The copyright © of this thesis belongs to its rightful author and/or other copyright owner. Copies can be accessed and downloaded for non-commercial or learning purposes without any charge and permission. The thesis cannot be reproduced or quoted as a whole without the permission from its rightful owner. No alteration or changes in format is allowed without permission from its rightful owner.
Thesis submitted to Dean of Awang Had Salleh Graduate School in Partial Fulfillment of the requirement for the degree Master of Science in Information Technology University Utara Malaysia

Shakir Mahmood Mahdi
Permission to Use

In presenting this thesis in fulfilment of the requirements for a postgraduate degree from University Utara Malaysia, I agree that the University Library may make it freely available for inspection. I further agree that permission for the copying of this thesis in any manner, in whole or in part, for scholarly purpose may be granted by my supervisor(s) or, in their absence, by the Dean of Awang Had Salleh Graduate School of Arts and Sciences. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to University Utara Malaysia for any scholarly use which may be made of any material from my thesis.

Requests for permission to copy or to make other use of materials in this thesis, in whole or in part, should be addressed to:

Dean of Awang Had Salleh Graduate School
College of Arts and Sciences
University Utara Malaysia
06010 UUM Sintok
Kedah Darul Aman
Malaysia
Abstract

Children can learn while playing computer educational games. Therefore, it is important that educational games for children are well designed and usable. This study proposes an educational mobile game design for children to learn mathematics. Based on the design, a low fidelity and high fidelity prototypes called PreMath Operations were designed and developed. A usability evaluation was conducted on the prototypes by observing children playing with the games. The result of the evaluation suggested that PreMath Operations prototypes is usable and can help children to learn math while playing. This study provides a design strategy of mathematic educational game for children to learn in a fun and interesting.

Keywords: educational game design for children, edutainment app for mathematics, game design factors.
Abstrak


Kata kunci: reka bentuk permainan berasaskan pendidikan untuk kanak-kanak, aplikasi berasaskan hiburan untuk matematik, faktor reka bentuk permainan.
Acknowledgment

First and foremost, all praise to Allah for providing me with the strength, perseverance, and wisdom to have this work done on time.

I would like to express my deepest gratitude to my supervisor, Dr. Husniza binti Husni for her intellectual guidance and kind support given to me during the period of this study, as well as giving necessary advices and guidance and arranged all facilities to make my study (master information and technology) easier.

I dedicate this thesis to my wife Noora Mohamed and my sons (Taha and Manaf) who unremittingly supported me during my years of study. They made this work possible.

I want to express my gratitude and dedicate this thesis to my father and my mother. They are continuously praying and encourage me and expresses confidence in my abilities to complete my study.

I am deeply grateful to my family (Ibrahim, Shymaa and Hayder) for their love and support during my Master studies. I truly could not have achieved this milestone without their support.

I am also grateful to my uncles (Prof. Dr. Riyadh Khaleel and Dr. Nazar Abdulminum) for helping and inspiration and for their praying throughout my study.

I say thank you to the staffs of School of Computing, College of Arts and Science, University Utara Malaysia and those that contributed indirectly towards the success of my studies.

Thank You All.
Table of contents

Permission to Use .............................................................................................................i
Abstract ............................................................................................................................ ii
Abstrak ........................................................................................................................... iii
Acknowledgment ............................................................................................................ iv
Table of contents .......................................................................................................... v
List of Figures ................................................................................................................ viii
List of Table .................................................................................................................... x

CHAPTER ONE INTRODUCTION ............................................................................. 1
  1.1 Overview .................................................................................................................. 1
  1.2 Problem Statement ................................................................................................. 4
  1.3 Research Questions ............................................................................................... 6
  1.4 Research Objectives ............................................................................................. 6
  1.5 Scope ...................................................................................................................... 6
  1.6 Significance of Research ....................................................................................... 7
  1.7 Summary ............................................................................................................... 7

CHAPTER TWO LITERATURE REVIEW ................................................................. 8
  2.1 Introduction ............................................................................................................ 8
  2.2 Game Definition .................................................................................................... 8
  2.3 Mobile Learning ................................................................................................... 9
  2.4 Game-Based Learning (GBL) ............................................................................. 10
    2.4.1 Categories of GBL .......................................................................................... 10
    2.4.2 Mobile Game-Based learning (mGBL) .......................................................... 12
  2.5 Edutainment concept and children learning ....................................................... 13
  2.6 Educational Games .............................................................................................. 13
  2.7 Effective methods in game-based education ..................................................... 15
  2.8 Effective factors of educational game ............................................................... 18
2.9 Math games review .................................................................................................................. 25

2.11 Summary.................................................................................................................................. 29

CHAPTER THREE RESEARCH METHODOLOGY ........................................................................... 30

3.1 Introduction .................................................................................................................................. 30

3.2 Phases in Methodology .............................................................................................................. 30

3.2.1 Awareness problem ............................................................................................................. 32

3.2.1.1 Literature review ............................................................................................................ 32

3.2.1.2 Preliminary study ............................................................................................................ 32

3.2.1.2 Data Gathering ............................................................................................................... 33

3.2.2 Suggestion and Design ......................................................................................................... 35

3.2.3 Development ........................................................................................................................ 36

3.2.3.1 Rapid application development (RAD) ........................................................................ 36

3.2.3.2 Prototype development .................................................................................................... 37

3.2.4 Evaluation ............................................................................................................................. 38

3.2.4.2 The Usability Test ........................................................................................................... 39

3.2.4.3 Procedure description ..................................................................................................... 41

3.2.4.4 Sampling for usability test .............................................................................................. 44

3.2.4.5 The gathering and examination of data .......................................................................... 44

3.2.4.6 Analysis Techniques ....................................................................................................... 45

3.2.5 Conclusion ............................................................................................................................. 46

3.3 Summary .................................................................................................................................... 46

CHAPTER FOUR PROTOTYPE DEVELOPMENT ............................................................................ 47

4.1 Introduction .................................................................................................................................. 47

4.2 Game factors and its elements ................................................................................................... 47

4.3 Narrative and Sociality .............................................................................................................. 51

4.4 Low fidelity prototype design .................................................................................................. 52

4.5 High fidelity prototype ............................................................................................................... 55

4.5.1 Home page ............................................................................................................................ 56

4.5.2 Levels of application .......................................................................................................... 57

4.5.3 Playing Stage one of application ......................................................................................... 59

4.5.4 Playing Stage two of application ......................................................................................... 64

4.5.5 Game finishing ...................................................................................................................... 70
4.6 PreMath Operations Application testing .......................................................... 70
4.7 Summary .......................................................................................................... 71

CHAPTER FIVE EVALUATION ........................................................................... 72
5.1 Introduction ...................................................................................................... 72
5.2 Evaluation Procedure ...................................................................................... 72
   5.2.1 Usability Test .......................................................................................... 72
5.3.1 Results of Teacher’s Interview ................................................................. 73
5.3.2 Results of Children’s Observation ............................................................ 75
5.4 Summary .......................................................................................................... 88

CHAPTER SIX CONCLUSION ........................................................................... 89
6.1 Introduction ...................................................................................................... 89
6.2 The Achieved Objectives ................................................................................ 89
6.3 Limitations and Recommendations for Future Studies ............................... 91
   6.3.1 Time Constraints .................................................................................... 91
6.3.2 The narrative and sociality factors ......................................................... 91
6.3.3 Future work .............................................................................................. 92
6.4 Contribution of Research .............................................................................. 92
6.5 Summary .......................................................................................................... 94

REFERENCES ...................................................................................................... 95

APPENDIXES ...................................................................................................... 106
List of Figures

Figure 2.1: The model of Cagiltay, et al., (2015) ........................................... 20
Figure 2.2: Model for Hamari, Juho, et al. (2016) ........................................... 21
Figure 2.3: The general model for Shi and Shih (2015) .................................. 22
Figure 3.1: The general methodology of the design science research ................... 31
Figure 3.2: Awareness of problem Phase .................................................. 33
Figure 3.3: One of the teachers during the interview ....................................... 34
Figure 3.4: Suggestion and Design Phase .................................................... 35
Figure 3.5: Development Phase ................................................................. 37
Figure 3.6: Evaluation Phase ................................................................. 39
Figure 3.7: The sample of observation item from ............................................ 41
Figure 3.8: Teachers being given instructions on how to use the new App ............. 43
Figure 3.9: The teacher give the instructions on how to use the new App ............ 43
Figure 3.10: Two of the participants interacting with PreMath Operations App ... 44
Figure 3.11: Conclusion Phase ................................................................. 46
Figure 4.1: The sketch of the first stage .................................................... 54
Figure 4.2: The sketch of the second stage ............................................... 55
Figure 4.3: Home Page of PreMath Operations ........................................ 58
Figure 4.4: The stage of application ......................................................... 59
Figure 4.5: The second stage for 7 years old student ..................................... 60
Figure 4.6: The student not allowed to select the second stage ....................... 61
Figure 4.7: The stage one content ......................................................... 62
Figure 4.8: The addition and subtraction game play .................................... 63
Figure 4.9: The wrong answer choice .................................................... 64
Figure 4.10: The correct answer action .................................................. 64
Figure 4.11: The stage 2 activation ....................................................... 65
Figure 4.12: The second stage for student in even years old ......................... 66
Figure 4.13: The stage two ................................................................. 67
Figure 4.14: The wrong answer action .................................................. 68
Figure 4.15: The right answer action ..................................................... 68
Figure 4.16: The activation button for all stage two .................................... 69
Figure 4.17: The right answer action ..................................................... 70
Figure 4.18 The complete game .................................................................71
List of Table

Table 2.1: Types of game for children...............................................................27
Table 4.1 Shi and Shih (2015) model factors.................................................48
Table 4.2 GBL factors and specific characteristics .......................................51
Table 5.1: List of Tasks for the Effectiveness Evaluation...............................78
Table 5.2 Summary of Effectiveness Analysis Table....................................79
Table 5.3: effectiveness description .............................................................81
Table 5.4 Analysis of the Efficiency Using Success Rate Evaluation..........83
Table 5.5: Summary of Efficiency Analysis Table......................................84
Table 5.6: efficiency description .................................................................85
Table 5.7: Likert Scale Points Table Used in Questionnaire........................86
Table 5.8: Likert Scale Points Table Used in Questionnaire with Children....86
Table 5.9: satisfaction description ...............................................................87
CHAPTER ONE
INTRODUCTION

1.1 Overview

During the past years, there has been an increased in the use of digital technology and social networks. These technologies are also starting to play bigger parts in teaching students from pre-school to higher education (Garrison, 2011; Laurillard, 2005). Mobile communication devices are one of the most important and popular technologies among people nowadays. The functions of mobile communication devices have now gone beyond the traditional communication role which they used to play. It could now be used for teaching and learning as well (Mtega, Bernard, Msungu, & Sanare, 2012). These days, children use mobile phones mostly for entertainment purposes; many of them play games regularly. Given the importance that some of these games have in stimulating and promoting children's skills, the researchers are looking into the utilisation of such games in education and learning (Durkin, Boyle, Hunter, & Conti-Ramsden, 2015). Because of the mobile game industry continues to thrive and the increasing demands and growing markets have made it possible for mobile game developers to come up with numerous mobile games (Amory, & Seagram, 2003). Moreover, with the recent technological advances, digital games have become new tools for teaching as well (Frost, Wortham, & Reifel, 2008).

According to Van Eck (2006), learning through games is a method that has been in used in education for decades. Today’s generation of students can access technological advancements like computers, mobile phones, digital music and video players, and video games among others. These gadgets can be used as tools for
The contents of the thesis is for internal user only
References

Abdullah, K. A., & Ismail, Z. I. (2014). IMPLEMENTATION OF VIDEO GAMES AS TEACHING AID FOR MORAL EDUCATION SUBJECT IN MALAYSIAN KINDERGARTEN.


Almomani, M. A. (2012). Game-Based Learning Courseware for Pre-School Children for Healthy Eating. *Universiti Utara Malaysia*.

Almomani, M. A. (2012). Game-Based Learning Courseware for Pre-School Children for Healthy Eating. *(Doctoral dissertation, Universiti Utara Malaysia)*.


Costikyan, G. (1994). I have no words and I must design. *Interactive Fantasy # 2. British roleplaying journal*.


case of Sokoine University of Agriculture in Tanzania. In Proceedings and report of the 15th UbuntuN.


Wan, N. (2010). the development of an educational writing game application for preschool children based on user centered design. *University utara malaysia.*


