FORMULATING M-LEARNING FRAMEWORK FOR GENERATION Z USING THE FUZZY DELPHI METHOD

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SULTAN IDRIS EDUCATION UNIVERSITY

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ABSTRACT

This study was aimed to formulate m-learning framework for generation Z as a guideline to improve the teaching and learning process among generation Z learners, who was born in the year 1995 – 2012, also known as "Digital Natives", "Me Generation", and "Generation N". This generation is the first generation to be born and grown with ready-to-use technology and a high-tech environment that differentiate their outlook from the previous generations. Although several researchers demonstrate the m-learning frameworks for teaching and learning, there is a limitation in the user interface (UI) design in the frameworks that suitable for the generation Z. To conduct this research study, Design and Development Research (DDR) method is used to identify the elements of generation Z characteristics, user interface (UI) design, and the m-learning instructional design (ID), formulate and evaluate the m-learning framework for generation Z. The instrument used in this research study is library research, survey, and Fuzzy Delphi Method (FDM). There were 91 generation Zs were involved in the first survey which were the percentage of education level recorded were 45.1% from secondary school student, 5.4% from pre-university student, 14.3% from Diploma student, and 35.2% from Bachelor's Degree student. The collected data were transcribed and analysed thematically to form the items of the FDM questionnaire. The findings showed that 23 elements which seven elements of generation Z characteristics, 12 elements of user interface (UI) design, and four elements of m-learning instructional design (ID) were collected. The collected data was extended to the second survey using FDM questionnaire was administered to the panel of 10 experts. The analysis was conducted using the FDM machine by converting the five Likert scale to five-point fuzzy scale and applying the FDM techniques. To find the expert's consensus, 10 experts were selected from various fields such as Human-Computer Interaction (HCI), multimedia, m-learning, e-learning, information system, instructional design, and learning design. The result showed that there were 22 essential elements that met the expert consensus: five elements of generation Z characteristics, 12 elements of user interface (UI) design, and four elements of m-learning instructional design (ID). The study implicates that the formulated m-learning framework for generation Z can be utilized by the stakeholders to enhance the effectiveness of teaching and learning through mobile technology.

FORMULASI RANGKA KERJA M-PEMBELAJARAN UNTUK GENERASI Z MENGGUNAKAN KAEDAH FUZZY DELPHI

ABSTRAK

Kajian ini bertujuan untuk merumus rangka kerja m-pembelajaran untuk generasi Z sebagai garis panduan untuk penambahbaikan proses pengajaran dan pembelajaran dalam kalangan pelajar generasi Z, yang dilahirkan pada tahun 1995 – 2012, juga dikenali sebagai *"Digital Natives"*, *"Me Generation"* dan *"Generation N"*. Generasi ini adalah generasi pertama yang lahir bersama zaman perkembangan dan persekitaran berteknologi tinggi yang membezakan pandangan mereka daripada generasi sebelumnya. Berdasarkan kajian yang dijalankan, rangka kerja m-pembelajaran yang sedia ada berfokus kepada tujuan pengajaran dan pemebelajaran, namun terdapat kekurangan di dalam rangka kerja tersebut iaitu kekangan di dalam antara muka pengguna *(UI)* yang bersesuaian dengan generasi Z. Kaedah Penyelidikan Reka Bentuk dan Pembangunan *(DDR)* menggunakan kajian perpustakaan dan tinjauan sebagai instrumen digunakan untuk mengenal pasti elemen ciri generasi Z, reka bentuk antara muka pengguna *(UI)* dan reka bentuk pengajaran *(ID)* m-pembelajaran, dan untuk merumuskan rangka kerja m-pembelajaran bagi generasi Z. Seramai 91 orang daripada generasi Z terlibat dalam tinjauan pertama iaitu peratusan tahap pendidikan yang direkodkan ialah 45.1% daripada pelajar sekolah menengah, 5.4% daripada pelajar pra-universiti, 14.3% daripada pelajar Diploma, dan 35.2% daripada pelajar Ijazah Sarjana Muda. Data yang dikumpul telah ditranskripsi dan dianalisis secara tematik untuk membentuk item soal selidik Kaedah Fuzzy Delphi *(FDM)*. Dapatan kajian menunjukkan 23 elemen yang terdiri daripada tujuh elemen ciri generasi Z, 12 elemen reka bentuk antara muka pengguna *(UI)*, dan empat elemen reka bentuk pengajaran *(ID)* m-learning telah dikumpul. Data yang dikumpul telah dilanjutkan kepada tinjauan kedua menggunakan soal selidik *FDM* telah ditadbirkan kepada 10 orang panel pakar. Analisis dijalankan menggunakan mesin *FDM* dengan menukar lima skala Likert kepada skala kabur lima mata dan menggunakan teknik *FDM*. Untuk mendapat kesepakatan daripada pakar, 10 orang pakar telah dipilih daripada pelbagai bidang seperti *"Human-Computer Interaction (HCI)"*, multimedia, m-pembelajaran, e-pembelajaran, sistem maklumat, reka bentuk pengajaran, dan reka bentuk pembelajaran. Hasil kajian menunjukkan terdapat 22 elemen penting yang memenuhi konsensus pakar: lima elemen ciri generasi Z, 12 elemen reka bentuk antara muka pengguna (UI), dan empat elemen reka bentuk pengajaran *(ID)* m-pembelajaran. Kajian ini memberi implikasi bahawa rangka kerja m-pembelajaran yang digubal untuk generasi Z boleh digunakan oleh pihak berkepentingan untuk meningkatkan keberkesanan pengajaran dan pembelajaran melalui teknologi mudah alih.

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LIST OF ABBREVIATIONS

AR	Augmented Reality
BYOD	Bring Your Own Device
DDR	Design and Development Research
E-learning	electronic learning
FRAME	Framework for the Rational Analysis in Mobile Education
FDM	Fuzzy Delphi Method
GUIs	Graphical User Interfaces
HCI	Human-Computer Interaction
IS	Information System
LMSs	Learning Management Systems
MALL	Mobile-assisted Language Learning
MLFAF	Mobile Learning Framework for Assessment Feedback
SAMR	Substitution, Augmentation, Modification, and Redefinition
TPACK	Technological pedagogical content knowledge
VR	Virtual Reality
VUIs	Voice-controlled interfaces

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CHAPTER 1

INTRODUCTION

1.1 Introduction

This is an introductory chapter describing the background of the research which describes the evolution of technology used in education and the essentiality of mobile learning (m-learning) for generation Z. Moreover, the limitations and challenges in implementing m-learning in the educational environment have been also highlighted. In line with the research background, the problem statement indicated the existing research gap. In addition to this, the research objectives and questions regarding the issues of User Interface (UI) Design in m-learning are also the core elements of this chapter, which also considers the previous study of m-learning. Apart from that, the scope of this study is also discussed in this section. Meanwhile, this chapter identifies the theoretical framework and the significance of the research. Last, it proposes the operational definition of the research based on the research title.

1.2 Research Background

The adoption of advanced technology in the current century is playing an essential role in daily routine for individuals, school institutions, organizations, governments, industries, etc. For instance, the rapid development of electronic communication and smart devices has improved the platform of teaching and learning in the education field especially for learners, teachers, instructors, lecturers, and administrators. Before the era's 90s, our educational system was conducted based on the traditional method which is known as "face-to-face" learning, which involved physical interaction during the class period or in classroom learning. In the era of globalization, the great collaboration of traditional classrooms and advanced technology has triggered the development of electronic learning (e-learning) that contributes to the effectiveness of an educational system for the time being.

The first acknowledged word for connecting education explicitly with technologies appears to be electronic learning and witnessed increased usage in the past decade. According to (Tavangarian et al., 2004) e-learning is defined as all forms of electronically supported learning and teaching, which are procedural and aim to affect the construction of knowledge concerning individual experience, practice, and knowledge of the learner. Information and communication systems, whether networked or not, serve as specific media to implement the learning process. There is the advantage of e-learning is it helps to cater the learners to access the learning materials in various kinds of formats such as word documents, PDFs, videos, and

slideshows. Moreover, e-learning offers the ability for learners to learn without boundaries in four walls. Apart from that, e-learning plays a critical role in distance learning by providing availability in areas where there is no school or educational institution to access information and educational content at any time and any place. As appointed by (Nagro & Aldekhail, 2021; S. et al., 2018; Sangra et al., 2012), e-learning is a natural evolution of distance learning, and in Malaysia, distance learning program has been using the e-learning portal as a platform for teaching and learning through a home-grown electronic portal, followed by the migration into Learning Management Systems (LMSs) (Rosli et al., 2012). There is a plethora of e-learning systems or Learning Management Systems (LMSs) such as Google Classroom, Udemy, Coursera, Khan Academy, Pandai.org, YouTube, Home Tutor Online Learning, MyGuru, Canva, etc., which allow for courses to be delivered. Following this, with the proliferation of advanced technologies since the launch of the internet, learners are familiar with smart devices such as portable smartphones, which have the characteristic to be easily carried or moved. Therefore, as e-learning continues to develop, the learner's expectations towards e-learning are high and the striking features of e-learning are leading to a revolution in mobile learning (m-learning).

The need for flexibility in learning has resulted in the use of m-learning. According to (Chee et al., 2017), m-learning means using mobile technology such as mobile phones, smartphones, iPads, and tablets, to deliver learning materials to learners regardless of their location. As mentioned by (Crompton, 2013), the term m-learning was recognized in 2005. In the early recognition, instead of expensive mobile devices, m-learning also faced many weaknesses such as lack of functionality, screen

size, processor speed, and battery life. As m-learning becomes a demand, many technology companies have improved in terms of the specifications and features in their technology products. Many definitions of mobile learning were defined by researchers that centered on flexible learning to improve access. According to (O' Malley et al., 2003), m-learning is defined as any sort of learning that happens when the learner is not at a fixed, predetermined location, or learning that happens when the learner takes advantage of the learning opportunities offered by mobile technologies. Early on, as stated by (Behera, 2013; Traxler & Wishart, 2011), m-learning was typically used to channel e-learning methods and techniques, quickly exposing the limitations of cell phones and PDAs compared with desktop computers at the time. These definitions emphasize that learners are mobile and that they use technologies to learn while they are mobile.

Mobile technology provides an equal opportunity to access the learning materials to all learners, including adult learners, the disabled, and those with limited mobility. Apart from that, the disadvantaged learners who cannot afford to go to school also can access the learning materials using mobile technology from wherever they are located. On the other hand, the flexibility of mobile technology also provides benefits to using mobile learning in education. This is because by using m-learning, it can be used for both formal and informal learning. For example, in formal learning, learners can access the course materials while they are in the class, on the move, or indeed any time they want to learn. Whereas, for an informal setting, learners can learn from anywhere at any time so that they can be applied what they learn right away to facilitate meaningful learning. Not only in education, but m-learning can also

be a benefit for the health, agriculture, and finance sector. In essence, mobile technology makes m-learning more accessible and increases learners' motivation to preserve, especially for learners with their busy schedules. Therefore, as the advanced mobile technology devices used are exceeded, it has completely dominated our lives in communication, socializing, and learning especially among the young generation learners.

The young generation learners are the teenagers and learners in their twenties, are known as the mobile generation because they were born and grew up in the era of mobile-ready technology. The most class of generation that applied mobile technology in their daily life is known as generation Z (Gen Z). Generation Z is a cohort born in the mid of 1990s and late 2000s, that is a generation who is born in the ready-made technology era. According to (Mat Salleh et al., 2017), gen Z was born between 1995 – 2012 and known as "Digital Natives", "Me Generation", and "Generation N". Meanwhile, (Yusri, 2015) described that gen Z is a generation who was born between 1995 and 2009, and this generation is the first generation to be born and grown with ready-to-use technology and a high-tech environment that differentiates their outlook from previous generations. Apart from that, (Ozkan & Solmaz, 2015) stressed that generation Z is a big group leading to the use of the Internet and also known as the "internet generation". This young generation's lifestyle is very different from that of the previous generation, in which it is comfortable to stay connected virtually to the outside world instead of directly "face-to-face".

In the learning process, generation Z will be using all the technology tools or devices that they have to help them to gain knowledge and keep up to date with the global changes. Therefore, for educational purposes, this age cohort will easily adapt to any e-learning and m-learning platform that is used as a method for the teaching and learning process. A study by (Guo et al., 2014), analysed that the traditional method used in previous years, such as the presentation style, is not effective in online educational videos. This is because people tend to use the opportunity and take advantage of the latest communication platform. The development of this generation is far beyond the learning process. Instead of going through the articles, generation Z also prefers to see how the studies have been carried out. For example, they prefer more on following the tutorial videos to help them understand the contents of the lesson. Besides, the most influential factors that distract their attitudes towards the m-learning system are the attractiveness of system interfaces or platform applications. The efficiency and effectiveness of system or application functional requirements are the keys to how the system is rated. Therefore, it has been proven that generation Z prefers the easy-to-use aspect rather than being a trap in a complicated way.

Therefore, in this study, the m-learning framework for generation Z is formulated and validated using the Fuzzy Delphi Method (FDM) will be presented as guidance for teaching and learning among youngsters especially in the Generation Z age cohort via the m-learning platform. Thus, this framework can be comprehensive guidance for the stakeholders in this field who intend to adopt m-learning into the educational program. This study is based on one of the features of Human-Computer

Interaction (HCI) which is User Interface (UI) Design elements for m-learning that suits generation Z needs. The knowledge of m-learning is largely based on the limited data and outcomes from the previous studies conducted by the researchers in e-learning, m-learning, and the issues of the user interface design (UI) in the current m-learning platform. Apart from that, the m-learning instructional design (ID) is also taken into account as part of the essential elements in this framework. Therefore, the consensus from the experts on the related field such as HCI, e-learning, m-learning, multimedia, learning design, information system, and instructional design, is important as a guide to developing the framework.

1.3 Research Objectives

The approaches of cutting-edge technology in the m-learning lead to a big impact on the teaching and learning process. The development of many m-learning platforms and user acceptance towards the platform has determined the goal achievement of one m-learning platform. Therefore, the objectives of the research are listed below:

i. To identify the generation Z characteristics, the element of User Interface (UI) Design, and M-learning Instructional Design (ID) for m-learning among generation Z.

ii. To formulate the m-learning framework for generation Z using the generation Z characteristics, the element of User Interface (UI) Design, and M-learning Instructional Design (ID).

iii. To evaluate the formulated m-learning framework for generation Z.

1.4 Research Questions

This research aims to investigate the following questions:

i. What are the elements of m-learning in the learning process among generation Z?

ii. How to frame effective elements to improve the m-learning framework for generation Z?

iii. How to validate the proposed m-learning framework for generation Z?

1.5 Research Conceptual Framework

A conceptual framework is the researcher's summary of the literature on how to explain a phenomenon. It outlines the actions that must be taken during the study, based on his prior knowledge of other researchers' points of view and his observations on the subject of research. As pointed out by (Crompton & Traxler, 2015), m-learning is multiple contexts learning through social and content interactions using personal electronic devices. Therefore, to establish m-learning, it is important to identify the elements that contribute to the efficiency of m-learning. According to (Arambepola & Munasinghe, 2020), the user interface (UI) of mobile applications is

one of the most important factors that determines the app's usability. Since the age group among generation Z is the major user of mobile technology devices, it is important to develop the m-learning framework based on their expectation. Apart from that, instructional design (ID) is an essential part of the m-learning. This is because instructional design used systematic methodology (based on instructional theories and models) to design and develop content, experiences, and other solutions to aid in the acquisition of new knowledge or skills (ATD, n.d.). Figure 1.1 illustrates the conceptual framework of the research.

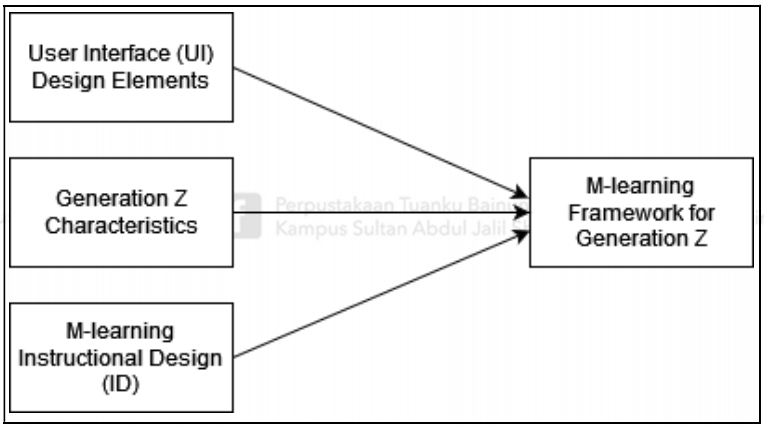

Figure 1.1. The research conceptual framework

1.6 Research Scope

The research focuses on the User Interface (UI) Design elements for m-learning that meets the requirement and specifications among generation Z. The elements of user interface design will be identified based on the previous existing studies. A survey also will be conducted to identify the characteristics of generation Z, and the samples

will be collected from the respondents among generation Z through online questionnaire using google form. Apart from that, m-learning instructional design (ID) elements will be identified as suggested by (Sharples, Arnedillo-Sánchez, et al., 2009), as one of the essential parts in designing the m-learning. As a result, this study will come out with the m-learning framework for generation Z as comprehensive guidance for the policymakers, academicians, and researchers in this field who intend to adopt m-learning into the educational program.

To finalize the framework, the experts from related fields such as Human Computer Interaction (HCI), multimedia, m-learning, e-learning, instructional design, information systems, and learning design will be selected. The expert consensus would be done through the utilization of online questionnaire as a survey and reference. At the end of this result, the researchers will be able to know the suitable design of user interface that will be satisfied the requirements among generation Z learners.

1.6.1 Significance of the Research

The proposed framework is hoped to help enhance the quality of the User Interface (UI) Design in the m-learning platform based on the requirement and specifications of generation Z. Apart from that, this study will help the learners, academicians, researchers, researchers, and also administrators to provide feedback to the

Instructional Designer and stakeholders about the weaknesses and strengths that existed in the used platform. It is valuable since the technology keeps on updating, the current m-learning platforms should be adapted with the latest update. Table 1.1 shows the significance of Research Questions, Research Objectives, and Expected Outcomes from this study.

Table 1.1

The significance of Research Questions, Research Objectives, and Expected Outcomes from this research

Research Questions	Research Objectives	Expected outcomes
What are the elements of m-learning in the learning process among the generation Z?	To identify the generation Z characteristics and the element of User Interface (UI) Design and M-learning Instructional Design (ID) for m-learning among generation Z.	A list of User Interface (UI) Design elements for m-learning that satisfy the requirements and specifications of generation Z.
How to frame effective elements to improve the m-learning framework for Generation Z?	To formulate the m-learning framework for generation Z.	A formulation of m-learning framework for generation Z.
How to validate the	To evaluate the	The process used to reach

(continue)

Table 1.1 *(continue)*

proposed m-learning framework for generation Z?	formulated m-learning framework for generation Z.	a final consensus among the expertise based on the measurement of Fuzzy Delphi Method (FDM).

1.7 Research Problem Statement

As mobile technologies are growing rapidly, the demand for m-learning is exceeded. Based on previous studies of m-learning, the study found the limitations and challenges in implementing m-learning in the educational environment. The limitations and challenges are stated as below:

i. Lack of interest and engagement in m-learning due to poor User Interface (UI) Design.

The most recent research study by (Nagro & Aldekhail, 2021) found that numerous mobile educational apps have been created as a result of the recent advancement of technology, including mobile devices, multimedia interfaces, and m-learning. These types of software have been created to make it possible for non-programmers to create their own mobile learning applications. Although these tools are useful for developing mobile learning applications,

they do not offer easily accessible, affordable, design-based methods to satisfy students' criteria for choosing design media. This research study supported by (Ling et al., 2020) which mentioned that users in m-learning are seeking an enjoyable and engaging experience in addition to application usability. Additionally, m-learning course content should be arranged for effective learning that encourages students to use mobile devices.

ii. Lack of guidelines to develop an attractive m-learning framework

According to (Curum & Khedo, 2021) which in previous studies in the field of m-learning demonstrated that poor learning element design is still present in mobile systems, which has a negative impact on the dynamic content adaption.

Another issue presented by (Nagro & Aldekhail, 2021) in the research studies mentioned that there are certain existing guidelines proposed some guidelines for planning specific media types based on information types. On the other hand, did not provide or design a method; instead, it simply evaluated educational multi-media, and ignored the Universal Instructional Design (UID) which were created to guide and assist interface developers and designers who must create educational material interfaces for a diverse group of students. Moreover, there is no guidelines that specific to subject due to existing guidelines are too general. For example, in the study by (Ariffin, 2020) there is lack of cultural design standards and the investigation of regional cultures.

iii. Lack of validation of m-learning framework

The purpose of the revolution of m-learning is as a supporting tool that is used to deliver the lesson anytime and anywhere. Before the delivery, it is essential to evaluate to satisfy the user specifications and requirements, and also prevent the failure of that m-learning or e-learning system. According to (Jayatilleke et al., 2018), there is still a lack of transferable m-learning design frameworks regardless of those developed earlier. The study is supported by (Mohaimen-Bin-noor et al., 2021a) which that researchers behind m-learning technology have proposed that m-learning be standardized to ensure that it runs smoothly within educational institutes' existing IT infrastructure. Therefore, this issue requires the instructional designer, practitioners, and instructors to consider the instructional design in m-learning. This can be achieved by examining all aspects related to education and technology and requires validation from the expertise related to this field.

1.8 Research Operational Definition

The operational definition of the variables used for the present research is described in Table 1.2.

Table 1.2

The operational definition of the research

Variables	Operational Definition
M-learning effectiveness	To measure the m-learning effectiveness, this study conducted the random survey among the learners using the online questionnaires which is Google Form as an instrument, to collect learner's perception toward m-learning and how much learners utilize their mobile devices. The collected data was analyze using the Google Analytic.
Characteristics of generation Z	The characteristics of generation Z was identified using the library research from previous research studies that conducting the research in generation Z's behavior and acceptance toward m-learning.
User Interface (UI) elements	Library research from previous studies is used to identify the UI elements in m-learning. The keywords that are mostly used to identify the UI elements are "m-learning interface design", "user interface elements", "m-learning application UI", and "the best UI in m-learning".
M-learning Instructional Design (ID) principles	Instructional Design (ID) principles was identify using the library research. The mostly keywords

(continue)

Table 1.2 *(continue)*

	used is "m-learning instructional design".
Expert Consensus	In this study, the Fuzzy Delphi Method (FDM) is used to find the expert consensus. 10 experts were selected that specialized in m-learning, e-learning, learning design, Human – Computer Interaction (HCI), multimedia, instructional design, and information systems. FDM machine is used to analyze the collected data.

1.9 Summary

In general, there are existing m-learning frameworks that have been conducted by researchers and approved since the platform had been introduced into the educational system. The research is focused on the generation Z target group since this cohort of generation mostly owns portable electronic devices such as tablets and smartphones. The framework that is proposed is mainly about the user interface (UI) design in the m-learning that satisfy the needs of generation Z. By combining the elements of user interface design, characteristic of generation Z, and m-learning instructional design, it can help to improve the attractiveness of m-learning, also help the policymakers, academicians, and researchers to apply the m-learning for teaching and learning.

To validate the developed framework, the Fuzzy Delphi Method (FDM) will be used since this method is very accurate to find the consensus among the experts in the related fields. Since the research aims to develop the m-learning framework for generation Z, the Fuzzy Delphi Method is the suitable method to validate the framework because it covers the stage of validity and reliability of questionnaire items and stage of data analysis (triangular fuzzy numbers, average response, threshold value, group consensus, defuzzification, and ranking items).

The next chapter, Chapter 2, will discuss the literature review on m-learning. The sub-topic in the literature review will be explained the significance and existing studies that are related to the research.