

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



DOCTOR OF PHILOSOPHY

2023





**Faculty of Information and Communication Technology**

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

اونيورسيتي تيكنيكل مليسيا ملاك

**Hanif Al Fatta**

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

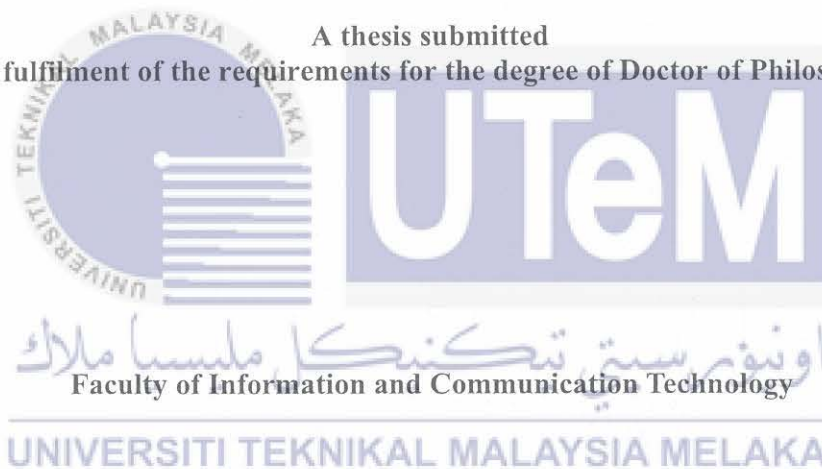
**Doctor of Philosophy**

**2023**

**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



**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

Date

:

:

:

Hanif Al Fatta

5/4/2023



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## 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



اونيورسيتي تيكنيكل مليسيا ملاك

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## DEDICATION

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

*Alhamdulillah 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.

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**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 pengesanan pusingan. Setiap pusingan pengesanan 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.*



## ACKNOWLEDGMENTS

First of all, I would like to express my gratitude to the presence of Allah for all the blessings and guidance given so that this research is completed.

I also would like to express my immeasurable gratitude to the main supervisor, Dr. Zulisman Maksom, for his patience in guiding, for the long but warm discussions to resolve the dead-end and obstacles that arose during this research, and the motivation that kept me going. We also would like to thank the co-supervisor Dr. Mohd. Hafiz Zakaria, for his very useful guidance and comments. It is a moment that I will always treasure, to learn about research from both supervisors.

I also express my deepest gratitude to AMIKOM University Yogyakarta, especially Professor Dr. M. Suyanto, for the moral assistance and funding for the completion of this research. All my Ph. D fellow from AMIKOM Yogyakarta: Mr. Hanafi, Mr. Tony, Mr. Emha, Mr. Melwin, Mr. Robert, Mr. Agung and all the fellow Ph. D classmates from 2017 class.

Last but not least, I would like to express my deepest gratitude to my wife (Anny Choirunnisa), the boy (Zafaroni Fikri Alfatta) and the girl (Nayyara Jihan Nazila Alfatta), and my beloved parents for the inspiration, the motivation and the countless supports and prayers.

## TABLE OF CONTENT

	PAGE
DECLARATION	i
APPROVAL	ii
DEDICATION	iii
ABSTRACT	iv
ABSTRAK	vii
ACKNOWLEDGMENTS	x
TABLE OF CONTENT	xii
LIST OF TABLES	xiii
LIST OF FIGURES	xvii
LIST OF APPENDICES	
LIST OF ABBREVIATIONS AND GLOSSARY	
LIST OF PUBLICATIONS	
 <b>CHAPTER</b>	
<b>1. INTRODUCTION</b>	<b>1</b>
1.1 Research background	2
1.1.1 Game industry context	2
1.1.2 Indonesian education context and benefit of mobile educational games utilization.	3
1.1.3 Role of usability in software quality	4
1.1.4 Usability awareness among games developers	6
1.1.5 Existing usability evaluation models limitation	7
1.2 Research problems	9
1.3 Research questions	12
1.4 Research objectives	12
1.5 Relationship between research problems, questions and objectives	13
1.6 Research contribution	14
1.7 Research scope	15
1.8 Organization of the Thesis	16
 <b>2. LITERATURE REVIEW</b>	<b>19</b>
2.1 Educational game	19
2.1.1 Game and digital game	19
2.1.2 Serious games	21
2.1.3 Educational game and game-based learning	24
2.1.4 Mobile educational game	26
2.2 Educational aspect on mobile educational games	26
2.2.1 Learning theory	26
2.2.2 Learning style	28
2.3 Usability and usability evaluation	30
2.3.1 Usability	30
2.3.2 Usability Criteria	30
2.3.3 Usability evaluation	31
2.4 Usability evaluation for mobile educational games	32

2.4.1	Usability evaluation model for mobile educational games	39
2.4.2	Usability evaluation model for game application	41
2.4.3	Usability evaluation model for mobile application	42
2.4.4	Children E-learning usability evaluation model	44
2.5	Pedagogical element on usability for mobile educational game	45
2.6	Testing method for usability evaluation in mobile educational game	49
2.7	Methods to determine heuristics for usability evaluation model	52
2.8	Primary literatures influencing the proposed model	55
<b>3.</b>	<b>RESEARCH METHODOLOGY</b>	<b>59</b>
3.1	Introduction	59
3.2	Research phase	60
3.2.1	Stage 1: Literature Review	64
3.2.2	Stage 2: Model Development	65
3.2.3	Stage 3: Model/Item refinement	68
3.2.4	Stage 4: Final model assessment	70
3.2.5	Stage 5: Expert validation	72
3.3	Research scope and research design	72
3.3.1	Research scope	72
3.3.2	Research design	76
3.4	Data preparation	76
<b>4.</b>	<b>CONCEPTUAL MODEL</b>	<b>84</b>
4.1	Pedagogy dimension	84
4.1.1	Pedagogy construct	85
4.1.2	Learning style construct	88
4.1.3	Learning content construct	91
4.1.4	Items for pedagogy dimensions	93
4.2	Playability dimension	98
4.2.1	Playability constructs	105
4.2.2	Fun factor	105
4.2.3	Play factor	107
4.2.4	Challenge factor	110
4.2.5	Generating items for playability dimension	112
4.3	Mobile application interface dimension	121
4.4	Theoretical model	128
<b>5.</b>	<b>DATA ANALYSIS</b>	<b>137</b>
5.1	First stage validation	137
5.1.1	Subjects of questionnaire	138
5.1.2	Evaluation of the measurement model (First version)	141
5.1.3	Evaluation of structural model (first version)	146
5.2	Second stage validation	153
5.2.1	Variables and measures	156
5.2.2	Data collection (second stage)	169
5.2.3	Evaluation of the measurement model (second stage)	173
5.2.4	Evaluation of structural model (second stage)	176
5.3	Hypotheses analysis	179



5.3.1	Hypothesis 1: Content quality positively affects learning content	179
5.3.2	Hypothesis 2: System adaptation positively affects learning content	180
5.3.3	Hypothesis 3: Learner positively affects learning style	180
5.3.4	Hypothesis 4: Preference positively affects learning style	181
5.3.5	Hypothesis 5: Learning style positively affects pedagogy	181
5.3.6	Hypothesis 6: Learning content positively affects pedagogy	182
5.3.7	Hypothesis 7: Pedagogy positively affects total usability	182
5.3.8	Hypothesis 8: Player variation positively affects play factor	183
5.3.9	Hypothesis 9: Flow positively affects play factor	183
5.3.10	Hypothesis 10: Fantasy positively affects fun factor	184
5.3.11	Hypothesis 11: Endurability positively affects fun factor	184
5.3.12	Hypothesis 12: Game story positively affects fun factor	185
5.3.13	Hypothesis 13: Play factor positively affects playability	185
5.3.14	Hypothesis 14: Fun factor positively affects playability	186
5.3.15	Hypothesis 15: Challenge factor positively affects playability	186
5.3.16	Hypothesis 16: Playability positively affects total usability	186
5.3.17	Hypothesis 17: Design positively affects mobility	187
5.3.18	Hypothesis 18: Control positively affects mobility	187
5.3.19	Hypothesis 19: Mobility positively affects total usability	188
5.4	Qualitative validation	188
5.4.1	Sample definition	189
5.4.2	Result of the qualitative validation from Respondent 1	191
5.4.3	Result of the qualitative validation from Respondent 2	197
<b>6.</b>	<b>CONCLUSION AND RECOMMENDATIONS</b>	<b>205</b>
6.1	Conclusions and research contributions	205
6.1.1	Conclusion related to research objective 1	208
6.1.2	Conclusion related to research objective 2	209
6.1.3	Conclusion related to research objective 3	210
6.2	Future work	211
	<b>REFERENCES</b>	<b>214</b>
	<b>APPENDICES</b>	<b>233</b>

## LIST OF TABLES

TABLE	TITLE	PAGE
1.1	Relationship between RPs, RQs and ROs	13
2.1	Usability dimension across reviewed papers	38
2.2	Distribution of usability evaluation methods	52
2.3	User involvement on reviewed papers	55
2.4.	Primary literature mapped into relevant dimensions	58
3.1.	Research methods proposed by Loiacono et al. (2004)	61
3.2.	Research methodology: phases, task and related chapters	62
3.3.	Activities and output for Stage 2	66
3.4.	Activities and output for Stage 3	69
3.5	Data preparation for the proposed model	78
4.1.	Rationales for pedagogical aspects definition	87
4.2	Possible game genre-based on user's learning	91
4.3	The relationship between learning objectives and games genre	93
4.4.	Complete GQM model to evaluate educational dimension	94
4.5.	Motivating component in educational games	98
4.6.	Constructs for playability dimensions and their rationales	103
4.7	GQM providing guideline and goals for playability dimension	112
4.8	Measurement items for each playability factor	116
4.9	Complete GQM model for playability	118
4.10	Measurement items for the mobility dimensions	124

4.11	Guideline for the mobility dimensions measurement	125
4.12	Complete GQM model for mobility dimension	127
4.13	Items for dependent variable (Usability construct)	132
4.14	All constructs' items following hybrid approach	133
5.1	The sample size required based on literature review	138
5.2	Population of participant from the three selected departments	139
5.3	Composite reliability and AVE of the initial model before items deletion	142
5.4	Composite reliability and AVE after item deletion	143
5.5	Coefficient of determination for the proposed model	147
5.6	Path Coefficient for the first version model	149
5.7	Assessment for first version proposed hypothesis	151
5.8	Independent variables for the second version model	156
5.9	Intervening variables for the second version model	160
5.10	Dependent variables for the second version model	162
5.11	All items for the revised measurement model	163
5.12	The sample size required based on literature review	170
5.13	Population of the respondent for second version model validation	171
5.14	Composite Reliability for the second version model	173
5.15	R square for second version model	177
5.16	Path coefficient for the second version model	178
5.17	Assessment for the proposed hypothesis (second version).	179
5.18	Comment on playability dimension from Respondent 1	192
5.19	Comment on pedagogy dimension from Respondent 1	196



5.20	Comment on playability dimension from Respondent 2	198
5.21	Comment on pedagogy dimension from Respondent 2	202



## LIST OF FIGURES

FIGURE	TITLE	PAGE
1.1	Relationship between RP, RQ and RC	15
1.2	Organization of the Thesis	18
2.1	Positioning of serious games among other application	23
2.2	The principles and mechanisms of game-based learning (Perrotta et al., 2013)	25
2.3	The distribution of the selected papers	35
2.4	Distribution of the selected papers based on the dimensions	36
2.5	Usability evaluation methods based on Zhang (2018)	51
2.6	Initial version of the proposed measurement dimensions	57
2.7	Revised version of the proposed measurement dimensions	57
3.1	Detailed research methodology: stages, activities, methods and output	63
3.2	Detailed activities conducted during Stage 1	64
3.3	Detailed activities conducted during Stage 2	65
3.4	Detailed activities conducted during Stage 3	68
3.5	Detailed activities conducted during Stage 4	71
3.6	Detailed activities conducted during Stage 5	72
3.7	K-Chart for scope of research	73
4.1	Constructs for the proposed model	86
4.2	Proposed playability model	102
4.3.	Layout, hierarchy and design as interface aspect and control as interaction aspect of interactive design	122

4.4	Proposed model for mobility dimension	123
4.5	Conceptual model for mobile educational game usability evaluation model	131
4.6	The relationship between all construct in first model	134
4.7	The relationship between all constructs are represented in first model	135
5.1	Toon Math games, the selected game-based learning	140
5.2	Validation mechanism using confirmatory factor analysis based on Joseph E Hair et al. (2014)	141
5.3	First version model after validation process	152
5.4	The overall constructs from the initial model with possible deleted construct	154
5.5	Constructs for final model validation	155
5.6	Hypothesis for the second version model	168
5.7	The display of usability meter	190
5.8	The score for playability dimension from Respondent 1	191
5.9	The score for pedagogy dimension from Respondent 1	195
5.10	The score for mobility dimension from Respondent 1	197
5.11	Playability score from Respondent 2	198
5.12	Pedagogy score from Respondent 2	202
5.13	The score for mobility dimension from Respondent 2	204
6.1	Final usability evaluation model	209



## LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Loading for all items for the initial model before deletion process	232
B	Loading for all items for the initial model after deletion process	237
C	Discriminant Validity of the first version mode (Fornell-Larcher Criterion)	240
D	Discriminant Validity measured by Cross Loading for the first model	242
E	Collinearity Assessment/Variance Inflation Factor for first version model	246
F	Loading value for all items in second version model	249
G	Discriminant Validity of the second version model (Fornell-Larcher Criterion)	254
H	Collinearity Assessment / Variance Inflation Factor for Second Version Model	256
I	PLATMO Evaluation Rubric for User Testing	258
J	PLATMO Evaluation Rubric for Expert Validation	267
K	Usability-meter Graphical Result from The Expert Validation (Academician)	279

## 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.
- VARC - *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.

اوتومر سیتی تکنیکل ملیسیا ملاک

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

## 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.