course at the Department of Visual and Performing Arts, at a public University in the United States. The study involves 16 students attending a course for undergraduate studies. All participants performed their assigned task using their personal mobile gadgets which run on iPad or Tablet. M-learning facilitates learning flexibility in discrete classifications of activities, inclusive of behaviorist, constructivist, situated, collaborative, personalized, and informal learning [7][8]. However, with the affordability of telecommunication services and the vast availability of a wide range of user interfaces for end-user devices, M-learning content. M-learning has undisputedly gained momentum in becoming the potential mainstream of the current generation. The Technology Acceptance Model (TAM) has been designed with a motive to determine how end-users could recognize or decline a specific technology [9]. Further, it was claimed that attitudes concerning any educational technology might be treated to quantify with usability analysis of mobile interfaces for M-learning [10]. This is becoming extensively significant in handling high-end extent consumers of the technology (learners and educators) who have the ambition of technology use and determine if mobile technology has conducive or adverse influences on the environment. Furthermore, it was empirically determined that Technology Aided Modelling (TAM) provides the base to determine the impacts of the variable on attitudes. Users'

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attitudes indicate the intent of use and the real use of the latest system. By this means, the attitude of learning can provide a perspective framework for comprehending the learner's intention to use and acceptance of new technology [11]. The successful proliferation of the mobile learning community needs consistent action to examine the requirements and preferences of theoreticians as well as practitioners through usability analysis towards grounding a framework of broader comprehension of M-learning users' attitudes and perceptions.

THE RESEARCH PROBLEM

The screen size requires a particular layout of information to be displayed to convey the information in an effective manner. There are major limitations arising due to implementation problems of different user interfaces in M-learning for different mobile device platforms as the learning perception of potential end-users of M-learning are not extensively captured using direct practical engagement and participatory usability analysis across a wide range of university-level curriculum in the educational spectrum, which this study aims to achieve.

Problems Found in Past Research and Practice

Usability analysis of user interfaces before the advancement of M-learning applications has a major role in determining the learning attitude and perception of end users. Most of the M-learning applications have device compatibility issues occurring due to variations in the user interface from different manufacturers leading to further usability issues that make M-learning unfit for the purpose [12]. The overall issues comprise too much variation in the interfaces (e.g., keyboard size and arrangement) by diverse manufacturers, innovative copies of devices being released too repeatedly (which enforces adverse side-effects on the interface learnability), the requirement for quite often recharging, frugal memory processing capability of the devices (resulting the applications to function too sluggish), etc. A few discipline-specific issues, for instance, accountancy (spreadsheet display or data entry) and music composition instructions are too small and poorly lit monitors and keyboards that are heavily compacted. Due to these hardware problems, many of the devices are exceedingly portable and commonly come with tiny display screens and keyboards that do not fit to handle complex user interaction and navigation systems without disappointing the user. There were several deficiencies in existing knowledge about the problem. Systematic quantitative analyses on the effects of M-learning due to differences in user interfaces based on different mobile device platforms were lacking in the existing literature. The lack of proper usability analysis based on the ease of use for M-learning applications arising due to multiple user interfaces inspires to fill the void in the existing literature. Future efforts were required to broaden and systemize the expertise related to usability issues during the advancement of M-learning applications. The audiences benefit from the study of this problem in several ways. The findings could become a layover platform for future researchers, mobile developers, educators, practitioners, and policymakers for future reference in the realm of M-Learning regarding the latest trends of usability analysis before the deployment of M-learning apps.

The Purpose Statement

Higher education establishments are accountable for supplying convenient infrastructure for every student and must highlight collaborations that revolve around a substantial alteration in an information and communication-oriented society. Mobile technology is an exceptional avenue for outdoor lesson engagement. With a swelling number of educational applications, improved user experience during application usage was essential. Therefore, the rational justification for the research problem was the need for the application's usability to remain judged with appropriate usability estimation methods. Both the efficiency and effectiveness of the application's usability could influence user satisfaction for any mobile application. The assessment of usability involves evaluating with an impartial approach to consistency. Usability evaluation relies on the magnitude of how people converse with a particular product or service. Thus, usability evaluation or usability testing was primarily employed in calculating the client interaction using a specific application or product. The purpose of the study was to evaluate the application's usability to be evaluated with appropriate usability assessment methods. The challenges of design for user interfaces revolve around a wide scope of usability aspects including navigation, content usefulness, and user experience. The researcher's purpose was to determine how different types of user interfaces based on the mobile platform used in M-learning can enhance learning attitudes and perceptions for students following the 'Graphic Design' curriculum of respective undergraduate-level courses of university studies by performing a usability analysis of multiple user interfaces used in M-learning using both Apple iOS and Google Android platform. Moreover, research has found that M-learning produces a substantial impact on the learning attitude of students [13]. The independent variables to be used while conducting the randomized experiment is the device features based on the mobile platform used in the M-learning mode of instruction delivery while the dependent variable is the learning perception of university students.

Review of Literature

Mobile devices offer individualized and personal experiences. Mobile devices offer five benefits for the learning industry: portability, accessibility, learning opportunities, connection, and personal experience [14]. Mobile-Assisted Language Learning (MALL) delivers students rich, real-time, convenient, social contact, collaborative, and contextual learning [15]. The Interactive Learning Network (ILN) model, which involves both tablet

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PCs and wireless technology has been executed for pre-and post-tests to gauge the student's learning performance [16]. The impacts of mobile technologies on teaching and learning under social media in the format of Skype, Twitter, and Vlogs were in limelight [17]. The amalgamation of mobile devices and E-Books to build the student's acquaintance with a digital library was addressed [18]. Two studies were conducted to assess the usage of iPads through one semester in a Mathematical course [19]. It was emphasized how learning context encounters different trials in relationship to user interface design of mobile devices have various constraints i.e., small screen size, varying screen width among devices, touch screen capability, text typing difficulties, and limited attention to the user and physical environment [20]. Besides, there are a few specific hardware problems like limited battery power, limited computing ability, limited bandwidth, and limited storage or memory which affect the designing of mobile learning applications. Such challenges constantly impact the design of M-learning applications. The learning content needs to be in a small layout to fit on the device's screen without sacrificing any quality information using an accurate user interface. General indicators like the linearity and significance level of information are applied to evaluate the quality of any user interface. The user interface needs to adapt to different sizes of the device's display.

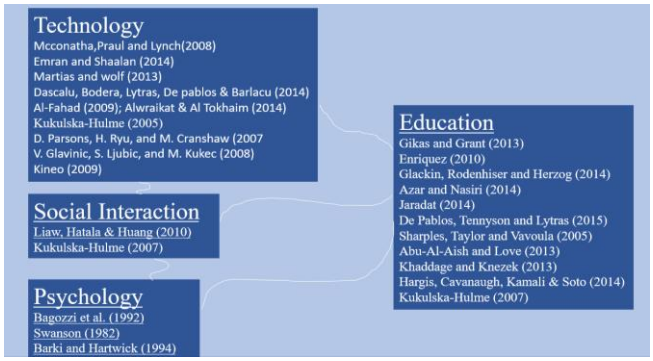

Figure 1. Literature map derived based on literature review

Figure 1 in the article indicates that the study employs a systematic literature study procedure by extracting understandings from already circulated research efforts.

This research article on usability analysis and testing of mobile applications used in M-learning will help to extend the literature by helping future researchers and developers to ensure that the M-learning application under consideration is used by different types of persons ranging from IT experts to students and disabled.

MATERIALS AND METHODS

It was hypothesized that mobile device user interfaces that provide better ease of use, flexibility of usage, along with immediacy of information acquisition leads to better learning attitudes and perception among undergraduate university students. To address the hypothesis, it was sought to answer the research question of how the different features of a user interface applied in M-learning affect the factors - like the ease of operation, the flexibility of usage, and immediacy of information acquisition which are used to judge the learning attitude and perception. Additionally, the researcher qualitatively determines how the form of the mobile device applied in M-learning can cause an alteration in the effectiveness and availability of learning activities. Determining the compatibility of M-learning applications with a wide variety of potential device configurations is of major significance as some M-learning application features are not available on every device. For instance, some devices may not incorporate a compass sensor. If an M-learning app's core functionality expects the use of a compass sensor, then the app is compatible only with a device that incorporates a compass sensor. In determining the usability of quality attributes for any mobile applications, the application developers should determine whether the end-user finds the application user-friendly and attractive, and the extent to which the product is understood, and simple to operate. Determining usability also involves functional testing. Inspection, review, and evaluation, which are to be performed on the M-learning applications as a part of the usability testing technique. This qualitative study utilizes content analysis methods to evaluate and acquire insight from the literature. The research design involved a qualitative coding methodology to search for the interrelated keywords and detect themes linked to keywords, followed by categorizing the keywords into themes. The extraction process is instinctively done using macro add-ons for word processors. Open coding involves finding a descriptive concept for each sentence. The concepts were then coded into three themes based on the three concepts of M-learning such as mobility of technology, mobility of learning, and mobility of learner. Every sentence was paired with one of these specified concepts. Lastly, the framework was formulated and grounded on the output of the coding procedure and related literature. The sampling process consists of extraction from 42 papers, 222 valid sentences that contain "interface" words were chosen and coded. The data collection source for analysis was previously published works in a journal database enabling the researcher to conduct the study enabling further research ability to duplicate the outcome in a higher education environment.

Data Analysis

The papers under review were sorted into categories. The study of mobile learning began to surface in 2012 upwards. In 2015 the number subsided faintly before reaching a summit a year later. Largely, the volume of investigation on this M-learning is still mounting every year. Students were the most regular users of M-learning as nearly 40 percent of the articles were examined in this context. To give these study findings better content validity, suitability, dependability, and quality, triangulation of data was performed using students' feedback on i) ease of use ii) flexibility of usage iii) immediacy of information acquisition for the selected user interface design based on two different device platforms for comparison.

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From the data depicted in Table 1 below, it is evident that when the quasi-experiment was done based on repeated measure design for the target group of 16 students, the iPad depicted better adaptive capability due to a better user interface and students had a better learning attitude with iPad devices.

FIGURE & TABLES

Table 1. Response of students based on closed-ended questionnaire.

iPad Features / Characteristics	Type of Device Service for iPad	Student Count	Student Percentage
The immediacy of information acquisition due to the adequacy of memory	Very prompt delivery	12	75
	Prompt delivery	2	12.5
	Not prompt delivery	2	12.5
Flexibility of usage due to Battery Life	Very flexible to use	12	75
	Flexible to use	3	18.75
	Not flexible to use	1	6.25
Size of Display /Screen is attractive to accessing learning content like video, audio, and text	Very Attractive to Use	11	68.75
	Attractive to Use	3	18.75
	Not Attractive to Use	2	12.5
Keyboard Size and arrangement in ease of usability	Best Ease of Use	10	62.5
	Easy to Use	4	25
	Poor Ease of Use	2	12.5
Android tablet Features / Characteristics	Type of Device Service for Tablet	Student Count	Student Percentage
The immediacy of information acquisition due to the adequacy of memory	Very prompt delivery	9	56.25
	Prompt delivery	4	25
	Not prompt delivery	3	18.75
Flexibility of usage due to Battery Life	Very flexible to use	8	50
	Flexible to use	4	25
	Not flexible to use	4	25
The size of the Display /Screen is attractive for accessing learning content like video, audio, and text	Very Attractive to Use	7	43.75
	Attractive to Use	4	25
	Not Attractive to Use	5	31.25
Keyboard Size and arrangement in ease of usability	Best Ease of Use	5	31.25
	Easy to Use	6	37.5
	Poor Ease of Use	5	31.25

Note: The table identifies the percentage of students who accept the user interface based on the mobile platform

Grounded on the questionnaire facts, this study used the Friedman Test to compare students' attitudes toward M-learning using the iPad's user interface and the Android tab's user interface. The iPad user interface of M-learning mode achieved higher rankings on learning attitude and the results suggested that the iPad user interface was superior in content organization and fostering better learning attitude among undergraduate students. However, it is interesting to note that the Android tab user interface received significantly lower learning attitude ratings on some items indicating students preferred the iPad user interface for M-learning instruction delivery. The Friedman test was employed for one-way repeated measures investigation of variance by ranks and this technique assumes that the primary observations are rated on an ordinal scale at the minimum [21].

The source of analysis was primarily based on the conclusions of a 5-point Likert scale questionnaire. The evaluation acknowledged several positive opinions from the respondents concerning their issues for improvement purposes. Usability was analyzed by determining the ease with which the students could access the service with the slightest complexity and finest fulfillment while experiencing the desired objective. The efficiency of the mobile application was found to be at a moderate level and most of the participants were satisfied with using the same application.

DISCUSSION ON FINDINGS

The initial phase of the coding procedure generated 91 open codes from 221 sentences. These 91 concepts were then plotted into three scales of M-learning. The codes were categorized as dimensions for learners, learning, and technology. The sentences on the 'user interface' topic was then coded to detect the themes. The result depicted that there were 4 scales of the user interface founded on 4 themes generated – i. Design Principle ii. Hardware specifications iii. Context of usage, and iv. Modeling Language to support the

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researcher's argument. The practice of modeling language in constructing a M-learning application's user interface is critical. It is concerned with the model amendment during the development along with the enhancement stage of the application. An object-oriented method was proposed as modeling language in the design of the user interface. There are certain modeling languages that generally help in designing user interfaces, like the Data Flow Modelling Language and Unified Modelling Language (UML). The findings depicted an extent of visualization of the outcome to strongly support how it correlated to the aim of this study. Some concerns arose due to the unsupported platform of the operating system and the condition or age span of mobiles.

REFLECTION AND SUMMARY

Recent technology supports collaborative work among users which is becoming a more eminent feature in M-learning. Furthermore, the design of any user interface for any type of mobile platform should highly consider the monitor size of the gadget so that it can be exhibited neatly. Learning behavior through mobile gadgets is not determined by time and place. It has restricted attention from the users which affects the level of the user's attention in doing tasks. Thus, the interface must be created grounded on the mobility of the user. The app was considered good in terms of effectiveness. This article shall be useful to future researchers on how user interface plays an effective function in M-learning app design while reflecting on the way the user interface of the application could be designed and the user acceptance. Further investigations are needed to specify comparative results on interface upgrades based on behavioral intention to apply in higher education mobile apps. Depending on the time to finish each chore, it may be deduced whether the app was efficient for use.

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