PERSUASIVE MATHEMATICS COURSEWARE DESIGN MODEL FOR
SPECIAL NEED CHILDREN

SITI NUR ADILAH BINTI SULAIMAN

A dissertation submitted in partial fulfilment of the
requirement for the award of the degree of
Master of Information Technology specialization in
Information Technology Management

Faculty of Computing
Universiti Teknologi Malaysia

AUGUST 2016
This dissertation is dedicated to my family for their endless support and encouragement.
ACKNOWLEDGEMENT

First and foremost, I would like to express my greatest appreciation to my main supervisor, Dr. Aryati Bakri and my co-supervisor for her guidance and encouragements throughout the research. With her motivation and advices, I am able to conduct this research within the time given. She have leaded me and shared their knowledge during my research process. She always makes time available for me to have discussion and provided me with valuable advices.

Besides, I would like to thank the institution that involved in the research which includes special education class in SK Taman Desa Skudai, and Sekolah Sinar Harapan Penang. With their cooperation and advices, the research can be carried on successfully. The teachers from these institutions have contributed a lot of knowledge and information sharing that is important in the research.

Lastly, I would like to dedicate my appreciation to my beloved family. They have provided me with supports throughout my research process. With their supports and concerns, I am able to finish my research successfully.
ABSTRACT

There has been a big growth on number of research of courseware design model for children with special needs. A lot of people interested in this topic. However, there is still lack of courseware design model for children with special needs especially in learning mathematics. Reviews from literatures indicate that content application such as courseware specifically designed to cater for the needs of children with special needs in learning is highly scarce. It is found that most of the existing content applications including courseware have focused on the needs of normal learners, in which most of this courseware means too little to the children with special needs learners with their own problem of learning difficulty. Across many courseware reviewed in this research, only two of them are for learning mathematics. Children with special needs required special module or syllabus that can fit in well with their impairment. Thus, this study aims at studying the core element needed in education courseware for children with special needs. In this study, six courseware components have been proposed; which are Structural Component, Content Composition, Design Guideline, Learning Theory, Learning Approach and Technology. To test the design model, some pre-tests and post-tests, observations and evaluations are conducted. The result of the test shows the improvement in their mathematical skill. In addition, the children have shown positive behaviour change in learning mathematics throughout the testing period. Furthermore, the result has also been acknowledged by expert as a useful learning tool for the children with special needs. In this study, MyMath has been proven to be an effective courseware for learning mathematic among children with special needs.
ABSTRAK

# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>CHAPTER</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>ii.</td>
<td></td>
</tr>
<tr>
<td>DEDICATION</td>
<td>iii.</td>
<td></td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iv.</td>
<td></td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v.</td>
<td></td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vi.</td>
<td></td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vii.</td>
<td></td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>xi.</td>
<td></td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xiii.</td>
<td></td>
</tr>
<tr>
<td>LIST OF APPENDICES</td>
<td>xvi.</td>
<td></td>
</tr>
</tbody>
</table>

## 1 INTRODUCTION

1.1 Introduction 1
1.2 Problem Background 4
1.3 Problem Statement 5
1.4 Objectives of the Study 6
1.5 Scope of the Study 6
1.6 Significance of the Study 6
1.7 Chapter Summary 7

## 2 LITERATURE REVIEW

2.1 Introduction 8
2.2 Courseware 10
  2.2.1 Courseware Component 11
  2.2.2 Courseware Review and Design Model 14
2.2.2.1 Down Syndrome 19
2.2.2.2 Slow learner 25
2.2.2.3 Dyslexia 30
2.2.2.4 Autism Spectrum Disorders (ASDs) 35

2.3 Persuasive design 40
2.3.1 Fogg’s Behaviour Model (FBM) 42
2.3.2 Persuasive System Design (PSD) Model 44
2.3.3 Integration of Fogg’s Behaviour Model (FBM) and Persuasive System Design (PSD) Model 48

2.4 Learning Theory 49
2.4.1 Dual-coding theory 49

2.5 Learning approach 50

2.6 Learning Content Composition 51
2.6.1 "Asas 3M Matematik" Learning Series 52
2.6.2 Personalization Learning 52
2.6.3 Counting Principle 53
2.6.4 Multimedia Principles 55

2.7 Structural Components 57

2.8 Children with Special Needs in Malaysia 59
2.8.1 Characteristics and Learning Problems of Children with Special Needs 59
2.8.2 Behavior Disabilities and Support Tools 61
2.8.3 Children with Special Needs and Computer 62
2.8.4 Mobile learning 62

2.9 Chapter Summary 63

3 RESEARCH METHODOLOGY

3.1 Introduction 65
3.2 Research Question 67
3.3 Research Design 67
3.4 Research Operational Framework 68
4 DESIGN MODEL

4.1 Introduction 81
4.2 Initial Proposed Courseware Design Model 83
4.3 Proposed Courseware Design Model 87
  4.3.1 Courseware Component Comparison 88
  4.3.2 Courseware Component: Content Composition 90
  4.3.3 Courseware Component: Structural Component 93
    4.3.4 Courseware Component: Learning Theory 94
    4.3.5 Courseware Component: Learning Approach 95
    4.3.6 Courseware Component: Technology 95
    4.3.7 Courseware Component: Design Guideline 96
4.4 Implementation of Each Element in the Design Model 99
  4.4.1 Persuasive Design 99
  4.4.2 Picture Word Inductive Model (PWIM) 101
  4.4.3 Personalization 102
  4.4.4 Dual-coding theory 103
  4.4.5 Principles of Multimedia 105
  4.4.6 Counting Principles 107
  4.4.7 Mobile Learning 108
  4.4.8 “Asas 3M Matematik” Learning series 109
  4.4.9 Mathematic Curriculum for Special Need Children 110
4.5 Courseware Design 111
  4.5.1 UML Diagram 111
  4.5.2 Relationship between User Interface and the Courseware Component 117
4.6 Chapter Summary 131
5 EVALUATION AND FINDINGS

5.1 Introduction 132
5.2 Pre-Test and Post-Test Evaluation 134
5.3 Observation on “MyMath” Courseware 136
5.4 Evaluation of “MyMath” Courseware Design 140
   Model by Expert
5.5 Proof of Unbias Results 144
5.6 Chapter Summary 145

6 CONCLUSION

6.1 Introduction 146
6.2 Research Contribution 148
6.3 Challenge and Constrains 149
6.4 Future Works 150

REFERENCES 151

Appendices A- G 167
## LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE NO</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Courseware’s Review for Down syndrome</td>
<td>24</td>
</tr>
<tr>
<td>2.2</td>
<td>Courseware’s Review for Slow Learners</td>
<td>29</td>
</tr>
<tr>
<td>2.3</td>
<td>Adapted Multimedia Principles</td>
<td>31</td>
</tr>
<tr>
<td>2.4</td>
<td>Courseware’s Review for Dyslexia</td>
<td>25</td>
</tr>
<tr>
<td>2.5</td>
<td>Features available in iPrompts®</td>
<td>38</td>
</tr>
<tr>
<td>2.6</td>
<td>Courseware’s Review for ASDs</td>
<td>39</td>
</tr>
<tr>
<td>2.7</td>
<td>Categories of persuasive design principles</td>
<td>47</td>
</tr>
<tr>
<td>2.8</td>
<td>Twelve Multimedia Instructional Principles</td>
<td>56</td>
</tr>
<tr>
<td>2.9</td>
<td>Registration of Children with Special Needs 2004 – 2012</td>
<td>59</td>
</tr>
<tr>
<td>4.1</td>
<td>Component of current existing courseware for Mathematic learning.</td>
<td>83</td>
</tr>
<tr>
<td>4.2</td>
<td>Related studies of children’s learning</td>
<td>89</td>
</tr>
<tr>
<td>4.3</td>
<td>Selected Persuasive Principles and its implementation in courseware.</td>
<td>100</td>
</tr>
<tr>
<td>4.4</td>
<td>Selected Principles of Multimedia and its implementation in courseware</td>
<td>106</td>
</tr>
<tr>
<td>4.5</td>
<td>Home page explanation</td>
<td>117</td>
</tr>
<tr>
<td>4.6</td>
<td>The component that matching with the setting design of interface</td>
<td>118</td>
</tr>
<tr>
<td>4.7</td>
<td>The component matching with the menu page design of interface</td>
<td>119</td>
</tr>
<tr>
<td>4.8</td>
<td>The component matching with the sub menu page design of interface</td>
<td>120</td>
</tr>
<tr>
<td>4.9</td>
<td>The component that matches with the sub-module design of interface</td>
<td>121</td>
</tr>
</tbody>
</table>
4.10 The component that matches with the sub-module of first leaning module design of interface.

4.11 The component that matches with the sub-module of first leaning module design of interface.

4.12 The component that matches with the *Bilang dan Sebut* activity in the *Nombor hingga 10* module design of interface.

4.13 The component that matches with the *Bilang dan Sebut* activity in the *Nombor hingga 10* module design of interface.

4.14 The component that matches with the Latihan Bilang Dan Susun activity in the *Nombor hingga 10* module design of interface.

4.15 The component that matches with the Mari Kenal Wang activity design of interface.

4.16 The component that matches with the test score design of interface.

4.17 The component that matches with the scoreboard interface design

5.1 Pre-Test and Post-Test scores

5.2 Pre-Test and Post-Test mean, standard deviation and significant value

5.3 The time spent on the courseware
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>FIGURE NO</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Flow chart of Chapter 1</td>
<td>3</td>
</tr>
<tr>
<td>2.1</td>
<td>Flow of content for Chapter 2</td>
<td>9</td>
</tr>
<tr>
<td>2.2</td>
<td>Block structure of a Multimedia Courseware</td>
<td>12</td>
</tr>
<tr>
<td>2.3</td>
<td>Common Component Model of AC4LV</td>
<td>14</td>
</tr>
<tr>
<td>2.4</td>
<td>Scaffolding Model: Listen and Read Stories</td>
<td>21</td>
</tr>
<tr>
<td>2.5</td>
<td>Conceptual Framework of AR-BACA SinD</td>
<td>22</td>
</tr>
<tr>
<td>2.6</td>
<td>Methodology for the development of SynMax Courseware</td>
<td>23</td>
</tr>
<tr>
<td>2.7</td>
<td>Addie: Stages</td>
<td>26</td>
</tr>
<tr>
<td>2.8</td>
<td>Pedagogical Model</td>
<td>27</td>
</tr>
<tr>
<td>2.9</td>
<td>Instructional Design (ID) Model</td>
<td>27</td>
</tr>
<tr>
<td>2.10</td>
<td><em>Komputer Saya</em> Courseware Modules</td>
<td>28</td>
</tr>
<tr>
<td>2.11</td>
<td>Adoption of Learning Strategies Of <em>Bijak Membaca</em></td>
<td>33</td>
</tr>
<tr>
<td>2.12</td>
<td>Design model of V-Hajj courseware</td>
<td>42</td>
</tr>
<tr>
<td>2.13</td>
<td>Conceptual framework of an Arabic courseware</td>
<td>42</td>
</tr>
<tr>
<td>2.14</td>
<td>Three factors of Fogg Behavior Model and their subcomponents</td>
<td>43</td>
</tr>
<tr>
<td>2.15</td>
<td>Three generic steps in PSD development</td>
<td>44</td>
</tr>
<tr>
<td>2.16</td>
<td>Postulates behind Persuasive Design</td>
<td>44</td>
</tr>
<tr>
<td>2.17</td>
<td>Core component of the PSD Model</td>
<td>46</td>
</tr>
<tr>
<td>2.18</td>
<td>Integration of FBM and PSD</td>
<td>48</td>
</tr>
<tr>
<td>2.19</td>
<td>Cardinality Principle, One-to-One Principle and Stable Order Principle</td>
<td>54</td>
</tr>
<tr>
<td>2.20</td>
<td>Exercise toward Cardinality and One-to-One Principles</td>
<td>57</td>
</tr>
<tr>
<td>2.21</td>
<td>Exercise toward Stable Order Principles</td>
<td>58</td>
</tr>
</tbody>
</table>
3.1 Flow of content for Chapter 3 66
3.2 Design Science Research Methodology process model 69
3.3 Three generic steps in PSD development 72
4.1 Flow chart of overall content of Chapter 4 82
4.2 Initial Model of Courseware Design 87
4.3 Steps to develop complete courseware design model 88
4.4 “MyMath” courseware design model 98
4.5 An example of PWIM in “MyMath” courseware 101
4.6 Codes for randomizing the position in “MyMath” courseware 102
4.7 Codes for select favourite theme in “MyMath” courseware 103
4.8 Codes for select favourite theme in “MyMath” courseware 103
4.9 Codes for score display and the ranking in “MyMath” courseware 104
4.10 Azim’s activity on Wednesday 105
4.11 One-to-one principle as applied in this courseware 107
4.12 Stable order principles applied in this courseware 108
4.13 Cardinality principles applied in this courseware 108
4.14 Special children at SK Taman Desa Skudai using the “MyMath” courseware. 109
4.15 One of the 3M is menulis 110
4.16 Overall structure content and its sub-module 111
4.17 Use case diagram of “MyMath” courseware 112
4.18 Sequence diagram of “MyMath” courseware 114
4.19 Activity diagram when user selects user account 115
4.20 Users choosing a module or activity 116
4.21 ERD diagram of “MyMath” courseware 116
4.22 Home page 117
4.23 Interface for user account 118
4.24 Interface of menu page 119
4.25 Interface of sub menu page 120
4.26 Interface of sub-module of first leaning module 121
<table>
<thead>
<tr>
<th>Section</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.27</td>
<td>Interface of sub-module of first leaning module</td>
<td>122</td>
</tr>
<tr>
<td>4.28</td>
<td>Interface of sub-module of first leaning module</td>
<td>123</td>
</tr>
<tr>
<td>4.29</td>
<td>Interface for <em>Bilang dan Sebut</em> activity in the <em>Nombor hingga 10</em> module</td>
<td>125</td>
</tr>
<tr>
<td>4.30</td>
<td>Interface for <em>Latihan Bilang Dan Sebut</em> activity in the <em>Nombor hingga 10</em> module</td>
<td>126</td>
</tr>
<tr>
<td>4.31</td>
<td>Interface for <em>Latihan Bilang Dan Susun</em> activity in the <em>Nombor hingga 10</em> module</td>
<td>127</td>
</tr>
<tr>
<td>4.32</td>
<td>Interface for <em>Mari Kenal Wang</em> activity in the <em>Wang</em> module</td>
<td>128</td>
</tr>
<tr>
<td>4.33</td>
<td>Interface for test or score</td>
<td>129</td>
</tr>
<tr>
<td>4.34</td>
<td>The interface of the scoreboard</td>
<td>130</td>
</tr>
<tr>
<td>5.1</td>
<td>Flow chart on overall Evaluation of Findings</td>
<td>133</td>
</tr>
<tr>
<td>5.2</td>
<td>Pre-test and Post-test scores using courseware against mean</td>
<td>135</td>
</tr>
<tr>
<td>5.3</td>
<td>Mean score for all six components in courseware design model</td>
<td>144</td>
</tr>
<tr>
<td>6.1</td>
<td>Flow chart on overall Chapter 6</td>
<td>147</td>
</tr>
</tbody>
</table>
## LIST OF APPENDICES

<table>
<thead>
<tr>
<th>APPENDIX</th>
<th>TITLE</th>
<th>PAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Mathematic Text Book <em>Asas 3M</em></td>
<td>167</td>
</tr>
<tr>
<td>B</td>
<td>Text Book <em>Asas 3M</em> ‘s Syllabus</td>
<td>168</td>
</tr>
<tr>
<td>C</td>
<td>Scenario Interview Question</td>
<td>169</td>
</tr>
<tr>
<td>D</td>
<td>List of Comments for Improvement</td>
<td>172</td>
</tr>
<tr>
<td>E</td>
<td>Pre-Test and Post-Test questions</td>
<td>173</td>
</tr>
<tr>
<td>F</td>
<td>Children with Special Needs Behaviour Checklist in Using Courseware</td>
<td>176</td>
</tr>
<tr>
<td>G</td>
<td>Knowledge Expert Questionnaire</td>
<td>178</td>
</tr>
</tbody>
</table>
CHAPTER 1

INTRODUCTION

1.1 Introduction

There has been a growth of interest in the use of computer technology to support social skills and self-management skills in children with learning difficulties. There are various kinds of disabilities such as Down Syndrome, Autistic Spectrum Disorders etc. These special children have different ways of absorbing what they are learning. They may have their own unique learning difficulties.

The topic for this research is “Persuasive Mathematics Courseware Design Model for children with special needs”. This study focuses on the courseware design model for special need children in order to facilitate difficulty of learning faced by them. Based on research, one same application or courseware cannot be used by two or more different groups of special needs learners (Khan, 2010). Lack of the current design model is identified to fulfil the requirement for special education. A list of behaviours and problems of the children with difficulty of learning are listed down to get the big pictures of courseware components needed in the courseware design model that can help this kind of children by the persuasive approach.

Instructional technology for learners has been identified in a number of formats. However, there is still lack courseware for learning purpose specifically for these special children. In special education, instructional technology needs to be
conceptualized as simply as the design of teaching through the complexity of assistive devices.

Persuasive technology or persuasive design is defined as interactive information technology designed for changing users’ attitudes or behavior (Fogg, 2003). Traditionally, persuasion is meant for human communication designed to influence the actions and autonomous judgments of others (Simons et al. 2001). Persuasive technologies can be adjusted to what they will do based on user needs, inputs, and situations (Fogg, 2003). It is sometimes called captology, which is a term derived from the acronym CAPT which means computers as persuasive technology, as suggested by Fogg in 1996. In short, captology is the study of the problems and possibilities related to the use of computers for persuasive purposes.

This research tries to adopt mobile technology as the development platform for the courseware to encourage mobile learning to benefit the education special need children by using mobile applications (Fernandez-Lopez et al., 2013). Mobile technologies, particularly games, are considered promising in assisting spastic children, such as autism in learning social interactions and developing language skills. However, very few tools are available to target a crucial factor in communication, emotions (Abirached et al. 2011). The process of design and development have involved a series of meetings with the assigned teacher alternating it with design work. In the initial stage of design, interview sessions with the teachers are conducted to obtain information on concepts that were taught, what the teachers believed they needed to effectively teach these concepts, and student characteristics that would impact the design. Adopting persuasive approach in the system analysis and design is essential in this project because designing an interactive learning system for users with special needs is a challenge due to needs of inadequate understanding of the life experiences of people with special needs and difficulty of learning (AlSuwaidan et al, 2010). Figure 1.1 shows the flow of content for this chapter.
Figure 1.1: Flow chart of Chapter 1.
1.2 Problem Background

In the recent studies towards courseware development for children with special needs, some techniques have been applied for the courseware design, such as Dual Coding Learning (Shafie et al., 2013; Abdullah et al., 2009) and Scaffolding Method (Abdullah et al., 2009; Yussof and Zaman, 2011).

An analysis on model design of courseware is important as it should identify their common components to be adapted in the conceptual design (Aziz et al., 2014). However, the same application or courseware cannot be used by two or more different groups of special learners (Khan, 2010). Most of the existing courseware contents are designed to support certain specific needs of the group (Aziz et al., 2015).

Five basic elements in multimedia courseware are course content, learning/pedagogical methods, architecture, course objective and multimedia element have been highlighted (Hossain and Rahman, 2006). This content with the required media elements to be linked with some types of learning/pedagogical methods for the strategy to achieve the expected learning outcomes or course objective (Hossain & Rahman, 2006). Meanwhile, Aziz et al., (2014b) has proposed 8 common components of courseware design model, which are Learning Approach, Structural Component, Technology, Design Guideline, Content Composition, Learning Theory Development Process and Instructional Design (ID) Model. However, the problem identified in this studies is that there are a lot of courseware in the market but mostly designed for a normal learning ability (Abdollah et al., 2012). Even if the courseware content is helpful and suitable, it is still considered less effective as it does not comply with their learning needs.

According to a report by United Nations Children’s Fund (UNICEF) (2014), a total of 22,089 children has been registered with special need from 2004 until 2012. They need specific courseware, on highlighted in the literature review; such as SynMax courseware that is designed for Down syndrome Mathematic learning problems. Persuasive design studies the human behaviour and persuades users to
achieve target behaviour (Fogg, 2009). It can help and support their problems; such as learning mathematics, understanding concept of object and poor short term memory.

The proposed courseware design model in this research would serve as a solution for difficulties in learning faced by special need children. With the use of suitable elements in the design model, it is believed that the children learning process can be improved from time to time. Thus, this research aims not only to provide a suitable design model for courseware development, but to observe their behaviours in using the courseware through persuasive design.

1.3 Problem Statements

Based on the brief introduction and research background, some problem statement and question have been identified in this study. Three main problem statements that have been identified are:

I. Special needs children need a special courseware design model to assist their learning difficulty.

II. Courseware design models for normal children have different requirements for its component and learning problem.

III. There are so many models of learning application however; there is a lack of Mathematics design model for special need children.

The problem questions that been points out base on problem statement in this study are:

I. What are the courseware design models that available for special need children?

II. What are the components for Mathematics needed in courseware design model for special need education?
III. What is the suitable Mathematics courseware design model that can be proposed for special need children?

1.4 Objectives of the Study

Research objectives are answer for those problem statements. The objectives that have been identified are as follows:

I. To study the courseware design model for special need children
II. To identify the components for Mathematics courseware design model learning.
III. To propose and test the Mathematics courseware design model appropriate for special need children.

1.5 Scope of the Study

The scope of this study is will be narrowed down to ensure timelines for this research. The scopes for this study are as follows:

i. The area of study is at Sekolah Kebangsaan Taman Desa Skudai in Johor Bharu, Malaysia.

ii. The respondents involved in this study are special children at the age of 7 to 9 years old with difficulty of learning mathematics.

iii. To use mobile applications or courseware as a means of learning Mathematics at an early age and to study their behaviour change in learning.
1.6 Significance of the Study

The significands of this study is summarised as follows:

i. To help targeted group in learn Mathematic using mobile apps.

ii. Develop a suitable learning application for targeted group.

iii. Encourage people to use an application suitable for their learning needs.

1.7 Chapter Summary

This chapter summarizes focus of the research including its objectives, scopes, aims, research purposes and significance. It is important to identify all these information before the research is conducted to ensure that the research is able to benefit the target group.
REFERENCES


Al-Rasseees, Reem Fahed., 2003. The effectiveness of an educational program to help in teaching the skill of addition for students with mild mental disabilities. Unpublished master thesis. Kingdom of Bahrain: Faculty of Education the Arabian Gulf University.


DePaul University., 2013. *Course Objectives & Learning Outcomes.* Available at: [http://resources.depaul.edu/teaching-commons/teaching-guides/course-](http://resources.depaul.edu/teaching-commons/teaching-guides/course-).


McLaughlin, T., 2011. *The effects of using flashcards with reading racetrack to teach letter sounds, sight words, and math facts to elementary students with learning disabilities.*


Ramli, R., & Zaman, H. B., 2011. *Designing usability evaluation methodology framework of Augmented Reality basic reading courseware (AR BACA*


Robertson, S., & Robertson, J., 2012. Mastering the requirements process: Getting requirements right; Addison-wesley.


Van Genuchten, E., Scheiter, K., & Schüler, A., 2012. Examining learning from text and pictures for different task types: Does the multimedia effect differ for conceptual, causal.


