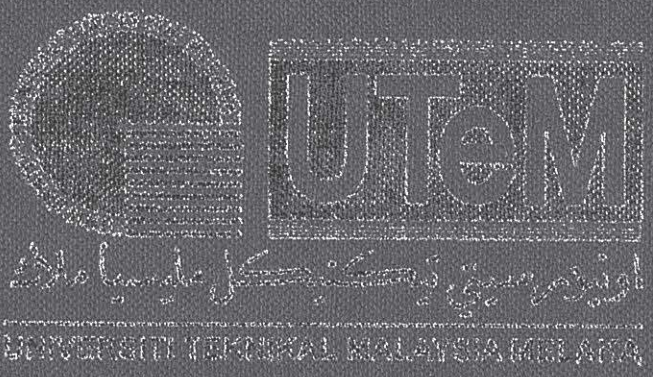

USABILITY EVALUATION MODEL BASED ON PEDAGOGY, PLAYABILITY AND MOBILITY FOR MOBILE EDUCATIONAL GAME

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Hanif Al Fatta

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USABILITY EVALUATION MODEL BASED ON PEDAGOGY, PLAYABILITY AND MOBILITY FOR MOBILE EDUCATIONAL GAME

HANIF AL FATTA

A thesis submitted
in fulfilment of the requirements for the degree of Doctor of Philosophy

Faculty of Information and Communication Technology

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2023

DECLARATION

I declare that this thesis entitled "Usability Evaluation Model Based on Pedagogy, Playability and Mobility for Mobile Educational Game" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature :

Name : Hanif Al Fatta

Date : 5/4/2023

APPROVAL

I hereby declare that I have read this thesis and, in my opinion, this thesis is sufficient in terms of scope and quality for the award of Doctor of Philosophy.

Signature :

Supervisor Name : Dr. Zulisman Maksom

Date : 5/4/2023

DEDICATION

In the name of Allah, the most Gracious, the most beneficent, the most merciful

Alhamdulillahi rabbil 'alamin

All the praises and thanks be to Allah, the Lord of the 'Alamin.

This work is dedicated to:

My beloved parents,

[Bapak Supriyadi and Ibu Sri Sarworini]

My wife,

[Anny Choirunnisa]

My children,

[Zafaroni Fikri Alfatta and Nayyara Jihan Nazila Alfatta]

All members of my big family.

ABSTRACT

The research to propose a usability evaluation model for mobile educational games increased rapidly in recent years. The usability evaluation model was an effective tool for conducting usability evaluation during the software evaluation process. The high-quality model used in evaluating the usability aspect will ensure that the educational games show good quality and support their primary function in delivering educational content. This research proposed a comprehensive model to evaluate the usability of mobile educational games. This research suggested the PLATMO model, where three dimensions were proposed to measure playability, mobility and pedagogy. This study also presented suitable heuristics for each dimension to detect more usability issues during the usability testing. This research used a multi-methods methodology. The quantitative approach was employed to test the data by performing two round validation process. each round of validation involved more than 350 participants in collecting the data, followed by Confirmatory Factor Analysis to evaluate the model fitness, ensuring the validity of the PLATMO Model. In addition, the qualitative approach was also employed by involving two participants serving as experts conducting the usability testing using a usability-meter prototype based on the proposed model. The result showed that PLATMO Model could be used as a fast and comprehensive tool for evaluation. Based on these results, this study succeeded in presenting two research contributions: the new model to measure usability and the usability prototype as a tool to conduct usability. New dimensions, such as learning assessment, could be added for future development to enhance the PLATMO Model capability. PLATMO Model could also be used as a development guideline to produce good quality mobile educational games.

MODEL PENILAIAN KEBOLEHGUNAAN BERDASARKAN PEDAGOGI, KEBOLEHMAINAN DAN MOBILITI UNTUK PERMAINAN PENDIDIKAN MUDAH ALIH

ABSTRAK

Penyelidikan untuk mencadangkan model penilaian kebolehgunaan untuk permainan pendidikan mudah alih meningkat dengan pesat dalam beberapa tahun kebelakangan ini. Model penilaian kebolehgunaan adalah alat yang berkesan untuk menjalankan penilaian kebolehgunaan semasa proses penilaian perisian. Model berkualiti tinggi yang digunakan dalam menilai aspek kebolehgunaan akan memastikan permainan pendidikan menunjukkan kualiti yang baik dan menyokong fungsi utamanya dalam menyampaikan kandungan pendidikan. Penyelidikan ini mencadangkan model komprehensif untuk menilai kebolehgunaan permainan pendidikan mudah alih. Penyelidikan ini mencadangkan model PLATMO, di mana tiga dimensi dicadangkan untuk mengukur kebolehmainan, mobiliti dan pedagogi. Kajian ini juga membentangkan heuristik yang sesuai untuk setiap dimensi untuk mengesan lebih banyak isu kebolehgunaan semasa ujian kebolehgunaan. Penyelidikan ini menggunakan metodologi pelbagai kaedah. Pendekatan kuantitatif digunakan untuk menguji data dengan melakukan dua proses pengesahan pusingan. Setiap pusingan pengesahan melibatkan lebih daripada 350 peserta dalam mengumpul data, diikuti dengan Confirmatory Factor Analysis untuk menilai kecergasan model, memastikan kesahihan Model PLATMO. Di samping itu, pendekatan kualitatif juga digunakan dengan melibatkan dua orang peserta yang berkhidmat sebagai pakar yang menjalankan ujian kebolehgunaan menggunakan prototaip meter kebolehgunaan berdasarkan model yang dicadangkan. Keputusan menunjukkan bahawa Model PLATMO boleh digunakan sebagai alat yang cepat dan komprehensif untuk penilaian. Berdasarkan keputusan ini, kajian ini berjaya membentangkan dua sumbangan kajian: model baharu untuk mengukur kebolehgunaan dan prototaip kebolehgunaan sebagai alat untuk menjalankan kebolehgunaan. Dimensi baharu, seperti penilaian pembelajaran, boleh ditambah untuk pembangunan masa hadapan bagi meningkatkan keupayaan Model PLATMO. Model PLATMO juga boleh digunakan sebagai garis panduan pembangunan untuk menghasilkan permainan pendidikan mudah alih yang berkualiti.

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LIST OF ABBREVIATIONS AND GLOSSARY

AVE - *Average Variance Extracted.* To confirm convergent validity the Average Variance Extracted (AVE) score is established. Hair et al. (1998) defined AVE as: "the average squared completely standardized factor loading or average communality"and is calculated for all latent variable in measurement model. And an AVE greater of equal to 0.5 is acceptable since the value less than 0.5 indicating more error remains, on average, in the items than the variance explained by the factor structure that was measured.

CFA - *Confirmatory Factor Analysis*. Confirmatory Factor Analysis (CFA) is utilized to calculate the construct validity of the questionnaire. CFA indicated how well the underlying indicators explained the related construct. It means whenever the correlation of the items is relatively high, it can be concluded that the construct validity is assured (Hair et al., 1998).

CR - *Composite Reliability.* CR value is an indicator to show how well items/indicators describing their underlying constructs. And according to W.Chin (2015), the threshold value for this CR is 0.7 and the value above 0.7 is required to show how a construct is well described by their respective indicators.

G/P/S - *Gameplay, Purpose and Sector*. Model consisted of gameplay, purpose and sector, a serious game should bring game play (G) as well as deliver purpose (P) in specific domain (S) (Alvarez and Damien, 2011).

GQM - *Goal Question Metrics*. A method to produce questionnaire item based on the goal of the measurement (Basili, 1992).

HCI - *Human Computer Interaction*. A branch of computer science focused on studying the interaction between human and computer comprising design, evaluation and implementation of user interface to make the computer user more comfortable in using the technology.

HCM - *Hierarchical Component Model.* Hierarchical component models is representations of multidimensional constructs that some constructs

served as higher order component (HOC) summarizing their respective lower order component (LOC).

HEP - *Heuristic Evaluation for Playability.* HEP is a comprehensive model proposing four heuristics designing to measure the playability dimension of a digital game. HEP delivered a new method for Human Computer Interaction community using gameplay, game story, game mechanics and game usability to enhance the usability degree and playability of the game they developed (Desurvire et al., 2004).

HOC - *Higher Order Construct.* In a Hierarchical Component Model concept, some constructs served as higher order component (HOC) summarizing their respective lower order component (LOC).

ICT - *Information and Communication Technology.* A vast umbrella of terminology comprising all technical equipment to process and disseminate significant information. ICT consists of two aspects information technology and communication technology. Information technology includes all things dealing with the processing, using, manipulating and managing available information.

iOS - *iPhone Operating System.* A mobile operating system develops by Apple inc. to be used in their mobile device such as iPhone, iPad, iPod.

ISO - *International Organisation for Standardization.* ISO actually is not an abbreviation. ISO derived from "isos"means equal. It is an international organisation to define international standard in industrial and commerce sectors.

LOC - *Lower Order Construct.* In a Hierarchical Component Model concept, some constructs served as higher order component (HOC) summarizing their respective lower order component (LOC)

LSQ - *Learning Style Questionnaire.* Briefly described, this model divided learning style into four categories: activists, reflectors, theorists, and pragmatists. (Honey and Mumford, 1982)

MBTI - *The Myers-Briggs Type Indicator.* Based on Jung's Theory of Psychological Types, Myers-Briggs Type Indicator (MBTI) classifies people into four categories: Extraverts, Sensors, thinkers, and Judgers (Pittenger, 1993)

MUEF - *Mobile Universities Evaluation Framework.* A framework to evaluate the usability of university's website proposed by Hend S. Al-Khalifa

PC - *Personal Computer.* An individual computer device, usually used at home or office.

PHEG - *Playability Heuristic Evaluation for Educational Computer Game.* PHEG is a model to measure usability educational games. proposed several criteria, including Educational Elements and Playability in their heuristics criteria as a unique heuristic for measuring educational games (Omar and Jaafar, 2010)

PLS-SEM - *Partial Least Square-SEM.* PLS SEM is a second-generation SEM that mainly used to develop new theories particularly in explanatory research. This method worked by paying more attention on explaining the variance of the dependant variables (Hair et.al., 2014).

Pre-MEGA - *Proposed Framework for the Design and Evaluation of Pre-schoolers' Mobile Educational Games.* A framework, aimed to measure usability of educational games for pre-school children, resulting in development of a set of heuristics for combining play, learning, usability and mobility (Shoukry et al., 2015)

RPG - *Role Play Game.* RPG is a genre of video games where the player controls the character into a imaginative adventure, and the character can develop based on the direction of the user.

SEEM - *Structured Expert Evaluation Method.* This model is constructed based on two significant theory, Norman's Theory of Action and Malone's Fun Concept (Malone, 1980). The predictive test model is proposed to measure playability using three heuristics: fantasy, curiosity and challenge (Ester Baauw et al., 2005).

SEM - *Structured Equation Modeling.* SEM is a statistical technique used to construct and test statistical models which are usually in the form of causal models. SEM is actually a hybrid technique that includes confirmatory aspects of factor analysis, path analysis and regression which can be considered as a special case in SEM.

UGALCO - A model to evaluate simulation games, proposing five-dimension framework consisted of detailed assessment of player's learning, usability, motivation, user experience and communicability (Peixoto et al., 2014).

UsaECG - *Usability of Educational Computer Games*. ECG focused on creation of function to calculate the usability problem found during evaluation and presenting them in more convenience form (qualitative form) (Mohamed-Omar et al., 2012).

UX - *User Experience*. UX is the process of designing a product based on user centered approach. Using this approach, it is possible to create a product that is suitable for the user's need. Product with better UX design, will bring enjoyable experience while the user using the product.

VARK - *Visual, Aural, Read/Write and Kinaesthetic*. Based on this model learners are classified as Visual-where learner experienced the best learning by seeing it. Aural-where the best learning is by hearing. Read/Write-learner that prefer to look at the written word. Kinesthetic-experience and practice are the best way to learn. And the Multimodal category for a learner with multiple types of learning style. (Fleming and Baume, 2006).

VIF - *Variance Inflation Factor*. VIF a measure of the amount of multicollinearity in a set of multiple regression variables.

LIST OF PUBLICATIONS

1. Al Fatta, H., Maksom, Z. and Zakaria, M.H., 2018. Systematic Literature Review on Usability Evaluation Model of Educational Games: Playability, Pedagogy, And Mobility Aspects. *Journal of Theoretical and Applied Information Technology*, 96 (14).

2. Al Fatta, H., Maksom, Z. and Zakaria, M.H., 2018. Game-based learning and gamification: Searching for definitions. *International Journal of Simulation: Systems, Science and Technology*, 19 (6), pp. 41.1- 41.5.

3. Al Fatta, H., Maksom, Z. and Zakaria, M.H., 2019. Fun, Play and Challenge Factors for Playability Measurement of Game-Based Learning. *International Journal of Advanced Trends in Computer Science and Engineering*, Vol. 18 (1.5), pp. 305-316.

4. Al Fatta, H., Maksom, Z. and Zakaria, M.H., 2019. Learning Style on Mobile-Game-Based Learning Design: How to Measure? In *Intelligent and Interactive Computing*, pp. 503-512. Springer, Singapore.

CHAPTER 1

INTRODUCTION

This chapter presents the significance of the research, starting with the research background. The research background starts with the development of educational games industry as a very serious business, followed by the fact that the involvement of educational games in educational institution brings significant advantages. Furthermore, the role of the usability evaluation to ensure the quality of the mobile educational game is presented. The next part is the research problems section, describing the problem in available usability evaluation model and the need to provide more comprehensive usability evaluation model. From the available research problems, three research questions are proposed and available on research problem section. In addition, the research objectives section describes the objectives based on the three proposed research questions. The relationship between the research problem, research question and research objectives are also available in this chapter. Furthermore, the next section is research contribution, where the contribution to body of knowledge and the contribution for more practical use of the proposed model are available. This chapter also provide the research scope and the organization of the thesis in the end of the chapter.