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**HYBRIDIZATION OF SIGNALING PRINCIPLE AND
NIELSEN'S DESIGN GUIDELINE IN A MOBILE APPLICATION**



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**DOCTOR OF PHILOSOPHY
UNIVERSITI UTARA MALAYSIA
2022**



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Abstrak

Sebilangan besar aplikasi mudah alih pendidikan yang ada di pasaran menggunakan prinsip multimedia dalam beberapa aspek. Walau bagaimanapun, komponen reka bentuk antara muka pengguna sering diabaikan. Oleh itu, aplikasi tersebut kurang berkesan untuk melibatkan pengguna dalam mempelajari kandungan pembelajaran dengan perasaan teruja dan bermotivasi. Oleh itu, projek ini diusahakan untuk memenuhi keperluan tersebut. Satu kajian mengenai aplikasi mudah alih yang dihibrid dengan prinsip Isyarat (*Signaling*) dan garis panduan Nielsen melalui pembinaan model NSPIXD telah dilaksanakan. Dua aplikasi mudah alih telah direka, dibangunkan dan dinilai, dan Model Reka Bentuk Instruksional Alessi dan Trollip diadaptasi di kedua-dua aplikasi tersebut. Aplikasi mudah alih pertama, AHMA-0, berfungsi sebagai model asas. Sebaliknya, AHMA- NSPIXD diintegrasikan dengan model NSPIXD yang disertakan dengan hibridisasi dari prinsip Isyarat dan garis panduan reka bentuk Nielsen. Tiga parameter telah diukur, dinilai dan dibandingkan antara AHMA-0 dan AHMA-NSPIXD. Parameter yang berkaitan adalah; pengetahuan dan kesedaran pelajar mengenai topik, dan motivasi pelajar terhadap penggunaan bahan pembelajaran topik tersebut. Didapati bahawa AHMA- NSPIXD mengatasi AHMA-0. Sehubungan dengan itu, ianya membuktikan bahawa dengan mengambil berat kepada keperluan pengguna, aplikasi yang efektif dapat dihasilkan untuk digunakan di semua peringkat. Selanjutnya, penemuan ini menekankan pentingnya mempertimbangkan aspek teknikal dan estetika antara muka pengguna secara kritis, yang mana dapat menyumbang kepada kemajuan pengetahuan dalam reka bentuk interaksi.

Kata Kunci: Pembelajaran mudah alih, Aplikasi mudah alih, Prinsip Isyarat, Garis panduan rekabentuk Nielsen, Beban kognitif.

Abstract

Many educational mobile applications available in the market use multimedia principles in several aspects. However, the user interface design component is often disregarded. Therefore, such applications are less effective in engaging users in learning content with excitement and motivation. Therefore, this project is being worked on to meet those needs. A study on mobile applications hybridized with the Signaling principle and Nielsen guidelines through the construction of the NSPIxD model was carried out. Two mobile applications were designed, developed, and evaluated, and the Alessi and Trollip Instructional Design Models were adapted in both applications. The first mobile application, AHMA-0, serves as the base model. Instead, the AHMA- NSPIxD is integrated with the NSPIxD model, accompanied by a hybridization of the Signal principles and Nielsen design guidelines. Three parameters were measured, evaluated, and compared between AHMA-0 and AHMA-NSPIxD. The relevant parameters are; students' knowledge and awareness of the topic and students' motivation to use learning materials on the subject. It was found that AHMA-NSPIxD outperformed AHMA-0. Accordingly, it proves that practical applications can be produced at all levels by considering users' needs. Further, these findings emphasize the importance of critically considering user interfaces' technical and aesthetic aspects, contributing to advancing interaction design knowledge.

Keywords: Mobile learning, Mobile application, Signaling principle, Nielsen's design guideline, Cognitive load.



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Table of Contents

Permission to Use	iii
Abstrak.....	iv
Abstract.....	v
Acknowledgment	vi
Table of Contents.....	vii
List of Figures	xiii
List of Tables	xv
List of Appendices	xviii
List of Abbreviations	xix
List of Publications and Awards	xx
CHAPTER ONE INTRODUCTION	22
1.1 Background.....	22
1.4 Problem Statement.....	24
1.5 Research Gaps	28
1.6 Research Objectives	28
1.7 Research Questions.....	29
1.8 Null Hypotheses	29
1.9 Research Scope.....	30
1.10 Significance of the Study.....	31
1.10.1 Hybridized Nielsen and Signaling Principle Interaction Model (NSPIxD)	31
1.10.2 Asmaul Husna Mobile Application (AHMA) Prototype	32
1.10.3 Evaluation Instruments	32

1.10.4 Body of Knowledge	33
1.10.5 Users.....	33
1.11 Limitations of the Study	33
1.12 Theoretical Framework.....	34
1.13 Cognitive Theory of Multimedia Learning (CTML).....	35
1.14 Principles of Multimedia Design.....	35
1.14.1 Signaling Principle	36
1.14.2 Constructivist Learning Environments (CLEs).....	36
1.14.3 Nielsen's Design Guideline	37
1.15 Research Framework	38
1.16 Operational Definition.....	38
1.16.1 Asmaul Husna	38
1.16.2 Knowledge	39
1.16.3 Perceived Awareness	39
1.16.4 Perceived Motivation	39
1.16.5 Mode of Mobile Application.....	40
1.17 Thesis Structure	40
CHAPTER TWO LITERATURE REVIEW	43
2.1 Introduction	43
2.2 Multimedia.....	43
2.2.1 Multimedia Learning.....	44
2.3 Cognitive Theory of Multimedia Learning (CTML).....	44
2.3.1 Multimedia Design Principle	46
2.3.2 Signaling or Cueing Principle	49

2.4 Nielsen’s Design Guideline	53
2.5 Constructivist Learning Environments (CLEs)	59
2.6 Mobile Learning	63
2.6.1 Islamic Mobile Content.....	64
2.7 Asmaul Husna.....	67
2.7.1 Asmaul Husna Application in Daily Life.....	81
2.8 Asmaul Husna Preliminary Investigation (PI).....	84
2.8.1 Interview with Content Experts	85
2.8.2 Interview with Islamic Education Teacher	87
2.8.3 Survey on Knowledge and Awareness of Asmaul Husna among Muslim	88
2.9 Asmaul Husna Multimedia Application	91
2.10 Knowledge.....	94
2.11 Perceived Awareness	95
2.12 Perceived Motivation.....	96
2.12.1 ARCS Model.....	97
2.13 Summary.....	99
CHAPTER THREE METHODOLOGY	100
3.1 Introduction	100
3.2 Research Design	100
3.3 Theoretical Study.....	102
3.3.1 Preliminary Study	102
3.3.2 Literature Elicitation	103
3.4 Development of the NSPIxD Model.....	104
3.4.1 Comparative Analysis	105
3.4.2 Expert Review	106

3.5 Evaluation of the NSPIxD Model.....	106
3.5.1 Expert Review 2.....	107
3.5.2 Prototyping.....	108
3.5.3 User Interactions Study.....	109
3.6 User Testing.....	114
3.6.1 Quasi-Experiment Procedures.....	114
3.7 Data Analysis Technique.....	119
3.7.1 Descriptive Statistics.....	119
3.7.2 Inferential Statistics.....	119
3.8 Summary.....	120
CHAPTER FOUR.....	121
HYBRIDIZED NIELSEN AND SIGNALING PRINCIPLE IxD MODEL (NSPIxD).....	121
4.1 Introduction.....	121
4.2 Signaling Principle and Nielsen Design Guidelines.....	122
4.2.1 Signaling or Cueing Principle.....	122
4.2.2 Nielsen’s design guideline.....	122
4.3 Comparative Analysis and User Requirement.....	123
4.3.1 Comparative Analysis.....	124
4.3.2 User Requirement Survey.....	135
4.4 Formulation of the Model.....	145
4.5 Expert Review 2.....	148
4.5.1 The NSPIxD Model.....	150
4.6 Summary.....	152
CHAPTER FIVE PROTOTYPE DESIGN AND DEVELOPMENT.....	153

5.1 Introduction	153
5.2 Instructional Design Model	153
5.2.1 Planning	154
5.2.2 Design	156
5.2.3 Macro and Micro Strategy in the Design of AHMA.....	160
5.2.4 Development	161
5.3 Applications of the NSPIxD Model in AHMA	164
5.4 Heuristic Evaluation Results.....	165
5.5 Summary.....	169
CHAPTER SIX RESULTS AND DISCUSSIONS.....	170
6.1 Introduction	170
6.2 Sample Distribution.....	170
6.3 Homogeneity of the Two Experimental Groups.....	171
6.4 Normality Test.....	175
6.4.1 Normality Test on Knowledge Scores	175
6.4.2 Normality Test on Perceived Awareness Scores	177
6.4.3 Normality Test on Perceived Motivation Scores Towards Learning Materials.....	178
6.5 Statistical Analysis of Results Corresponding to research Questions	180
6.5.1 Testing of Hypothesis H_{01a}	181
6.5.6 Testing of Hypothesis H_{02a}	184
6.5.10 Testing of Hypothesis H_{03a}	187
6.6 Summary of Research Findings.....	190
CHAPTER SEVEN CONCLUSIONS	191
7.1 Introduction	191

7.2 Conclusion of NSPIxD Model Design and development	191
7.2.1 Finding the appropriate components for the hybridized model of NSPIxD	191
7.2.2 Constructing the NSPIxD Model	192
7.2.3 Implementing the NSPIxD Model	193
7.2.4 Validating the NSPIxD Model via Expert Review and Quasi-Experiments	193
7.3 The implication of the Study	196
7.3.1 Impact on Learning in the New Norm	196
7.3.2 Impact on Society.....	197
7.3.3 Novel Theory	197
7.3.4 Impact on the Body of Knowledge	197
7.4 Recommendations for Future Study	198
7.5 Summary.....	199
REFERENCES.....	201

List of Figures

Figure 1.1. Theoretical Framework.....	35
Figure 1.2. Research Framework	38
Figure 2.1. Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2001).....	45
Figure 2.2. Signals or Cues Employed in Previous Works	51
Figure 2.3. Model for Designing CLEs.....	60
Figure 2.4. Model of Holistic Parenting Techniques	82
Figure 2.5. Asmaul Husna Learning Medium.....	90
Figure 3.1. Summary of Research Activities.....	98
Figure 3.2. Theoretical Study.....	99
Figure 3.3. Development of the NSPIxD Model.....	102
Figure 3.4. Evaluation of the NSPIxD Model.....	104
Figure 3.5. Prototype Design.....	106
Figure 3.6. Research Variables.....	107
Figure 3.7. Research Design.....	111
Figure 4.1 The Process of Constructing the NSPIxD Model.	121
Figure 4.2. Proposed NSPIxD Model Version 1	131
Figure 4.3. Title or Headlines	138
Figure 4.4. Navigation.....	139
Figure 4.5. Background Color.....	140
Figure 4.6. Proposed NSPIxD Model Version 2.....	147
Figure 4.7. NSPIxD Model Based on Final Expert’s Review.....	151
Figure 5.1. Alessi and Trollip instructional Design Model.....	154
Figure 5.2. Storyboard	157

Figure 5.3. Paper Prototyping Process with A Group of College Students	159
Figure 5.4. Macro and Micro Strategy in the Design of AHMA-NSPIxD	161
Figure 5.5. Infusion of NSPIxD Model in the Prototype	164
Figure 5.6. Heuristic Evaluation Result	168
Figure 6.1. Histogram for Normality of Knowledge Score	176
Figure 6.2. Normal Q-Q Plot of Knowledge Score.....	176
Figure 6.3. Histogram for Normality of Perceived Awareness Score.....	177
Figure 6.4. Normal Q-Q Plot of Perceived Awareness Score.....	178
Figure 6.5. Histogram for Normality of Perceived Motivation Score	179
Figure 6.6. Normal Q-Q Plot of Perceived Motivation Score.....	179



List of Tables

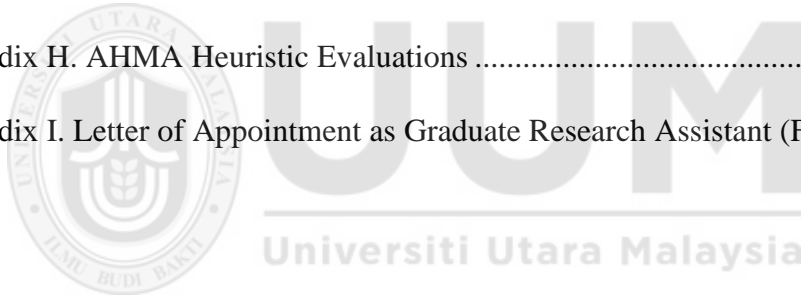
Table 2.1. Principles of Multimedia Design	46
Table 2.2. Hybridization of Principles in Multimedia Presentation.....	48
Table 2.3. Results from Utilization of Signaling Principle in Previous Works	51
Table 2.4. Application of Nielsen's Usability Design Principles and Heuristics	54
Table 2.5. Nielsen's Design Guideline	56
Table 2.6. The Implementation of CLEs in the Previous Researches.....	61
Table 2.7. Comparison of Islamic Mobile Applications	66
Table 2.8. The 99 Names of Allah	68
Table 2.9. Demographic Data of Respondents.....	88
Table 2.10. Respondents' Feedbacks on Knowledge and Awareness.....	89
Table 2.11. Comparison Table on Asmaul Husna Mobile Apps	92
Table 2.12. ARCS Models Categories and Definitions	97
Table 2.13. Past Researches on the Use of the ARCS Model.....	98
Table 3.1. List of Experts for AHKAI	111
Table 3.2. Pilot Test Result	115
Table 3.3. Paired Samples Test	116
Table 3.4. Initial Participants Involved	118
Table 3.5. Actual Participants Involved.....	118
Table 3.6. Participants' Gender.....	118
Table 4.1. Justification for Selecting Models	125
Table 4.2. Comparative Analysis of Main Components	127
Table 4.3. Comparative Analysis of Main Multimedia Elements.....	128
Table 4.4. Signaling Principles	129

Table 4.5. Nielsen's Design Guidelines	130
Table 4.6. User Requirement Survey Questions	136
Table 4.7. Demographic	137
Table 4.8. Elements to be included in a Mobile Learning App	141
Table 4.9. Suggestions from Respondents	142
Table 4.10. Summary of User Requirements	142
Table 4.11. List of Content Experts	144
Table 4.12. Feedback from Content Experts.....	145
Table 4.13. List of Experts.....	148
Table 4.14. Experts Review and Comments	149
Table 5.1. List Of Content and Software Experts	159
Table 5.2. List of Experts for Heuristic Evaluation	166
Table 5.3. Heuristic Evaluation Questionnaire	166
Table 6.1. Initial Participants Involved.....	170
Table 6.2. Actual Participants Involved.....	171
Table 6.3. Gender.....	171
Table 6.4. Levene's Test on Knowledge Pre-Test Score.....	172
Table 6.5. Levene's Test on Perceived Awareness Pre-Test Score.....	172
Table 6.6. Levene's Test on Perceived Motivation Score	173
Table 6.7. ANOVA Analysis on Knowledge Pre-Test Score	174
Table 6.8. ANOVA Analysis on Perceived Awareness Pre-Test Score	174
Table 6.9. Skewness and Kurtosis on Knowledge Scores	175
Table 6.10. Skewness and Kurtosis on Perceived Awareness Scores.....	177
Table 6.11. Skewness and Kurtosis on Perceived Motivation Scores	178

Table 6.12. Descriptive Statistics for Pre-Test and Post-Test for Knowledge Score between Groups.....	181
Table 6.13. Levene's Test of Equality of Error Variances for Knowledge Score between Groups.....	182
Table 6.14. ANCOVA Analysis for Knowledge Score between Groups	183
Table 6.15. Pair-Wise Comparisons for Knowledge Score between Groups	183
Table 6.16. Descriptive Statistics for Pre-Test and Post-Test for Perceived Awareness Score between Groups	185
Table 6.17. Levene's Test of Equality of Error Variances for Perceived Awareness Score between Groups.....	186
Table 6.18. ANCOVA Analysis on Perceived Awareness Pre-Test Score between Groups	186
Table 6.19. Pair-Wise Comparisons for Perceived Awareness Score between Groups	187
Table 6.20. Means and Standard Deviation for Perceived Motivation Score between Groups.....	188
Table 6.21. Levene's Homogeneity Test for Perceived Motivation Score between Groups.....	188
Table 6.22. ANCOVA Analysis for Perceived Motivation Score between Groups	189
Table 6.23. Pair-Wise Comparison for Perceived Motivation Score between Groups	189
Table 6.24. Summary of Research Finding.....	190

List of Appendices

Appendix A. Application to Conduct Research.....	227
Appendix B. Asmaul Husna Knowledge and Awareness Instrument (AHKAI).....	228
Appendix C. Instructional Materials Motivation Scale (IMMS)	232
Appendix D. Letter of Appointment as Technical Expertise	235
Appendix E. Letter of Appointment as Content Reviewer for AHKAI AND AHMA	236
Appendix F. Letter of Appointment as Expert Reviewer for AHKAI.....	238
Appendix G. Letter of Appointment as Expert Reviewer for NSPIxD Model and AHMA	240
Appendix H. AHMA Heuristic Evaluations	243
Appendix I. Letter of Appointment as Graduate Research Assistant (FRGS).....	246



List of Abbreviations

AHKAI	Asmaul Husna Knowledge and Awareness Instrument
AHMA	Asmaul Husna Mobile Application
AHMA-NSPIxD	AHMA is integrated with the NSPIxD model
AHMA-0	AHMA is not integrated with the NSPIxD model
ALM	Assistive Learning Model
ANCOVA	Analysis of Covariance
ANOVA	Analysis of Variance
ARCS	Attention, Relevance, Confidence and Satisfaction Model
ATID	Alessi and Trollip Instructional Design Model
CLEs	Constructivist Learning Environments
CTML	Cognitive Theory of Multimedia Learning
ERP	Enterprise Resource Planning
ICT	Information Communication Technology
IMMS	Instructional Materials Motivation Survey
MLM	Mobile Learning Models
NSPIxD	Hybridized Nielsen and Signaling Principle IxD Model
PI	Preliminary Investigation
SMAC	Social, Mobile, Analytics and Cloud
SPM	Sijil Pelajaran Malaysia
STPM	Sijil Tinggi Pelajaran Malaysia

List of Publications and Awards

Journals:

Rosmani, A. F., Abdul Mutalib, A., & Sarif, S. M. (2021). Hybridising Signaling Principle and Nielsen's Design Guidelines in A Mobile Application. *Asia-Pacific Journal of Information Technology and Multimedia*, 10(2), 62–76. <http://www.ftsm.ukm.my/apjitm>.

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Rosmani, A. F., Abdul Mutalib, A., & Sarif, S. M. (2020). Construction of the Guidelines for Mobile Learning Design: Hybridizing Signaling Principle and Nielsen's Design Guidelines. *2nd National Conference on Human-Computer Interaction 2020 (FUSION 2020)*, 92–99.

Rosmani, A. F., Abdul Mutalib, A., & Sarif, S. M. (2018). Proposed Design and Development of Mobile Learning Environment for Higher Education 4.0. *2nd International Conference on Applied Science, Engineering, Business & Information Technology (ICO-ASCNITECH 2018)*, 517–524.

Rosmani, A. F., Abdul Mutalib, A., & Sarif, S. M. (2018). The Effect of Signaling Principle in Asmaul Husna Mobile App on Knowledge, Perceived Awareness and Perceived Motivation Among Muslim. *SMMTC Postgraduate Symposium 2018*.

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Awards:

Gold Medal and Best Poster Award at 1st Technology and Research Exhibition (TREX) 2021, Universiti Malaysia Perlis.

- Project Title: *AHMA: Asmaul Husna Mobile Application*
- Project Members: **Arifah Fasha Rosmani**, Ariffin Abdul Mutalib, Siti Mahfuzah Sarif.

Silver Medal Award at Innovation Development Through Educational Activities (iDEA21), Institut Latihan Kemahiran Belia dan Sukan and The Malaysian Ministry of Youth and Sports.

- Project Title: *Asmaul Husna Mobile Application (AHMA)*
- Project Members: **Arifah Fasha Rosmani**, Siti Mahfuzah Sarif.

Silver Medal Award at International University Carnival on e-Learning (IUCEL) 2021, Universiti Utara Malaysia.

- Project Title: *Asmaul Husna Mobile Application (AHMA)*
- Project Members: **Arifah Fasha Rosmani**, Ariffin Abdul Mutalib, Siti Mahfuzah Sarif.

Silver Medal Award at Innovate Research, Invention, and Application Exhibition (i-ria 2021), School of Computing, Universiti Utara Malaysia.

- Project Title: *AHMA: Asmaul Husna Mobile Application*
- Project Members: **Arifah Fasha Rosmani**, Ariffin Abdul Mutalib, Siti Mahfuzah Sarif.

Best Paper Award at SMMTC *Postgraduate Symposium 2018*, School of Multimedia Technology and Communication, Universiti Utara Malaysia.

- Paper Title: *The Effect of Signaling Principle in Asmaul Husna Mobile App on Knowledge, Perceived Awareness, and Perceived Motivation Among Muslim*
- Members: **Arifah Fasha Rosmani**, Ariffin Abdul Mutalib, Siti Mahfuzah Sarif.

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- Paper Title: *Asmaul Husna Knowledge and Awareness: A Preliminary Investigation*
- Members: **Arifah Fasha Rosmani**, Ariffin Abdul Mutalib, Siti Mahfuzah Sarif.

CHAPTER ONE

INTRODUCTION

1.1 Background

Tablets, smartphones, and wearable devices can be beneficial in promoting academic learning (Mayer, 2020). This mode of instruction has evolved into the primary teaching method in formal and informal education; multimedia components can boost user engagement and interest in mobile applications and increase users' usage and interest in them (Mayer, 2017). Mayer (2001) has introduced Cognitive Multimedia Learning Theories (CTML) to assist in learning by adding multimedia design principles to create multimedia learning aids intended to promote more profound knowledge and provide cognitive support. The theory could be applied in various contexts in a mobile environment. It comprises 12 principles: Coherence Principle, Signaling Principle, Redundancy Principle, Spatial Contiguity Principle, Temporal Contiguity Principle, Segmenting Principle, Pre-training Principle, Modality Principle, Multimedia Principle, Personalization Principle, Voice Principle, and Image Principle (Mayer, 2001). CTML is also used to encourage learning, facilitate knowledge acquisition, and eliminate or significantly reduce extraneous cognitive load, confusing variables, and non-correspondent information.

CTML focus on cognition-centered approaches, which serve as the theoretical foundation of the signaling effect or cueing in learners' limited cognitive resources (Schneider et al., 2018; Yung & Paas, 2015). The idea is to emphasize the elements in the learning material to ease the learning process (Mayer, 2005). According to the knowledge construction hypothesis, signaling can serve as a cognitive guide that helps

learners sense the presented material (Mautone & Mayer, 2001). It aids readers by emphasizing the semantic or structure of the content, thus facilitating them in selecting the texts and connecting to the information provided. Cueing can reduce subjective cognitive load and promote retention and transfer performance (Richter et al., 2016; Schneider et al., 2018; Xie et al., 2017; Yang, 2016). Works that apply the Signaling principle have been vastly carried out. Among the techniques included were the use of spotlight (Doolittle, P. E., & Altstaedter, 2009), use of color in concept map (Ferrara & Butcher, 2011), arrows (Huk et al., 2010), flashing sections (Jeung et al., 1997), labeled diagram (Jeung et al., 1997), graphic organizer (De Jong & Van Der Hulst, 2002), mixed cueing (De Jong & Van Der Hulst, 2002), picture referencing (Seufert & Brünken, 2006), text highlighting (Murray & McGlone, 1997) and mixed text signaling (Sung & Mayer, 2012). The signals or cues assist learners in their study, especially for multimedia presentations such as mobile learning.

Nielsen's design guidelines have also been renowned for their usage to ensure that interactive applications serve their users as intended. Since 1998, The Nielsen Norman Group has been a leading voice in the user experience field in conducting groundbreaking research, assessing interfaces of all shapes and sizes, and guiding critical design decisions to improve the bottom line. They are considered pioneers in user research and interface design, addressing the most recent and relevant usability topics, from evergreen challenges such as information architecture and intranet usability to emerging social media and mobile usability trends.

The guidelines have been applied in numerous studies in making mobile applications effective. As an example, Hu (2018) used it in mobile music service, Inal (2018) for

the National Library of Turkey website, and Yen, Walker, Smith, Zhou, Menser, and McAlearney, 2018) in a commercial inpatient portal. Hence, the Signaling principle and Nielsen's design guidelines effectively support interactive products, including the wireless environment.

A paradigm shift is necessary for this mobile technology to succeed in education. Some propose that parents and teachers inspire students to learn heutagogically (self-determined learning) (Gillaspy & Vasilica, 2021) via mobile phones under their administration and monitoring (Ng et al., 2020). In contrast, others are concerned about how mobile learning might not be suitable and can cause unnecessary extra work for teachers (Ariffin et al., 2012). As nowadays, learning is accessible via mobile phones, desktop computers, and laptops; mobile learning is an excellent initiative as it offers flexibility, luxury, and an effective way of learning for generations Y and Z (Chee, Ibrahim, Yahaya, Surif, Rosli, & Megat Zakaria, 2017). It benefits many parties, especially digital users, who enjoy a more interactive and personalized experience through social, mobile, analytics, and cloud (SMAC) technologies (Selamat et al., 2017). Plus, embracing the MOHE's vision of Higher Education 4.0, which is to create heutagogy (self-determined learning), paragogy (peer-oriented learning), and cybergogy (virtual-based learning) (MOHE, 2018).

1.4 Problem Statement

Various types of pedagogy, namely heutagogy (determined self-learning), paragogy (peer-oriented learning), and cybergogy (virtual learning), are highly promoted in dealing with society in Education 4.0 era. As CTML encompasses several aspects of the science of learning and instruction, including self-learning (heutagogy) and e-

learning, this theory could be embedded in mobile applications. It could be one of the impacts of embracing the vision. It is also in line with the user-oriented perspective (i-SCOOP, 2017; Nainy, 2017), bringing personalization and customization to mobile applications technology in the education settings. Furthermore, multimedia learning material was developed in previous studies without applying any learning concepts, making it less effective in fostering the mental effort of the student (Baharuddin et al., 2018). Heutagogically learning has become more important with the increasingly mandatory online learning situation due to the Covid-19 crisis sweeping the globe.

Focusing on actual learning situations, Mayer did some in-depth studies involving testing learning theories. From CTML, Mayer has identified, reviewed, and explored many design effects and principles to improve learning outcomes with multimedia teaching materials. One of the principles suggested is the Signaling principle (Mayer, 2009). The Signaling or Cueing principles idea emphasizes essential in the material presented (Mayer, 2016). The emphasizing technique can be applied in visual and audio representation. In technical terms, signaling and cueing emphasize verbal or highlighting using graphics. The methods used in signaling involved using voice intonation in audio or a bold font in written texts; or highlighting important parts using circles, arrows, or zooming effects.

Another signaling or cueing effect is in using color-coding (Van Gog, 2014), for example, the use of red, yellow, and green for traffic lights that indicates either "stop", "beware", or "go" instructions. According to the hypothesis of knowledge construction, signals can serve as a cognitive guide that helps students understand the material presented (Mautone & Mayer, 2001). It assists readers by emphasizing the

semantic or structure of the content, facilitating them in selecting the texts and connecting (making them understand) to the information provided.

The signaling principle was deemed positive in guiding learners' attention. Some studies revealed that signaling enhanced visual search efficiency to find relevant information and improved learning performance, such as pointing gestures. It reduces extraneous processing by directing the learner's attention to critical elements when the learner does not know where to proceed (Davis, 2018). Hence, it is crucial to include color-coding, labeling, and verbal references in multimedia learning environments (Alemdag & Cagiltay, 2018).

Although previous studies have suggested that signaling enhances multimedia learning, insufficient evidence shows why signaling leads to better understanding (Ozcelik et al., 2010). Furthermore, the signaling principle for multimedia learning lacks a comprehensive review, including relevant studies from different testbeds (Richter et al., 2016). It needs to be regarded in the light of numerous moderators (Schneider et al., 2018). This limitation reveals the need to investigate specific signaling techniques, instructional materials, and participants (Schneider et al., 2018). Moreover, the signaling effect's cognitive processes and generalizability to young learners are indeterminate (Jian, 2018). As Signaling principles and Nielsen's design guidelines are two compelling principles, this study believes hybridizing them contributes significantly to knowledge acquisition and motivation.

The changes in Islamic knowledge dissemination are rapidly growing from just preaching, books and radio to the era of modern technology such as mobile

applications (Islam, 2019). Such innovations accommodate all ages who sought information in the field of religion (Zainal et al., 2017). The findings show that research on Islamic applications, their criteria (including multimedia principles), users' awareness, and mobile Islamic content is still deficient (Ismail et al., 2016; Khan & Shambour, 2017; Mustaffa et al., 2020). Hence, a better mobile app covering this context should be designed and developed. Therefore, studies on the development of Islamic-based smartphone applications need to be continuously researched (Ismail et al., 2016; Mustaffa et al., 2020).

Consequently, since heutagogy has become a necessity in learning nowadays, apps combining heutagogy techniques to emphasize the signaling principle and Nielsen design guidelines are needed. The need for online learning has turned into a must, especially in this time of the pandemic. In bridging the gap, a study on Islamic mobile applications integrated with the Signaling principle and Nielsen's Design Guideline is performed to investigate the knowledge and perceived awareness of the target users' context and perceived motivation in using the learning material. Islamic mobile apps are suggested to employ the Signaling principle since these principles guide attention, organize knowledge, and integrate knowledge (Mautone & Mayer, 2001). Generally, it reduces extraneous load and unnecessary memory burden, which can cause a decrease in learning outcomes (Richter et al., 2016). The signals ease the demands on the user's working memory. Thus, reducing the cognitive load and the information is easily comprehended conjointly with Nielsen's design guideline to determine the usability trends. Therefore, this research is inspired to intensify the Islamic mobile app user's motivation to use the app, uplift their interest, and increase their awareness and knowledge of Islamic content.

1.5 Research Gaps

Based on the previous section's problem, three research gaps can be extracted to study further. Those gaps are:

- i. There is a lack of studying the Signaling principle and Nielsen's design guidelines from the previous works, especially in a study on knowledge, perceived awareness, and perceived motivation of the learning materials. Therefore, it is urgent to explore both principles' hybridization further to contribute to user interaction via mobile applications.
- ii. Most studies on Islamic mobile applications have little concern about the multimedia principle, particularly the Signaling principle to enhance user interaction.
- iii. It is necessary to design and develop a mobile app to fulfill the heutagogy learning style as it has become the most crucial learning style in this pandemic.

1.6 Research Objectives

This research involved two presentation modes: Asmaul Husna Mobile Application (AHMA) integrated with the NSPIxD model (Signaling principle hybridizes with Nielsen's design guidelines); AHMA-0 and mobile application without the proposed model; AHMA-NSPIxD.

1. To determine the components of the hybridized model of NSPIxD.
2. To construct the components of the hybridized model of NSPIxD.
3. To implement the NSPIxD Model.
4. To validate NSPIxD Model through;
 - a. expert review,
 - b. prototyping, and

- c. user interactions in terms of;
 - i. knowledge,
 - ii. perceived awareness, and
 - iii. perceived motivation towards the learning material.

1.7 Research Questions

- i. What are the appropriate components for the hybridized model of NSPIxD?
- ii. How to construct the hybridized model of NSPIxD?
- iii. How to implement the hybridized model of NSPIxD?
- iv. How to validate the hybridized model of NSPIxD for university students?

1.8 Null Hypotheses

The experiment investigates the effects of Asmaul Husna Mobile Application (AHMA) integrated with the NSPIxD model, AHMA-0, and mobile application without the proposed model; AHMA-NSPIxD enhances users' knowledge, perceived awareness, and perceived motivation of the context; Asmaul Husna. Therefore, there are three hypotheses generated for this purpose. The hypotheses are:

1. There is no significant difference in users' knowledge of Asmaul Husna between the mobile application integrated with NSPIxD (AHMA-NSPIxD) and the mobile app without the model (AHMA-0). As to support that, the following subsidiary hypotheses need to be tested:

H_{01a}: There is no significant difference in users' knowledge of Asmaul Husna between AHMA-0 and AHMA-NSPIxD.

2. There is no significant difference in users' perceived awareness of Asmaul Husna between the mobile application integrated with NSPIxD (AHMA-NSPIxD) and the mobile app without the model (AHMA-0). As to support that, the following subsidiary hypotheses need to be tested:

H_{02a}: There is no significant difference in users' perceived awareness of Asmaul Husna between AHMA-0 and AHMA-NSPIxD.

3. There is no significant difference in users' perceived motivation of Asmaul Husna between the mobile application integrated with NSPIxD (AHMA-NSPIxD) and the mobile app without the model (AHMA-0). As to support that, the following subsidiary hypotheses need to be tested:

H_{03a}: There is no significant difference in users' perceived motivation toward learning material between the AHMA-0 and AHMA-NSPIxD.

1.9 Research Scope

This research is carried out within the Malaysian context to avoid misleading perceptions in the broad setting. Therefore, this study limits its scientific works as follows:

- i. This study is limited to Muslims, particularly students in universities located in Perlis and Kedah, as university students are equivalent regardless of demographic aspects and possess the same abilities in the area tested (Brown & Green, 2016; Cohen & Swerdlik, 2009).
- ii. This study's respondents are youths (18 to 24 years old); university and college students are the major mobile phone users (Malaysian Communications and Multimedia Commission, 2017, 2018).

iii. This study scopes the prototype as to the following criteria:

- a) It is in a mobile application and is accessible via cloud storage.
- b) The mobile application content is based on Asmaul Husna's meaning, benefits, and daily usage.
- c) The prototype's validation focuses only on three aspects; 1) knowledge, 2) perceived awareness, and 3) perceived motivation related to the preliminary study's infancy.

1.10 Significance of the Study

The NSPIxD Model, coined in this study, is a hybrid model based on Nielsen's design guidelines and Mayer Signaling principles. It incorporates components that prioritize the needs of undergraduates. It contributes specifically to their knowledge, perceived awareness, and perceived motivation through a pleasant mobile application experience. The subsections that follow summarize the study's significance.

1.10.1 Hybridized Nielsen and Signaling Principle Interaction Model (NSPIxD)

The proposed model of NSPIxD is the study's primary contribution to the corpus of knowledge. The approach aims to familiarize undergraduates with a holistic learning idea through mobile learning technology. By identifying components, multimedia elements, and Nielsen's and Mayer's design principles, the components encompass pedagogical contexts such as learning theories, learning methods, learning strategies, and instructional design models. The model serves as a comprehensive design guide for anyone responsible for creating mobile learning content, such as educators, mobile developers, and instructional designers. The model is validated and certified by subject

matter experts in various fields, demonstrating its validity before conversion to a prototype form. This section is covered in greater detail in Chapters 4 and 5.

1.10.2 Asmaul Husna Mobile Application (AHMA) Prototype

This prototype is a mobile application that is based on the NSPIxD model. The mobile application is composed of components and elements derived throughout the research. The prototype is mainly used to test the idea from the standpoint of a mobile developer. It is to ensure that the NSPIxD model is beneficial in helping them design and develop a mobile app for undergraduates. The prototype adds value to the teaching and learning process by promoting parts of the learning experience conducive to a lecture or self-paced learning (heutagogy).

1.10.3 Evaluation Instruments

The evaluation procedure utilized various methodologies to assess multiple aspects of the user experience. The instruments used in this study are quantitative research to examine knowledge, perceived awareness, and motivation of the learning materials. The AHKAI instrument is developed to assess knowledge and perceived awareness escalation using the AHMA prototype. At the same time, IMMS is used to ascertain perceived motivation for utilizing instructional resources developed. The instrument is composed of appropriate elements for the target user to respond to. As a result, future researchers can alter such instruments to study the user experience of undergraduates in any subject.

1.10.4 Body of Knowledge

The study contributes to the body of knowledge, especially in human-computer interaction and interaction design. It reveals the benefits of learning through mobile towards bridging theory and practice to engage the students' attention and retain their motivation. The proposed NSPIxD model incorporated through AHMA design and development may help future multimedia developers develop better mobile learning applications. On the other hand, it may also provide an overview of the android platform's eligibility in supporting the multimedia learning environment.

1.10.5 Users

Additionally, this study increases Muslims' knowledge, perceived awareness of the importance of learning Asmaul Husna, and the perceived motivation of the learning material through a mobile application. It will diversify the range of materials available for studying and practicing Asmaul Husna as *dhikr*. Mobile applications, particularly those that incorporate engaging interactions, will also trigger their interest in Asmaul Husna for daily practice.

1.11 Limitations of the Study

This study is subject to certain restrictions; hence, it can avert the general probability of its findings. The method focuses on the Muslim community, attempting to rearise the knowledge in Asmaul Husna and outstretch in understanding and contemplating their benefits. This study's domain area is in the Malaysian context, particularly for university or college students aged 18 - 24 who own and are familiar with mobile phones and mobile applications.

This study is also limited to measuring the effects of two different presentation modes of AHMA-0 and AHMA-NSPIxD in increasing users' knowledge, perceived awareness, and perceived motivation levels after using both modes. AHMA- NSPIxD is designed according to Mayer's Signaling principle hybridized with Nielsen's design guidelines, and AHMA-0 is designed without them.

The multimedia application is designed and developed based on theories and design elements evaluated by content and media experts. However, the study results may be affected by the device's performance.

1.12 Theoretical Framework

The study's theoretical framework includes macro and micro design strategies Van Patten, Chao, and Reigeluth (1986) recommended. The ability to entwine micro and macro instructional principles is undoubtedly commendable (Spector et al., 2005). Macro strategies define the content's selection, order, and organization, encapsulating the overall strategic plan. The micro strategy defines the effective presentation of the learning content to the learner. Two theories fortify this study's macro strategy; CTML (Mayer, 2001) and ATID Instructional Design Model (Alessi & Trollip, 2001) are embedded in the macro strategy as a guideline for the design, development, and testing of the multimedia learning application. The micro strategy is comprised of Principles of Multimedia Design, precisely the Signaling principle (Mayer, 2008), Nielsen's Design Guideline (Loranger et al., 2014), and the ARCS model (Keller, 1987b), and these strategies are united in a Constructivist Learning Environment (Jonassen, 1999). Figure 1.2 depicts the graphical representation of the theoretical framework.

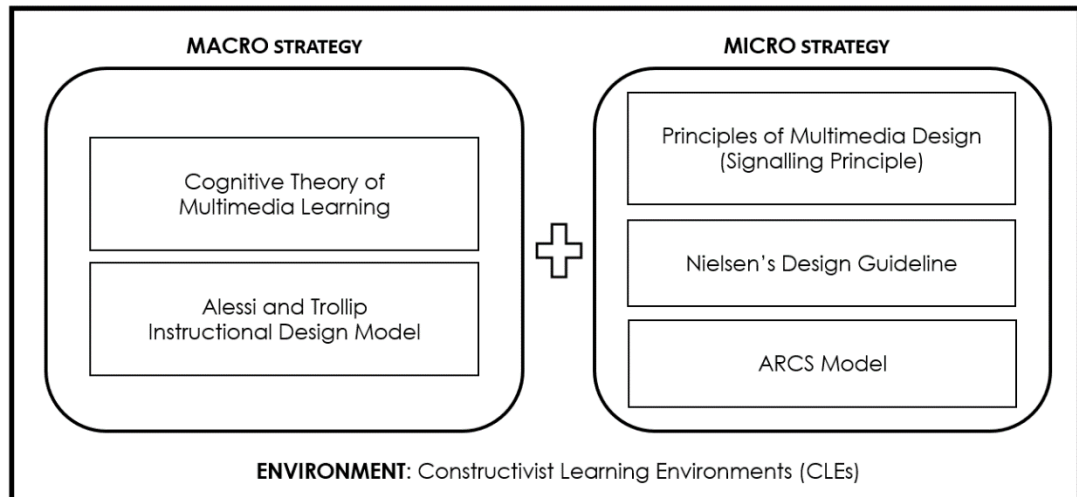


Figure 1.1. Theoretical Framework

1.13 Cognitive Theory of Multimedia Learning (CTML)

The cognitive theory of multimedia learning (Mayer, 2005) is based on three key assumptions: there are two separate channels (auditory and visual) for processing information; there is limited channel capacity; and that learning is an active process of filtering, selecting, organizing, and integrating information. More explanation can be found in Chapter 2: Literature Review.

1.14 Principles of Multimedia Design

In contemplating planning and developing effective PowerPoint presentations, online courses, setting up flip classrooms, and other multimedia presentations, it is vital to consider learners' involvement with materials without regular face-to-face interaction. Thus, Mayer (2001) discusses twelve principles that can shape the design and organization of multimedia presentations:

- i. Coherence Principle
- ii. Signaling Principle
- iii. Redundancy Principle
- iv. Spatial Contiguity Principle

- v. Temporal Contiguity Principle
- vi. Segmenting Principle
- vii. Pre-training Principle
- viii. Modality Principle
- ix. Multimedia Principle
- x. Personalization Principle
- xi. Voice Principle
- xii. Image Principle

1.14.1 Signaling Principle

For the design and development of AHMA, the researcher has used Signaling Principle. This multimedia design principle guided that learners learn more deeply when signals or cues are added to highlight the essential material organization, understand better when keywords are highlighted, and learn more when cues are added to highlight the primary content organization (Mayer, 2014). Moreover, to draw attention to critical elements of the lesson, it is necessary to use visual, auditory, or temporal cues; conventional techniques include the use of colors, arrows, circles, highlighting or bolding text, and pausing or vocal emphasis in narration (Issa et al., 2011; Johnson et al., 2015; Mayer, 2017; Van Gog, 2014). Ending lesson segments after providing critical information could also aid as a signaling cue.

1.14.2 Constructivist Learning Environments (CLEs)

Constructivism is a theory of learning found in psychology that explains how people may acquire knowledge and understanding. Therefore, it has a direct application to education. Constructivist Learning Environments (CLEs) (Jonassen, 1999) theory

shows that humans build knowledge and meaning from their experiences and provides a complete set of methods to promote a constructivist learning environment.

In this study, CLEs are used to ensure that users could learn Asmaul Husna on their own via AHMA and connect themselves with the previous knowledge that they already retained on this topic. As Asmaul Husna commonly sings as *nasyid*, they connect their singing experience with the new principles, meaning, dhikr, and *du'a* added in the mobile app.

1.14.3 Nielsen's Design Guideline

Usability is the measurement of quality that user experiences when interacting with a system; hence, the reluctance to adhere to well-established principles could cause adversity (J. Nielsen, 2012; Norman & Nielsen, 2010). These essential principles must be integrated and combined to enhance new innovative technology and portable devices' performance and facilities and satisfy users' needs (Issa & Isaias, 2015). Therefore, various Nielsen design guidelines have been established to avoid errors and usability disasters by providing apparent aspects in developing learning environments that cater to different target users. This guideline is selected as Loranger et al. (2014) have conducted empirical usability studies with real users: the college and university students, which is the same as targeted for this study. They have determined how the multimedia application could be improved to match users' abilities and preferences. Examples of the model categories are visual design, writing, navigation and interaction design, and multimedia as discussed in Chapter 4.

1.15 Research Framework

The research framework consists of one independent variable with two modes, three dependent variables, and one moderator variable. Independent variables influence dependent variables in response to moderator variables. The independent variable is the presentation mode, either AHMA-0 or AHMA-NSPIxD. AHMA-NSPIxD is a presentation mode incorporating the proposed NSPIxD Model, whereas AHMA-0 does not. Meanwhile, knowledge, perceived awareness, and perceived motivation toward learning materials serve as the dependent variables. Figure 1.2 exemplifies the research framework.

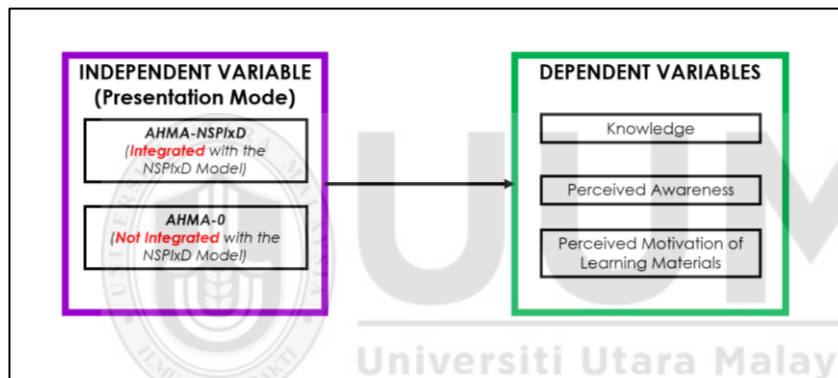


Figure 1.2. Research Framework

1.16 Operational Definition

1.16.1 Asmaul Husna

Asmaul Husna is one of Allah's 99 most beautiful names, and they are stated in the Qur'an and Hadith. They represent each of the Creator's characters, and understanding them is essential for achieving *ma'rifatullah* based on the Qur'an and sunnah. By repeatedly calling the unique Name of Allah (dhikr) and praying, asking for energy from God through the soul, energy will flow through the soul, and the energy produced will flow to the brain, the heart, and body. This technique is stated in Al Quran in Surah Al A'raf verse 180.

1.16.2 Knowledge

Knowledge could be defined as a belief that agrees with the facts. It is also defined as facts, information, and skills acquired through experience or education. The theoretical or practical understanding is known as awareness or familiarity gained by experience of reality or situation. In this study, knowledge refers to learners' knowledge of Asmaul Husna, their meaning, and the benefits of practicing them. It is measured using a knowledge awareness instrument called Asmaul Husna Knowledge and Awareness Instrument (AHKAI), designed by the researcher based on the guideline from Bradburn, Sudman, and Wansink (2004).

1.16.3 Perceived Awareness

Awareness refers to the ability to experience oneself as past, present, and future subjects, including reflecting and understanding the surrounding environment. Besides, perceived awareness may refer to knowledge about others' competence, skills, and operating methods. Perceived awareness in this study is discussed on the Muslims' awareness level regarding the 99 names. It is measured using Asmaul Husna Knowledge and Awareness Instrument (AHKAI) developed by the researcher.

1.16.4 Perceived Motivation

Motivation refers extensively to what people yearn for, what they choose and obligate in doing certain things. In psychology, the purpose is to gain scientific knowledge that could be used to improve the human experience. In this study, motivation refers to learners' perception of motivation towards the learning material, and it is measured via the Instructional Materials Motivation Survey (IMMS) introduced by Keller (2006).

1.16.5 Mode of Mobile Application

Mobile application mode refers to presenting Asmaul Husna through mobile phones. In this study, the mobile application employs the NSPIxD Model in one mode of presentation, namely mobile app with Signaling principles hybridized with Nielsen's design guideline called AHMA- NSPIxD. Another mode without the model is called AHMA-0.

1.17 Thesis Structure

This thesis is divided into seven chapters, focusing on different aspects of the study's primary activities.

Chapter 1: Introduction - This chapter discusses the preliminary study and rationale behind this research. It begins with a pre-study that creates the problem, research purpose, questions, scope, and proposed solution. Then, several contributions to the body of knowledge and practical field are highlighted to demonstrate the study's importance. Finally, the operational definition section defines the terms used throughout this thesis. The theoretical and research frameworks have been used to illustrate the total research efforts.

Chapter 2: Literature Review - This chapter discusses literature pertinent to this topic. The concepts and hypotheses have been examined in detail, and their consequences directly support the study's primary purpose.

Chapter 3: Methodology - This chapter summarizes all phases, activities, and deliverables associated with a particular study design. It is divided into three major stages with detailed actions to accomplish the study objectives outlined in Chapter 1.

Chapter 4: NSPIxD Model - This chapter details the process of construction, which involves comparative study and interaction with subject matter experts. As a result of these actions, a proposed model was provided for determining the components and elements. Following that, expert assessments of the model validation process are detailed, culminating in an endorsed NSPIxD Model presentation. Those deliverables implied that the first, second, and third objectives had been met.

Chapter 5: AHMA Prototype - This chapter discusses the continuation of the NSPIxD Model validation activity, confirming the achievement of the third objective's second portion. The model is converted to a functional prototype, and the development process is detailed accordingly.

Chapter 6: AHMA-0 and AHMA-NSPIxD User Experience - This chapter discusses AHMA's knowledge, perceived awareness, and perceived motivation components via the lens of user experience activities involving target users. This chapter discusses the equipment used in the testing and the study's findings. At this point, the third objective has been fulfilled in its entirety.

Chapter 7: Conclusion: The concluding chapter summarizes the research findings concerning the research objectives and the NSPIxD Model's general implications for

the body of knowledge and teaching and learning practice. This chapter also discusses the chapter's limitations and makes recommendations for future embarks.



CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

This chapter commences with a discussion of the problem domain understanding. It is later followed by an in-depth survey on concepts, theories, principles, and previous studies related to this study.

2.2 Multimedia

Multimedia comprises text, graphic arts, audio, animation, and video delivered to viewers through computers and other electronic or digital modes (Vaughan, 2008). It is rich with sensation because when every multimedia element is bundled together, stunning photos and multimedia animations, fascinating sounds, exciting video clips, and basic textual information can radiate a center of thought and action in a person's mind (Vaughan, 2008). When interactive controls are provided, the user will be fascinated by the multimedia content. Multimedia could be applied in various environments, including education, business, health, security, transportation, home, and public places, and has evolved into image tweets, audio pictures, and geo-tagged videos through social media (Cui et al., 2014; Vaughan, 2008). The goal of multimedia computing is to deliver multimedia content to users according to their information needs (intentions) (Cui et al., 2014).

Multimedia data is becoming ubiquitous on any computing device, from small, handheld devices like PDAs and mobile phones, to medium-sized devices such as traditional desktop PCs and laptops, to substantial appliances such as public

information systems with big screens. The growing pervasiveness of multimedia on any computing device increases the relevance of knowledge about multimedia for computer scientists and software engineers (Friedland et al., 2007).

2.2.1 Multimedia Learning

Multimedia learning involves learning from texts and pictures. It includes learning from textbooks containing passages and illustrations, computer-based lessons encompassing animations and narratives, and slides containing graphics and presentations accompanied by sound (Mayer, 2009). Multimedia learning theories focus on the cognitive processes involved in learning, such as choosing relevant information, administering the material into a coherent organization, and integrating it with previous knowledge and long-term memory, as suggested in the Multimedia Learning Cognitive Theory (Mayer, 2014).

2.3 Cognitive Theory of Multimedia Learning (CTML)

According to the CTML (Mayer, 2009), as shown in Figure 2.1, learning is based on three assumptions about meaningful cognitive processes that are human processes through two channels (visual/pictorial and auditory/verbal). Each channel can process limited information, and it occurs during active processing. Information processing in work memory involves choosing relevant words and related images, organizing selected words and images, and integrating visual and audio information with prior knowledge.

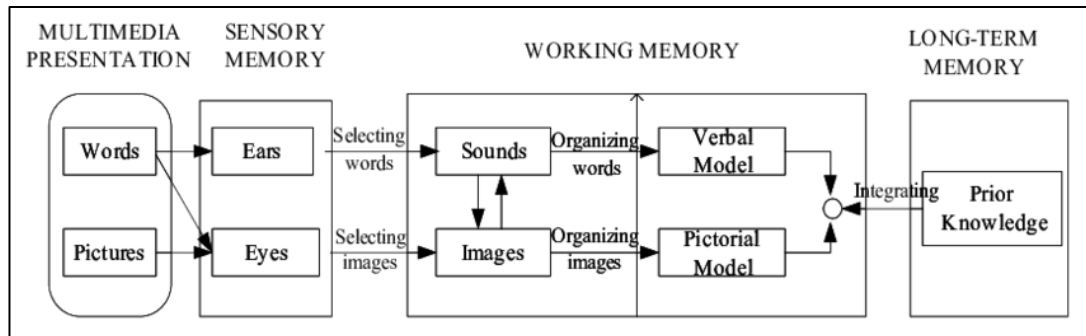


Figure 2.1. Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2001)

This theory explains how students choose relevant visual and verbal materials from what is presented during multimedia learning, builds visual and verbal representations of this information, and connects visual and oral presentations and prior knowledge (Mayer, 2014).

CTML guides the multimedia content structure and instructions to fully utilize how the brain processes visual and auditory information to produce quality multimedia teaching materials for students. Teachers and instructional designers are taught using principles to use multimedia tools that utilize brain cognitive abilities with visual and auditory capabilities provided by texts, images, graphics, animations, videos, and narratives (Mayer, 2014).

The empirical research proposes some prescriptive principles to help multimedia designers make educational materials more suited to human cognitive architecture to eliminate or reduce cognitive burden, confusing variables, and information incompetence (Mohamed, 2011; Rapp, 2013).

2.3.1 Multimedia Design Principle

Mayer introduces the principles of multimedia learning (2001). These principles guide in producing engaging multimedia courseware without the traditional face-to-face method. It primarily focused on courseware design and organization. Mayer (2014) discusses various multimedia learning principles, supported by research distinguishing different multimedia learning situations to decide which results in a better learning process. It involves twelve principles that shape multimedia presentations' design and organization, as shown in Table 2.1.

Table 2.1

<i>Principles of Multimedia Design</i>	
Principles	Descriptions
<i>Principles for Reducing Extraneous Processing in Multimedia Learning</i>	
Coherence Principle	People learn better when extraneous words, pictures, and sounds are omitted rather than present.
Signaling Principle	People learn better when signals that highlight necessary organizational materials are added.
Redundancy Principle	People learn better from graphics and narration than graphics, narrative, and on-screen text.
Spatial Contiguity Principle	People learn better when matching words and pictures are presented adjacently rather than distantly from each other on the page or screen.
Temporal Contiguity Principle	People learn better when matching words and pictures are presented simultaneously rather than sequentially.
<i>Principles for Managing Essential Processing in Multimedia Learning</i>	

Segmenting Principle	People learn better using multimedia lessons presented in a user-paced segment rather than a continuous unit.
Pre-training Principle	People learn better from multimedia lessons when they know the names and characteristics of critical concepts.
Modality Principle	People learn better from illustrations and narratives than from animation and text on the screen.

Principles for Fostering Generative Processing in Multimedia Learning

Multimedia Principle	People learn better from words and pictures than just words.
Personalization Principle	People learn better from multimedia lessons when words are in an informal style rather than a formal style.
Voice Principle	People learn better when the narrative in multimedia lessons is spoken in a friendly human voice rather than a machine.
Image Principle	People do not necessarily learn better from a multimedia lesson when the narrator's image is affixed to the screen.

(Source: Mayer, 2001)

Table 2.2 displays the previous projects that have been designed and developed with the use and hybrid of various multimedia principles and the aspects being studied, and none that have hybridized the Signaling principles with Nielsen's design guidelines.

Table 2.2

Hybridization of Principles in Multimedia Presentation

Author	Context	Principles	The Aspect of the Study
Wong (2018)	Science Laboratory	Visual Signaling Principle	Students' Performance, Cognitive Load, Perceived Motivation
Wan Azman (2017)	Vocabulary	Multimedia and Modality Principles	Vocabulary learning and Retention
Mohamad Zaini (2017)	Islamic Funeral	Segmenting Principle	Knowledge
Abdul Wahab (2016)	Cyberbully	Personalization Principles + Persuasive Technology Principles (Similarity, Suggestion, and Tailoring)	Knowledge, Perceived Awareness, Perceived Motivation
Al-Rikabi (2016)	Arabic Language	Coherence, Spatial Contiguity, Temporal Contiguity, Multimedia, and Voice Principles	Perceived Usefulness, Ease of Use, Learnability
Muhammed (2016)	English Language	Signaling Principle	Listening Skills, Motivation
Ahmad (2015)	Islamic Funeral Rites	Signaling Principle	Recognition, Recall, and Transfer Learning
Othman (2015)	Children Sexual Abuse	Personalization Principle + Persuasive Technology Principles (Attractiveness,	Knowledge, Perceived Awareness, Perceived Motivation

		Similarity, Suggestion, Simulation in Real-world Contexts)	
Osman (2015)	Dyslexia	Segmenting Principles	Knowledge, Self- Efficacy Belief, Perceived Motivation
Rapp (2013)	Science Class	Signaling Principles and Multimedia Principles (Modality, Segmenting, Temporal Contiguity, and Redundancy)	Knowledge Retention, Cognitive Difficulty
Govindasamy (2011)	Science Subject	Personalization Principles (Pedagogical Agent)	Perceived Motivation, Self-Efficacy Belief, Learning Engagement
Mohamed (2011)	Educational Video	Segmenting Principles, Weeding Principles, Signaling Principles	Knowledge, Knowledge Retention
Foo (2010)	ICT in Education	Personalization Principles (Pedagogical Agent)	Achievement, Motivation, Learners' Cognitive Style

2.3.2 Signaling or Cueing Principle

This principle is chosen because it is significant in Asmaul Husna, especially in e-learning and multimedia presentations. Additionally, the chosen principle successfully facilitated Asmaul Husna's learning and memorization via courseware and games (Rosmani et al., 2017; Rosmani & Zakaria, 2018). Based on the research, decent

results were obtained using Signaling Principles, such as the students' engagement, excitement, and attractiveness in the learning materials and the content.

With their cognition-centered approaches, Theories like CTML serve as the theoretical basis of the signaling effect or cueing in learners' limited cognitive resources (Schneider et al., 2018; Yung & Paas, 2015). The idea emphasizes the essential info in the material presented (Mayer, 2016). Visual signaling techniques were expected to alleviate the unnecessary load associated with the CTML's selection phase, thus freeing cognitive resources for more essential processes such as information organization and integration (Johnson et al., 2015). According to Van Gog (2014) and based on CTML, the combination of attention-guiding cues can significantly increase the effectiveness of educational materials (Schneider et al., 2018) and make learning more favorable, depending on student characteristics, teaching materials, and experimental procedures (Richter et al., 2016).

Cueing can help lower subjective cognitive load, facilitate signal transmission, and improve retention and transfer performance. The more mental capacity, the more effectively multimedia learning is retained and transmitted (Xie et al., 2017; Yang, 2016) regardless of learners' cognitive styles. Figure 2.2 depicts the previous works that have been achieved using the Signaling principle in their learning methods (Schneider et al., 2018). The signals or cues that have been employed in these studies are the spotlights, use of color in the concept map, arrows, flashing sections, labeled diagrams, graphic organizer, mixed cueing, picture referencing, text highlighting, and mixed text signaling. The signals or cues may assist learners in their study, especially for multimedia presentations such as mobile learning.

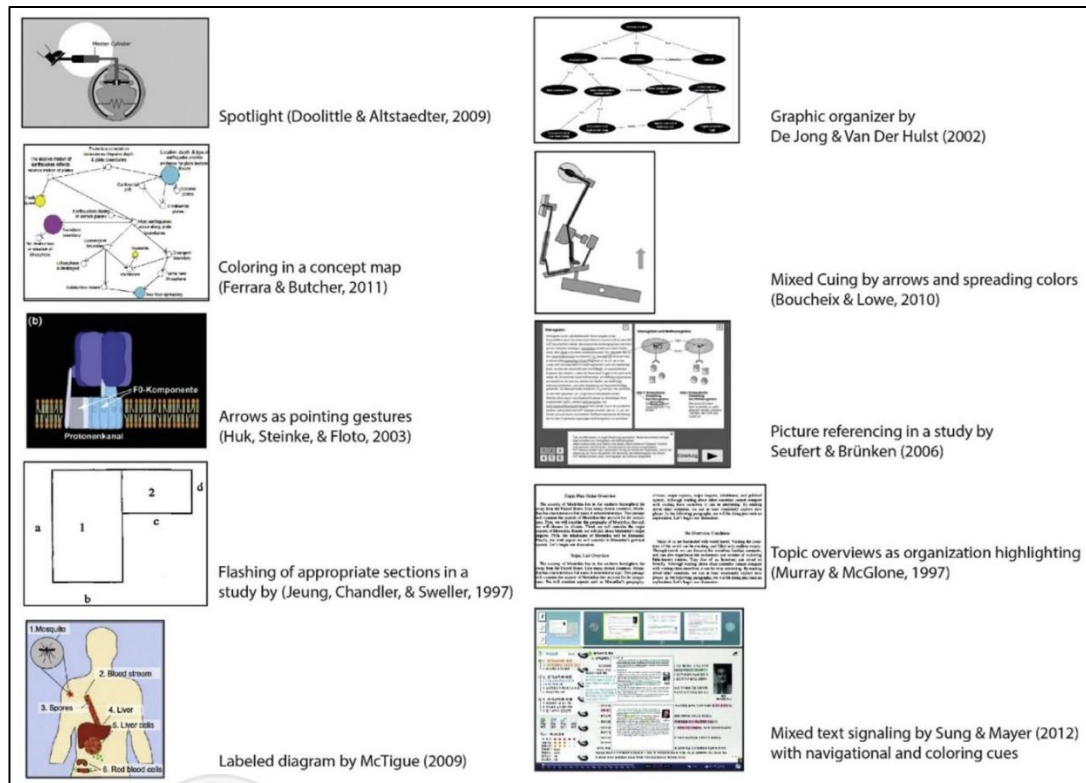


Figure 2.2. Signals or Cues Employed in Previous Works

Table 2.3

Results from Utilization of Signaling Principle in Previous Works

Author	Context	Signal/Cue Used	Results
Azam Khan and Simon Breslav (2018)	Bayesian Inference	Visual Cues	They are improving human performance in Bayesian inference, notably Mammography Problem.
Mayer (2017)	Engineering	<ul style="list-style-type: none"> Text Graphics 	Students score better on tests when multimedia lessons contain keyword cues or primary features of graphics.
Murphy and Liew (2016)	Screencast	Animation	The principles offer a reasonable basis for designing

			practical instructions.	multimedia
Yang (2016)	Biology	Visual Cues	<ul style="list-style-type: none"> • Reduce the learners' mental load. • Animation • Arrow 	<ul style="list-style-type: none"> • Both high- and low-visualizers received equally good benefits.
Ahmad and Wan Yahya (2015)	Islamic Funeral Rites	<ul style="list-style-type: none"> • Narration • Text 	<ul style="list-style-type: none"> • Increase students' knowledge achievement on Islamic funeral rites. 	
Scheiter and Eitel (2015)	Circulatory Heart System	Visual Ques	<ul style="list-style-type: none"> • Text • Diagram 	Alerts by highlighting specific textual charts.
Glaser and Schwan (2015)	Fictional Buildings	<ul style="list-style-type: none"> • Picture • Audio 	<ul style="list-style-type: none"> • Images accompanied by audio text can be learned better. 	
Johnson et al. (2015)	Electric Circuit Analysis	<ul style="list-style-type: none"> • Animation • Arrow 	<ul style="list-style-type: none"> • Students' characteristics, including prior domain knowledge, contribute to the effectiveness of visual signaling techniques and the animated pedagogical agent's visible presence. 	
(Boucheix, Lowe, Putri and Groff (2013)	Mechanism's Dynamics	Animation	<ul style="list-style-type: none"> • Participants in the two-relational event unit cueing conditions performed better than in entity-based and non-cued situations. 	

Johnson, Ozogul, Moreno, and Reisslein (2013)	Electrical Circuits	Visual Signal • Arrow • Animation	Visual signaling facilitated the selection of relevant information.
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As a result of the findings in Table 2.3, this principle was chosen for this study since previous research suggested that signaling principles aided learners in the following areas:

- i. Improve learner's performance.
- ii. Reduce the learners' mental load.
- iii. Both high- and low-visualizers received equally good benefits.
- iv. Increase learners' knowledge achievement.
- v. Provide help and assistance to the learners.
- vi. It makes learners focus on the most relevant content or a chunk of information.
- vii. Suitable to be applied to visual learners.
- viii. Demonstrates that visual cue is most beneficial when used in mobile learning environments.

2.4 Nielsen's Design Guideline

Nielsen's design guideline is well-known for its application and uses in human-computer interaction. Consequently, numerous studies have developed an excellent mobile learning environment using these guidelines. However, none have adopted and utilized the Signaling principle and Nielsen's design guideline in the manner intended

in this study. Table 2.4 demonstrates the learning materials that have been selected using only Nielsen’s Usability Design Principles and Nielsen’s Heuristics.

Table 2.4

Application of Nielsen’s Usability Design Principles and Heuristics.

Author	Principle / Guideline	Context
Hu (2018)	Nielsen’s Heuristics	Mobile Music Service
Inal (2018)	Nielsen’s Heuristics	National Library of Turkey Website
Yen et al. (2018)	Nielsen’s Heuristics	Commercial Inpatient Portal
Grzybowski, Minkowski and Olszewski (2017)	Nielsen’s Heuristics	Mobile Telecare
Sability and Pettersson (2016)	Nielsen’s Usability Design Principles and Heuristics	Mobile Web
Sharples (2014)	Nielsen’s Heuristics	Mobile Learning
Gu, Gu, and Laffey (2011)	Nielsen’s Usability Design Principles and Heuristics	Mobile Lifelong Learning <ul style="list-style-type: none"> • Expo English • Six-Step Change Tire
Babaian, Lucas, Xu and Topi (2010)	Nielsen’s Usability Design Principles	Enterprise Resource Planning (ERP)
Desurvire and Wiberg (2009)	Nielsen’s Usability Design Principles	Video and Computer Games
Chorianopoulos (2008)	Nielsen’s Usability Design Principles	Interactive Television Applications

Boivie, Blomkvist,	Nielsen's Usability Design	User-Centered Systems
Gulliksen, Goransson and Cajander (2003)	Principles	Design
Federoff (2002)	Nielsen's Usability Design Principles and Heuristics	Video Games

Based on these researches in Table 2.5, Nielsen's design guideline is selected for this study as it promises for:

- i. Suitability for the e-learning environments, especially for a mobile learning environment.
- ii. Cover the perspectives that are best suited for the development of learning applications.
- iii. Customization, according to the learners' category.

Many respondents were 18-24 years old in the initial investigation conducted. Therefore, Nielsen's design guideline for this age category has been chosen. Besides, they are most mobile phone users (Malaysian Communications and Multimedia Commission, 2017, 2018) and future generations who will eventually become the nation's leaders, their families, or themselves. Table 2.8 describes the usability suggestions by Budiu and Nielsen (2010), Kumar et al. (2019, 2020), Kumar and Mohite (2016), Loranger et al. (2014), Nielsen (1994a, 2012, 1994c), Nielsen and Budiu (2013), and Nielsen and Landauer (1993). These suggestions are considered in the designing and developing phase of this study.

Table 2.5

Nielsen's Design Guideline

Elements/Components	Usability Recommendations	Sources
Visual Design	1. Attract with clean, simplistic designs and ample white space (visual gaps).	(Budiu & Nielsen, 2010; Kumar et al., 2019, 2020; Kumar & Mohite, 2016;
	2. Feature an elegant visual design that matches the content.	Loranger et al., 2014; J. Nielsen, 1994c)
	3. Minimize the use of generic-looking stock photography. Authentic, relevant, and action-oriented images receive more positive attention than staged photographs.	
	4. Use colors sparingly. Excessive colors inundate people's senses needlessly.	
	5. Balance style and function with a lean towards function.	
	6. Feature images with simple backgrounds to keep the focus on the picture.	
Writing	7. Choose words and concepts that relate to the audience.	(Budiu & Nielsen, 2010; Kumar et al., 2019, 2020;
	8. Summarize key points and pare down.	Kumar & Mohite, 2016; Loranger et al., 2014; J.
	9. Divide information into small clear groupings.	Nielsen, 1994c; J. Nielsen & Budiu, 2013)
	10. Limit the use of jargon.	

-
11. Minimize redundancy.
 12. Format text for readability.
 13. Format content so that multiple items can be compared at a glance.
 14. Embed links within content that lead to more detailed information.
 15. Avoid cutting content arbitrarily over multiple pages.
 16. When appropriate, consider alternative representations of information so that the data can be interpreted quickly and accurately.

Navigation and
Interaction Design

17. Choose familiar navigation schemes. (Budi & Nielsen, 2010; Kumar et al., 2019, 2020;
 18. Match interaction design with familiar standards. Kumar & Mohite, 2016; Loranger et al., 2014; J.
 19. Avoid cute and fancy navigation. Nielsen, 2002; Norman &
 20. Avoid including fancy features just for the sake of having them. Nielsen, 2010)
 21. Provide direct access to high-priority content. Place links to the material in a prominent, consistent location.
 22. Offer a reasonable number of choices. Too many options can deter people from making the correct decisions or from deciding at all.
-

-
23. Organize content by meaningful categories. Avoid structuring only by segmentation.
 24. Indicate clickable elements. Similarly, don't make items appear clickable if they are not.
 25. Make sure links do not look like decorations or ads.
 26. Feature icons sparingly, and only when they have meaning.
 27. When a graphic is associated with a link, make them both clickable
 28. Provide breadcrumbs and other navigational cues to orient users to the rest of the site.
 29. Make sure the back button works.

Multimedia

30. Optimize site performance. A half-second delay could result in a notable downward shift in user satisfaction. (Kumar et al., 2019; Kumar & Mohite, 2016; Loranger et al., 2014; Norman & Nielsen, 2010)
 31. Integrate videos with the related content.
 32. Feature clear indicators to help users identify video content.
 33. Avoid playing sound automatically, and provide easy-to-use audio controls.
 34. A few fancy components can increase appeal, but first, consider the most straightforward solution.
-

35. Use videos to show emotion or concepts that writing cannot convey.

Therefore, when looking at the advantages inherent in the signaling principle and Nielsen design guidelines, apps that combine the two need to be developed to fill the void in heutagogy techniques to ensure more effective learning. Combining these two principles is found to fulfill dreams in designing in applied art and designing in instructional media. Signaling facilitates learning by focusing students on essential things in the materials, but Nielsen also helps cover and customize the perspective for students to learn online. Both are centered on visual learning to ensure better and more friendly user interaction to increase students' motivation to learn and improve their knowledge of a topic.

2.5 Constructivist Learning Environments (CLEs)

Objectivist learning concepts assume that knowledge can be transported from a teacher or conveyed by a learner's technology and learned. On the contrary, the idea of constructivist learning does that knowledge is built individually and socially constructed by learners based on their interpretation of the world's experience. Because knowledge could not be delivered, the instructions should consist of experiences facilitating knowledge building. The model for designing CLEs (Jonassen, 1999), as depicted in Figure 2.3, demonstrates the essential components. This model illustrates problems, questions, or projects as the environmental focus, with the various interpretation and educational support systems. The learner aims to interpret and solve problems or complete the project.

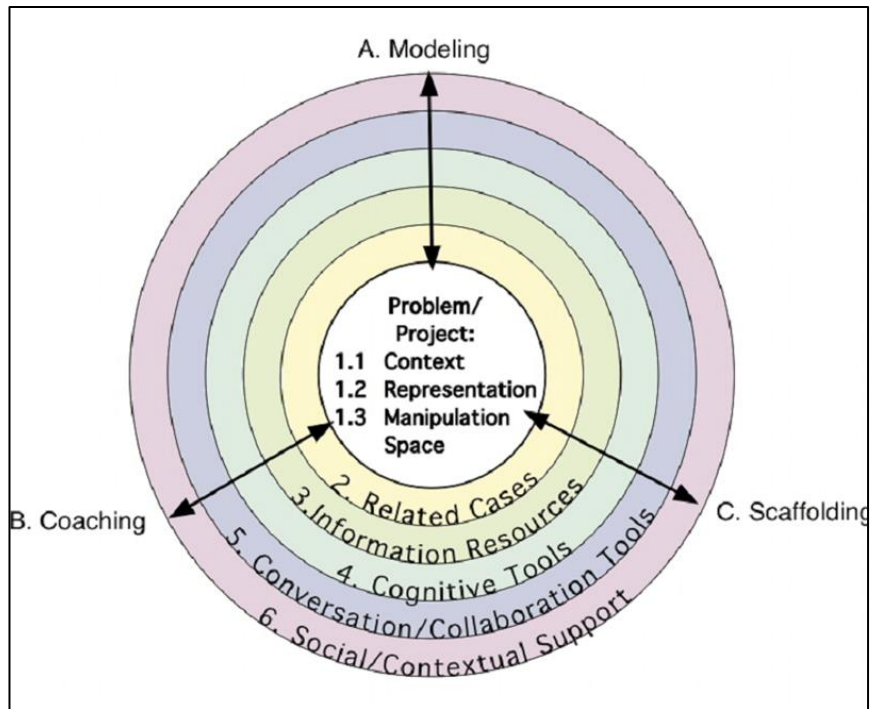


Figure 2.3. Model for Designing CLEs

In the constructivist learning environments, learners are encouraged to engage in exploration, articulation, and reflection; instructors are encouraged to provide instructional support in (1) modeling, which focuses on the expert's performance (how to do it): including modeling the performance and the thinking processes, i.e., behavioral and cognitive modeling, (2) coaching, which focuses on the learner's performance (how am I doing): to motivational prompts, monitor and regulate the learner's performance, provoke reflection, and perturb learners' models, and (3) scaffolding, which is a systemic approach to supporting the learners in different aspects of the learning environment (the tasks, the teacher, the learner, the materials, the tools): based on learner's level of understanding and need, adjust task difficulty, restructure the task and provide alternative assessments (Jonassen, 1999).

The concept of constructivism emphasizes that active learners play a vital role in intermediaries and control learning (Jonassen, 1999). Emphasis should be placed on student-centered learning that encourages the acquisition of the learning experience.

Table 2.6 represents the implementation of CLEs in the previous research.

Table 2.6

The Implementation of CLEs in the Previous Research

Author	Context	Results
Diana Adela Martin and Edward Conlon (2018)	Engineering	Enhance some aspects of students' understanding of the social dimension of the engineering profession.
Gündüz, Alemdağ, Yaşar and Erdem (2016)	Problem-based learning	Potential to contribute both to learning and confidence.
Leow, Neo, and Hew (2016)	Graphic Design and Animations	Enhances students' learning experiences and promotes active learning.
Ahmad and Wan Yahya (2015)	Islamic Funeral Rites	Successful in increasing students' achievement.
Leow and Neo (2013)	Web-based learning	Increased motivation and satisfaction, more communication and interaction stimulated in the learning process
Theng and Mai (2013)	Interactive photo albums	Positive learning experience.

McInerney and Adshead (2013)	Public Policy	Increase student connectedness, engagement, motivation, and pro- learning attitudes.
Krishnasamy, Chong, and Umar (2012)	Chemistry	Occupy students in the construction of personal and collaborative knowledge and problem-solving.
Clarke (2011)	Law	Increase student engagement via online teamwork.
Oliveira, Tinoca, and Pereira (2011)	Open and Distance Learning	Successful in decisive contributions to shared knowledge and knowledge convergence.
Choi and Lee (2009)	Ill-structured problems	Valid for the transfer of learning in ill-structured problem-solving.

Based on Table 2.6, CLEs is needed to be included in the study as it contributes to the following aspect:

- i. Enhance some elements of learners' understanding.
- ii. Contribute both to learning and confidence.
- iii. Enhances learners' learning experiences and promotes active learning.
- iv. Increase learners' achievement.
- v. Increased motivation and satisfaction, more communication and interaction stimulated in the learning process
- vi. Positive learning experience.
- vii. Increase learners' connectedness, engagement, motivation, and pro-learning attitudes.

- viii. Occupy learners in the construction of personal and collaborative knowledge and problem-solving.
- ix. Increase learners' engagement via online teamwork.
- x. Successful in decisive contributions to shared knowledge and knowledge convergence.
- xi. Valid for the transfer of learning in ill-structured problem-solving.

2.6 Mobile Learning

The transition from traditional information dissemination and acquisition modes to mobile technology has been swift. While individuals require various devices to communicate and perform multiple tasks, a smartphone is now sufficient as a standard and intuitive means of interacting with other people, places, and objects (Nielsen & Arvidsen, 2021). Wireless technology, particularly mobile phones or smartphones, has fundamentally altered how people communicate and manage their personal and social lives. The exponential growth in mobile phone penetration rates across Asia, including Malaysia, demonstrates this. In 2019, 98.2 percent of Malaysian households had access to a mobile phone (Department of Statistics Malaysia, 2020b).

A paradigm shift is required for this mobile technology to succeed in education. According to some, lecturers and teachers must encourage students to learn independently using technology, such as mobile phones, while still being supervised and monitored (Ng et al., 2020); others are concerned about how this learning may be inappropriate and lead to additional work for teachers. (Ariffin et al., 2012).

Nevertheless, given the current COVID-19 pandemic's impact, digital tools have become critical as teaching and learning activities shift away from traditional face-to-face teaching and toward online distance learning platforms (Al-Rahmi et al., 2021; Fook et al., 2021). At the moment, mobile phones serve as an indispensable tool for learning, profoundly affecting education. (Dollah et al., 2017; Fook et al., 2021; Mayer, 2020)

It also suggests that mobile devices are more comfortable making learning happen anywhere than worn-out and perishable notebooks (Rosmani et al., 2014). Mobile learning applications can be created for various purposes, such as assisting students with their studies. Customized online learning strategies responsive to students' needs can enhance the online learning experience and outcomes (Ranganathan et al., 2021).

However, these benefits require new pedagogics and a new approach to conveying and facilitating instructions. If adequately encouraged, mobile learning can benefit students by providing teaching materials and interactions through mobile devices anywhere and whenever needed (Ng et al., 2020; Sarlan et al., 2016).

2.6.1 Islamic Mobile Content

Malaysia's population has been rising significantly through the decades. In 2020, the Malaysian population was projected at 32.0 million, with 29.7 million citizens and 3.0 million non-citizens (Department of Statistics Malaysia, 2020a). According to the Population Distribution and Basic Demographic Characteristic Report 2010, Islam was the most widely professed religion in Malaysia, with 61.3 percent. As a multi-

racial nation, other religions embraced were Buddhism (19.8%), Christianity (9.2%), and Hinduism (6.3%) (Department of Statistics Malaysia, 2015).

Thus, informal learning in Islam for Muslims, especially children, is integral to Islamic development. However, the platform for obtaining informal learning in the Islamic context is rarely found (Sarlan et al., 2016) though it is crucial (Mustaffa et al., 2020). Besides, most reading and memorizing Islamic content guides are limited to specific online sources and static books (Ng et al., 2020; Rosmani et al., 2014; Saidin et al., 2015). Therefore, an effective way to make them more attractive and exciting is to attract users with interactive mobile apps that experience differences between traditional reading and mobile technologies that exceed other technologies.

Often, Islamic applications are based on scriptures; that refer to the Quran and are associated with writing from previous religious leaders, and they are developed as a tool to support Muslims in daily spiritual practice as well as to access and learn the Qur'an in their course of time (Campbell & Campbell, 2014; Elobaid et al., 2014). The scope of Islamic content on mobile is significantly greater than anticipated compared to entertainment and game applications. Evaluations of criteria, usage, material, interface layout, and research on user awareness and consumption of Islamic mobile content could not be obtained or are rarely noticed (Ismail et al., 2014; Ismail, Ismail, & Abd Razak, 2013; Khan & Shambour, 2017). Therefore, seldom used Islamic content should implement a multimedia element approach to attract users as an entertainment app. The pattern of cell phone usage indicates that Muslim consumers are interested in entertainment applications primarily related to multimedia elements (Ismail et al., 2014). Moreover, Islamic-based mobile applications in Malaysia alone

or other Muslim countries are still scarce and should be explored (Kamarudin & Salam, 2012; Nawi & Hamzah, 2013).

Mobile devices highlight the reputation and availability of the Internet and have altered the way people access information. Therefore, there is a need to capitalize on this rapidly expanding technology in spreading the teachings of the Quran, providing users with Islamic advice, teaching, and learning of Islamic education, and primarily serving the religion (Elobaid et al., 2014; Huraimel et al., 2007; Nawi & Hamzah, 2013; Osman & Mohamed, 2016).

Table 2.7

Comparison of Islamic Mobile Applications

Author	Context
Mohd Ali et al., (2019)	Asmaul Husna
Dollah et al. (2017)	Islamic Banking and Finance
Ismail, Samsudin, Sulaiman, Zainol, and Zaid (2016)	Islamic Study
Osman and Mohamed (2016)	Pregnancy
Sarlan et al. (2016)	The lifestyle of the Prophet Muhammad PBUH
Almosallam et al. (2016)	Quran Memorization
Saidin, Mohamed, Adzmi, and Azhar (2015)	KAFA (UPKK examination)
Elobaid, Hameed and Yahia Eldow (2014)	Quran Learning
Abdulkarem and Sevkli (2014)	Cultural Learning through Hadith
Ismail, Ismail, Hanis, and Razak (2013)	Zakat
Rahman, Fauzan and Zeki (2014)	Muslim Necessities

Rosmani, Ahmad, Mazlan, Zainuddin and Ibrahim (2014)	Dhikr
Mantoro, Jaafar, Aris and Ayu (2011)	Hajj Locator
Ismail, Ismail, Hanis, and Razak (2013)	Islamic History
Tahnoon Al Ali, Berri, and Zemerly (2008)	Muslim Reminder (e.g., the time and call of prayer)
Huraimel, Zemerly, and Al-Hammadi (2007)	Zakat Calculator

Table 2.7 shows some examples of mobile apps based on Islamic content. There are many more Islamic mobile apps online, and the number is very encouraging. However, studies behind the existence of any guidelines and procedures used in developing these mobile apps can still be questioned due to the lack of articles commenting on the matter. Therefore, this study considers the need to integrate essential guidelines and principles to enable the effectiveness and reliability of Islamic mobile apps in aiding learning and motivational efforts.

2.7 Asmaul Husna

Asmaul Husna is Allah's significant attribute and beautiful name, *asma* is the plural form of the word *ism*, which means name, and *husna* means good or beautiful (Muntasir et al., 2019). Therefore, the combination of Asmaul Husna means the most beautiful name of Allah. According to Murtadho (2012), from 99 names of Allah are 69 names found in the Holy Qur'an with different frequencies, ranging from 1 to 138 times. The other 30 names are located in the Hadith of the Prophet.

Unfortunately, the public is unaware that Asmaul Husna contains beautiful meanings that can be used in everyday life either as a supplication or dhikr (Ab Rahman, 2016; Abdul Muhsin Al-Badr, 2020; Al-Qurtubi, 2017; Nik Mat, 2016; Wan Mohd, 2015a). It has been supported by Surah Al-A'raaf verse 180, "And to Allah belong the best names, so invoke Him by them. And leave [the company of] those who practice deviation concerning His names. They will be recompensed for what they have been doing".

In Islamic theology, the meaning of Asmaul Husna must be understood and not just based on linguistic forms. Asmaul Husna can be divided into *mubalaghah*, and *non-mubalaghah*, which means the impossible or beyond reality and is usually added with "Maha".

However, from the perspective of Islamic theology, all translations should ideally use the word "Maha" or a similar expression to keep reverence for godly perfection in all the divine attributes in Asmaul Husna (Murtadho, 2012). Table 2.8 displays the 99 names of Allah. The Quran has stated, "He is Allah, the Creator, the Inventor, the Fashioner; to Him belong the best names. Whatever is in the heavens and earth is exalting Him. And He is the Exalted in Might, the Wise" (Surah Al-Haysr, 59: 23). In Surah Taha verse 8, "Allah - there is no deity except Him. To Him belong the best names".

Table 2.8

The 99 Names of Allah

#	Name	Transliteration	Meaning	Explanation
1	الرَّحْمَنُ	Ar-Rahmaan	The Beneficent	He who wills goodness and mercy for all His creatures
2	الرَّحِيمُ	Ar-Raheem	The Merciful	He who acts with extreme kindness
3	الْمَلِكُ	Al-Malik	The Eternal Lord	The Sovereign Lord, The One with the complete Dominion, the One Whose Dominion is clear from imperfection
4	الْقُدُّوسُ	Al-Quddus	The Most Sacred	The One who is pure from any imperfection and clear from children and adversaries
5	السَّلَامُ	As-Salam	The Embodiment of Peace	The One who is free from every imperfection.
6	الْمُؤْمِنُ	Al-Mu'min	The Infuser of Faith	The One who witnessed for Himself that no one is God but Him. And He witnessed for His believers that they are truthful in their belief that no one is God but Him
7	الْمُهَيِّمُ	Al-Muhaymin	The Preserver of Safety	The One who witnesses the saying and deeds of His creatures
8	الْعَزِيزُ	Al-Aziz	The Mighty One	The Strong, The Defeater who is not defeated

9	الْجَبَّارُ	Al-Jabbar	The Omnipotent One	The One that nothing happens in His Dominion except that which He willed
10	الْمُتَكَبِّرُ	Al-Mutakabbir	The Dominant One	The One is clear from the creatures' attributes and resembling them.
11	الْخَالِقُ	Al-Khaaliq	The Creator	The One who brings everything from non-existence to existence
12	الْبَارِئُ	Al-Baari	The Evolver	The Maker, The Creator who has the power to turn the entities.
13	الْمُصَوِّرُ	Al-Musawwir	The Flawless Shaper	The One who forms His creatures in different pictures.
14	الْغَفَّارُ	Al-Ghaffar	The Great Forgiver	The Forgiver, The One who forgives the sins of His slaves time and time again.
15	الْقَهَّارُ	Al-Qahhaar	The All-Prevailing One	The Dominant, The One who has the perfect Power and can control anything.
16	الْوَهَّابُ	Al-Wahhab	The Supreme Bestower	The One who is Generous in giving plenty without any return. He is everything that benefits, whether Halal or Haram.
17	الرَّزَّاقُ	Ar-Razzaq	The Total Provider	The Sustainer, The Provider.

18	الْفَاتِحُ	Al-Fattah	The Supreme Solver	The Opener, The Reliever, The Judge, The One who opens His slaves the closed worldly and religious matters.
19	الْعَلِيمُ	Al-Alim	The All-Knowing One	The Knowledgeable; The One nothing is absent from His knowledge
20	الْقَابِضُ	Al-Qaabid	The Restricting One	The Constrictor, The Withholder, The One constricts the sustenance by His wisdom and expands and widens it with His Generosity and Mercy.
21	الْبَاسِطُ	Al-Baasit	The Extender	The Enlarger, The One who constricts the sustenance by His wisdom, expands and widens it with His Generosity and Mercy.
22	الْخَافِضُ	Al-Khaafid	The Reducer	The Abaser, The One who lowers whoever He willed by His Destruction, raises whoever He willed by His Endowment.
23	الرَّافِعُ	Ar-Rafi	The Elevating One	The Exalter, The Elevator, The One who lowers whoever He willed by His Destruction and raises whoever He willed by His Endowment.
24	الْمُعِزُّ	Al-Mu'izz	The Honourer-Bestower	He gives esteem to whomever He willed; hence there is no one

				to degrade Him; He degrades whoever He wanted.
25	المُذِلُّ	Al-Muzil	The Abaser	The Dishonourer, The Humiliator, gives esteem to whomever He willed; hence, there is no one to degrade Him; He degrades whoever He wanted.
26	السَّمِيعُ	As-Sami'	The All-Hearer	The Hearer, The One who Hears all things heard by His Eternal Hearing without an ear, instrument, or organ.
27	البَصِيرُ	Al-Baseer	The All-Seeing	The All-Noticing, The One who Sees all things; seen by His Eternal Seeing.
28	الْحَكَمُ	Al-Hakam	The Impartial Judge	The Judge is the Ruler, and His judgment is His Word.
29	الْعَدْلُ	Al-Adl	The Embodiment of Justice	The Just, The One who is entitled to do what He does.
30	اللطيفُ	Al-Lateef	The Knower of Subtleties	The Subtle One, The Gracious, The One who is kind to His slaves and endows upon them.
31	الخبيرُ	Al-Khabeer	The All-Aware One	One who knows the truth of things.
32	الْحَلِيمُ	Al-Haleem	The Clement One	The Forbearing, The One who delays the punishment for those

			who deserve it, and He might forgive them.
33	العَظِيمُ Al-Azeem	The Magnificent One	The Great One, The Mighty, The One deserves the attributes of Exalted, Glory, Extolment, and Purity from all imperfection.
34	الْغَفُورُ Al-Ghafoor	The Great Forgiver	The All-Forgiving, The Forgiving, The One who forgives a lot.
35	الشَّاكُورُ Ash-Shakoor	The Acknowledging One	The Grateful, The Appreciative, The One who gives many rewards for a bit of obedience.
36	الْعَلِيُّ Al-Aliyy	The Sublime One	The Highest, The One clear from the attributes of the creatures.
37	الْكَبِيرُ Al-Kabeer	The Great One	The Most Great, The Great, The One higher than everything in status.
38	الْحَفِيفُ Al-Hafiz	The Guarding One	The Preserver, The Protector, The One who protects whatever and whoever He willed to save.
39	الْمُقِيتُ Al-Muqteet	The Sustaining One	The Maintainer, The Guardian, The Feeder, The One who has the Power.
40	الْحَسِيبُ Al-Haseeb	The Reckoning One	The Reckoner, The One who gives the satisfaction.

41	الْجَلِيلُ	Al-Jaleel	The Majestic One	The Sublime One, The Beneficent, The One attributed to the greatness of Power and Glory of status.
42	الْكَرِيمُ	Al-Kareem	The Bountiful One	The Generous One, The Gracious, The One attributed to the greatness of Power and Glory of status.
43	الرَّقِيبُ	Ar-Raqeeb	The Watchful One	The Watcher, The One that nothing is absent from Him. Hence, its meaning is related to the attribute of Knowledge.
44	الْمُجِيبُ	Al-Mujeeb	The Responding One	The Responsive, The Hearkener, The One who answers the one in need if he asks Him and rescues the yearner if he calls upon Him.
45	الْوَاسِعُ	Al-Waasi'	The All-Pervading One	The Vast, The All-Embracing, The Knowledgeable.
46	الْحَكِيمُ	Al-Hakeem	The Wise One	The Wise, The Judge of Judges, The One who is correct in His doings.
47	الْوَدُودُ	Al-Wadud	The Loving One	The One who loves His believing slaves and His believing slaves love Him. His love for His slaves is His Will to be merciful to them and praise them

48	الْمَجِيدُ	Al-Majeed	The Glorious One	The Most Glorious One, The One with perfect Power, High Status, Compassion, Generosity, and Kindness.
49	الْبَاعِثُ	Al-Ba'ith	The Infuser of New Life	The Resurrector, The Raiser (from death), The One who resurrects His slaves after death for reward and punishment.
50	الشَّهِيدُ	Ash-Shaheed	The All Observing Witness	The Witness, The One who nothing is absent from Him.
51	الْحَقُّ	Al-Haqq	The Embodiment of Truth	The Truth, The True, The One who truly exists.
52	الْوَكِيلُ	Al-Wakeel	The Universal Trustee	The Trustee, The One who gives the satisfaction and is relied upon.
53	الْقَوِيُّ	Al-Qawwiyy	The Strong One	The Strongest, The One with the complete Power
54	الْمَتِينُ	Al-Mateen	The Firm One	The One with uninterrupted extreme Power and He does not get tired.
55	الْوَالِيُّ	Al-Waliyy	The Protecting Associate	The Protecting Friend, The Supporter.
56	الْحَمِيدُ	Al-Hameed	The Sole-Laudable One	The Praiseworthy, The praised One who deserves to be praised.

57	المُحْصِي	Al-Muhsee	The All-Enumerating One	The Counter, The Reckoner, The One whom the count of things is known to him.
58	المُبْدِي	Al-Mubdi	The Originator	One who started the human being. That is, He created him.
59	المُعِيدُ	Al-Mueed	The Restorer	The Reproducer, The One who brings back the creatures after death
60	المُحْيِي	Al-Muhyi	The Maintainer of life	The Restorer, The Giver of Life, The One who took out a living human from semen that does not have a soul. He gives life by giving the souls back to the worn-out bodies on the resurrection day, and He makes the hearts alive by the light of knowledge.
61	المُمِيتُ	Al-Mumeet	The Inflictor of Death	The Creator of Death, The Destroyer, The One who renders the living dead.
62	الْحَيُّ	Al-Hayy	The Eternally Living One	The Alive, The One attributed with life unlike ours, is not a combination of soul, flesh, or blood.
63	الْقَيُّومُ	Al-Qayyoom	The Self-Subsisting One	The One who remains and does not end.



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64	الْوَّاجِدُ	Al-Waajid	The Pointing One	The Perceiver, The Finder, The Rich, who is never lacking. Al-Wajid is Richness.
65	الْمَاجِدُ	Al-Maajid	The All-Noble One	The Glorious, He who is Most Glorious.
66	الْوَّاحِدُ	Al-Waahid	The Only One	The Unique, The One, The One without a partner
67	الْأَحَدُ	Al-Ahad	The Sole One	The One
68	الصَّمَدُ	As-Samad	The Supreme Provider	The Eternal, The Independent, The Master who is relied upon in matters and reverted to one's needs.
69	الْقَادِرُ	Al-Qaadir	The Omnipotent One	The Able, The Capable, The One attributed with Power.
70	الْمُقْتَدِرُ	Al-Muqtadir	The All Authoritative One	The Powerful, The Dominant, The One with the perfect Power that nothing is withheld from Him.
71	الْمُقَدِّمُ	Al-Muqaddim	The Expediting One	The Expediter, The Promoter, The One who puts things in their correct places. He makes ahead of what He wills and delays what He wills.
72	الْمُؤَخِّرُ	Al-Mu'akhkhir	The Procrastinator	The Delayer, the Retarder, The One who puts things in their proper places. He makes ahead

				of what He wills and delays what He wills.
73	الأوّل	Al-Awwal	The Very First	The First, The One whose Existence is without a beginning.
74	الأخر	Al-Akhir	The Infinite Last One	The Last, The One whose Existence is without an end.
75	الظاهر	Az-Zaahir	The Perceptible	The Manifest, The One that nothing is above Him and underneath Him; hence, He exists without a place. He, The Exalted, His Existence is apparent by proofs, and He is clear from the delusions of bodies' attributes.
76	الباطن	Al-Baatin	The Imperceptible	The Hidden, The One that nothing is above Him and underneath Him; hence, He exists without a place. He, The Exalted, His Existence is apparent by proofs, and He is clear from the delusions of bodies' attributes.
77	الوالي	Al-Waali	The Holder of the Supreme Authority	The Governor, The One who owns things and manages them.

78	الْمُتَعَالِي	Al-Muta'ali	The Extremely Exalted One	The Most Exalted, The High Exalted, The One clear from the creation's attributes.
79	الْبَرُّ	Al-Barr	The Fountain-Head of Truth	The Source of All Goodness, The Righteous, The One who is kind to His creatures, who covered them with sustenance and specified whoever He willed among them by His support, protection, and special mercy.
80	التَّوَّابُ	At-Tawwaab	The Ever-Acceptor of Repentance	The Relenting, The One who grants repentance to whomever He willed among His creatures and accepts his repentance.
81	الْمُنْتَقِمُ	Al-Muntaqim	The Retaliator	The Avenger, The One who victoriously prevails over His enemies and punishes them for their sins. It may mean the One who destroys them.
82	الْعَفُوُّ	Al-Afuww	The Supreme Pardonner	The Forgiver, The One with total forgiveness.
83	الرَّؤُوفٌ	Ar-Ra'oof	The Benign One	The Compassionate, The One with extreme Mercy. The Mercy of Allah is His will to endow upon whoever He willed among His creatures.

84	مَالِكُ الْمُلْكِ لُكِّ	Maalik-ul-Mulk	The Eternal Possessor of Sovereignty	The One who controls the Dominion and gives dominion to whomever He willed.
85	ذُو الْجَلَالِ وَ الْإِكْرَامِ	Zul-Jalaali-wal- Ikram	The Possessor of Majesty and Honour	The Lord of Majesty and Bounty, The One who deserves to be Exalted and not denied.
86	الْمُقْسِطُ	Al-Muqsit	The Just One	The Equitable, The One who is Just in His judgment.
87	الْجَامِعُ	Al-Jaami'	The Assembler of Scattered Creations	The Gatherer, The One who gathers the creatures on the Day of Judgment.
88	الْغَنِيُّ	Al-Ghaniyy	The Self- Sufficient One	One who does not need the creation.
89	الْمُعْطِي	Al-Mughni	The Bestower of Sufficiency	The Enricher, The One who satisfies the necessities of the creatures.
90	الْمَانِعُ	Al-Maani'	The Preventer	The Withholder.
91	الضَّارُّ	Ad-Daarr	The Distressor	The One who harms reaches to whomever He willed and benefits whomever He willed.
92	النَّافِعُ	An-Naafi'	The Bestower of Benefits	The Propitious, The One who does harm, reaches whomever He willed and benefits whomever He willed.
93	النُّورُ	An-Noor	The Prime Light	The Light, The One who guides.
94	الْهَادِي	Al-Haadi	The Provider of Guidance	The Guide, The One with His Guidance His believers were

			guided, and with His Guidance, the living beings conducted to what is beneficial and protected from what is harmful to them.
95	الْبَدِيعُ Al-Badi'	The Unique One	The Incomparable, The One who created and formed the creation without any preceding example.
96	الْبَاقِي Al-Baaqi	The Ever Surviving One	The Everlasting, The One that the state of non-existence is impossible for Him.
97	الْوَارِثُ Al-Waaris	The Eternal Inheritor	The Heir, The One whose Existence remains.
98	الرَّشِيدُ Ar-Rasheed	The Guide to Path of Rectitude	The Guide to the Right Path, The One who guides.
99	الصَّبُورُ As-Saboor	The Extensively Enduring One	The Patient, The One who does not quickly punish the sinners.

(Source: Quotes Of Islam, n.d.)

2.7.1 Asmaul Husna Application in Daily Life

The 99 names of Allah can be utilized in everyday life as a prayer and *dhikr*. Muslims can map each name with their situation and condition in their prayer. For example, if one is in grief and sorrow, they can repeat As-Salam and Al-Mukmin to ask Allah for calmness and tranquility in their heart. Furthermore, the Names of Allah, Ar-Rahman, Ar-Rahim, Al-Jaami' will create caring and loving in the soul and establish caring and loving activities and culture. The element of high wisdom through Al- 'Alim, Al-

Hakim, and Ar-Rashid can boost parenting knowledge, skill, and creativity. Through the Names of Al-Khaliq, Al-Baari', Al-Musowwir will provide various parenting and family activities that promote learning among children.

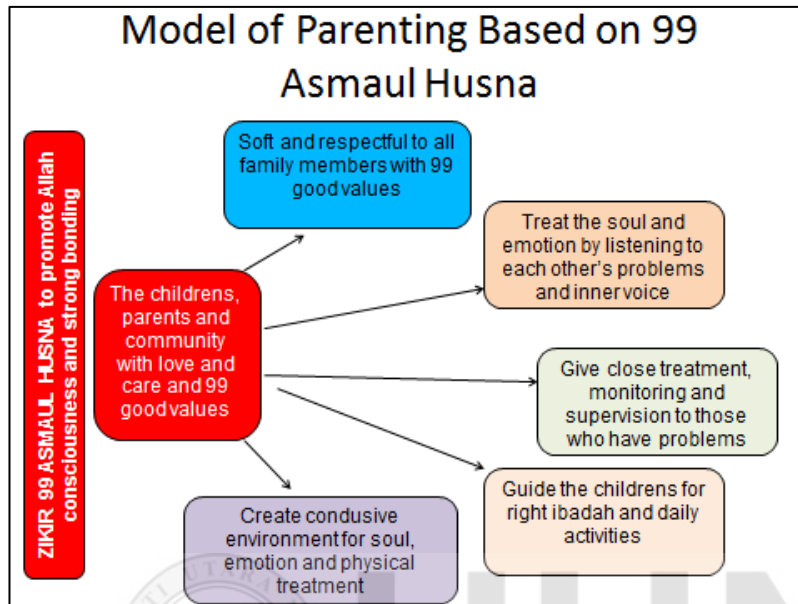


Figure 2.4. Model of Holistic Parenting Techniques

Figure 2.4 describes models for holistic parenting techniques that have undergone a nine-year trial attempt in various families. Children need a holistic parenting approach that starts from the soul, the brain, the emotions, and the physical. The 99 Names of Allah could generate 99 energies and 99 ethical values among children, families, communities, teachers, and colleagues. It is a practical approach to solving parenting problems and challenges (Wan Mohd, 2015b).

The field of Asmaul Husna learning is selected as the context of this research as knowledge and awareness of Asmaul Husna is still deemed lightly by the Muslim society (Muntasir et al., 2019; Rosmani & Zakaria, 2018). The public is unaware that Asmaul Husna contains beautiful meanings that can be used in everyday life as a supplication or dhikr (Ab Rahman, 2016; Abdul Muhsin Al-Badr, 2020; Al-Qurtubi,

2017; Nik Mat, 2016; Wan Mohd, 2015a). It has been supported by Surah Al-A'raaf verse 180, "And to Allah belong the best names, so invoke Him by them. And leave [the company of] those who practice deviation concerning His names. They will be recompensed for what they have been doing". Abu Huraira also narrated a hadith in Bukhari, Book 8, Volume 75, Hadith 419. Allah has ninety-nine Names, one hundred minus one, and whoever believes in their meanings and acts accordingly will enter Paradise.

The stated verse and hadith revealed that Islam had emphasized the importance of appreciating Allah's name in Muslim life. As a vicegerent on earth as defined in surah Al-Baqarah verse 30, Muslims must absorb 99 Names into the heart through repetitively mentioning them (dhikr). This process will eventually create a balanced, emotional, spiritual, physical, and logical individual (Alkumayi, 2009; Sabirin, 2014). Mentioning Asmaul Husna will strengthen one's faith because trust in God is one of the fundamentals of faith; with that, one would not lose his trust during misery (Al-Qurtubi, 2017). It is undeniable that it could significantly impact human life, such as bringing truth and happiness to humans and good behavior (*akhlakul mahmudah*) (Hamat & Shuhari, 2010; Shariat & Puji, 2016; Utami et al., 2018). Therefore, the understanding and appreciation of Allah's beautiful names are essential in developing a balanced, virtuous, faithful human character (Hamdi Rahman et al., 2012; Haris et al., 2011; Wan Mohd, 2015c; Yousef, 2018).

Moreover, the 99 names could be uttered during studying, praying, cooking, washing, and other activities to connect with Allah. It is stated in Surah Ali Imran verses 190 - 191, "Indeed, in the creation of the heavens and earth and the alternation of night and

day are signs for those of understanding. Whom remember Allah while standing, sitting, or lying on their sides and give thought to the creation of the heavens and the earth". The method of making *du'a* by mentioning Asmaul Husna is required by Allah, which motivates and recommends the believers to recite (mention) His Name when pleading to Him in their request for good things (Nik Mat, 2016).

Surah Al-Ankabut verse 45, "Recite, [O Muhammad], what has been revealed to you of the Book and establish prayer. Indeed, prayer prohibits immorality and wrongdoing, and the remembrance of Allah is greater. And Allah knows that which you do." Hence, it is clear that performing *solat*. The remembrance of Allah may protect and prevent Muslims, especially adolescents, from going astray, and it is vital to strengthen Allah's recollection in the family institution (Idris et al., 2008; Tunggak et al., 2015). Therefore, it is indispensable to implement faith through Allah's remembrance via the 99 names to succeed (Ab Rahman, 2016; Al-Qurtubi, 2017; Shariat & Puji, 2016; Wan Mohd, 2014).

In accordance, a preliminary investigation has been carried out by Rosmani et al. (2018a) to investigate the knowledge and awareness of the Asmaul Husna in the Muslim community to reflect the Muslims' need to practice Asmaul Husna as a way of life.

2.8 Asmaul Husna Preliminary Investigation (PI)

The Preliminary Investigation (PI) has been conducted to investigate the current issues in the context of knowledge and awareness of Asmaul Husna among Muslims. Three content experts were interviewed during the PI, comprising former lecturers and

Islamic Education teachers. Also, 55 participants between 20 and more than 50 years of age were surveyed.

A semi-structured interview and a survey based on a simple random sampling technique, as Berndt (2020) suggested, have been performed for the preliminary investigation. In this type of interview, this study recognized more specific information than the data obtained in other interviews and may make the discussion flexible and comfortable. Additional relevant information can still be enquired (Chua, 2012; Dawson, 2002). Three Ph.D. lecturers from public universities with a minimum of five years of research experience validated the interview and survey questions before being disseminated to the interviewees and respondents. As a result of the survey, this study gained information on a random Muslim community context. The following subsections describe the in-depth understanding of the issue.

2.8.1 Interview with Content Experts

The researcher interviewed a former public university professor who is also an expert in Asmaul Husna. The expert has published more than 20 books on Asmaul Husna and has made public lectures for more than 11 years for federal agencies, universities, banks, and other Islamic communities inside and outside the country. According to this content expert, knowledge and awareness about Asmaul Husna among Muslims in this country are still low. Only 1 percent of 60 percent of Muslim society in the country is aware of the practice of appreciating Asmaul Husna in life. About 70% of them only learn Asmaul Husna in regular *nasyid* singing.

Meanwhile, only 10 percent use the 99 names as a dhikr (*wirid*) without understanding the meaning of asking for specific prayers. Another 10 percent of them know the importance of Asmaul Husna but are not practicing the techniques. Meanwhile, only 1 percent know Asmaul Husna and practice the method through a program named the Intensive Courses of 99 Asmaul Husna held all over Malaysia initiated by the expert. During the course, every meaning of 99 Asmaul Husna is described in detail and how these names can be used in everyday life. This course is one of the best choices for learning and appreciating Asmaul Husna's techniques in everyday life. The expert agreed if a mobile app is developed to introduce Asmaul Husna to Muslims. However, the application must be interactive and incorporate the Signaling principle to highlight critical content and intelligence. The expert made other suggestions to raise the public's awareness and knowledge about Asmaul Husna, its advantages, and its benefits, spreading across all levels through education curriculum as counseling, a motivational and religious module in mosques. The ideal age to introduce Asmaul Husna is as early as four months old. This knowledge is vital to a Muslim because by knowing the Name and the Attributes of God, a servant can praise, achieve *khusyuk* in *solat* with His Names, purify the heart (forgiveness and repentance), understand the essence of the Quran, enjoy nature while praising God and contemplate the hereafter.

The second expert was another former lecturer at a public university with five years of experience. This content expert has been lecturing to various agencies and the public, locally and abroad. From her experience and point of view, the general awareness of Asmaul Husna is shallow; most people know what Asmaul Husna is, which are the 99 Names of Allah but lack understanding of the application of the 99 names for excellence in this life and hereafter. The public's level of knowledge so far

is only focusing on singing the Asmaul Husna through *nasyid*. For her, the ideal age to introduce the application of Asmaul Husna is since birth because this is the crucial knowledge of God's character, or we call it *tauhid*, an Islamic term. Therefore, Muslims need to get to know Allah since birth, and by knowing Allah, we can live entirely dependent on Him in any matter of life, whether for worship or daily life activities. Various techniques can be used to teach people the benefits of Asmaul Husna; for example, through life events they have gone through and may practice Asmaul Husna in *dhikr* and *du'a* to establish a relationship with God. This content expert agrees with the Asmaul Husna mobile app's development and mentioned that it is convenient to carry it anywhere.

2.8.2 Interview with Islamic Education Teacher

The researcher has also had the opportunity to interview a schoolteacher who teaches Islamic Education. She claims that the public awareness of Allah's Name is shallow; many only know Asmaul Husna by singing *nasyid*. Religious school students may memorize Asmaul Husna through *nasyid*, but she is convinced that only 5% of 60% of Muslims in Malaysia's population recognize the meaning. Even the level of knowledge of society is limited to only *sifat 20*. She agreed that any means meets Islam's requirements, including mobile application, as a learning method that could create awareness and understanding of Asmaul Husna. She suggested that Islamic lectures continue to impart knowledge and instill an appreciation for Asmaul Husna's significance. Education experts may incorporate it as a syllabus in all university subjects. She recommends that individuals learn Asmaul Husna while still in their mother's womb. Asmaul Husna is crucial because it includes a necessary

understanding and is practiced as a believing Muslim. A person cannot know God without knowing the attributes contained in His Name.

2.8.3 Survey on Knowledge and Awareness of Asmaul Husna among Muslim

A study has been conducted to investigate the knowledge and awareness of Asmaul Husna among randomly selected Muslims. Altogether, 55 respondents were involved in answering the survey. Details in Table 2.9 show that the respondents consist of 24 males and 31 females between below 20 to more than 50. Their education level varies between primary school and Ph.D.

Table 2.9

Demographic Data of Respondents

Age/Education	Male	Female	Grand Total
20 - 29 years old	19	16	35
Diploma	16	10	26
Ph.D.	1		1
Degree	1	5	6
Secondary School Certificate		1	1
30 - 39 years old		4	4
Ph.D.		1	1
Master		1	1
Degree		2	2
40 - 49 years old		4	4
Master		3	3
Secondary School		1	1
50 years old and above	3	4	7
Diploma	1	2	3
Ph.D.	1	1	2
Degree		1	1
Secondary School	1		1
Below 20 years old	2	3	5
Diploma	1	2	3
Secondary School	1		1
Primary School		1	1
Grand Total	24	31	55

From the survey, four questions were asked to gain information on the participants' knowledge and awareness about Asmaul Husna. It was found that the majority (78.10%) agree that they have a fair understanding of the 99 names of Allah and 74.55 percent of their benefits. However, they are unsuccessful in memorizing all the 99 names and their meanings, where 83.64 percent are not confident that they can remember and understand all the names. Most of them can only remember some names usually practiced in daily prayer (*solat*).

Table 2.10

Respondents' Feedback on Knowledge and Awareness

Questions	Percent (%)				
	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
I have a fair knowledge of Asmaul Husna and its meanings.	0.00	1.80	20.00	63.60	14.50
I have a fair knowledge of Asmaul Husna and its benefit.	0.00	1.82	23.64	52.73	21.82
I am confident I can provide the correct meaning for each Asmaul Husna.	3.64	12.73	67.27	10.91	5.45
I am interested in learning Asmaul Husna via a mobile application.	1.82	1.82	3.64	45.45	47.27

Table 2.10 shows that 92.70 percent of the respondents were interested in learning more about Asmaul Husna via a mobile application. It can be associated as most Islamic applications were not highlighted or focused on Multimedia principles. As stated in the literature review in Chapter 2, the Asmaul Husna application is not incorporated with the benefits and techniques for daily life activities.

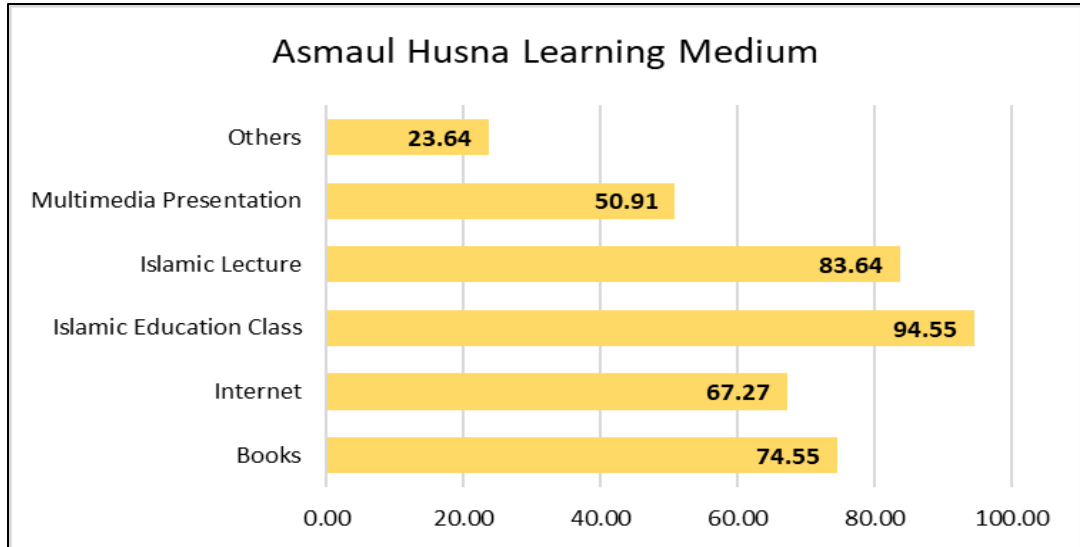


Figure 2.5. Asmaul Husna Learning Medium

There are six ways of learning experienced by respondents, as shown in Figure 2.5. The highest method is learning through Islamic Education Classes (either during school days or during university). This time has long gone, and people may forget all the knowledge gained from this class, especially those who do not update their learning. The second and third highest are Islamic lectures and books, as those are the most common and traditional ways of learning Islamic knowledge. The new learning methods have evolved from the conventional approach to the modern practice via the Internet, such as YouTube and Facebook. Other multimedia presentations were assumed from videos, PowerPoint presentations, and mobile applications.

Finally, the respondents were asked about the importance of understanding and practicing Asmaul Husna as a Muslim. It can be summarized that all of them agree that learning the names is very significant and beneficial in life. The answers are as follows:

- i. To gain benefit in the daily life of a Muslim.
- ii. To form a humble, obeyed, and devoted Muslim.

- iii. To be acquainted, faithful, and closer to the Creator.
- iv. To take the obligation in getting to know Allah.
- v. To handle problems and to act as guidance in life.
- vi. To evoke consciousness of how Almighty God is.
- vii. To get a reward for the practice.
- viii. To engage (*khusyuk*) with Allah during prayer, as the names are recited in *solat*.
- ix. To profoundly understand the teachings of Islam.
- x. To understand the foundation of being a Muslim

Recapitulate from the interviews and survey reveals that Muslims' awareness and knowledge about Asmaul Husna are still scarce. Therefore, there is necessary to begin research on this context to confront the deficiency.

2.9 Asmaul Husna Multimedia Application

Referring to Table 2.11, There are quite a few existing Asmaul Husna mobile applications in Play Store and App Store; however, none of the mobile apps incorporates the 99 names for daily life as envisioned for this study. All these applications are only focusing on the meaning and singing part. Unfortunately, many only know how to sing but do not understand each essence and apply them daily.

These apps only introduce the names and the meaning with only several that includes each name's benefits. Some with new interfaces for children. At the same time, most of the others are simple and uninteresting for adults. Most of these applications are deficient in the signaling principle that could ease learning processes. The unresolved issues in these applications include the absence of embedded principles or guidelines

in the documentation, the lack of appropriate multimedia elements, the non-appearance of daily dhikr and prayer (*du'a*) using Asmaul Husna, the inadequacy of specific Asmaul Husna for dealing with various life problems, and only focus on children.

Table 2.11

Comparison of Asmaul Husna Mobile Apps

No.	Name of Mobile Applications	Target Audience	Content
1.	99 Names of Allah - Asma Ul Husna and Asma Ul Nabi	Adult	Ninety-nine names, meaning, benefits, and names of the Prophets.
2.	99 Names Allah (Asma ul Husna)	Adult	99 names and meaning.
3.	Asmaul Husna	Children	Ninety-nine names, meanings, and Islamic stories.
4.	Asmaul Husna Audio	Adult	Ninety-nine names, meanings, and benefits in audio.
5.	Asmaul Husna – Let’s Sing Together	Children and Adult	Ninety-nine names in the form of <i>nasyid</i> .
6.	Belajar Asmaul Husna + Suara	Children	Ninety-nine names and meanings in audio.

7.	Benefits of Asma Ul Husna	Adult	Ninety-nine names, meanings, and benefits.
8.	Cerita Asmaul Husna untuk Anak	Children	Ninety-nine names, meanings, and explanations.
9.	Dzikir 99 Asmaul Husna	Children	Ninety-nine names and meaning and <i>nasyid</i> .
10.	Keutamaan Asmaul Husna	Adult	Ninety-nine names and meaning.
11.	Marbel Asmaul Husna + Suara dan Terjemahan	Children	Ninety-nine names and meanings in audio.
12.	Memory Asmaul Husna	Children	Ninety-nine names and meanings.
13.	Names of Allah	Adult	Ninety-nine names and meanings.
14.	Nyanyian Asmaul Husna Bersama Diva	Children	<i>Nasyid</i> and Asmaul Husna meaning.
15.	Remember Asma' Ul Husna	Children	Ninety-nine names and meanings.
16.	Zikir Asmaul Husna	Adult	Ninety-nine names and meanings.

None of these Asmaul Husna mobile applications incorporates the 99 names for daily life as envisioned for this study. All these applications are only focusing on the meaning and singing part. Unfortunately, many only know how to sing but do not understand each meaning and apply it daily.

Asmaul Husna may be used by associating each name with specific activities. For example, students may repeat and make a prayer (*du'a*) invoking the names of Al-'Alim (The Most Knowledgeable), Al-Hakim (The Wisest), and Ar-Rashid (The Most Intelligent) before beginning class or while studying at home. They may also invoke the names of Al-Khaliq (The Creator) and Al-Baarik (The Organizer). It is tally with Surah Al-Isra' Verse 110, "Say, call upon Allah or call upon the Most Merciful. Whichever [name] you call - to Him belong the best names. And do not recite [too] loudly in your prayer or [too] quietly but seek between that a [intermediate] way."

2.10 Knowledge

According to Benjamin Bloom (1956), learning is when learners can remember, recall, retrieve, or recognize information, ideas, and principles in the approximate form they were learned from previously learned material. Questions are asked solely to test whether a learner has gained specific information from the lesson and includes knowledge of the main ideas being taught. Bloom's Taxonomy was created to categorize the levels of reasoning skills required in classroom situations. There are six levels in the taxonomy, each requiring a higher level of abstraction from the students. The six levels of Bloom's Taxonomy are: 1) Knowledge, 2) Comprehension, 3) Application, 4) Analysis, 5) Synthesis, and 6) Evaluation.

However, according to Krathwohl (2002), knowledge can be divided into four categories which are:

- i. Factual Knowledge - The essential elements that learners must know to be acquainted with a discipline or solve them.

- ii. Conceptual Knowledge - The interrelationships among the fundamental elements within a more massive structure enable them to function together.
- iii. Procedural Knowledge - How to do something; methods of inquiry, and criteria for using skills, algorithms, techniques, and practices.
- iv. Metacognitive Knowledge - Knowledge of cognition in general and awareness and knowledge of one's comprehension.

Knowledge is one of the dependent variables examined in this study. The researcher must ensure that users better understand the context due to utilizing the generated app. Existing knowledge of Allah's 99 names also contributes to their increased understanding of this subject.

2.11 Perceived Awareness

Awareness refers to processing the organism's nervous system (including the sensory device) and its environment. This processing results in the primary organism's ability to respond to environmental stimuli (Arp, 2007). Awareness is associated with sentience, perception, feeling, and cognition. It requires any mental activity from the central nervous system or awareness to conscious experience in a psychological state.

Awareness is also defined as understanding others' activities and providing context for one's activities (Dourish & Bellotti, 1992). However, it is essential to state that a lack of awareness can lead to systematic efforts and slow down innovation (Reinhardt et al., 2012).

In this study, perceived awareness is the second dependent variable. It is crucial in this study to ensure that Muslims would upgrade their knowledge of Asmaul Husna after using the application.

2.12 Perceived Motivation

Motivation is one of the most common words in psychology that refers to the factors that move or stimulate creatures. It can be deduced that motivation exists when people work hard towards a specific goal. For example, a student who gave his best effort in nearly every task can conclude that he is motivated to accomplish. (*Motivation*, n.d.). Motivation also refers to the underlying causes of behavior characterized by readiness and stance. Intrinsic motivation is powered by personal enjoyment, interest, or pleasure, while defense contingencies control extrinsic motivation. Motivation involves the constellation of beliefs, perceptions, values, interests, and closely related actions. Motivation in individuals tends to vary in all areas, and these domains' specificity increases with age (Lai, 2011).

The motivational role is somewhat less evident in CTML, although the theory distinguishes between the three memory capacity requests during learning: external, necessary, and generative. In CTML, motivation is a force that incites, improves, and maintains generative processing, leading to better learning outcomes. The learner is not continually overloaded with extraneous processing or overly distracted from necessary processing (Mayer, 2014; Mayer & Estrella, 2014). Therefore, Keller (2010) proposes a motivational model to analyze students' motivational characteristics and design a motivational approach.

2.12.1 ARCS Model

ARCS Model (Keller, 1987b) is categorized into four as depicted in Table 2.12; this category can quickly get an idea of the main dimensions of human motivation, especially in the context of learning motivation, and how to create strategies to stimulate and maintain motivation in every four areas.

Table 2.12

ARCS Models Categories and Definitions

Major Categories	Definition
Attention	Capturing the interest of learners; stimulating the curiosity to learn.
Relevance	Meeting the learner's personal needs or goals affects a positive attitude.
Confidence	Helping learners believe or feel that they will succeed and control their success.
Satisfaction	Reinforcing accomplishment with rewards (internal and external).

According to Poulsen, Khoa, Trust, and Cisneros (2008), the attention mentioned in this theory refers to the learners' interest in taking the concepts or ideas taught. These components are divided into perceptual arousal, using surprise or uncertain situations; inquiry arousal, which offers challenging questions and problems to answer or solve; and variability, using various sources and teaching methods. Keller (1987) has provided a stimulus to grab attention in each category. Grabbing attention is the most critical part of this model, as it initiates motivation for learners. When they are interested in the topic, they are willing to invest time, pay attention, and learn more. Relevance must be created using the language and familiar examples to the learners. The three main strategies are goal orientation, motive matching, and familiarity.

Students will overlook the concept if their attention cannot be captured and maintained, which is irrelevant (Keller, 1987).

The ARCS model's confidence focuses on creating optimistic hopes for success among learners. Learners' confidence levels are often associated with motivation and effort to achieve performance goals. For this reason, the learning design must provide them with a way of estimating the probability of their success. It can be accomplished in syllabus and grading, rubrics, or estimated time to complete the task. Also, confidence is built when positive reinforcement for personal achievement is provided through timely feedback (Keller,1987).

Finally, learners need to get satisfaction or reward from the learning experience. This satisfaction could be from a sense of accomplishment, praise, or entertainment. Feedback and consolidation are essential elements, and learners will be motivated to learn when they value the results. Satisfaction is based on motivation, which can be intrinsic or extrinsic. The instructions should be designed to use their new skills as quickly as possible to ensure that learners are satisfied. Table 2.13 briefly explains the context and the results of previous works on the ARCS Model.

Table 2.13

Past Research on the Use of the ARCS Model

Author	Context	Results
Alekhya and Prabhu Kishore (2018)	Engineering	Motivates students to attend class, read concepts well, improve performance in

		any subject, and show interest in learning.
Angelo (2017)	Teachers' Guidelines	Enhance students' motivation
Chen and Chen (2017)	Museum	Increase student's motivation
Reynolds, Roberts, and Hauck (2017)	Information Literacy	Improve student engagement during Information Literacy sessions.
Tlili, Essalmi, Jemni, and Kinshuk (2017)	Educational Games	Improve student motivation, keep them active, and help them gain the needed technical skills.
Almahasheer (2016)	e-learning	Increase learners' learning speed, motivation, and awareness.
Ali, Hishamuddin, Mohd Tahir, and Mohd Said (2016)	Multimedia Course	Retain students' interest and motivation.
Asiksoy and Özdamlı (2016)	Physics	Increase students' achievements.

2.13 Summary

The idea of multimedia and mobile environment as a method of promoting learning has been discussed based on the literature on mobile apps, Islamic mobile apps, and Asmaul Husna. The elements of theories and principles involved in the AHMA's instructional design theoretical framework are also defined in this chapter.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

This chapter describes this study's process of accomplishing the objectives stated in Chapter 1. The layout of each phase is presented comprehensively by emphasizing all elements concerning its activities and outcomes. It explains designing and developing the NSPIxD Model from the first phase until the last stage, including theoretical study, development, and evaluation.

3.2 Research Design

The research design is planned systematically to explain this study's phases, activities, and outcomes. The research is divided into three stages, illustrated in Figure 3.1. These phases comprise (i) theoretical study, (ii) development, and (iii) evaluation. Those phases are then associated with the activities that represent the methods carried out to achieve the sub-objectives of the study, as the main objective is to propose the NSPIxD Model.

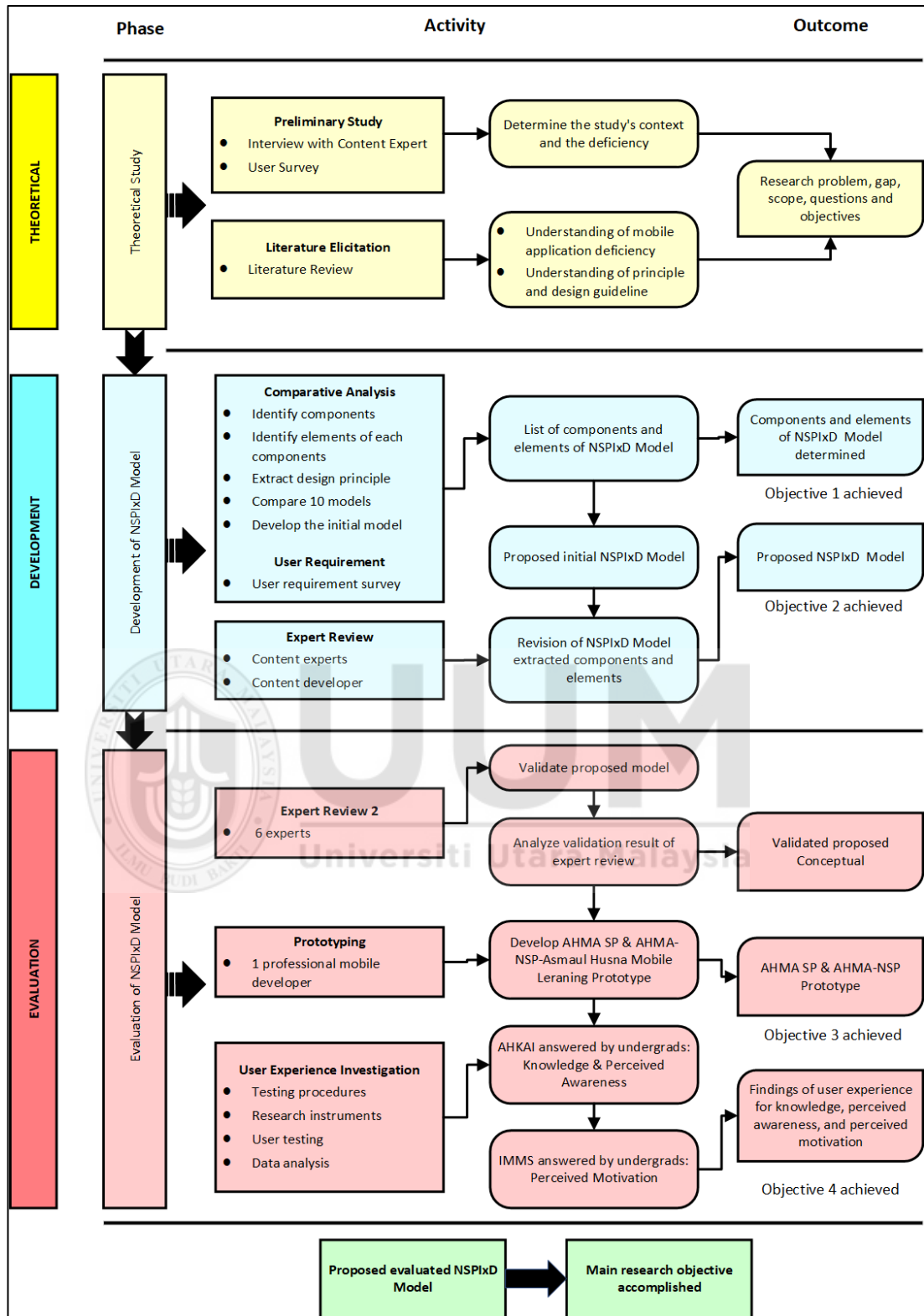


Figure 3.1 Summary of Research Activities

3.3 Theoretical Study

Explorations of the significant issues require extensive research to comprehend and identify the research problem, gaps, and scope. The primary point in contexts and their deficiency can be clearly defined by conducting a preliminary study that utilizes various methods and sources. A theoretical study has been undertaken to understand the solidification process thoroughly.

This study aims to define and characterize the available educational concepts in the context of university education. Both activities produce findings that can strengthen the research problem formulation, gaps, and objectives, as shown in Figure 3.2. The following section details the primary activities that take place during this phase.

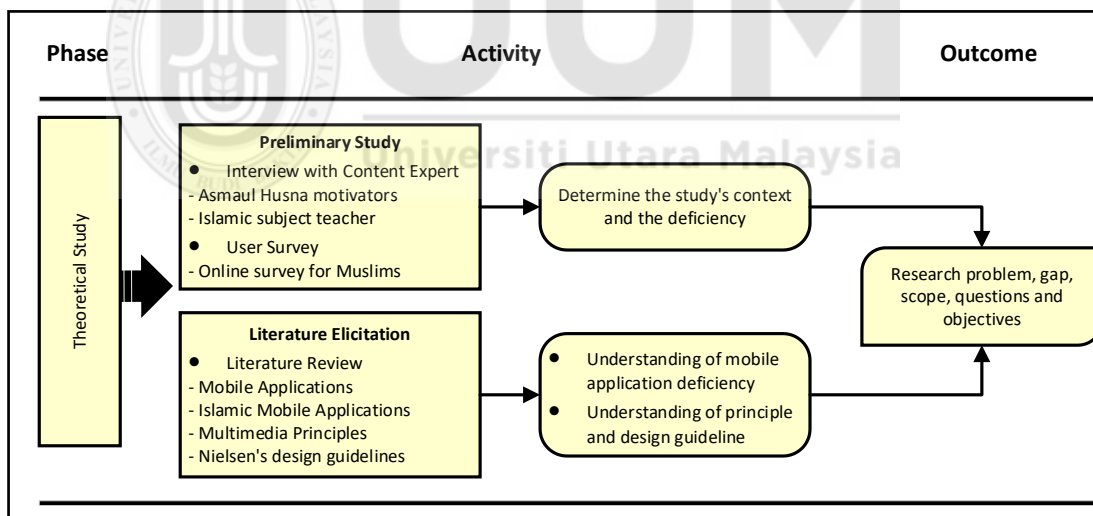


Figure 3.2 Theoretical Study

3.3.1 Preliminary Study

A preliminary study is a necessary first step in identifying and resolving issues in the study context and domain. As a result, field studies, specifically interviewing subject matter experts and conducting online surveys, are necessary. An extensive literature

search was conducted to understand Asmaul Husna's context before the field study activities discussed in Chapter 1 (Preliminary Investigation). After collecting data, it was analyzed and used to inform the actual problems.

3.3.1.1 Interview with Content Experts

The term "content experts" refers to motivational speakers and educators working with the Muslim community, particularly those who have been giving talks or classes on this subject for more than five years. The primary reason for selecting this group of experts is that they have extensive experience dealing with the target group's lack of knowledge and awareness. Additionally, they can provide detailed information because they have received formal and informal training on the subjects.

3.3.1.2 Survey

A survey is a type of research that collects data from a predefined group of respondents to elicit information and insights about various topics of interest. The process entails soliciting information from individuals via a questionnaire, either online or offline. This survey is conducted online to ascertain respondents' knowledge and awareness of the Asmaul Husna context.

3.3.2 Literature Elicitation

Model design and development literature exists in a variety of contexts and focuses. It is available through various academic journals, conference proceedings, books, and online databases. As a result, a manual elicitation process is required to ensure that only the most pertinent articles are chosen for further analysis based on their theme and suitability (Abdul Mutalib, 2009).

3.3.2.1 Literature Review

A thorough selection was conducted using available online tools to ensure an adequate amount of literature relevant to this study. This phase entails gathering, analyzing, and synthesizing prior work on the concepts and theories discussed in Chapter 2. The outcomes of these activities are critical in instilling some fundamental concepts into developing interaction model concepts, understanding mobile application deficiencies, and understanding design principles and guidelines. The preliminary study and literature elicitation results are beneficial in this initial phase because they help strengthen the problem statement, research gaps, and scopes, formulating the research objectives and questions. As illustrated in Figure 3.2, this outcome also serves as the primary contributor to the execution of the model construction.

3.4 Development of the NSPIxD Model

As mentioned previously, the outcome of the previous phase serves as the foundation for developing the initial NSPIxD Model. The construction process in this phase is guided by the strategies designed by Abdul Aziz (2016), Abdul Mutalib (2009), Ahmad (2017), Al-Aidaros (2017), Aziz (2015), Hussain (2017), Sarif (2011), and Zaibon (2011). Essentially, two major activities were conducted to propose the model: comparative analysis and (ii) consultation, as illustrated in Figure 3.3.

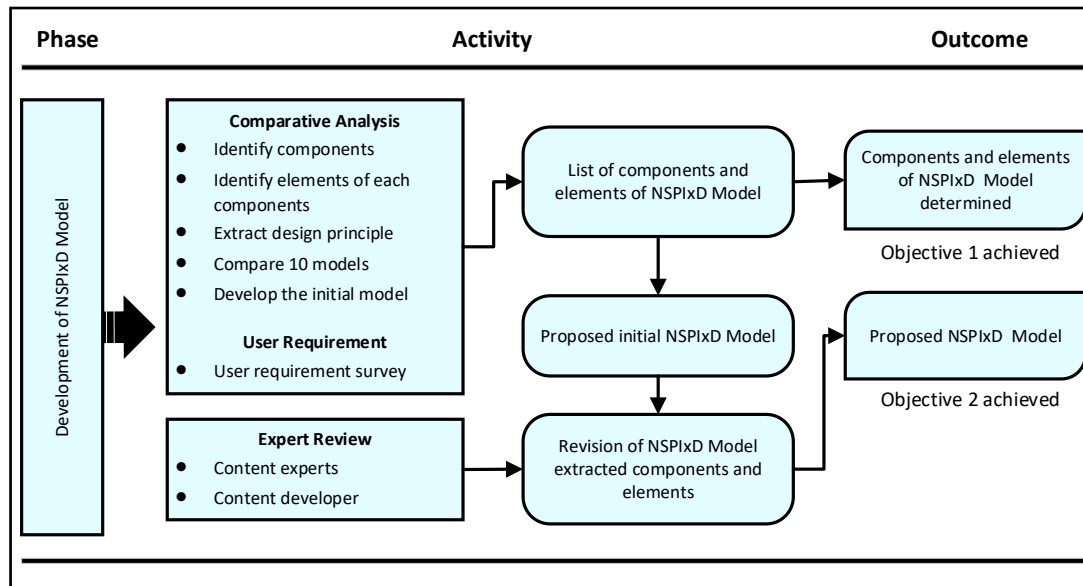


Figure 3.3 Development of the NSPIxD Model

3.4.1 Comparative Analysis

In addition to the literature review, a comparative analysis is conducted to understand the NSPIxD model better. Additionally, a review of pre-selected existing conceptual models is undertaken. Apart from identifying research gaps, it was also beneficial for categorizing the significant components and entities from previous studies through analysis and comparison of their characteristics (Abdul Mutalib, 2009; Aziz, 2015; Sarif, 2011; Zaibon, 2011). The analysis concentrated on existing research on assistive and mobile learning models, as both provide insight into the target users' learning concepts and approaches.

This activity examines existing conceptual models to propose the NSPIxD Model. According to Abdul Mutalib (2009), each conceptual model contains unique features and characteristics, and it is essential to evaluate these components and elements critically. The components and elements deduced from the preceding result were tabulated and separated into columns. Additional analysis was conducted to justify the

appropriate components included in the proposed model. The gathered components and elements, including the design principles and identified components, will also be based on the user requirements to ensure applicability. Ultimately, these activities result in a list of components and their constituents for developing the NSPIxD model. The model was precisely drawn as it will be discussed with content experts during the review process.

User requirement survey is conducted by conducting online surveys to target users. This survey was conducted to gather more detailed elements related to the mobile app interface based on the Nielsen design guideline reviewed at the beginning of the literature review. The results of this survey provide a more detailed list of elements needed in a deeper context.

3.4.2 Expert Review

The following activity solicits suggestions and input from subject matter experts to confirm the suitability of components and elements included in the model proposal. This activity entailed the participation of content experts and content developers. Suggestions from users were gathered via a model diagram that required their comments. The content experts' comments and recommendations were beneficial because they aided in designing and developing the model (Ahmad, 2017). After determining the components and elements of the model, this study conducts a comprehensive review to validate the NSPIxD Model.

3.5 Evaluation of the NSPIxD Model

The evaluation phase of this study was empirical and incorporated various methods and sources. The model developed in the previous stage was rigorously validated to

ensure that the proposed solution is feasible (Abdul Mutalib, 2009; Aziz, 2015; Zaibon, 2011). As to accomplish this, the model was validated using strategies from previous studies, including expert review (Al-Aidaros, 2017; Aziz, 2015; Sarif, 2011) and prototyping (Abdul Aziz, 2016; Abdul Mutalib, 2009; Ahmad, 2017; Al-Aidaros, 2017; Hussain, 2017), with the prototype serving as evidence of the validated model used to investigate user experience. The following subsection discusses each validation method illustrated in Figure 3.4 in greater detail.

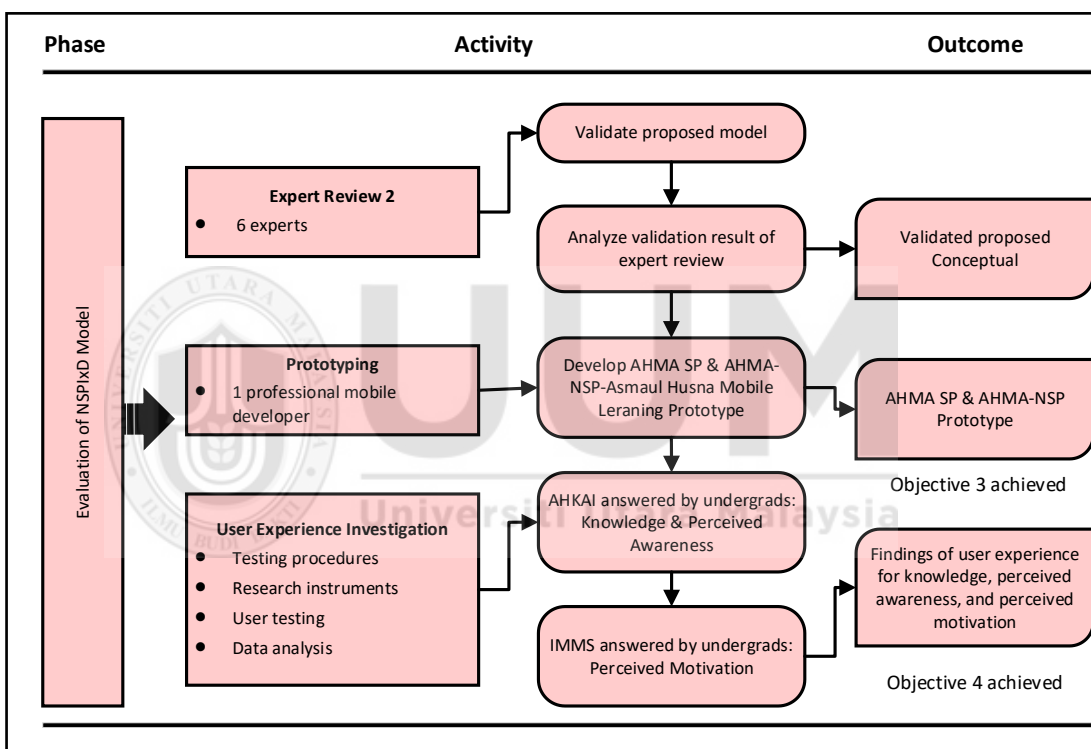


Figure 3.4 Evaluation of the NSPIxD Model

3.5.1 Expert Review 2

In this study, the proposed initial NSPIxD Model was validated by academics with at least five years of experience in HCI, SE, and education fields from local institutions. This study appointed academicians in HCI fields who also have expertise in multimedia and interaction design domains, as suggested by Shneiderman and Plaisant (2005). The reason for selecting those experts is to ensure the proposed model can suit

the intended outcome of this research, which reflects the learning experience of the undergraduates.

The review process was conducted through face-to-face communication. The experts provided a printed version of the proposed model and their comments. The procedures include conducting the review process and analyzing the findings. Based on the result of the expert reviews, refinement of the NSPIxD Model was conducted before it was translated into different evaluation methods, which is the prototyping

3.5.2 Prototyping

A prototype is a physical or digital representation of critical design elements and an iterative tool used to facilitate communication, facilitate learning, and inform decision-making at any stage of the design process. (Lauff et al., 2018). This activity was conducted by a software developer experienced in creative content development. One professional courseware developer was appointed and induced with the validated NSPIxD Model as a guideline to develop a prototype. This method has been chosen based on the achievement in the previous studies that also implemented the same strategy in evaluating and validating the conceptual model, such as Abdul Aziz (2016), Abdul Mutalib (2009), Ahmad (2017), Al-Aidaros (2017), Aziz (2015), and Sarif (2011). The outcome of this activity is a working prototype known as Asmaul Husna Mobile Application; AHMA-NSPIxD (integrated with NSPIxD Model) and AHMA-0 (not combined with the model). The prototype design consists of three phases - planning, design, and development, based on the Alessi and Trollip Design Model. Simultaneously, the Constructivist Learning Environment (CLEs) is utilized as an

environmental design strategy. The development process of the prototype is further explained in Chapter 5.

3.5.3 User Interactions Study

This study intends to examine the effects of two mobile applications in assessing Muslims' knowledge, perceived awareness of Asmaul Husna, and their perceived motivation for the mobile apps. The mobile applications consisted of AHMA-0 and AHMA-NSPIxD. The prototype design is depicted in figure 3.5.

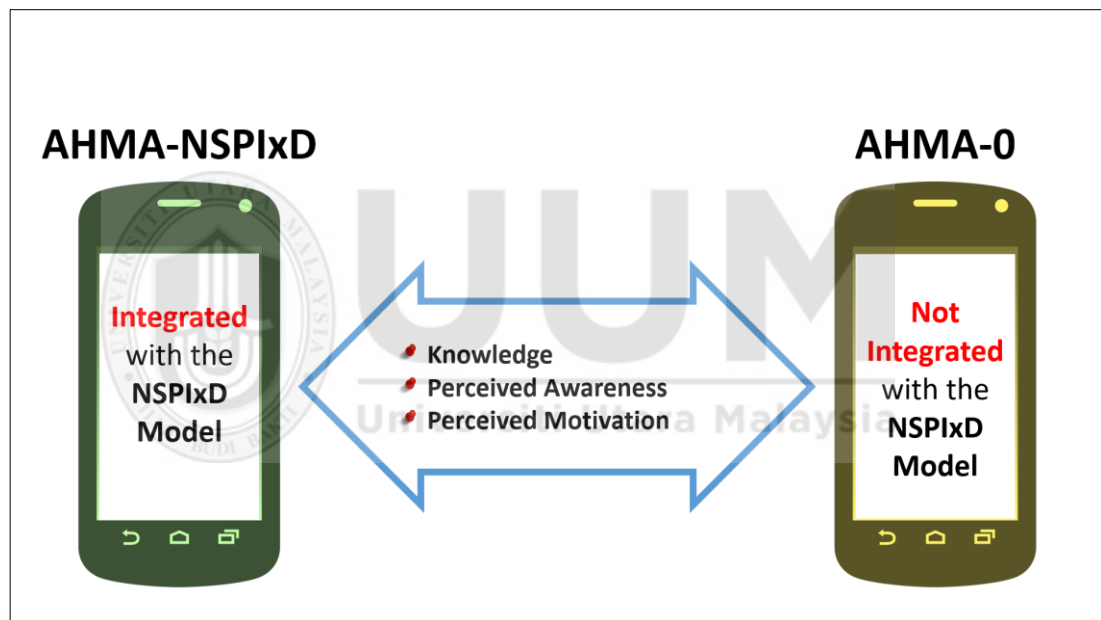


Figure 3.5. Prototype Design

3.5.3.1 Testing Procedures

In designing the mobile application, the Signaling principle and Nielsen's design guideline are selected to be hybridized, resulting in a proposed interaction model, namely NSPIxD Model. Since both are robust principles, this study believes that hybridization contributes significantly to attaining knowledge and motivation. AHMA-NSPIxD is integrated with the NSPIxD Model, and the other mode is without the interaction model. The Signaling principle consists of visual signals consisting of

prominent texts and colors. At the same time, Nielsen's design guidelines include visual design, writing, navigation, interaction design, and multimedia design principles. These principles are chosen as a result of the astounding earlier investigation.

1. Research Variables

This study involves three variables, as illustrated in Figure 3.6: dependent and independent variables.

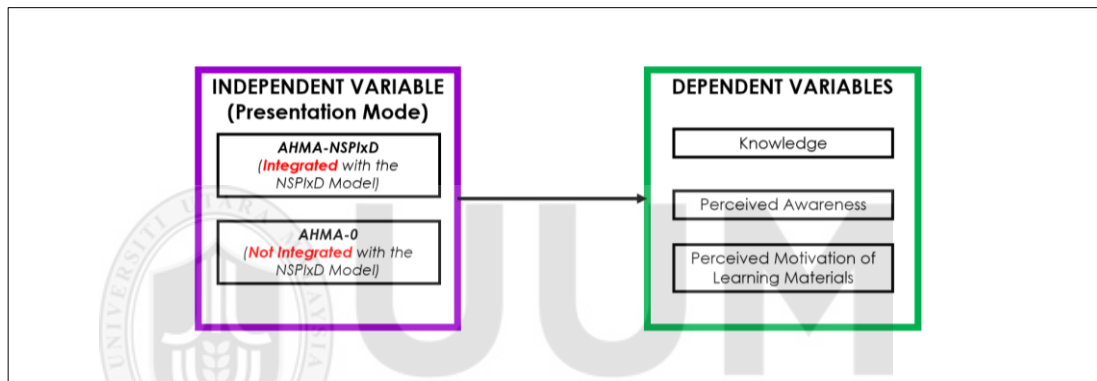


Figure 3.6. Research Variables

3.5.3.2 Research Instruments

There are two research instruments involved in this study. These instruments assess participants' knowledge and perceived awareness of Asmaul Husna before and after exploring AHMA and their perceived motivation for the learning material after completing the experiments.

1. Asmaul Husna Knowledge and Awareness Instrument (AHKAI)

The researcher developed Asmaul Husna Knowledge and Awareness Instrument (AHKAI), as attached in appendix B, and content experts have examined the items in this instrument. There are three sections included in this instrument: demographic,

awareness, and knowledge sections. Three to five experts are required for an independent analysis (Shneiderman et al., 2010). In response to those recommendations, this study has enlisted an adequate list of experts. Three content experts were chosen to evaluate this instrument; two are Ph.D. holders, and one is a local university professor, as shown in Table 3.1. The items in AHKAI assess participants' knowledge and perceived awareness about Asmaul Husna before and after using AHMA, which corresponds to the pre-and post-test sessions during the experiments.

Table 3.1

List of Experts for AHKAI

No.	Gender	Education	Fields of Expertise	Experience (Year)	Affiliations
1.	Female	Ph.D.	Computer Science	20	Universiti Malaysia Perlis
2.	Female	Ph.D.	Multimedia Learning	10	Universiti Teknologi MARA
3.	Female	Ph.D.	Instructional Design	11	Universiti Teknologi MARA

These experts were given links to the questions the researchers had developed, and they scrutinized each question to be precise to assess user knowledge and awareness. The relevant experts have changed some sentence structures and added a new item to the existing questions. The researchers also improved the questions according to expert suggestions, such as adding questions regarding sentence construction using Asmaul Husna that had been learned before and after using AHMA.

For quantitative data analysis, validity and reliability issues are essential, and it is to demonstrate that the method of choice measures what is intended to be measured. It also ensures that the measurement is stable and consistent and that no errors or biases are present from respondents or researchers (Dawson, 2002). The validation process is conducted to check and validate the items in the instruments used in the study. Suitable content experts are chosen to fulfill this task. Simultaneously, the Cronbach Alpha test is performed accordingly to ensure that the instruments are reliable for the study. Cohen and Swerdlik (2009) and Heale and Twycross (2015) recommend that Cronbach's Alpha is one of the best methods to obtain internal consistency reliability estimates.

i. AHKAI's validity

Validity is an instrument's capability to measure the actual value (Chua, 2012). Three experts from local public universities have checked and validated the instruments, as mentioned in Table 3.1.

ii. AHKAI's reliability

Reliability relates to the consistency of a measure; an acceptable reliability score is 0.7 and higher (Heale & Twycross, 2015). Thirty-one sample feedbacks have been done to check the reliability of these instruments; the Cronbach alpha value is 0.718, which is greater than the minimum acceptable reliability score of 0.7. Therefore, the instrument is considered reliable and consistent.

2. Instructional Materials Motivational Survey (IMMS)

Instructional Materials Motivational Survey (IMMS) is adopted from the instrument developed by Keller (2006). After completing the experiments, this instrument evaluates the participants' perceived motivation for the learning material. As AHKAI, the pre-test and post-test instruments were developed in Malay, and the translated version of the IMMS was used. It is named as *Skala Motivasi Bahan Pengajaran* (Toh, 2005). The IMMS, as shown in Appendix C, consists of four (4) constructs; attention, relevance, confidence, and satisfaction, with 36 survey items. 10 out of 36 items are stated negatively on a Likert scale ranging from 1 (Not True) to 5 (Very True). The Cronbach alpha internal consistency reliability coefficient for this instrument is 0.91.

3. Research Population and Sampling

The populations of this study are Muslims in Malaysia and those familiar with mobile applications. Based on the target audience, Muslims, and the mobile app's primary users, the most suitable candidates are between 18 and 24 years old, mainly university and college students (Malaysian Communications and Multimedia Commission, 2017, 2018). Purposive sampling is appropriate and attainable for this study (Cohen & Swerdlik, 2009; Randolph, 2008). The sample is chosen using an appropriate sampling method for quantitative analysis, and the minimally acceptable sample size is usually 30 participants (Brown & Green, 2016; Cohen & Swerdlik, 2009; Gay et al., 2012; Randolph, 2008; Roblyer, 2006; Roscoe, 1975). A successful study with a sample size of 10 to 20 is also attainable in experimental research with adequate experimental control (Roscoe, 1975). This study was conducted at several universities to obtain homogeneous sampling as university students are equivalent regardless of demographic aspects and possess the same abilities in the area tested (Brown & Green, 2016; Cohen & Swerdlik, 2009). Consequently, Universiti Utara Malaysia, Universiti

Malaysia Perlis, and Universiti Teknologi MARA Perlis are chosen based on the homogeneity characteristics.

3.6 User Testing

This study is classified into a quantitative category and utilizes a quasi-experimental approach, as illustrated in Figure 3.7, using pre-test and post-test factorial design (Randolph, 2008). Both treatment groups experienced different mobile applications to develop their understanding of Asmaul Husna.

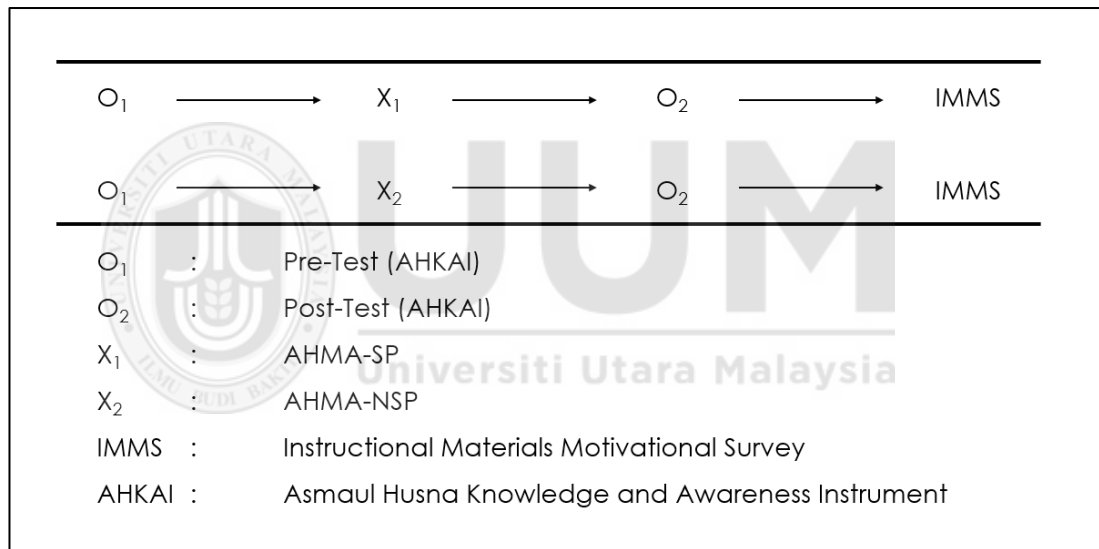


Figure 3.7. Research Design

3.6.1 Quasi-Experiment Procedures

This experiment is in 2 phases, (i) pilot study and (ii) actual study.

3.6.1.1 Pilot Study

Before the actual study, a pilot study is carried out to validate research procedures and instruments, gather feedback on the mobile app from learners for improvement, and expose the shortcomings in the experiments' design or the proposed method. A group

of students at a selected university has participated in the pilot study sessions, and these students are not involved in the actual study.

Initially, they are given a pre-test question before implementing the treatment using AHMA adapted to the NSPIxD model (AHMA-NSPIxD). The questionnaire that is used in the pre-test is AHKAI. After a week from the pre-test, the post-test is later done to avoid the students remembering the questions. After a week, the treatment begins after the facilitator introduces AHMA and describes the treatment procedure. Students can seek help from facilitators during treatment.

After one hour of using AHMA, the student took the post-test using AHKAI. The post-test questions are the same as the pre-test, but the items are randomly arranged to avoid the possibility of memorizing the answers. Finally, the students took the IMMS questionnaire to complete the research procedure. Feedback from students during the pilot test was considered and used to improve the app's effectiveness and usability for execution in actual experiment sessions. The data collected in this study is analyzed using descriptive statistics involving pre-test, post-test, and IMMS.

Table 3.2

Pilot Test Result

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pre-Test Marks	5.4286	35	1.63214	0.27588
	Post-Test Marks	7.6000	35	1.55677	0.26314

The collected data were analyzed using the pre-test and post-test results for the pilot study. This table presents the summary information on pre-test and post-test scores in Table 3.2. The mean score for pre-test marks is 5.43, while the mean score for post-test scores is 7.60. It indicated a substantial difference in knowledge and perceived awareness mean scores after students used the mobile app, with the post-test mean score being higher than the pre-test mean score.

Table 3.3

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Pre-Test Marks - Post-Test Marks	-2.17	2.15	0.36	-2.91	-1.43	-5.98	34	0.000

The paired samples test, $p < 0.05$, means a significant difference between the pre-test and post-test results. After treatment, students scored higher in knowledge and perceived awareness, as shown by the mean difference in Table 3.3.

3.6.1.2 Actual Study

The actual study is implemented at the three universities mentioned in section 3.6. Each university from each area is randomly assigned to different mobile apps to curb the probability of exchanging apps between diverse participants. Before treatment, the facilitator informs the participants of the session and introduces them to AHMA. Students participate in experimental studies during the same week but with different group schedules. This session is conducted in classes and computer labs, and the treatment period is approximately an hour a week.

At the beginning of the session, the participants were scheduled to sit for the pre-test. Then, after two weeks, they were briefed on the interface and navigation of the AHMA. After that, the participants were allowed to explore it by themselves. The group was monitored and provided help when necessary. Immediately after the treatment, they were given the post-test questions (AHKAI). This period was chosen to minimize the question remembering the effect of pre-test questions on post-test questions. Finally, after answering the post-test questions, the participants received the perceived motivation test using AHMA and IMMS. The participants were given unique links to download the mobile app according to their group, either AHMA-0 or AHMA-NSPIxD. It eliminates the internal threat. With this precaution, they do not accidentally download both apps simultaneously.

The study was initially conducted on 229 students at three universities in Perlis and Kedah, as depicted in Table 3.4. The actual study distinguished between 2 mobile application modes, namely AHMA-0 and AHMA-NSPIxD.

Table 3.4

<i>Initial Participants Involved</i>		
Experiments	Number of participants	%
AHMA-0	116	50.7
AHMA-NSPIxD	113	49.3
Total	229	100

Table 3.5

<i>Actual Participants Involved</i>		
Experiments	Number of participants	%
AHMA-0	89	43.6
AHMA-NSPIxD	88	42.5
Total	177	100

However, based on Table 3.5, as some students do not complete the pre-test and post-test or the IMMS, the total amount of data analyzed is less. Some attended the pre-test only, and others participated in the post-test only. Others only answered the IMMS and did not submit the other responses. Besides, many are non-Muslim students, so the data is invalid as they have no previous experience in Asmaul Husna learning.

Table 3.6

<i>Participants' Gender</i>	
Gender	Number of Participants
Male	76
Female	101
Total	177

There are 76 male participants involved in this test, whereas 101 participants are female, up to 177 Muslim undergraduate students, as illustrated in Table 3.6.

3.7 Data Analysis Technique

IBM SPSS Statistics Version 26 is used to analyze all the data obtained through this study, and the analysis used is descriptive and inferential statistics as having been conducted before in the same manner suggested by Abdul Wahab (2016), Melhem (2014), Menon (2016), Osman (2015b), and Othman (2015).

3.7.1 Descriptive Statistics

Descriptive statistics are used to analyze the essential features that resulted from this study. It encompasses the median, mean, standard deviation, and frequency as summaries for the pre-test and post-test.

3.7.2 Inferential Statistics

Inferential statistics for the data analysis are t-test, Analysis of Variance (ANOVA), Analysis of Covariance (ANCOVA), and Pair-Wise Comparisons. ANCOVA evaluates the pre-test and post-test results to investigate the significant difference among dependent variables: knowledge and perceived awareness of participants on the mobile application between the two mobile applications and the moderator variable. ANCOVA is also utilized to investigate the significant difference among the dependent variables perceived motivation on the mobile application between the two mobile apps.

3.8 Summary

This chapter explains that this study is divided into three main phases: (i) theoretical study, (ii) construction, and (iii) evaluation. Each stage consists of the main activities and sub-activities conducted to achieve the study's objectives, as illustrated in the research design diagram. These activities are explained in detail in the subsequent chapter. The methodology mentioned in this study has been studied according to previous studies. This established method is widely used in many projects and has proven notable. It is selected based on the achievements in previous studies that also apply the same methodology in evaluating and validating designs.



CHAPTER FOUR

HYBRIDIZED NIELSEN AND SIGNALING PRINCIPLE IxD MODEL (NSPIxD)

4.1 Introduction

The first part of this chapter describes the processes involved in constructing the interaction model. The construction process involves four main activities, including content analysis, user requirements survey, hybridization of principles and design guidelines, and consultation with experts; however, the prototype development and user testing are explained in another chapter individually. These activities' ultimate concern is determining the model's main components and elements. To summarize those activities, Figure 4.1 illustrates the methods and their objectives.

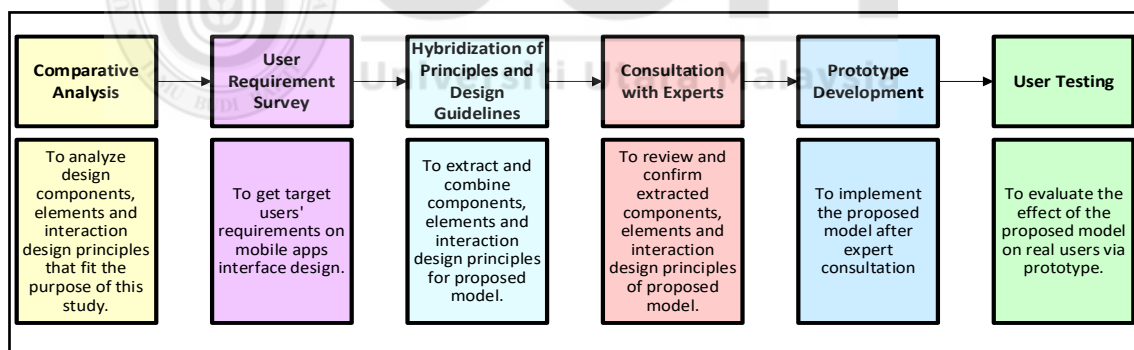


Figure 4.1 The Process of Constructing the NSPIxD Model.

The first step in this process is to launch content analysis to analyze design components, elements, and interaction design principles in the Signaling Principles and Nielsen's Design Guidelines that fit this study's purpose. These activities result from the selected cueing and signaling techniques appropriate for 18 to 24-year-old college students' guidelines for the target user. The second is to perform a survey to

determine target users' interface design requirements. Based on the respondents' feedback, certain elements have been selected and confirmed from this activity. Thirdly, to hybridize the established principles and design guidelines, the target users recommend, extract and combine components, elements, and interaction design principles for the proposed model. A set of newly proposed design models is obtained from this activity. Finally, experts' consultation must review and confirm the proposed model's extracted components, features, and interaction design principles. It is to ensure the suitability and usability of the new proposed guidelines. It is to provide the practicality and usability of the new proposed guidelines. Finally, the last phase is to apply the proposed hybridized guidelines into a prototype and perform user testing to assess the effect of mobile learning guidelines on the users' knowledge, perceived awareness, and perceived motivation of the learning materials.

4.2 Signaling Principle and Nielsen Design Guidelines

4.2.1 Signaling or Cueing Principle

The chosen principle is very significant in the learning of Asmaul Husna, especially in e-learning and multimedia presentations. This principle has been successful in the previous works on Asmaul Husna's learning and memorization. Based on the research, decent results were obtained using Signaling Principles, such as the students' engagement, excitement, and attractiveness in the learning materials and learning the content game (Rosmani et al., 2017; Rosmani & Zakaria, 2018).

4.2.2 Nielsen's design guideline

Nielsen's design guideline has been renowned for its usage and application in human-computer interaction. Therefore, numerous researches conducted to create an excellent

mobile learning environment based on these guidelines. However, none have adopted and used the Signaling and Nielsen design guidelines as intended in this study. Based on research in Table 2.7, Nielsen design guidelines selected for this study promise:

- i. Suitability for the e-learning environments, especially for a mobile learning environment.
- ii. Cover the perspectives that are best suited for the development of learning applications.
- iii. Customization, according to the learners' category.

Since both are robust principles, this study believes that hybridization contributes significantly to attaining knowledge and motivation. They are hybridized into one mode of the mobile application. The Signaling principle consisted of a visual signal consisting of prominent texts and colors, color-coded and text-based cueing, picture-based cueing, and audio intonation in spoken text. Nielsen's design guidelines comprise the visual design, writing, navigation, interaction design, and multimedia design principles. The chosen principles result from an astounding earlier investigation, as detailed in section 4.3. However, these principles and design guidelines align with the target users' requirements, as depicted in the survey analysis, as shown in section 4.4.

4.3 Comparative Analysis and User Requirement

This first version of the model is derived from meticulous processes involving the comparative analysis and user requirement survey. These processes are discussed in more detail in the next section.

4.3.1 Comparative Analysis

This activity aims to determine the components and elements of the conceptual model of NSPIxD based on the input from the works in literature and previous models. This study extracted generic entities or components of the prior literature and mobile apps to contribute to the model's construction for the initial step. Furthermore, the same process was conducted to extract the suitable user interface and interaction design elements and principles based on the existing design guidelines to define the interaction concept.

The main components in NSPIxD have also been agreed by previous studies that among the most important are visual design, content/writing, navigation/interaction design, and multimedia (Chachil et al., 2015; Huilcapi-Collantes et al., 2020; Lee et al., 2017; Muslimin et al., 2017; Vaghefi & Tulu, 2019; Widnall et al., 2020). But further analysis is done based on existing models listed in Table 4.1. Whereby a set of principles and elements guidelines has been established with the most cited principles of the six elements of interface design, namely text, color, graphic or image, animation, video, and sound (Chachil et al., 2015; Huilcapi-Collantes et al., 2020; Kamaruddin & Sulaiman, 2020, 2016; Lee et al., 2017; Malhotra & Verma, 2020; Muslimin et al., 2017). Based on existing models, further analysis is also made, as detailed in Table 4.3.

The content and HCI experts have also agreed upon these elements and components. They have been interviewed and combined with user surveys, as discussed in sections 4.4 and 4.5.

This section lists and justifies the critically evaluated selected models, including five Assistive Learning Models (ALM) and five Mobile Learning Models (MLM). The selection of those models (referring to the ten studies) is based on the primary rationale for extracting components and elements for the NSPIxD model. Table 4.1 complies with this by listing all models and appropriate justifications explaining why they are selected.

Table 4. 1

Justification for Selecting Models

No.	Author	Justification
Assistive Learning Models (ALM)		
1.	(Abdul Mutalib, 2009)	It is considered a conceptual design model for learning because of its completeness. Most of the elements are relevant and appropriate for this study.
2.	(Aziz, 2015)	It was proposed because of its inclusiveness as a conceptual model for assistive learning. Most of the information in this project is relevant and appropriate.
3.	(Abdul Aziz, 2016)	This model is considered successful because of its ability to deliver an integrated multimedia presentation for teachers.
4.	(Hussain, 2017)	It is considered due to its complex and comprehensive conceptual design features for a tablet, regarded as a mobile device. Most of the elements discussed should be essential and appropriate in the study.
5.	(Ahmad, 2017)	It is considered due to the scale and complexity of its conceptual design features for assisted learning. Most of the essential facts are related to this project.
Mobile Learning Models (MLM)		

1.	(Zaibon, 2011)	This model is the basis for mobile learning models, which exclusively outline mobile learning through gaming.
2.	(Kraleva et al., 2016)	This model was selected because the frameworks for mobile learning presented are based on an ongoing study of best practices in this area.
3.	(Al-Aidaros, 2017)	The model was chosen because it involves a complete multi-modal mobile device-assisted concept. This model contains various components of interaction design that relate to the primary concern of this study.
4.	(Jamaldeen et al., 2018)	The proposed design is under the guidelines for mobile application design. The study incorporates various aspects that constitute this research's main point.
5.	(Latiff et al., 2019)	This model opted for learning through mobile phone applications for students, and it includes essential elements necessary to conduct research.

The justifications in Table 4.1 demonstrate that each model is significant in its context. Some models are relevant to this study in a particular context, such as implementing learning theories, methods, strategies, and development. Meanwhile, some only apply to a specific context, such as user interface and interaction design guidelines. They are handy in evaluating and extracting the common components of the NSPIxD Model, which is the study's main contribution. As a result, the first section of the NSPIxD Model construction explains determining and extracting the standard components.

4.3.1.1 Common Component of Proposed Conceptual Model of iCAL4LA

The first step in proposing the common components in this analysis was comparing and contrasting the ten ALM and MLM studies. After performing the comparative analysis, this research separates the core concepts into five main components: visual

design, content/writing, navigation/interaction design, and multimedia, as have been agreed by previous studies by Chachil et al. (2015), Huilcapi-Collantes et al. (2020), Lee et al. (2017), Muslimin et al. (2017), Vaghefi and Tulu (2019), and Widnall et al. (2020) as the essential components. Table 4.2 and Table 4.3 list all the components and elements found in the existing models.

Table 4. 2

Comparative Analysis of Main Components

Main Components	ALM					MLM					Total	Percent
	1	2	3	4	5	1	2	3	4	5		
Visual Design	√		√	√	√		√		√		6	60
Content/Writing	√	√	√	√	√	√	√	√	√	√	10	100
Navigation/Interaction Design		√		√	√	√	√	√	√	√	8	80
Multimedia	√	√	√	√	√	√	√	√	√	√	10	100

After obtaining the result, the next step is to categorize the results into NSPIxD common components. It follows Abdul Mutalib (2009), Ahmad (2017), and Aziz (2015) studies to decide on each related component in Table 4.2. Thus, selecting all components is appropriate because they have a greater than 50 percent utilization rate in an earlier study.

4.3.1.2 Multimedia Elements

Since this analysis focuses on the interactive features of NSPIxD, multimedia design is inevitable. It consists of essential multimedia elements discussed in Chapter 2 and can be found in several previous studies. As seen in Table 4.3, similar elements (text,

graphics, pictures, video, and animation) were extracted from previous models. Table 4.3 displays a comparative analysis of each element to assess its applicability.

Table 4. 3

Comparative Analysis of Multimedia Elements

Multimedia Elements	ALM					MLM					Total	Percent
	1	2	3	4	5	1	2	3	4	5		
Text	√	√	√	√	√	√	√	√	√	√	10	100
Graphic	√	√	√	√	√	√	√	√	√	√	10	100
Audio	√	√	√	√	√	√	√	√	√	√	10	100
Video	√	√	√	√	√		√	√	√	√	9	90
Animation	√	√	√	√	√			√		√	7	70

In conclusion, this study suggested four main components with four main elements for the NSPIxD, having carried out a content analysis, a survey with the target audience, and a consultation with content experts. It comprises (i) visual design, (ii) content/writing, (iii) navigation/interaction design, and (iv) multimedia as general components. The key elements are (i) text, (ii) audio, (iii) graphics, and (iv) video. The model is distinct from the current models. It includes additional values regarding the material composition aspect of the NSPIxD strategies and (ii) systematic design concepts in all design components appropriate for university students. This study focuses more on design principles by ensuring students' learning content motivates them and can improve their knowledge and perceived awareness. This justification separates the NSPIxD from those in the previous models.

4.3.1.3 Selecting Signaling Principles

After selecting the NSPIxD model components, the next is selecting the appropriate signaling principles to be used in the model. This process involves selecting techniques that have been successfully used in previous studies, as shown in Table 4.4. Listed are the established and suitable signaling principles used in the mobile app—color-coded cueing, text-based, picture-based, and audio-based cueing (intonation in the spoken text).

Table 4. 4

<i>Signaling Principles</i>	
No.	Signaling Principles
1.	Color-coded cueing: text and picture elements with the same theme color. (Clinton et al., 2016; Godfroid et al., 2017; Mayer, 2016; Vogt et al., 2020)
2.	Text-based cueing: bold fonts for titles and headlines and colored key terms. (Darby et al., 2015; Mayer, 2016; Sisk et al., 2019; Vogt et al., 2020)
3.	Picture-based cueing: (icon/button) indicating that it is clickable. (Jian, 2019a; Mayer, 2016; Yang, 2019; Zhang et al., 2020)
4.	Audio-based cueing: Intonation in the spoken text, e.g., voice intonation accompanied with written text. (Darby et al., 2015; Mayer, 2016; Sisk et al., 2019; Vogt et al., 2020)

4.3.1.4 Selecting Nielsen’s Design Guidelines

Table 4.5 shows the items and usability recommendations from Nielsen’s design guidelines.

Table 4. 5

Nielsen's Design Guidelines

Elements/Components	Usability Recommendations	Sources
Visual Design	1. Attract with clean, simplistic designs and ample white space (visual gaps).	(Budiu & Nielsen, 2010; Kumar et al., 2019, 2020; Kumar & Mohite, 2016;
	2. Feature an elegant visual design that matches the content.	Loranger et al., 2014; J. Nielsen, 1994c)
	3. Minimize the use of generic-looking stock photography. Authentic, relevant, and action-oriented images receive more positive attention than staged photographs.	
	4. Use colors sparingly. Excessive colors inundate people's senses needlessly.	
	5. Balance style and function with a lean towards function.	
	6. Feature images with simple backgrounds to keep the focus on the picture.	
Writing	7. Choose words and concepts that relate to the audience.	(Budiu & Nielsen, 2010; Kumar et al., 2019, 2020;
	8. Summarize key points and pare down.	Kumar & Mohite, 2016; Loranger et al., 2014; J.
	9. Divide information into small clear groupings.	Nielsen, 1994c; J. Nielsen & Budiu, 2013)
	10. Limit the use of jargon.	

-
11. Minimize redundancy.
 12. Format text for readability.
 13. Format content so that multiple items can be compared at a glance.
 14. Embed links within content that lead to more detailed information.
 15. Avoid cutting content arbitrarily over multiple pages.
 16. When appropriate, consider alternative representations of information so that the data can be interpreted quickly and accurately.

Navigation and
Interaction Design

17. Choose familiar navigation schemes. (Budi & Nielsen, 2010; Kumar et al., 2019, 2020;
 18. Match interaction design with familiar standards. Kumar & Mohite, 2016; Loranger et al., 2014; J.
 19. Avoid cute and fancy navigation. Nielsen, 2002; Norman &
 20. Avoid including fancy features just for the sake of having them. Nielsen, 2010)
 21. Provide direct access to high-priority content. Place links to the material in a prominent, consistent location.
 22. Offer a reasonable number of choices. Too many options can deter people from making the correct decisions or from deciding at all.
-

-
23. Organize content by meaningful categories. Avoid structuring only by segmentation.
 24. Indicate clickable elements. Similarly, do not make items appear clickable if they are not.
 25. Make sure links do not look like decorations or ads.
 26. Feature icons sparingly, and only when they have meaning.
 27. When a graphic is associated with a link, make them both clickable
 28. Provide breadcrumbs and other navigational cues to orient users to the rest of the site.
 29. Make sure the back button works.

Multimedia

30. Optimize site performance. A half-second delay could result in a notable downward shift in user satisfaction. (Kumar et al., 2019; Kumar & Mohite, 2016; Loranger et al., 2014; Norman & Nielsen, 2010)
 31. Integrate videos with the related content.
 32. Feature clear indicators to help users identify video content.
 33. Avoid playing sound automatically, and provide easy-to-use audio controls.
 34. A few fancy components can increase appeal, but first, consider the most straightforward solution.
-

35. Use videos to show emotion or concepts that writing cannot convey.

Finally, after conducting comparative analysis and eliciting existing models, Figure 4.2 depicts the proposed model. The primary components and elements of the proposed NSPIxD Model result from this process.



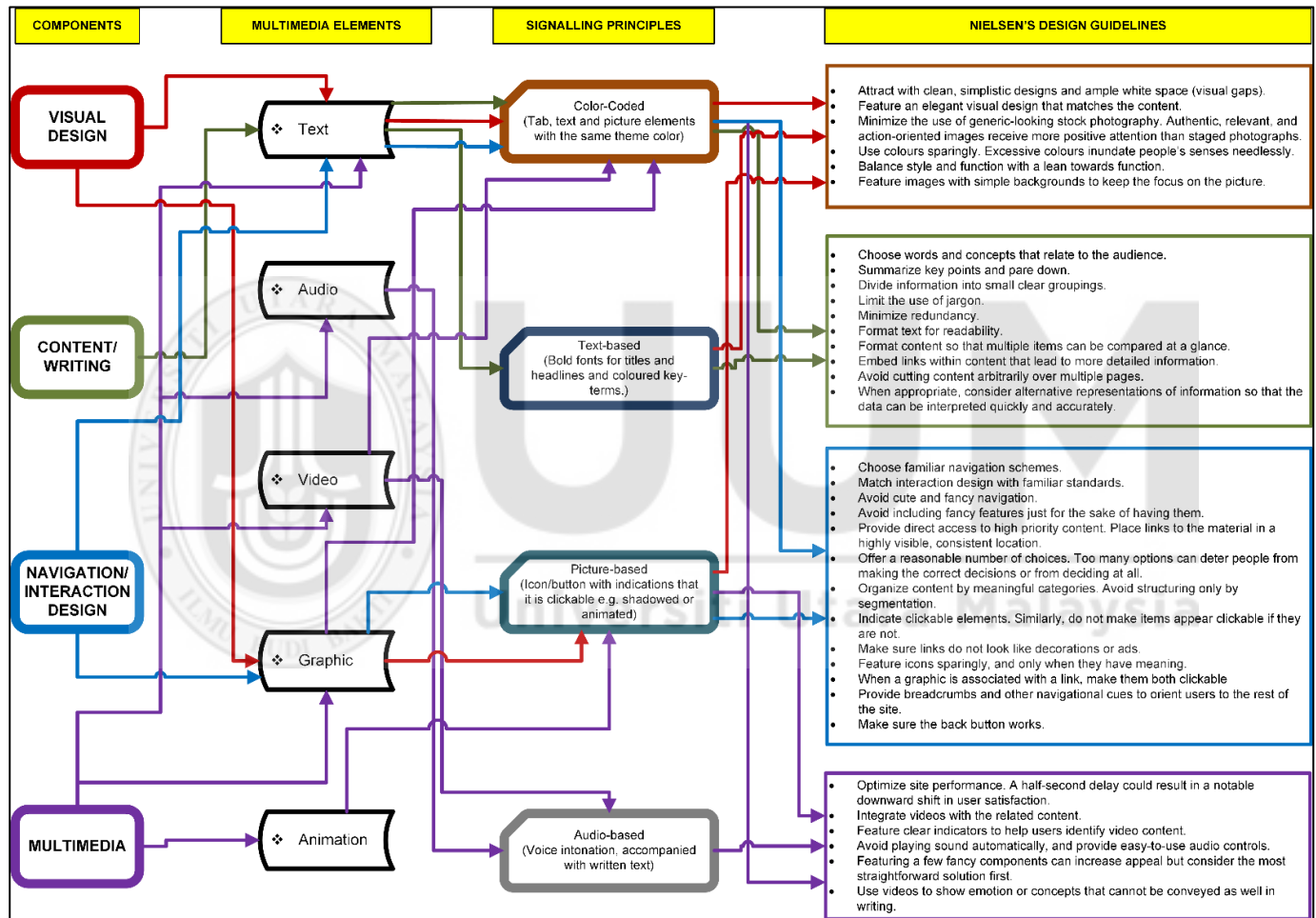


Figure 4.2. Proposed NSPIxD Model Version 1

4.3.2 User Requirement Survey

The user requirement survey is performed to gather requirements on the elements from users through a survey. This process serves as a complementing and detailing to the finding in the previous section. The online survey investigates the requirements of elements in a mobile application as demanded by the target users, the 18 to 24-year-old, as they fall into the highest age range using mobile phones (Malaysian Communications and Multimedia Commission, 2017, 2018). The subjects were selected through purposive sampling to provide valuable information that other options could not derive. The researcher includes participants in the study because they merit inclusion (Taherdoost, 2016).

The survey's questions, as indicated in Table 4.6, have been suggested, checked, and validated by three experts: an expert with a Ph.D. in IT; a professor who has served in Malaysia and various other countries for 30 years in the computing field; a software developer; and a six-year expert of the mobile industry, as well as from samples of questionnaires to ensure the questions' accuracy. These questions are based on the appropriate Nielsen design guidelines referred to by Kumar, Goundar, and Chand (2019, 2020), Lacey (2018), Loranger et al. (2014), Nielsen (2012), Nielsen and Budiu (2013), and Pettersson and Thai (2017). One hundred thirty-four participants of the targeted age have participated in this survey. This survey has three subsections: demographics, required elements for mobile apps, and suggestions.

Table 4. 6

User Requirement Survey Questions

No.	Questions	Options/Answer
Part A: Demographic		
1.	Age:	18-24 years old
2.	Gender:	Male/Female
3.	Education:	Masters/Degree/Diploma/Matriculation/Certificate/ SPM/STPM
Part B: Elements Required in A Mobile Interface Design		
4.	Title or Headlines	Bold/Italic/Underline /Colored fonts/Black colored
5.	Text for Content	Long explanation/ Short and simple
6.	Images	Real pictures/cartoon
7.	Voice	Children/Adult
8.	Audio	Automatically played/ Audio control, e.g., play, pause and stop
9.	Video	Embedded (Large memory capacity is needed when downloaded. Can be viewed anytime offline)/ Online, e.g., YouTube (Low memory capacity is needed during download. Consume data when playing the video)
10.	Background color	Color/Black/White
11.	Navigation	Button/Link/Icon
12.	Layout	Horizontal/Vertical
13.	Language	Easy/Medium/Difficult
14.	Organization of the overall app	Clean, simplistic designs and ample white space (visual gaps)/ An elaborate organization with intricate design and less white space.
15.	Quiz	Needed/Not needed
Part C: Suggestions		
16.	Other suggestions to improve the mobile apps interface design	

4.3.2.1 Demographics

Table 4.7 depicts the details for the first section of the survey, the demographic section. Students of various ages and education levels from numerous higher institutions have participated in this survey. 93 female and 41 male respondents with education backgrounds start from SPM/STPM/equivalent to Master level, most majoring in computing or IT fields. The sample is selected for quantitative analysis using an appropriate sampling technique, and the minimally suitable sample size is typically 30 participants (Brown & Green, 2016; Cohen & Swerdlik, 2009; Gay, Mills, & Airasian, 2012; Randolph, 2008).

Table 4. 7

<i>Demographic</i>			
Gender/Education	Female	Male	Grand Total
18 years old	11	3	14
Diploma / Matriculation / Equivalent	10	1	11
SPM / STPM / Equivalent	1	2	3
19 years old	21	11	32
Certificate / Equivalent		1	1
Degree / Equivalent	1		1
Diploma / Matriculation / Equivalent	20	8	28
SPM / STPM / Equivalent		2	2
20 years old	23	10	33
Degree / Equivalent	3	1	4
Diploma / Matriculation / Equivalent	19	9	28
SPM / STPM / Equivalent	1		1
21 years old	3	5	8
Degree / Equivalent		4	4
Diploma / Matriculation / Equivalent	3	1	4
22 years old	16	2	18
Degree / Equivalent	16	2	18
23 years old	9	5	14
Degree / Equivalent	7	5	12
Diploma / Matriculation / Equivalent	1		1
Master	1		1

24 years old	10	5	15
Degree / Equivalent	10	5	15
Grand Total	93	41	134

4.3.2.2 Required Elements in a Mobile App.

There are 12 questions in the second section of the survey, which consist of required detailed elements as suggested by (Chachil et al., 2015; Huilcapi-Collantes et al., 2020; Kamaruddin & Sulaiman, 2020, 2016; Lee et al., 2017; Malhotra & Verma, 2020; Muslimin et al., 2017). The first element is the title or headlines for mobile apps. As seen in Figure 4.3, 76.9 percent of respondents agreed that the title should be bold to highlight its importance. It is one of the Signaling principle's techniques in highlighting key ideas. It is the same as using colored fonts as voted by the respondents at 41.8 percent as their preference. Surprisingly, most respondents (greater than 70%) recommend that titles not apply black fonts, italic, and underlining. Therefore, designing a mobile app with bold and colored titles or headlines is essential.

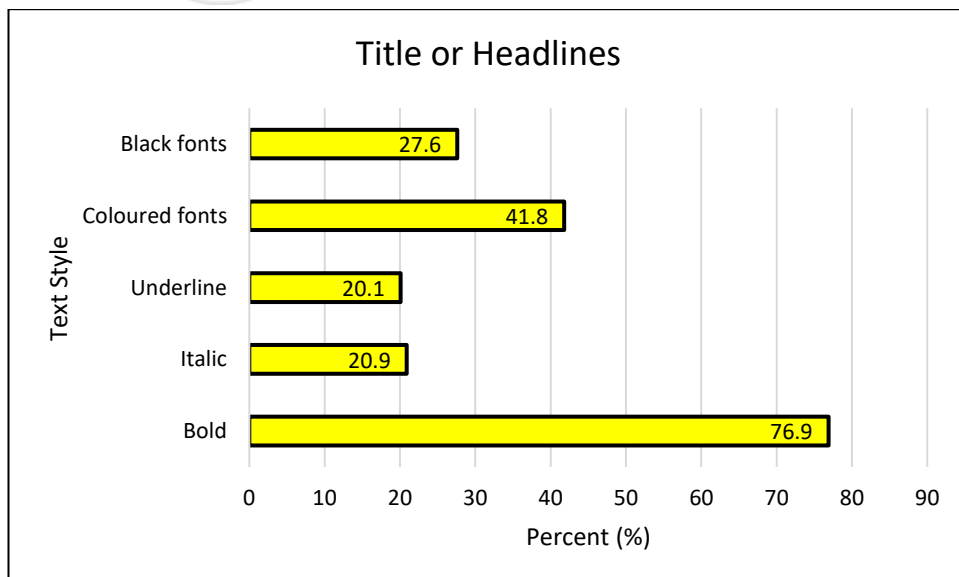


Figure 4.3. Title or Headlines

Next, in Figure 4.4, 82.8 percent of the respondents prefer icons for navigation style. Half of the respondents (58.2%) prefer buttons, and 13.4 percent prefer links. It explains that the most preferred navigation style for mobile apps is icon-based. It is perhaps because they interact with icons in most available mobile apps. There are various navigation styles, such as tabs and menus; however, it is not questioned in the survey as it is not suggested in the sample questions. Furthermore, it is more expected to be used on a website than on a mobile application.

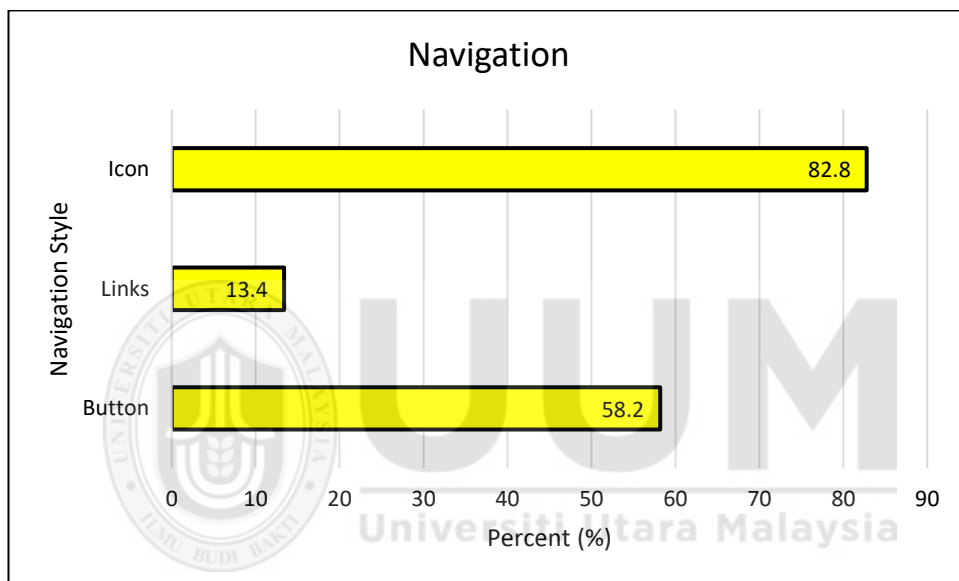


Figure 4.4. Navigation

As for background color, most respondents (50.7 percent) preferred a colored background over black or white, as seen in Figure 4.5, compared to white (31.3 percent) and black (17.9%). As a result, the most popular background color for mobile apps is a colored background. They likely prefer a bright setting because it is more cheerful and appealing.

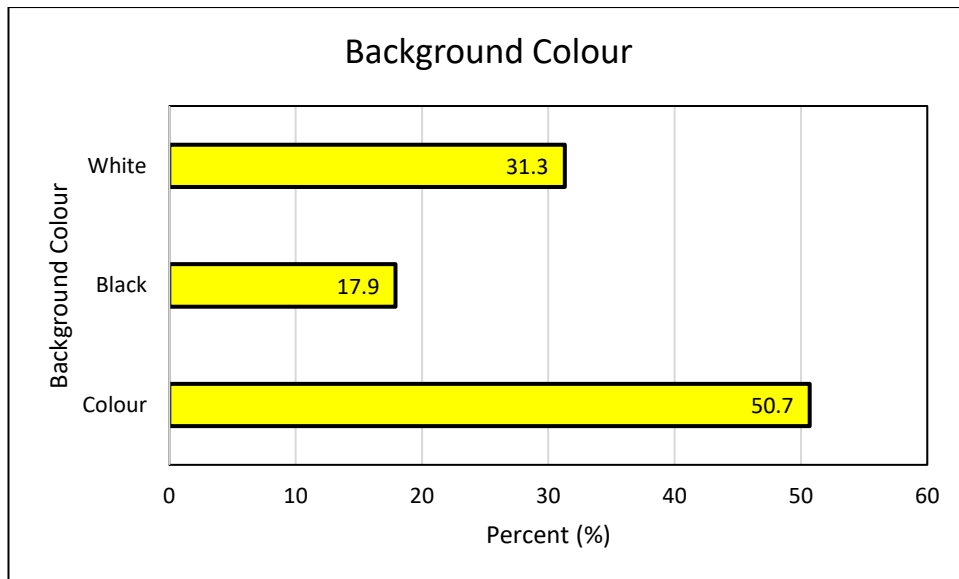


Figure 4.5. Background Color

Other elements needed in a mobile app are most commonly found in the content of the learning material, as depicted in Table 4.8. Almost all respondents prefer dealing with short and clear text to lengthy descriptions. Though Nielsen's design guideline states that college and university students detest their childhood treatment (Loranger et al., 2014), this appears to be severely understated. The same goes for cartoon and realistic images, where both are equal, with the difference only at 6 percent. People prefer the adult voice (67.9%) over children (36.7%). Most respondents choose audio controls (play, pause, and stop) rather than automatic playing.

While Nielsen (2014) recommends minimal downloading time, the studies find that respondents agree. However, it takes a toll on their handphone's memory as they prefer video learning materials to be embedded rather than streamed. Unfortunately, only a minority of students use their mobile data for studying, so only 62.70 percent vote on embedded videos. However, to ensure their phone memory's potential is not disturbed and the mobile app's size is optimized, the researcher decided to share links to the video instead of incorporating them into the applications. It is to avoid overwhelming

information from the videos. A vertical scroll surpasses a horizontal scroll by almost 80% of the layout element. There are initially three language choices, but 60 percent of respondents select the easy language form, and 39 percent select the medium language form. A quiz is conducted to determine the students' success and ensure that users understand the learning material. Finally, the users prefer a simple, clean, and ample white space layout that is simple to read and navigate (87.30 percent).

Table 4. 8

Elements to be included in A Mobile Learning App

Elements	Item 1 (%)	Item 2 (%)
Text for content	Short and simple 90.30	Long explanation 9.70
Images	Cartoon 53.00	Realistic 47.00
Voice	Adult 67.90	Children 32.10
Audio	Automatic 5.20	Audio Control 94.80
Video	Embedded 62.70	Online 37.30
Layout	Vertical Scroll 80.60	Horizontal Scroll 19.40
Language	Easy 60.40	Medium 39.60
Quiz	Needed 78.40	Not Needed 21.60
Overall Organization	Simple and clean 87.30	Elaborate and Complex 12.70

4.3.2.3 Suggestions

The last segment of the survey is intended to elicit input. A few suggestions have been made regarding what could be included in the mobile application. A few respondents have recommended that no advertising be incorporated into the mobile app, and one has proposed using caricatures instead. Other suggestions include a user-friendly and

aesthetic interface, various font families, icon organization, a search feature, and an up-to-date app. Table 4.9 depicts the suggestions from respondents.

Table 4.9

Suggestions from Respondents

No.	Suggestions
1.	no advertisement
2.	using anime for images though not to be too childish
3.	user-friendly and aesthetic design
4.	a variation of font-family
5.	icon organization
6.	Search function
7.	up to date

4.3.2.4 Summary of User Requirements

These user requirements are the assortments from the survey that have been done to target users. They are the preferable elements suggested and elected by respondents for mobile app design and development, as illustrated in Table 4.10.

Table 4.10

Summary of User Requirements

No.	Elements/Components	Guidelines from User Requirements
1.	Visual Design: Organization and layout	<ul style="list-style-type: none"> • The overall organization of the app should be clean and straightforward. • A vertical scroll layout is preferable.

-
- A colored background is preferable rather than a white or black colored background.
2. Content/Writing
- Title or headlines must be bold and colored.
 - Text for content must be short and straightforward.
 - Language should be easy to understand.
 - A quiz is compulsory for assessment.
 - Variation of font-family (suggestion).
 - No advertisements or inappropriate advertisements (suggestion).
3. Navigation and Interaction Design
- Navigation by the icon is a must, the next favorite is a button, and the least is a link.
 - Nicely organized icon.
 - User-Friendly and aesthetic design (suggestion).
4. Multimedia
- Search function (suggestion).
 - Embedded video is better than online / streaming video.
 - Audio control with pause, stop, and the play button is preferred over automatically played audio.
 - Adult voice is better than children's voice.
 - Cartoon images are the favorites though real photographs are also acceptable.
-



UUM
Universiti Utara Malaysia

4.3.2.5 Expert Review

This section contains recommendations from content experts to be included in the model. They were provided with the proposed NSPIxD model's softcopy and were asked to inspect the model for suggestions and improvements. Their suggestions came from a list given to them based on the appropriate Nielsen's design guidelines as alluding to Kumar, Goundar, and Chand (2019, 2020), Lacey (2018), Loranger et al. (2014), Nielsen (2012), Nielsen and Budiu (2013), and Pettersson and Thai (2017). Initial guidance from content experts states that the application must be interactive and incorporate the Signaling principle to highlight critical content and intelligence. Table 4.12 shows the survey feedback received from three content experts; two are Ph.D. holders from public universities in Malaysia, and one is from the industry, as stated in Table 4.11. It illustrates the results of the survey feedback received; the survey is structured around the four primary components identified by Chachil et al. (2015), Huilcapi-Collantes et al. (2020), Lee et al. (2017), Loranger et al. (2014), Muslimin et al. (2017), Vaghefi and Tulu (2019), and Widnall et al. (2020) as necessary components for an interaction model. This result is incorporated into the model to enhance and strengthen the proposed model's component guidelines.

Table 4.11

List of Content Experts

No.	Gender	Education	Fields of Expertise	Experience (Year)	Affiliations	
1.	Female	Ph.D.	Computer and Communication	30	Universiti Perlis	Malaysia
2.	Male	BSc. IT	Software Development	6	RPA Solution	
3.	Female	Ph.D.	Computer Science	15	Universiti Pahang	Malaysia

Table 4.12

Feedback from Content Experts

No.	Elements/Components	Guidelines from Content Experts
1.	Visual Design: Organization and layout	<ul style="list-style-type: none"> • The overall organization of the app should be clean and straightforward. • A vertical scroll layout is preferable. • A colored background is favored.
2.	Content/Writing	<ul style="list-style-type: none"> • Title or headlines must be bold. • Text for content must be short and straightforward. • Language should be easy to understand. • A quiz is compulsory for assessment.
3.	Navigation and Interaction Design	<ul style="list-style-type: none"> • Navigation by buttons and icons.
4.	Multimedia	<ul style="list-style-type: none"> • Embedded video or online/streaming video. • Audio control with pause, stop, and the play button is preferred over automatically played audio. • An adult voice is ideal. • Cartoon images or real photographs are tolerable.

4.4 Formulation of the Model

The NSPIxD Model has been formulated to reflect user requirements and expert recommendations, as illustrated in Figure 4.6. The distinction between versions 1 and 2 is that version 2 incorporates user requirements and expert advice, whereby version 1 only determines components and elements from the elicitation of existing models and comparative analysis. Moreover, version 1 contains only guidelines gleaned from

Nielsen's literature review. As a result, it is necessary to obtain better recommendations from the target user and experts based on the findings. Hence, version 2 is the complete version before the final expert review.



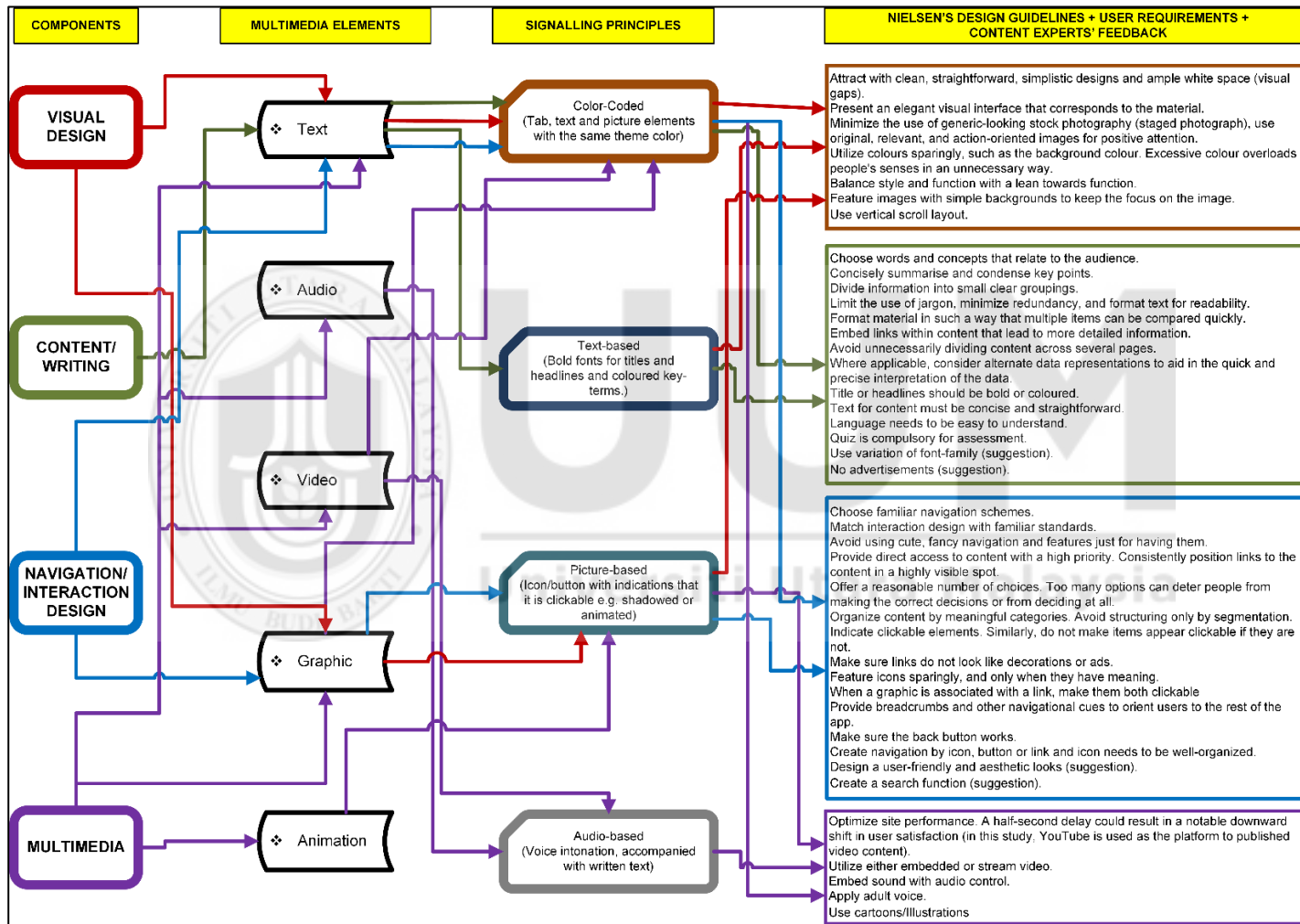


Figure 4.6. Proposed NSPIxD Model Version 2

4.5 Expert Review 2

According to Shneiderman, Plaisant, Cohen, and Jacobs (2010), three to five experts are needed for expert analysis. This report has enlisted more than enough experts in response to those recommendations, whose details are listed in Table 4.13. Experts from various public higher institutions were involved through interview sessions.

Table 4.13

List of Experts

No.	Gender	Education	Fields of Expertise	Experience (Year)	Affiliations
1.	Male	Ph.D.	HCI, Usability	19	Universiti Utara Malaysia
2.	Male	Ph.D.	Software Engineering	14	Universiti Teknologi MARA
3.	Male	Ph.D.	Instructional Design	21	Universiti Sains Malaysia
4.	Male	Ph.D.	Interaction Design	14	Universiti Kebangsaan Malaysia
5.	Female	Ph.D.	Multimedia Learning	10	Universiti Utara Malaysia
6.	Female	Ph.D.	Multimedia Systems, HCI	13	Universiti Utara Malaysia

The proposed guidelines were printed in color and A3 size and presented face-to-face to each expert. After scrutinizing the proposed guidelines, each has suggested a few added or eliminated factors from the list. The suggestions are listed in Table 4.14.

Table 4.14

Experts Review and Comments

Experts	Comments or Remarks
Expert 1	Overall, the components of the model are clearly stated. Information related to each component needs to be listed in detail.
Expert 2	Which theory and approach do you use to construct all the components, elements, and design principles? Do you have justifications for each component, element, and design principle? Simplify your terms and sentences; avoid ambiguous meaning.
Expert 3	The model should tally with the mobile applications, ensuring the principles are embedded precisely.
Expert 4	The model readability could be improved (it may need some rearrangement to ease reading flow). For example, use tick boxes instead of arrows.
Expert 5	The signaling/cueing could be used for multiple components, e.g., text-based can be used for interaction design, content, multimedia, and visual design.
Expert 6	Same comment as expert 5.

After five experts' reviews, the results were saturated, and the sixth expert no longer offered additional findings. As a result, the results obtained are adequate. As illustrated in Figure 4.7, the NSPIxD Model is revised to incorporate expert advice and comments and serve as the foundation for prototype development. The process is used to validate and refine the proposed model before implementing it in AHMA-0.

4.5.1 The NSPIxD Model

The model starts from the top to the bottom and from left to right. First, consider the application's primary components, the multimedia elements required for those components, the Signaling principles that must be employed, and ultimately, the Nielsen design guidelines that have been listed.

For instance, the designer must ensure that the application contains multimedia elements such as text and graphics for the Visual Design component. The Signaling principles employed are color-coded, text-based, and picture-based, concerning Nielsen's design recommendations.

The √ symbol indicates that the element is required for inclusion in the constructed application. At the same time, the colors red, green, blue, and purple represent the various components that must be adhered to. For instance, the red section is for the Visual Design component, which requires multimedia elements indicated in the √ symbol. As such, the Signaling principle is also denoted by the √ symbol. Finally, as shown in the box in the red region, the Nielsen design standards must be included.

Similarly, additional components, such as green for Content/Writing, blue for Navigation/Interaction design, and purple for Multimedia components, all use the same color scheme. Each color represents distinct components with aspects that must be applied to the mobile apps created to offer the best possible user experience.

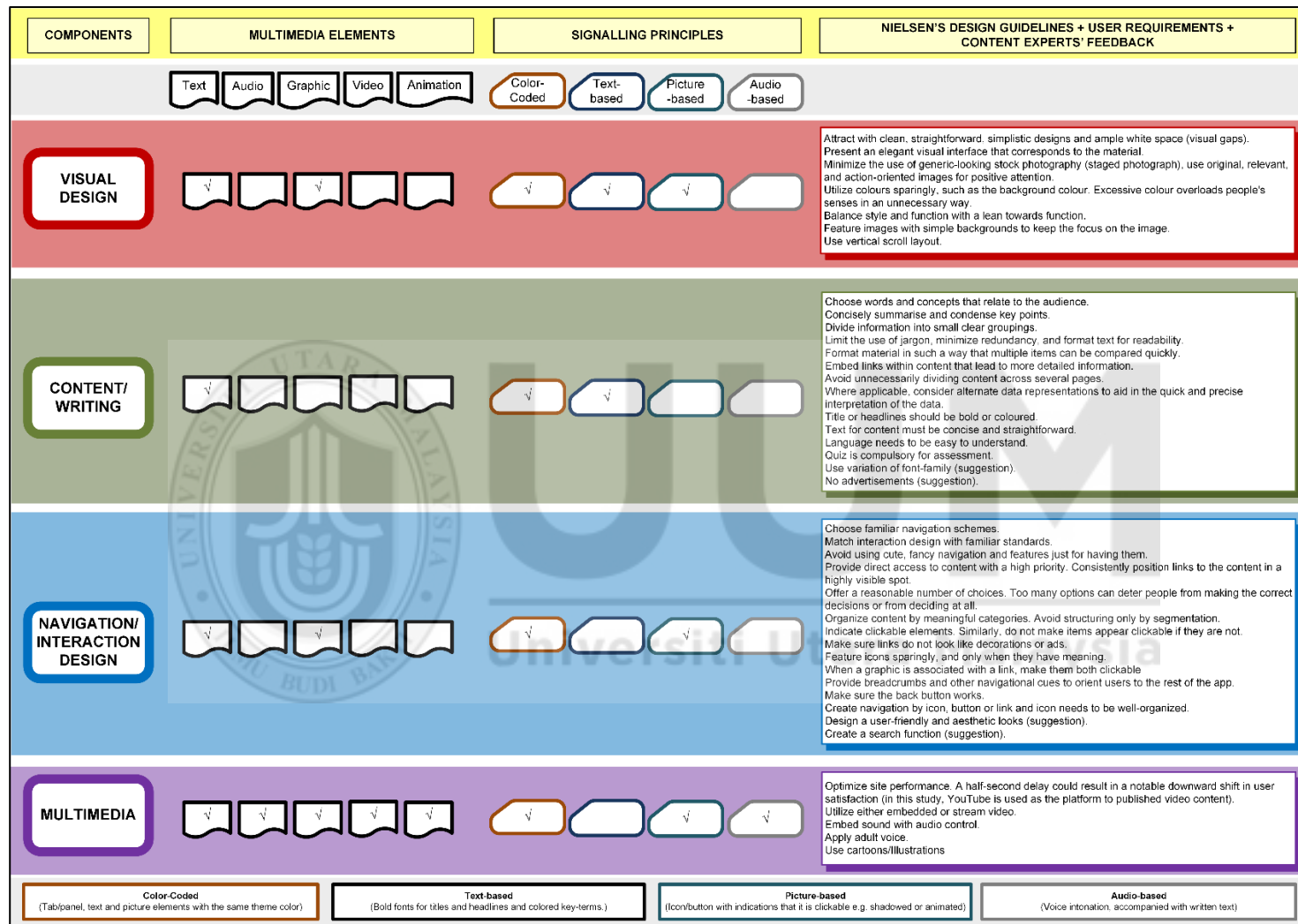


Figure 4.7. NSPIxD Model based on Final Experts' Review

4.6 Summary

This chapter explains the NSPIxD model in detail. It explains and proves ten models, encompassing five assistive and mobile learning models. Based on the comparative analysis in Chapter 4, core components were extracted. It produced four primary components, five multimedia elements, and four cues. Moreover, these researchers extracted various design elements and principles from existing studies and mapped them into their components. The study engaged the experts as consultants to verify these principles for university students. These design principles focus on user knowledge, perceived awareness, and perceived motivation of the learning materials. These features, which help the mobile application, illustrate that NSPIxD contains all the resources needed for a comprehensive platform. These outcomes further support the first and second objectives, which have already been determined. This investigation is also viewed as the first stage of the validation process because it utilizes expert review. The validated model is presented based on the findings. Finally, the model is translated into a working prototype, Asmaul Husna Mobile Application (AHMA-NSPIxD). It is to determine whether the anticipation of proposing this model is met.

CHAPTER FIVE

PROTOTYPE DESIGN AND DEVELOPMENT

5.1 Introduction

The prototype design and development are performed after the completion of the model. The prototype is developed based on the guidelines from the previous study, as stated in Chapter 4. Two prototypes were developed, one integrated with the proposed model, and the other has not, as described in Chapter 3. This chapter continues the validation process for the proposed model, which several experts have already validated in HCI, software engineering, and education. The revised version of the model was validated through prototyping to accomplish the study's third objective. This task requires a team of courseware developers to convert the NSPIxD model into a functioning prototype by decomposing it into its constituent parts. The success of the prototype development demonstrates that the model is beneficial in assisting the developers. Additionally, the model was tested at the end of the development phase. The content of AHMA- NSPIxD was aligned with design principles that address the target user's knowledge, perceived awareness, and motivation for the learning materials.

5.2 Instructional Design Model

Alessi and Trollip's Instructional Design Model govern this study's design and development phase (see Figure 5.1). The model envelopes three attributes and phases encompassing issues to be addressed and actions are taken, whereas the characteristics are standard, ongoing evaluation, and project management. Whereby the three stages involved are planning, design, and development. It serves as a guideline for designing and developing this research's mobile application. This model is selected because it is

flexible and fashioned according to needs, working style, philosophy, and environment. (Alessi & Trollip, 2001).

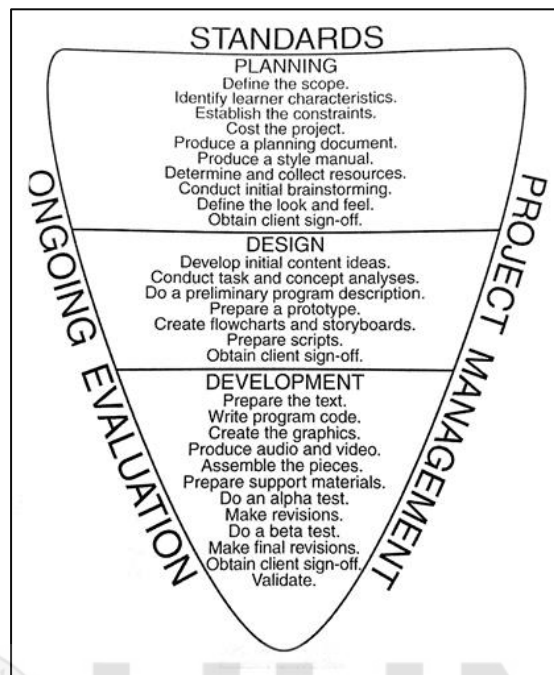


Figure 5.1. Alessi and Trollip Instructional Design Model (Alessi & Trollip, 2001)

5.2.1 Planning

The first phase in developing AHMA is the planning phase. This phase consists of three main activities, namely: (a) define the scope, (b) recognize learners' characteristics, and (d) determine and collect resources.

- a. Define the scope of the content.

To define the scope of the content, the researcher has conducted interviews with former lecturers from public universities who are the experts in Asmaul Husna and one Islamic religious teacher. According to the experts, knowledge, and awareness about Asmaul Husna, meaning, benefit, and application in daily life are still in infancy. The mobile application content is based on the 99 Asmaul Husna in the

Quran and Hadith. Content experts were consulted on the design and development of the mobile content to avoid any mistakes.

b. Identify learner characteristics.

The mobile learning application's target audience is Muslim youths from 18-24 years old, who are more likely would-be undergraduates.

c. Determine and collect resources.

Briefly, there are three kinds of resources needed in the study, especially before the development processes, which are: (i) content resources, (ii) instructional design resources, and (iii) delivery system resources.

i. Content Resources

The content source refers to information about the topic. The essential reference source is based mainly on interviews with content experts and other relevant materials such as printed and online materials—all the materials collected from a reliable and trusted party. The 99 names were collected and used, referring to established books based on the Quran and Hadith, articles, and consultation from the experts.

ii. Instructional Design Resources

The other essential reference is for design and instruction. The learning materials are books titled: (i) *Multimedia for Learning: Methods and Development* (Alessi and Trollip, 2001) to ensure the instructional design method, (ii) *Multimedia Learning* by Mayer (2016) to certify that the app is

presented with the correct multimedia design principles especially signaling principle, and (iii) Nielsen's Design Guidelines for College Students by Loranger et al., (2014) to ensure the definitive guides have been adopted for the target user which is the adolescents.

iii. Delivery System Resources

The resources include tutorials and textbooks on the software utilized in the mobile application development process. The delivery resources include the prototype's documentation and the software and hardware support manual.

5.2.2 Design

The second phase in the multimedia app development is the design phase; in this phase, the idea is translated into the first draft form. The activities involved in this phase are (i) developing content ideas, (ii) creating storyboards, (iii) preparing scripts, and (iv) preparing prototypes.

i. Developing content ideas

It is to develop ideas for content that generate concepts and learning approaches. Content and learning techniques were brainstormed with subject matter experts in the planning phase for this study.

ii. Drafting flowchart

A navigation map is needed to represent the mobile application's sequence and flow instead of a flowchart. The navigation map outlined the program structure

and depicted the connection between pages. It ensures the navigation's smoothness and the mobile application's user-friendliness.

iii. Creating storyboard.

A storyboard is a realistic visual planner, a progression of delineations and pictures in succession for a film, activity, realistic movement, or intuitive media arrangement. The fundamental motivation behind storyboard configuration is to consider the organization of ideas, deal with the materials, and inspect the concepts before the construction process. The upside of utilizing storyboards is that it permits the users to try different things with changes in the storyline to propose a more grounded response or intrigue (Rosmani & Wahab, 2011). The prototype design and development are performed after completing the model and storyboard. The prototype is developed based on the guidelines that have been generated in the design phase. Examples of the storyboard are depicted in Figure 5.2. It is crucial to determine all the information, principles, and design guidelines to implement and integrate. The storyboard is defined before the development process begins.

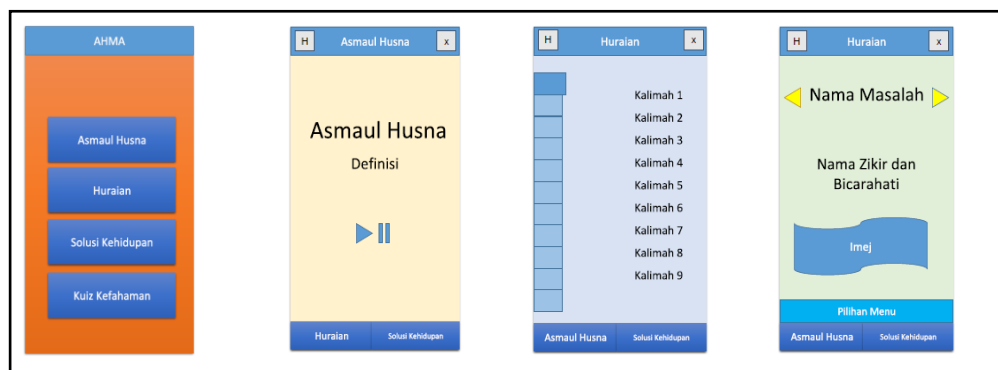


Figure 5.2 Storyboard

iv. Preparing prototype

A prototype is developed as an early intervention to validate the model into the learning material. It represents how the program looks and works and illustrates the look and feel, methodology, and metaphor used (Alessi & Trollip, 2001). Each successive prototype will increase infidelity (accuracy in presenting its products as visualized) until a final product is attained (Brown & Green, 2016). The development phase begins after all the storyboards and models are completed.

➤ Paper Prototyping

The paper prototyping technique was carried out before the development of the prototype. It ensures the mobile apps' flow and navigation and acquires and fulfills users' needs (Camburn et al., 2017; Hershman et al., 2018; Kang et al., 2019; Lauber et al., 2014; J. Nielsen, 2012; Thornton, 2019). Nielsen and Landaue (1993) suggest identifying around 85 percent of all usability problems with just five users. Therefore, this process was conducted in two parts: for experts and users. Three experts have been chosen to perform this activity: two Ph.D. holders from local universities and a mobile developer, as shown in Table 5.1. They are the content and software experts who have evaluated the content and flow or navigation. The experts are shown the paper mobile apps, divided into sections, and given some time to explore.

Table 5.1

List of Content and Software Experts

No.	Gender	Education	Fields of Expertise	Experience (Year)	Affiliations
1.	Female	Ph.D.	Social Science	10	Universiti Utara Malaysia
2.	Female	Ph.D.	Computer and Communication	25	Universiti Perlis
3.	Male	BSc. IT	Software Development	6	RPA Solution

After this process, students from a local college have been randomly selected to experience the prototyping process, as shown in Figure 5.3.

They are given some time to explore the paper apps, and each section is created to ensure they can navigate smoothly and adequately. Feedback from experts and students is considered, and appropriate acts have been done to accommodate their input.



Figure 5.3. Paper Prototyping Process with a Group of College Students

After the paper prototyping process, experts have some suggestions. The number of sub-menus provided is not too much and ensures that it is adequate for display in mobile applications because the phone screen is smaller than the laptop or desktop screen. The same goes for the content displayed so that it is not too long and difficult for users to read. Meanwhile, college students think the layout and navigation of apps should be more straightforward and not too much need to press the back button to return to the original page. It is essential to avoid confusing the users while using these apps. All suggestions were acknowledged and applied as best as possible in the prototype development process.

5.2.3 Macro and Micro Strategy in the Design of AHMA

The strategies for designing AHMA encompass macro and micro strategies recommended by Van Patten, Chao, and Reigeluth (1986), like the capability to meaningfully interweave micro and macro instructional principles indisputably brilliant (Spector et al., 2005). The macro strategy describes the selection, sequence, and organization of the contents to be presented, which summarizes the overall strategic plan. This research's macro strategy is stimulated by the Cognitive Theory of Multimedia Learning and Instructional Design Model as a guideline for designing, developing, and testing the multimedia learning application (Alessi & Trollip, 2001).

Micro strategies define effective learning content for learners, it embraces the Principles of Multimedia Design (Mayer, 2008) and Nielsen's Design Guideline (Loranger et al., 2014), and the design strategies are encapsulated in Constructivist

Learning Environment (Jonassen, 1999). Figure 3.3 represents the macro and micro strategies for the design of AHMA-NSPIxD.

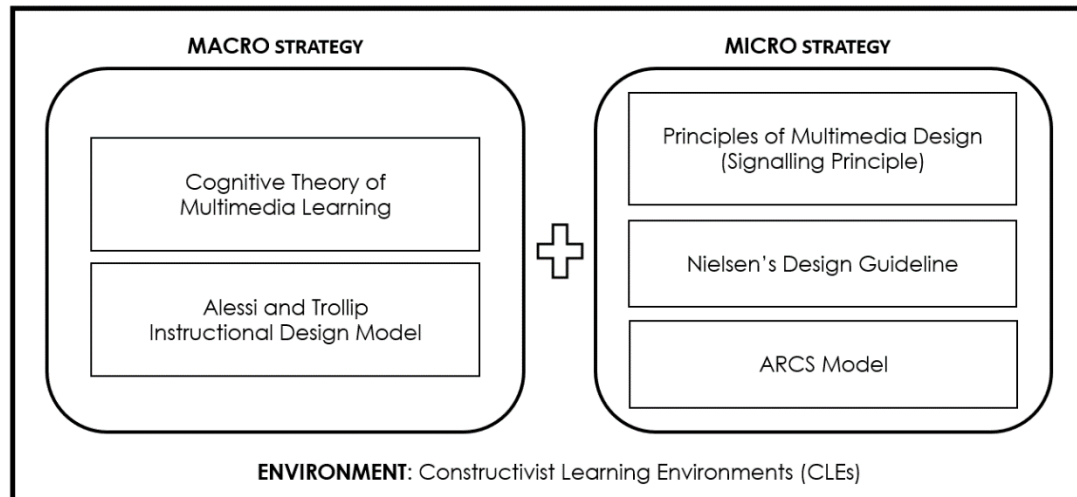


Figure 5.4. Macro and Micro Strategy in the Design of AHMA-NSPIxD

5.2.4 Development

There are seven steps in the development process altogether, (i) preparing the text, (ii) creating graphics, (iii) producing video and audio, (iv) assembling all the pieces, (v) conducting an alpha test, (vi) revising, and (vii) conducting the beta test.

i. Preparing text

The text is related to learning, which is about Asmaul Husna. It is prepared by the researcher based on interviews with content experts and Islamic references such as the Quran and Hadith. This text partially appears in the storyboard in the first place to review the mobile app draft.

ii. Creating graphics

Graphics is one of the most crucial multimedia elements in a mobile application. Suitable graphics illustrate the correct meaning for the content, and the pictures are retrieved from clip arts and public domain sources.

iii. Producing video and audio

Videos in these apps are related to the detailed explanation of Allah's names. These videos are captured during content experts' programs and edited to fit each of the names by the researcher. It is cut and modified from three days of video and audio recordings from different programs to meet the 99 names for more explanation and understanding. The voice-over recording of the app's supplication is checked by content experts and evaluated in terms of intonation and content of the prayer to make sure it is correct with the intended names and purpose of requests. Before hiring talent, examples are provided by the researcher to record the supplication audio to ensure the most suitable voice is chosen.

iv. Assembling pieces

When all required elements were created, the software developer combined them in Adobe Flash.

v. Conducting an alpha test

The alpha test is crucial for the design and development team; content and user interface validation occur at the end of alpha testing. Instructional design, user interface, and content experts are asked to review apps and instruments to evaluate content, flow, appearance, function, and interaction. In this study, the

alpha test is performed with a former lecturer with a Ph.D. qualification from a public university who is also a motivator for five years in Asmaul Husna learning. She has participated as a content expert in this alpha test. Three senior lecturers with Ph.D. qualifications have evaluated their usability in the developed Asmaul Husna mobile applications. Each expert completed questionnaires regarding the content and usability of these applications; the results are summarized in Section 5.4.

vi. Making revisions

The mobile application is then revised based on recommendations by experts in alpha testing. It is recommended that the assessment be made to eliminate weaknesses and stabilize the program.

vii. Conducting a beta test

After all the revisions are made, the last step is to run a beta test. Beta testing refers to a final inspection of end products by target users. It is officially carried out in small groups in a natural setting, with clear procedures on what to do and what to follow. Application verification was conducted to determine how much learning material works to achieve the intended learning outcome. For this study, beta testing is run as a pilot study where university students are selected as participants as the target audience. Thirty participants were involved in this test to ensure proper procedures were performed before the actual study.

5.3 Applications of the NSPIxD Model in AHMA

The model has been applied and implemented in the development of AHMA-NSPIxD.

The signaling principles and Nielsen’s design guidelines have been used in specific mobile app interfaces, as shown in Figure 5.5.



A flashing button is used using the picture-based technique, which indicates that it is clickable with a flashing signal.



No flashing button as a guidance



The app name is animated on the screen.

The main menu buttons are shown using an animated hand icon to depict the picture-based signal to show clickable buttons. The buttons are shadowed to make them stand out.



The app name is not animated.

No hand icon, colored and shadowed buttons.



One of the 99 names' meanings and the text-based signal are applied to highlight the meaning and essential keywords.

Images and videos are used to elaborate the meaning of the name.



The 99 names' meanings and keywords are not highlighted.

No images or videos for a detailed explanation.

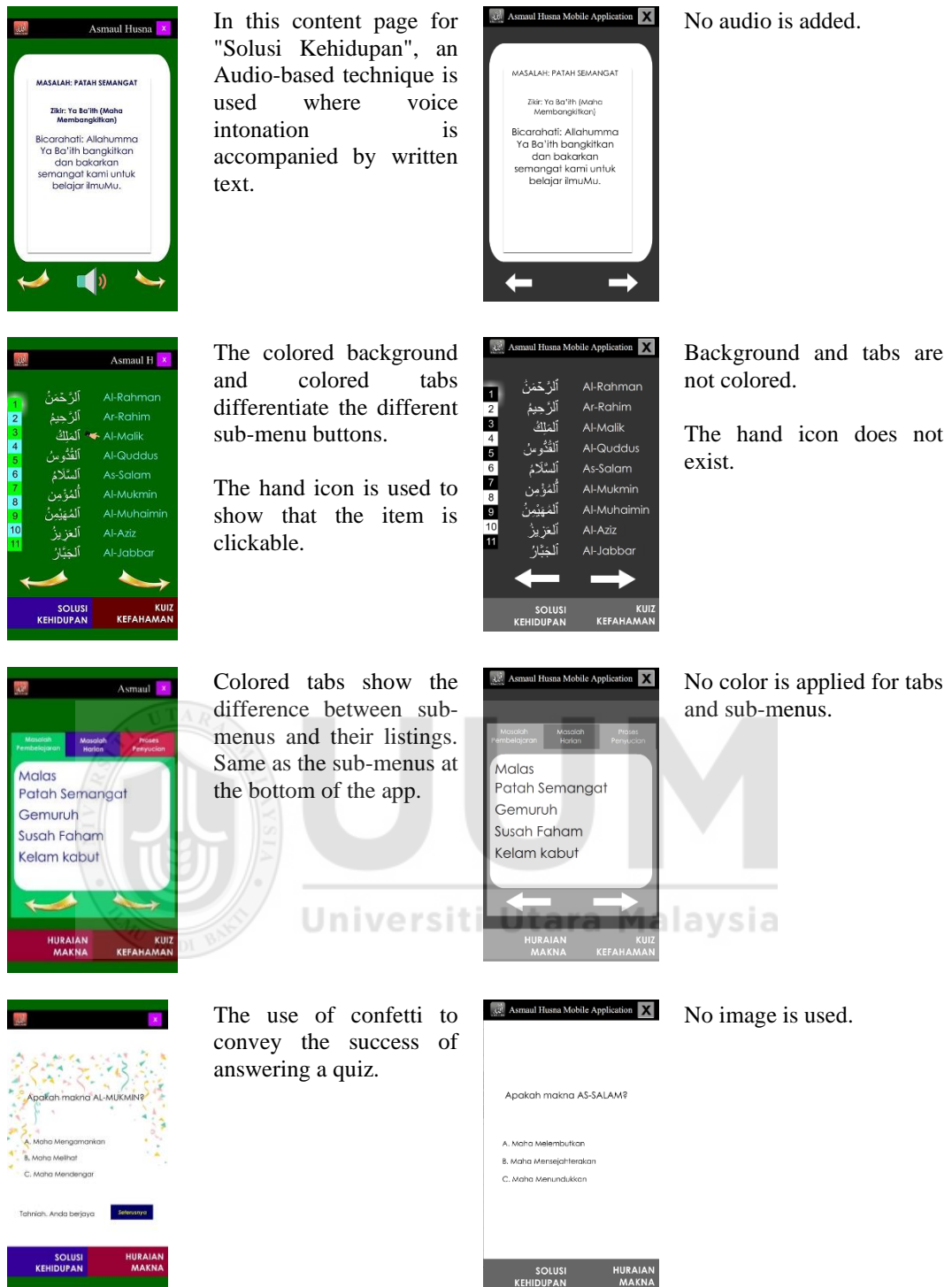


Figure 5.5 Integration of NSPIxD Model in the Prototype

5.4 Heuristic Evaluation Results

According to Nielsen (1994a), a heuristic assessment requires three individual evaluators. Three experts conducted these experiments to ensure that the proposed

model was used and applied. It is introduced for the prototype to operate efficiently and receive feedback and guidance to develop the prototype. The experts involved are listed in Table 5.2.

Table 5.2

List of Experts for Heuristic Evaluation

No.	Gender	Education	Fields of Expertise	Experience (Year)	Affiliations
1.	Male	Ph.D.	Software Engineering	14	Universiti Teknologi MARA
2.	Male	Ph.D.	Interaction Design	14	Universiti Kebangsaan Malaysia
3.	Male	Ph.D.	Instructional Design	21	Universiti Sains Malaysia

The questions in this questionnaire were adapted from Nielsen (1994b), listed in Table 5.3. This survey employs a Likert scale ranging from 1 to 5, from strongly disagree to strongly agree.

Table 5.3

Heuristic Evaluation Questionnaire

VISIBILITY OF SYSTEM STATUS	
1	It is clear what information is available at the current location.
2	The current information matches what you expect to find.
3	It is clear where you can go from the current location.
4	It is always clear what is happening from each action you perform.
NAVIGATION, USER CONTROL, AND FREEDOM	
5	It is always easy to return to the Main Menu
6	Accessing all significant portions of the application from the Main Menu is easy.
7	Graphic links are also available as text links
8	It is easy to cancel or exit from operations.

CONSISTENCY AND STANDARDS

- 9 Standard menus are used throughout the application.
- 10 Standard buttons are used throughout the application.
- 11 Standard fonts are used throughout the application.

AESTHETIC AND MINIMALIST DESIGN

- 12 The application's structure is straightforward without unnecessary complications.
 - 13 There are no instances of extraneous information.
 - 14 There are no instances of misplaced information.
 - 15 Color choices allow for easy readability.
 - 16 The application is aesthetically pleasing.
 - 17 No unnecessary technologies are used.
-

All the expert reviews were successful in bringing the following recommendations to

AHMA-NSPIxD:

- 1. Several of the navigation buttons are dysfunctional.
- 2. Some menu items are currently inactive.
- 3. Some shadowing is not required.
- 4. Maintaining a proper balance between simplicity and clarity of design is critical.
- 5. The animated text could make the user feel challenged to focus on the main content; therefore, the animation should stop when it reaches the middle of the screen.

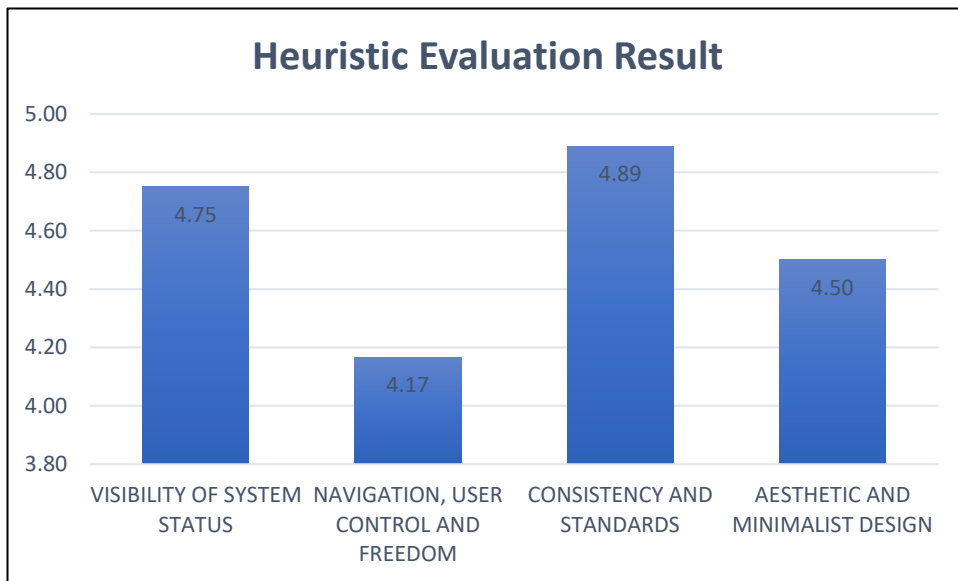


Figure 5.6. Heuristic Evaluation Result

The summary of the results is depicted in Figure 5.6. The visibility of system status describes how well the system status is conveyed. Users must be provided with relevant information to track what is happening as expeditiously as possible (Harley, 2018). This item's score is 4.75, which shows that the experts strongly agree with the system status's clarity. Navigation, user control, and freedom are when in many cases, users make mistakes or come to a change of mind, which means it's essential to provide an option to allow them to return to their previous state or undo their last action (Rosala, 2020). The score for this item is 4.17, which reveals that the experts concur with the application navigation. Consistency and standards are the most valuable principle of any product, brand, or identity. A system or product should never present a confusing mix of words, actions, looks, or scenarios to derive the same meaning (Krause, 2021). The experts give this item a score of 4.89, indicating that they strongly agree with AHMA-0's consistency. Appealing designs can create memorable consumer experiences that define a brand. However, only the core aspects of an interface should be included. Ultimately, the truth will always prevail in clarity over

style (Fessenden, 2021). This earned a score of 4.50, indicating that the mobile application is simple and appropriate.

5.5 Summary

This chapter describes the prototype creation method for validating the NSPIxD model. A team of developers conducts the prototyping method in a three-phase development process. As a result, the AHMA is delivered. The prototype contains the planned components and elements that experts have already accepted. They were included in the AHMA content framework, describing how to use each component and feature. The entire content is based on the NSPIxD design principles, emphasizing knowledge, perceived awareness, and perceived motivation of the learning materials. They are demonstrated with a series of screen samples, including detailed descriptions. This study concludes that the NSPIxD model's validation has been achieved after discussing and describing the development activity. AHMA is ready for data collection in user interface testing, conferring to the prototype. Consequently, Chapter 6 explains a user experience study that focuses on knowledge, perceived awareness, and perceived motivation of the learning materials.

CHAPTER SIX

RESULTS AND DISCUSSIONS

6.1 Introduction

Chapter 6 discusses the results after the experiments were successfully implemented for the target audience. These results include actual experiments on two different groups. Before the actual study, pilot studies are carried out to ensure that the instruments and flow that need to be carried out are in good working order. The two groups involved were groups using AHMA-0 and those using AHMA-NSPIxD, integrated with NSPIxD and without the integration. All data collected in this study are evaluated using IBM SPSS Statistics Version 26, and descriptive and inferential statistics are applied, as previously stated by Abdul Wahab (2016), Melhem (2014), Menon (2016), Osman (2015b), and Othman (2015).

6.2 Sample Distribution

The study was initially conducted on 229 students at three universities in Perlis and Kedah, as depicted in Table 6.1. The actual study distinguished between 2 mobile application modes, namely AHMA-0 and AHMA-NSPIxD.

Table 6.1

<i>Initial Participants Involved</i>		
Experiments	Number of participants	%
AHMA-0	116	50.7
AHMA-NSPIxD	113	49.3
Total	229	100

Table 6.2

Actual Participants Involved

Experiments	Number of participants	%
AHMA-0	89	43.6
AHMA-NSPIxD	88	42.5
Total	177	100

However, based on Table 6.2, as some students do not complete the pre-test and post-test or the IMMS, the total amount of data analyzed is less. Some attended the pre-test only, and others participated in the post-test only. Others only answered the IMMS and did not submit the other responses. Besides, many are non-Muslim students, so the data is invalid as they have no previous experience in Asmaul Husna learning.

Table 6.3

Gender

Gender	Number of Participants
Male	76
Female	101
Total	177

There are 76 male participants involved in this test, whereas 101 participants are female, up to 177 Muslim undergraduate students, as illustrated in Table 6.3.

6.3 Homogeneity of the Two Experimental Groups

Subjects were assumed to be similar in an educational context because they were screened through a centralized UPU online system before enrolling at their respective

university. There are homogeneous samples, as they have the same knowledge and skills regardless of the region. However, a Levene homogeneity test was performed on the pre-test knowledge scores to ensure that this sample is homogeneous regarding their existing knowledge about Asmaul Husna.

Table 6.4

Levene's Test on Knowledge Pre-Test Score

Levene Statistic	df1	df2	Sig.
3.849	1	175	.051

Levene's test verified the equality of variances in the samples (homogeneity of variance) ($p > 0.05$), as shown in Table 6.4. The result explains that it supports the homogeneity of variance assumption of ($F=3.849$, $p=0.051$). Thus, fulfilling the parametric statistical analysis' equality of variance assumption. The result also indicates that the p-value of 0.051 is more than 0.05 ($p > 0.05$). It designates that the variances between the groups in the pre-test scores are approximately equal. Therefore, before receiving the treatment, the participants could be considered homogeneous in their prior knowledge of Asmaul Husna. Consequently, any gains in their knowledge are assumed as treatment outcomes.

This test is also conducted for the Perceived Awareness pre-test to ensure the equality of variance between samples in the control and treatment groups.

Table 6.5

Levene's Test on Perceived Awareness Pre-Test Score

Levene Statistic	df1	df2	Sig.
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0.390	1	175	0.533
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Levene's test verified the equality of variances in the samples (homogeneity of variance) ($p > 0.05$), as shown in Table 6.5. It explains that it supports the homogeneity of variance assumption ($F=0.390$, $p=0.533$), thus fulfilling the parametric statistical analysis' equality of variance assumption. The result in Table 6.5 also indicates that the p-value of 0.533 is more than 0.05 ($p > 0.05$). That shows the variances between the groups in the pre-test scores are approximately equal. Therefore, before receiving the treatment, the participants could be considered homogeneous in their initial perceived awareness of Asmaul Husna. Consequently, any gains in their perceived awareness score are considered treatment outcomes.

This test is then carried out for the Perceived Motivation score to ensure the equality of variance between samples in the control and treatment groups.

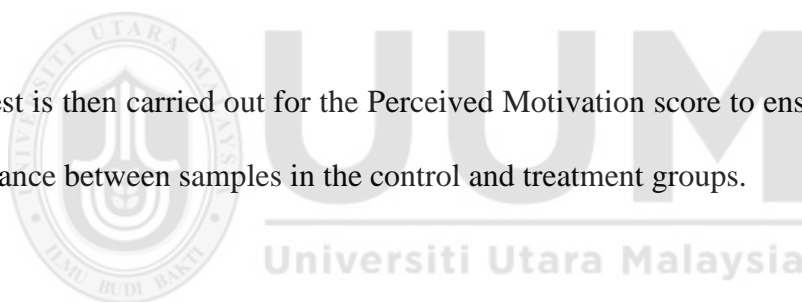


Table 6.6

Levene's Test on Perceived Motivation Score

Levene Statistic	df1	df2	Sig.
0.097	1	175	0.756

Levene's test verified the equality of variances in the samples (homogeneity of variance) ($p > 0.05$), as shown in Table 6.6. The result explains that it supports the homogeneity of variance assumption of ($F=0.097$, $p=0.756$). Thus, fulfilling the parametric statistical analysis' equality of variance assumption. The result also indicates that the p-value of 0.756 is more than 0.05 ($p > 0.05$). It means that the variances between the groups in the scores are approximately equal. Therefore, the

participants could be considered homogeneous in their motivation to use the learning materials. Consequently, any gains in their scores are assumed as treatment outcomes.

A one-way ANOVA pre-test data analysis was first measured, in which the results for knowledge are listed in Table 6.7. The table indicates that the p-value is below 0.05, implying appropriate for ANCOVA analysis.

Table 6.7

ANOVA Analysis of Knowledge Pre-Test Score

		Sum of Squares	df	Mean Square	F	Sig.
Pre-Test (Knowledge)	Between Groups	116.826	1	116.826	42.429	0.000
	Within Groups	481.852	175	2.753		
	Total	598.678	176			

Table 6.8 illustrates the ANOVA analysis for the perceived awareness pre-test scores. The p-value is 0.000, less than 0.05, and the data is ready for ANCOVA analysis.

Table 6. 8

ANOVA Analysis of Perceived Awareness Pre-Test Score

		Sum of Squares	df	Mean Square	F	Sig.
Pre-test (Perceived Awareness)	Between Groups	14.212	1	14.212	28.709	0.000
	Within Groups	86.632	175	.495		
	Total	100.845	176			

6.4 Normality Test

The normality test shall determine if the sample mean is normally distributed. An asymmetrical, bell-shaped curve indicates a standard distribution with the highest-scoring frequency in the center and the lowest in the extreme (Wallnau & Gravetter, 2016). Normality can be measured using the shape of the histogram's curve, the Normal Q-Q plots, and the Box Plots. Besides, Skew and Kurtosis's values can be used to evaluate the normality of distribution (Pallant, 2010). The test scores for knowledge, perceived awareness, and motivation toward learning materials have been tested for normality to assume a normal distribution.

6.4.1 Normality Test on Knowledge Scores

Knowledge score is the first dependent variable and has been tested for normality. The Skewness and Kurtosis values for the knowledge scores of the overall participants are shown in Table 6.9.

Table 6.9

Skewness and Kurtosis on Knowledge Scores

Dependent Variable	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Knowledge	0.127	0.183	-0.177	0.363

The Skewness value in Table 6.9 is 0.127 (SE=0.183), and the Kurtosis value is -0.177 (SE=0.363). These values fall between -1.96 and 1.96, which, according to Chua (2012), indicates the normal distribution of the mean scores. This result is supported by the Normality histogram (Figure 6.1) and Q-Q plots (Figure 6.2), showing that the learners' knowledge scores have been normally distributed.

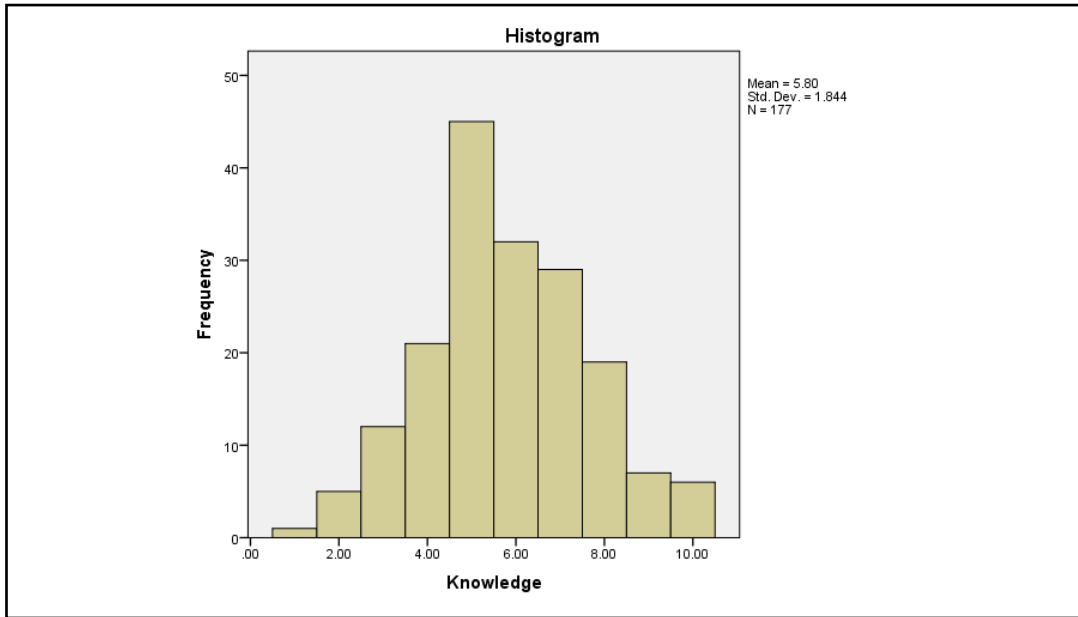


Figure 6.1. Histogram for Normality of Knowledge Score

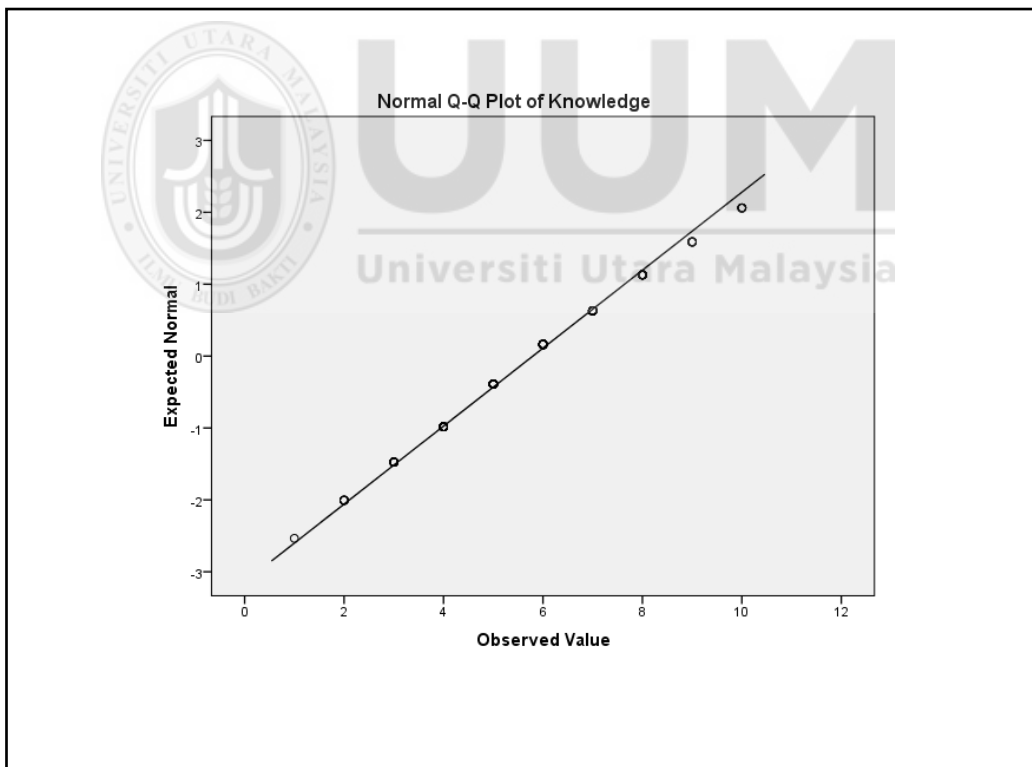


Figure 6.2. Normal Q-Q Plot of Knowledge Score

6.4.2 Normality Test on Perceived Awareness Scores

The normality test is carried out to analyze the distribution of perceived awareness scores among participants. Table 6.10 outlines the Skewness and Kurtosis statistical values, which fall between -1.96 and 1.96, indicating that this dependent variable's scores are normally distributed (Chua, 2012).

Table 6.10

Skewness and Kurtosis on Perceived Awareness Scores

Dependent Variable	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Perceived Awareness	0.299	0.183	-0.705	0.363

This result is also visible in the normality histogram (Figure 6.3) and the normal Q-Q plot (Figure 6.4).

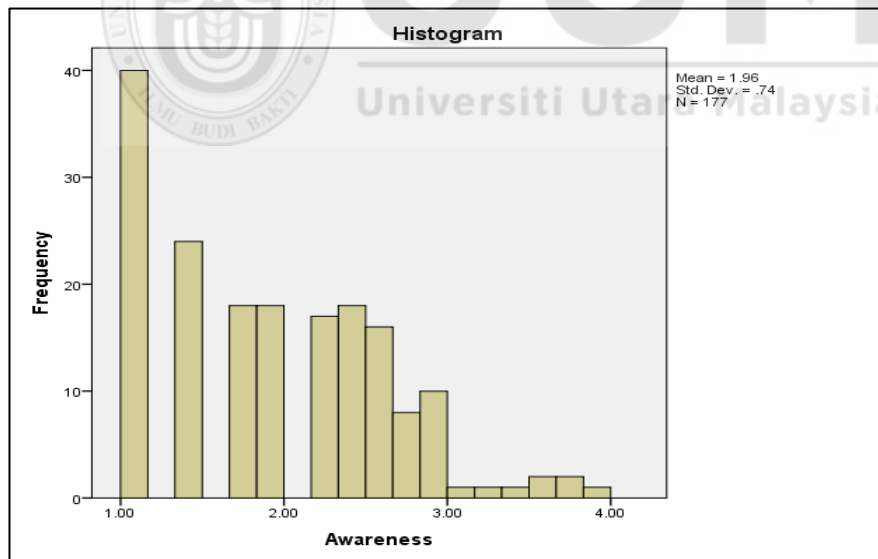


Figure 6.3. Histogram for Normality of Perceived Awareness Score

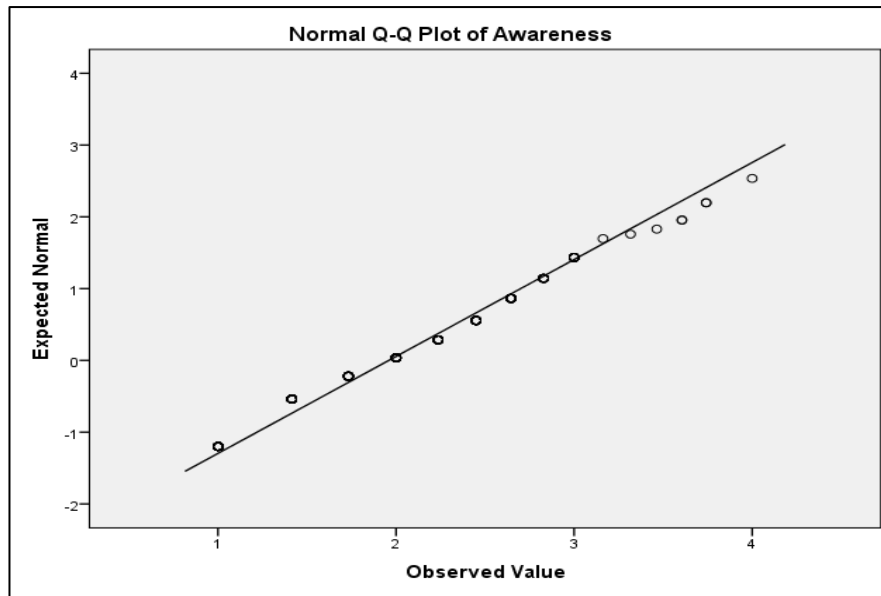


Figure 6.4. Normal Q-Q Plot of Perceived Awareness Score

6.4.3 Normality Test on Perceived Motivation Scores Towards Learning

Materials

Using the normality test, the participants' perceived motivation towards the instructional material IMMS scores were analyzed to determine whether the means were distributed normally. The Skewness and Kurtosis results are shown in Table 6.11.

Table 6.11

Skewness and Kurtosis on Perceived Motivation Scores

Dependent Variable	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Motivation	0.104	0.183	-0.235	0.363

In Table 6.11, the Skewness value is 0.104 (SE=0.183), and the Kurtosis value is -0.235 (SE=0.363). According to Chua (2012), these values fall between -1.96 and 1.96, which indicates the normal distribution of mean scores. The normality histogram

supports this outcome (Figure 6.5) and Q-Q plots (Figure 6.6), which show that the learners' perceived motivation scores were normally distributed.

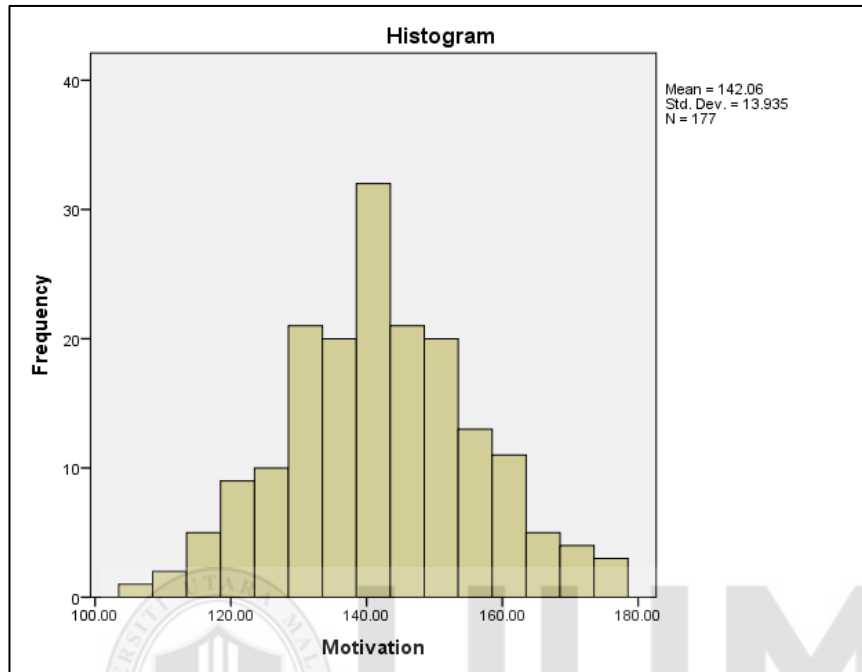


Figure 6.5. Histogram for Normality of Perceived Motivation Score

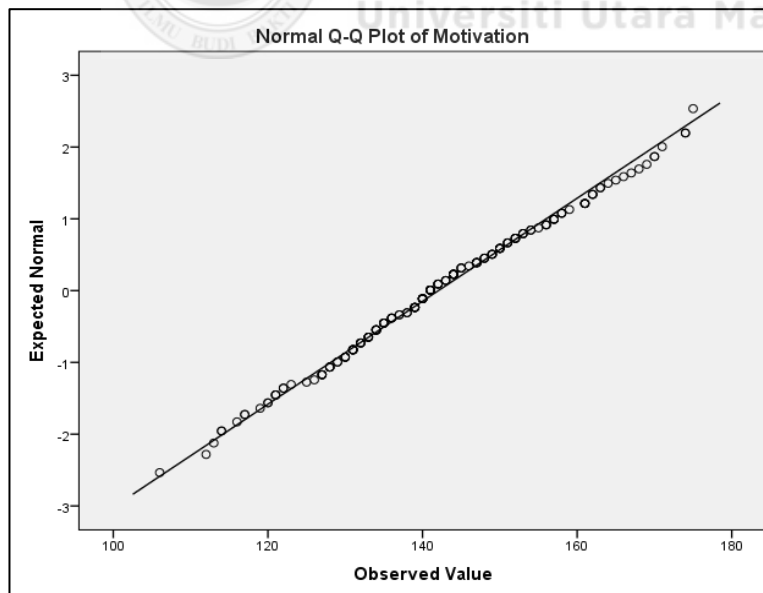


Figure 6.6. Normal Q-Q Plot of Perceived Motivation Score

6.5 Statistical Analysis of Results Corresponding to research Questions

This study was designed to respond to three research questions related to knowledge, perceived awareness, and motivation toward learning material, as defined in Chapter

1. The null hypotheses for the study are:

1. There is no significant difference in Muslim users' knowledge of Asmaul Husna between the mobile application integrated with the proposed model (AHMA-NSPIxD) and the mobile app without the model (AHMA-0). As to support that, the following subsidiary hypotheses need to be tested:

H_{01a}: There is no significant difference in Muslim users' knowledge of Asmaul Husna between AHMA-0 and AHMA-NSPIxD.

2. There is no significant difference in Muslim users' perceived awareness of Asmaul Husna between the mobile application integrated with the proposed model (AHMA-NSPIxD) and the mobile app without the model (AHMA-0).

H_{02a}: There is no significant difference in Muslim users' perceived awareness of Asmaul Husna between AHMA-0 and AHMA-NSPIxD.

3. There is no significant difference in Muslim users' perceived motivation toward learning material across the mobile application. The mobile application is integrated with the proposed model (AHMA-NSPIxD) and the mobile application without the model (AHMA-0).

H_{03a}: There is no significant difference in Muslim users' perceived motivation toward learning material between the AHMA-0 and AHMA-NSPIXD.

6.5.1 Testing of Hypothesis H_{01a}

H_{01a}: There is no significant difference in Muslim users' knowledge of Asmaul Husna between AHMA-0 and AHMA-NSPIXD.

Hypothesis H_{01a} analyzed the independent variable's acute effects: knowledge of the dependent variable, the presentation mode with signaling principles (AHMA-NSPIXD), and the presentation mode without the principles (AHMA-0). A descriptive test was conducted to evaluate the presentation mode with a significant difference in the participants' knowledge scores. In addition, the mean and standard deviation between the pre-test and post-test scores was also determined across the groups. Table 6.12 provides informative statistics on the disparity between pre-test and post-test scores through pre-test, post-test, and mean presentation types.

Table 6.12

Descriptive Statistics for Pre-and Post-Test for Knowledge Score between Groups

Group		Pre-Test	Post-Test
AHMA-0 (Control)	N	88	88
	Mean	6.6136	8.0455
	Std. Deviation	1.77746	2.06174
	Std. Error of Mean	0.18948	0.21978
AHMA- NSPIXD (Treatment)	N	89	89
	Mean	4.9888	8.3933
	Std. Deviation	1.53367	1.26687

	Std. Error of Mean	0.16257	0.13429
Total	N	177	177
	Mean	5.7966	8.2203
	Std. Deviation	1.84434	1.71293
	Std. Error of Mean	0.13863	0.12875

According to the comprehensive statistical review in Table 6.12, 89 participants were assessed through AHMA-0 and 88 via AHMA-NSPIxD. AHMA-NSPIxD pre-test scores mean is 4.9888, and the post-test scores mean is 8.3933. AHMA-0 displays 6.6136 for the pre-test mean and 8.0455 for the post-test mean. The mean difference for AHMA-NSPIxD between the post-test and pre-test scores is 3.4045, while the mean difference for AHMA-0 is 1.4319. Therefore, this suggests that compared to their peers, the participants who learned using AHMA-NSPIxD gained more knowledge.



Table 6.13

Levene's Test of Equality of Error Variances for Knowledge Score between Groups

Levene Statistic	df1	df2	Sig.
3.849	1	175	0.051

To further explore the hypothesis, Levene's homogeneity test was performed to assess if the error variance in the pre-test score is equal in both types of presentation. Accordingly, Table 6.13 illustrates Levene's test for knowledge equality of error variances across the results of AHMA-0 and AHMA-NSPIxD. The results show the p-value to be 0.051, greater than 0.05. Therefore, it violates the principle of equality, which means relatively similar variances in pre-test scores across the presentation types.

Table 6.14

ANCOVA Analysis for Knowledge Score between Groups

Source	Type III Sum		Mean Square	F	Sig.
	of Squares	df			
Corrected Model	161.090 ^a	2	80.545	39.443	0.000
Intercept	320.816	1	320.816	157.105	0.000
Pre-Test	155.737	1	155.737	76.265	0.000
Group	57.583	1	57.583	28.199	0.000
Error	355.317	174	2.042		
Total	12477.000	177			
Corrected Total	516.407	176			

a. R Squared = .312 (Adjusted R Squared = .304)

Also, ANCOVA was conducted to see whether there is a significant difference in knowledge between the AHMA-0 and AHMA-NSPIxD participants. The results obtained are summarized in table 6.14. The p-value is shown to be 0.000, which is under 0.05. Hence this result is significant. There is a substantial difference between AHMA-0 and AHMA-NSPIxD in the knowledge score. Therefore, the H_{01a} hypothesis has not been accepted. These results explain that participants who used the AHMA-NSPIxD received higher scores on their knowledge than AHMA-0. Thus, the AHMA-NSPIxD is effective in enhancing the student's understanding.

Table 6. 15

Pair-wise Comparisons for Knowledge Score between Groups

(I) Group	(J) Group	Mean	Std. Error	Sig. ^b	95% Confidence Interval for	
		Difference (I-J)			Difference ^b	
					Lower Bound	Upper Bound
AHMA-0 (Control)	AHMA- NSPIxD (Treatment)	-1.264*	.243	.000	-1.744	-.784

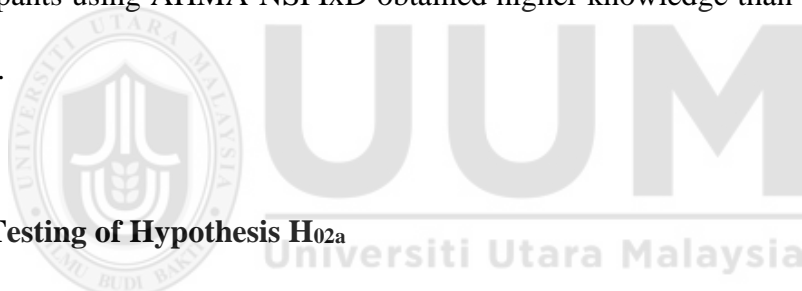
AHMA-NSPIxD (Treatment)	AHMA-0 (Control)	1.264*	.243	.000	.784	1.744
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Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

A pair-wise comparison is then carried out to examine whether participants have a substantial difference in knowledge gained. Finally, a separate variance analysis was performed to assess which group was responsible for the effect. The results of the pair-wise comparison are detailed in Table 6.15. The findings showed a substantial difference in knowledge gain between the treatment group participants and the control group (p-value=0.000, mean difference=1.264). This outcome suggests that participants using AHMA-NSPIxD obtained higher knowledge than the presentation modes.



6.5.6 Testing of Hypothesis H_{02a}

H_{02a}: There is no significant difference in Muslim users' perceived awareness of Asmaul Husna between AHMA-0 and AHMA-NSPIxD.

Hypothesis H_{02a} explores the principal effects of the independent variable's two presentation modes, AHMA-0 and AHMA-NSPIxD, on the dependent variable: perceived awareness. The descriptive statistical analysis of the perceived awareness scores across the presentation modes was conducted before the inferential statistical analysis. Eventually, the pre-test and post-test descriptive statistics for the groups were collected and shown in Table 6.16.

Table 6.16

Descriptive Statistics for Pre-Test and Post-Test for Perceived Awareness Score

Group		Awareness Pre-Test	Awareness Post-Test
AHMA-0 (Control)	Mean	31.4091	32.0568
	N	88	88
	Std. Deviation	2.97359	2.92574
AHMA-NSPIxD (Treatment)	Mean	28.7416	31.1798
	N	89	89
	Std. Deviation	3.91247	3.25982
Total	Mean	30.0678	31.6158
	N	177	177
	Std. Deviation	3.71666	3.12057

In all, 89 participants used AHMA-0, and 88 participants used AHMA-NSPIxD. For AHMA-0, the pre-test mean is 31.41, and the post-test mean is 32.06, while for AHMA-NSPIxD, the pre-test mean is 28.74 and the post-test mean is 31.18. There is a disparity between AHMA-0 (0.65) and AHMA-NSPIxD (2.44) in the mean scores for perceived awareness. It suggests that participants who used AHMA-NSPIxD obtained higher knowledge than participants who used AHMA-0 on their perceived awareness. It explains that when they use AHMA-NSPIxD, participants are more aware of Asmaul Husna.

Table 6.17

Levene's Test of Equality of Error Variances for Perceived Awareness Score between Groups

	Levene Statistic	df1	df2	Sig.
Awareness	.321	1	175	.572

A preliminary review has been embarked on to ensure the presumptions of normality and homogeneity of variances are not infringed. From Table 6.26, it is shown that the homogeneity between both groups is approximately equal ($p > 0.05$).

Table 6.18

ANCOVA Analysis on Perceived Awareness Pre-Test Score between Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	927.504 ^a	2	463.752	102.614	.000
Intercept	336.792	1	336.792	74.522	.000
Awareness Pre-Test	893.467	1	893.467	197.697	.000
Group	28.236	1	28.236	6.248	.013
Error	786.372	174	4.519		
Total	178636.000	177			
Corrected Total	1713.876	176			

a. R Squared = .541 (Adjusted R Squared = .536)

ANCOVA research was carried out to determine whether there is a substantial difference in participants' perceived awareness between AHMA-0 and AHMA-NSPIxD. The obtained findings are described in Table 6.27. It is shown that the p-value is 0.013, which is below 0.05. This result is, therefore, vital. In the perceived awareness score, there is a significant difference between AHMA-0 and AHMA-NSPIxD; the H_{02a} hypothesis has, therefore, been rejected.

Table 6.19

Pair-Wise Comparison for Perceived Awareness Score between Groups

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig. ^b	95% Confidence Interval for Difference ^b	
					Lower Bound	Upper Bound
AHMA-0 (Control)	AHMA-NSPIxD (Treatment)	-.856*	.343	.013	-1.532	-.180
AHMA-NSPIxD (Treatment)	AHMA-0 (Control)	.856*	.343	.013	.180	1.532

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

These findings from pair-wise comparisons in Table 6.28 clarify that participants who used the AHMA-NSPIxD earned higher scores on their perceived awareness than those using the AHMA-0 mode. The mean difference is 0.856.

6.5.10 Testing of Hypothesis H_{03a}

H_{03a}: There is no significant difference in Muslim users' perceived motivation toward learning material between the AHMA-0 and AHMA-NSPIxD.

Hypothesis H_{03a} analyzed the principal effects of the two independent variable presentation modes, AHMA-0 and AHMA-NSPIxD, on the dependent variable, perceived motivation. Statistical research was performed to see whether there was a substantial difference between the two presentation styles in participants' perceived motivation scores.

Table 6.20

Mean and Standard Deviation for Perceived Motivation Score between Groups

Control & Treatment	Mean	N	Std. Deviation
AHMA-0 (Control)	135.5341	88	12.35486
AHMA-NSPIxD (Treatment)	148.5056	89	12.36300
Total	142.0565	177	13.93480

The descriptive statistic in Table 6.39 indicates that mean scores for perceived motivation vary between AHMA-0 and AHMA-NSPIxD. The mean score for AHMA-NSPIxD is 148.5056 with a standard deviation of 12.36300, and for AHMA-0, it is 135.5341 with a standard deviation of 12.35486. It suggests that, relative to participants who used AHMA-0, those who used AHMA-NSPIxD scored greater on their perceived motivation. That means the participants viewed the AHMA-NSPIxD mode as being more motivating.

Table 6.21

Levene's Homogeneity Test for Perceived Motivation Score between Groups

Levene Statistic	df1	df2	Sig.
.097	1	175	.756

Levene's homogeneity test was performed to explore the hypothesis further to assess if the error variance in the pre-test score is equal in both presentation types. The test result of Levene indicates that it is not significant ($p > 0.05$); hence, it shows that the group variances in the motivation scores are approximately equal, as illustrated in Table 6.21.

Table 6.22

ANCOVA Analysis for Perceived Motivation Score between Groups

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	7445.290 ^a	1	7445.290	48.744	.000
Intercept	3569912.160	1	3569912.160	23371.913	.000
Group	7445.290	1	7445.290	48.744	.000
Error	26730.145	175	152.744		
Total	3606044.000	177			
Corrected Total	34175.435	176			

a. R Squared = .218 (Adjusted R Squared = .213)

In particular, ANCOVA was intended to examine a significant difference in perceived motivation scores between participants using AHMA-0 and AHMA-NSPIxD. Table 6.22 displays the results, showing that the p-value (0.000) is less than 0.05, indicating a sign of significance. It implies a substantial distinction in the perceived motivation scores between AHMA-0 and AHMA-NSPIxD. Therefore, Hypothesis H_{03a} failed to be acknowledged. It explains that participants who used AHMA-NSPIxD showed higher perceived motivation scores than those who used AHMA-0.

Table 6.23

Pair-Wise Comparison for Perceived Motivation Score between Groups

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.^b	95% Confidence Interval for Difference^b	
					Lower Bound	Upper Bound
AHMA-0 (Control)	AHMA-NSPIxD (Treatment)	-12.972*	1.858	.000	-16.638	-9.305
AHMA-NSPIxD (Treatment)	AHMA-0 (Control)	12.972*	1.858	.000	9.305	16.638

Based on estimated marginal means

*. The mean difference is significant at the .05 level.

b. Adjustment for multiple comparisons: Bonferroni.

A separate variance study was conducted to make a pair-wise comparison to determine which group was responsible for the effect. The results are detailed in Table 6.23. The table illustrates that in motivation scores where $p\text{-value} = 0,000$, there is a significant difference between the groups. Consequently, the H_{03a} hypothesis is refuted, indicating that the treatment group participants obtained higher motivation than the control group.

6.6 Summary of Research Findings

Table 6.24

Summary of Research Findings

H_0	Hypotheses	Test of Significant Reject/Accept	Finding in Textual Representation	Finding
H_{01a}	There is no significant difference in Muslim users' knowledge of Asmaul Husna between AHMA-0 and AHMA-NSPIxD.	$p = 0.000$ ($p < 0.05$) (significant) Fail to Accept	There is a significant difference in the knowledge score between AHMA-0 and AHMA-NSPIxD	AHMA-NSPIxD > AHMA-0
H_{02a}	There is no significant difference in Muslim users' perceived awareness of Asmaul Husna between AHMA-0 and AHMA-NSPIxD.	$p = 0.010$ ($p < 0.05$) (significant) Fail to Accept	There is a significant difference in the perceived awareness score between AHMA-0 and AHMA-NSPIxD	AHMA-NSPIxD > AHMA-0
H_{03a}	There is no significant difference in Muslim users' perceived motivation toward learning material between the AHMA-0 and AHMA-NSPIxD.	$p = 0.000$ ($p < 0.05$) (significant) Fail to Accept	There is a significant difference in the perceived motivation score between AHMA-0 and AHMA-NSPIxD	AHMA-NSPIxD > AHMA-0

CHAPTER SEVEN

CONCLUSIONS

7.1 Introduction

In line with the research objectives, questions, and hypotheses, this chapter explores the findings and discusses them with current studies and theories. The discussions on the findings are structured into five parts. The first section, centered on empirical research, interprets the analysis. It implies the influence of the dependent variables of the two presentation modes: knowledge, perceived awareness, and perceived motivation on the learning materials. The implications of the analysis are discussed in the second part. Limitations and recommendations are presented in the third section for future work. Eventually, the overview of the research and conclusion are discussed.

7.2 Conclusion of NSPIxD Model Design and development

In fulfilling the RQ and RO set out in Chapter 1, the following are the steps and processes that have been carried out.

7.2.1 Finding the appropriate components for the hybridized model of NSPIxD

In meeting the RQ set out in Chapter 1, various measures have been taken and implemented to ensure everything runs smoothly and successfully. In ensuring appropriate components for the NSPIxD Model, Comparative Analysis and User Requirements were conducted. Through this process, the critical components in the model have been obtained where the components found through the screening are Visual Design, Content/writing, Navigation/Interaction Design, and Multimedia components. Multimedia elements have also been obtained to ensure that the

appropriate elements are used in each component using text, audio, video, graphic, and animation elements. Subsequently, critical Signaling Principles were extracted from the Comparative Analysis process based on the previous models with appropriate justification. The Signaling principles obtained are as follows: 1) Color-coded (ensuring tabs, text, and picture elements use the same color theme), 2) Text-based (ensuring the use of bold text for titles and headlines and the use of colored key terms for essential keywords), 3) Picture-based (ensure the use of icons or buttons that show it can be clicked for example shadowed or animated buttons and icons), and 4) Audio-based (ensure the use of voice intonation accompanied by written text). Finally, Nielsen's design guidelines that match the components have also been obtained through the Comparative Analysis and User Requirement process to ensure that everything fits well with each other. With all these components, the NSPIxD model has a perfect framework and guidelines based on the best examples of previous models and input from users and experts. The first version of the NSPIxD model is produced through this process, as shown in Figure 4.2.

7.2.2 Constructing the NSPIxD Model

In building this model, the following processes must be implemented: performing User Requirement Survey, Expert Review 1 and 2. User Requirement Survey is conducted to obtain input from users on the deeper elements that need to be placed in a mobile app, such as title or headlines, text for content, multimedia elements such as images, voice usage, audio, video background color, navigation, layout, language, organization of the app and quizzes. These questions are asked to determine the users' preferences in using an app. At the same time, expert review one is implemented to

ensure that all components that have been selected are accurate and under the theme of the study, as shown in Figure 4.6.

Next, the model is formulated by considering the suggestions of users and experts. Also, by adapting all the existing requirements, the final model was obtained with the consent of 6 experts who met face to face at their respective universities. All components, elements, Signaling principles, and Nielsen's design guidelines that have been extracted are included and formulated in a model that has been presented and commented on by them. The final model was completed, corrected, and submitted through the comments in Figure 4.7.

7.2.3 Implementing the NSPIxD Model

This model has been implemented through a prototyping process where each component, element, principle, and guidelines adapted into the model are included in the prototype, a mobile app. Next, experts also review this app to ensure that every item in the model is well adapted. After receiving comments and criticism from experts, these mobile apps have been improved and subsequently used by users through quasi-experiments that have been conducted. These experiments have gone well and have had a positive impact on them. The quasi-experiment is also a validation process over the model developed in the previous phase.

7.2.4 Validating the NSPIxD Model via Expert Review and Quasi-Experiments

This model was first validated by experts who hold a doctor of philosophy degree in a field related to the study. They are comprised of experts in HCI, Multimedia Learning, Software Engineering, Instructional Design, Interaction Design, Multimedia

Systems, and Usability. Each of them has inspected and provided the best input to improve the model and subsequently amended and made the final model before being implemented into the prototype. It ensures that the model has been produced with the appropriate framework and functionality to guide the development of other prototypes in the future.

For the testing process, after the model was implemented into the prototype, 177 students from three universities participated in these quasi-experiments. This group was divided into control (AHMA-0) and treatment (AHMA-NSPIxD) groups, and they were tested in terms of knowledge, perceived awareness, and motivation.

7.2.4.1 Effects of AHMA on Knowledge

AHMA-NSPIxD was constructed according to Mayer's signaling principle and Nielsen's design guidelines using the proposed model, the NSPIxD; the mobile app uses signals or cues in teaching materials. The mobile learning materials in AHMA-NSPIxD are tailored with signs such as color-coded, text-based, video-based, and audio-based techniques. In comparison, the contents presented in AHMA-0 are without the elected cues and guidelines.

AHMA-0 and AHMA-NSPIxD have both had a positive impact on students' knowledge. The statistical findings suggest that both mobile apps' average knowledge assessment ratings increased. Students who used AHMA-NSPIxD, on the other hand, reported a much higher knowledge score than students who used AHMA-0. The learners learned more about Asmaul Husna when utilizing AHMA-NSPIxD; therefore, Mayer's CTML (2001) is supported. Mayer believes learning can improve when visual

cues and signals are used. It is founded on the premise that learners can easily interpret clues when offered.

7.2.4.2 Effects of AHMA on Perceived Awareness

In terms of students' perceived awareness, the results of this study revealed a considerable difference between AHMA-0 and AHMA-NSPIxD students. According to the study, students who used the AHMA-NSPIxD had a considerably higher perceived awareness score than those who used the AHMA-0. When students utilized AHMA-NSPIxD, they became more aware of Asmaul Husna.

AHMA-NSPIxD encourages learners to employ their available cognitive capacity for active cognitive processing during learning, and it has been associated with rising interest in awareness. The information should be structured into logical representations, including pictorial and verbal representations and prior knowledge.

7.2.4.3 Effects of AHMA on Perceived Motivation

The results of students' perceived motivation scores calculated using the IMMS questionnaire in this study indicate that students perceived all presentation styles as motivating them. However, there is a substantial difference between AHMA-0 and AHMA-NSPIxD in the perceived motivation among students.

The study reveals that students exposed to AHMA-NSPIxD have a higher perceived motivation than students who used AHMA-0. While both presentation styles were similarly established, the type with signals and cues was highly likely to motivate instruction to become a better learning material. Students may be inspired to learn

when they believe the teaching is attentive, engaging, and essential to their needs; according to Keller (1987a, 2010), such findings are imperative to performance. Students would feel more inspired if the learning environment could capture their attention.

7.3 The implication of the Study

The discussion on the results of this study has important implications for incorporating Nielsen's design guidelines and multimedia learning principles. The signaling principle in mobile learning applications for students increases knowledge, perceived awareness, and perceived motivation of the learning materials. This research has four significant implications.

7.3.1 Impact on Learning in the New Norm

Since many mobile apps were developed and commercialized, emphasizing online gaming rather than education, mobile learning apps have been left behind due to the obsession with gaming over online student learning. However, in the outbreak of the COVID19 pandemic, all parties recognized the importance of engagement and attraction in the virtual learning process (Katmon et al., 2021; Lapitan et al., 2021). This proposed model serves as a starting point for research and development efforts to establish the best online learning hub, particularly during this pandemic, and to realize the country's vision of becoming a global hub for open education. It assists students in their learning process and increases their knowledge of a subject. Additionally, the coronavirus pandemic ushered in a digital revolution in the educational system, notably sustainable education. All of these innovations have the potential to persist beyond the pandemic, assisting education in evolving and adopting novel trends and technologies (Dalimunthe et al., 2021; Rybakova et al., 2021).

7.3.2 Impact on Society

This study adopted the Ministry of Higher Education's vision for Higher Education 4.0, which calls for expanding the heutagogy learning style to provide students with greater flexibility and universal access to high-quality education. During the pandemic, campus closure altered students' planning and goal-setting strategies for completing assignments but had no discernible effect on the assignment's outcome, completion time, or self-reflection behavior. The findings indicate that most students completed tasks on time throughout the pandemic, which could be attributed to the flexibility and support provided by online learning modules (Zhang et al., 2021). Hence, the heutagogy approach can implement learning to maintain self-sufficiency, increase self-efficacy, and ignite students' enthusiasm and motivation for learning (Anand et al., 2021; Dewantara & Dibia, 2021).

7.3.3 Novel Theory

The NSPIxD model for mobile education comprises numerous components and elements that critically consider a user interface's technical and aesthetic aspects. It contributes to the advancement of knowledge in the field of interaction design. Such design techniques can also be extended and used as guides in developing other compelling mobile learning applications and are particularly well-suited for learning environments that incorporate multimedia principles for various learning contexts.

7.3.4 Impact on the Body of Knowledge

The study's findings demonstrate that when learners use AHMA-NSPIxD (integrated with NSPIxD), they gain more knowledge, perceived awareness, and motivation from the learning materials than those using AHMA-0 (none integrated). These beneficial

effects on learning outcomes were discovered when studies were of high quality, reported outcome reliability, included a pre-test, and controlled prior knowledge differences. The findings have significant implications for educators, instructional designers, and researchers who work with multimedia (Alpizar, Adesope, 2020). The signaling principle's effectiveness in multimedia learning has been increasingly confirmed by empirical research, for example, enhancing learning outcomes by emphasizing correspondences between text and images (Jian, 2019b). Multimedia learning environments contain educational material, but learners have limited capacity. When learners are assisted with signaling or cueing to direct their attention to the appropriate resources, they demonstrate improved learning performance. Cognitive load is significantly reduced when signaling techniques are used (Mutlu-Bayraktar et al., 2019). As a result, this study contributes to understanding how signals or cues can affect a learner's knowledge, perceived awareness, and perceived motivation regarding the learning materials.

7.4 Recommendations for Future Study

This research has posed several essential questions that need more research. First, the study sample is restricted to undergraduate students between 18 and 24. Therefore, this study suggests that future studies should also be extended to other learners' levels to evaluate the value of using AHMA-NSPIxD to increase the other users' knowledge, perceived awareness, and motivation. The outcome may be further generalized to a larger sample through future studies.

This study also has some shortcomings that allow future studies to implement such studies better. The first question posed by an HCI expert is that in combining Nielsen

and the signaling principle, a slight contradiction occurs. In terms of background color selection which is a contradiction between the use of colored background, as suggested by Mayer, and white background, as proposed by Nielsen. With this, it requires consideration from the designer to emphasize and choose the appropriate background color to meet users' needs well and accurately.

There are also concerns about using shadowed buttons. Mayer suggested it ensures that the button can be seen well, but the shadowing method is unnecessary when the background is blank and not filled with text. This situation has created a problem that triggers an appropriate equilibrium in implementing this hybridization.

7.5 Summary

This study aims to develop and assess the effects of AHMA-0 and AHMA-NSPIxD on university students to increase their knowledge, perceived awareness, and motivation of Asmaul Husna. The developed mobile app design and development provide a theoretical design structure that can guide other mobile apps' design and development for multimedia learning.

In general, the study finds that for both presentation modes, students' knowledge and perceived awareness of Asmaul Husna was increased by both mobile apps. It demonstrates the app's efficacy as an alternative and a creative approach to expanding the knowledge and perceived awareness of Asmaul Husna among students. The results also show that, relative to AHMA-0, students who used AHMA-NSPIxD performed significantly higher in their knowledge, perceived awareness, and motivation.

In conclusion, the study results also showed that the proposed model's mobile app has increased students' knowledge and perceived awareness of Asmaul Husna. This research, therefore, supports the advantage of hybridizing the Signaling principles and Nielsen design guidelines through the construction of the NSPIxD model.



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Appendix A

Application to Conduct Research



PUSAT PENGAJIAN TEKNOLOGI MULTIMEDIA DAN KOMUNIKASI
SCHOOL OF MULTIMEDIA TECHNOLOGY AND COMMUNICATION
Universiti Utara Malaysia
06010 UUM SINTOK
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UUM/CAS/SMMTC/P-14
27 FEBRUARY 2019

To whom it may concern,

Dear Sir/ Madam

APPLICATION TO CONDUCT RESEARCH

Referring to the above matters, I, Assoc. Prof. Dr. Ariffin Bin Abdul Mutalib is a supervisor for the PhD student as follows:

Student Name : Arifah Fasha Binti Rosmani
Matric No. : 901959
School : Multimedia Technology and Communication (SMMTC), UUM
Research Title : Hybridization of Signalling Principle and Nielsen's Design Guideline for Mobile Application

2. For your information, this student is in the process of collecting data for her research. Regarding to this matter, I would like to seek cooperation from Prof / Assoc Prof / Dr / Sir / Madam to allow her in conducting such research activities.

Your cooperation, time and assistance are greatly appreciated.

Thank you.

"KEDAH AMAN MAKMUR – HARAPAN BERSAMA MAKMURKAN KEDAH"
"ILMU BUDI BAKTI"

Yours sincerely,

ASSOC. PROF. DR. ARIFFIN BIN ABDUL MUTALIB
School of Multimedia Technology and Communication (SMMTC),
UUM College of Arts and Sciences,
Universiti Utara Malaysia.

Universiti Pengurusan Terkemuka
The Eminent Management University



Appendix B

Asmaul Husna Knowledge and Awareness Instrument (AHKAI)

(Kegunaan
Pejabat)



<p style="text-align: center;">AHKAI (Asmaul Husna Knowledge and Awareness Instrument)</p>
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Penyelidik:
ARIFAH FASHA BINTI ROSMANI
Pusat Teknologi Multimedia dan Komunikasi
Universiti Utara Malaysia
Emel: arie.fasha@gmail.com

-
1. Soalan-soalan Bahagian A ini adalah mengenai pendapat dan sikap sahaja. Oleh itu tidak wujud jawapan betul atau salah. Cuma pilih jawapan yang paling sesuai dengan perasaan anda.
 2. Jawapan anda kepada soalan-soalan berikut akan membantu kami merancang dan merekabentuk bahan pengajaran yang berkesan dan menarik.

BAHAGIAN A : AWARENESS

Sila bulatkan respons anda mengikut skala berikut:

1-Sangat Tidak Setuju 2-Tidak Setuju 3-Tidak Pasti 4-Setuju 5-Sangat Setuju

1	Saya yakin bahawa saya mempunyai pengetahuan mengenai asmaul husna dan maknanya .	1	2	3	4	5
2	Saya yakin bahawa saya mempunyai pengetahuan mengenai manfaat asmaul husna dalam kehidupan.	1	2	3	4	5
3	Saya yakin bahawa saya mengetahui dan boleh memberikan makna satu nama daripada 99 Asmaul Husna.	1	2	3	4	5
4	Saya berminat untuk mempelajari Asmaul Husna melalui aplikasi telefon pintar .	1	2	3	4	5
5	Apakah medium pembelajaran yang telah dilalui untuk mempelajari Asmaul Husna? (Boleh tanda lebih daripada satu). a) Kuliah Agama b) Kelas Pendidikan Islam c) Internet d) Bahan bercetak (buku/majalah/pamphlet dll.) e) Lain-lain (nyatakan)					
6	Apakah kepentingan memahami dan mengamalkan Asmaul Husna dalam kehidupan sebagai seorang Muslim? (Sila nyatakan).					

BAHAGIAN B : KNOWLEDGE

Sila bulatkan jawapan yang betul.

I. Makna Asmaul Husna

1.	APAKAH MAKNA AR-RAHMAN ?		
	A. Maha Pengasih	B. Maha Pengampun	C. Maha Baik
2.	APAKAH MAKNA AL-MUSOWWIR ?		
	A. Maha Menerima Taubat	B. Maha Kreatif	C. Maha Pemaksa
3.	APAKAH MAKNA AL-KHOLIQ ?		
	A. Maha Penyayang	B. Maha Sabar	C. Maha Pencipta
4.	APAKAH MAKNA AR-RAZZAQ ?		
	A. Maha Memberi Rezeki	B. Maha Penolong	C. Maha Mengatur
5.	APAKAH MAKNA AL-BASIR ?		
	A. Maha Mendengar	B. Maha Melihat	C. Maha Lembut

II. Solusi Masalah dengan Asmaul Husna

1.	ASMAUL HUSNA YANG BOLEH DIAMALKAN UNTUK MEMBUANG PERASAAN MALAS ?		
	A. Ar-Rahman, Ar-Rahim	B. Al-Ghofur, As-Syakur	C. Al-Quddus, Al-Jalil
2.	ASMAUL HUSNA YANG BOLEH DIGUNAKAN UNTUK MEMBUANG PERASAAN PATAH SEMANGAT ?		
	A. Al-Baith	B. Al-Malik	C. Al-Hafiz
3.	ASMAUL HUSNA YANG BOLEH DIGUNAKAN UNTUK MEMBUANG SIFAT KELAM-KABUT ?		
	A. Al-Wahhab	B. As-Sami'	C. Al-Baarik
4.	ASMAUL HUSNA YANG BOLEH DIGUNAKAN UNTUK MEMBUANG SIKAP KURANG SABAR ?		
	A. As-Sobur	B. Al-Latif	C. Al-Halim
5.	ASMAUL HUSNA YANG BOLEH DIGUNAKAN UNTUK MEMBUANG SIFAT PENAKUT ?		

	A. Al-Qadir	B. Al-'Adzim	C. Al-Muqtadir
6.	<p>TULISKAN BICARAHATI ANDA SENDIRI BERDASARKAN ASMAUL HUSNA YANG TELAH ANDA PELAJARI (CONTOHNYA: MEREDAKAN PERASAAN GEMENTAR UNTUK MENGHADAPI PEPERIKSAAN/PEMBENTANGAN MENGGUNAKAN ASMAUL HUSNA YANG BERSESUAIAN).</p>		



Appendix C

Instructional Materials Motivation Scale (IMMS)

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(Kegunaan Pejabat)



UUM
Universiti Utara Malaysia

Skala Motivasi Bahan Pengajaran
(Instructional Materials Motivation Scale)

Kecenderungan Perbandingan
(Comparative Preference)

Oleh:
JOHN M. KELLER
Florida State University, USA

diterjemah oleh:
PROFESOR MADYA DR. TOH SEONG CHONG
Pusat Teknologi Pendidikan & Multimedia
Universiti Sains Malaysia
© Toh Seong Chong, 1999 – 2005

Penyelidik:
ARIFAH FASHA BINTI ROSMANI
Pusat Teknologi Multimedia dan Komunikasi
Universiti Utara Malaysia
Emel: arie.fasha@gmail.com

1. Soalan-soalan ini adalah mengenai pendapat dan sikap sahaja. Oleh itu tidak wujud jawapan betul atau salah. Cuma pilih jawapan yang paling sesuai dengan perasaan anda.
2. Jawapan anda kepada soalan-soalan berikut akan membantu kami merancang dan merekabentuk bahan pengajaran yang berkesan dan menarik.

Arahan: Baca setiap soalan dan kemudian bulatkan markah untuk menunjukkan pilihan jawapan anda.

1 = Sangat Tidak Setuju 2 = Tidak Setuju 3 = Tidak Pasti 4 = Setuju 5 = Sangat Setuju

BIL	ITEM	SKOR
1	Apabila saya melihat pelajaran ini, saya berasa pelajaran ini mudah bagi saya.	1 2 3 4 5
2	Terdapat beberapa unsur yang menarik pada awal pelajaran ini dan ini menarik perhatian saya.	1 2 3 4 5
3	Topik-topik yang ada dalam pelajaran ini lebih sukar difahami daripada yang saya sangka.	1 2 3 4 5
4	Selepas membaca maklumat pengenalan, saya berasa yakin bahawa saya tahu apa yang harus saya pelajari dari pelajaran ini.	1 2 3 4 5
5	Soalan-soalan kuiz memberi saya satu perasaan kepuasan atas kejayaan.	1 2 3 4 5
6	Adalah jelas kepada saya bahawa isi kandungan pelajaran ini ada berhubungkait dengan perkara-perkara yang sudah saya ketahui.	1 2 3 4 5
7	Beberapa skrin paparan aplikasi mengandungi maklumat yang terlalu banyak sehingga sukar untuk memetik dan mengerti butir-butir yang penting.	1 2 3 4 5
8	Bahan-bahan yang terdapat pelajaran ini menarik.	1 2 3 4 5
9	Terdapat cerita atau contoh dalam pelajaran ini yang menunjukkan kepada saya bagaimana bahan ini mungkin penting kepada sesetengah orang.	1 2 3 4 5
10	Menghabiskan pelajaran ini dengan jayanya adalah penting untuk saya.	1 2 3 4 5
11	Mutu penulisan pelajaran ini telah membantu saya terus berminat.	1 2 3 4 5
12	Pelajaran ini begitu abstrak sehingga sukar bagi saya memberi perhatian yang berterusan terhadapnya.	1 2 3 4 5
13	Apabila saya mencuba pelajaran ini, saya berasa yakin menguasai isi kandungan.	1 2 3 4 5
14	Saya amat menyukai pelajaran ini sehingga saya ingin tahu dengan lebih mendalam topik ini.	1 2 3 4 5
15	Paparan skrin dalam pelajaran ini membosankan dan tidak menarik.	1 2 3 4 5
16	Isi kandungan dalam pelajaran ini adalah relevan kepada minat saya.	1 2 3 4 5
17	Cara maklumat disusun pada setiap skrin membantu saya memberi perhatian yang berterusan terhadapnya.	1 2 3 4 5
18	Terdapat penjelasan atau contoh mengenai bagaimana seseorang menggunakan pengetahuan dalam pelajaran ini.	1 2 3 4 5
19	Latihan atau kuiz dalam pelajaran ini terlalu sukar.	1 2 3 4 5

Arahan: Baca setiap soalan dan kemudian bulatkan markah untuk menunjukkan pilihan jawapan anda.

1 = Sangat Tidak Setuju 2 = Tidak Setuju 3 = Tidak Pasti 4 = Setuju 5 = Sangat Setuju

BIL	ITEM	SKOR
20	Pelajaran ini mempunyai unsur-unsur yang merangsangkan sikap ingin tahu saya.	1 2 3 4 5
21	Saya berasa sungguh seronok belajar pelajaran ini.	1 2 3 4 5
22	Ulangan yang terdapat dalam pelajaran ini menyebabkan saya kadang-kala berasa membosankan.	1 2 3 4 5
23	Isi kandungan dan gaya penulisan pelajaran ini memberi gambaran bahawa isi kandungannya sangat bermanfaat.	1 2 3 4 5
24	Saya mempelajari sesuatu yang menakjubkan dan di luar jangkaan saya.	1 2 3 4 5
25	Sejurus selepas saya mencuba pelajaran ini, saya yakin bahawa saya boleh lulus ujian tentangnya.	1 2 3 4 5
26	Pelajaran ini tidak relevan bagi keperluan saya kerana saya sudah pun tahu hampir kesemuanya.	1 2 3 4 5
27	Berbagai jenis keratan bacaan dan ilustrasi telah membantu saya terus menumpukan perhatian saya terhadap pelajaran.	1 2 3 4 5
28	Gaya penulisan pelajaran ini membosankan.	1 2 3 4 5
29	Saya dapat menghubungkaitkan isi kandungan ini dengan perkara yang pernah saya lihat, lakukan atau fikirkan dalam kehidupan saya.	1 2 3 4 5
30	Terdapat terlalu banyak perkataan di setiap paparan skrin sehingga ia kurang menyenangkan.	1 2 3 4 5
31	Saya berasa seronok kerana telah menamatkan pelajaran dengan jayanya.	1 2 3 4 5
32	Isi kandungan pelajaran akan berguna kepada saya kelak.	1 2 3 4 5
33	Sebenarnya saya tidak memahami sebahagian maklumat yang disampaikan dalam pelajaran ini.	1 2 3 4 5
34	Organisasi kandungan yang begitu baik telah membantu saya menambahkan keyakinan saya mempelajari pelajaran ini.	1 2 3 4 5
35	Saya berbangga belajar dengan pelajaran ini yang telah direkabentuk dengan baik.	1 2 3 4 5
36	Saya telah mendapat ganjaran yang memadai dengan ikhtiar saya.	1 2 3 4 5

Appendix D

Letter of Appointment as Technical Expertise



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Laman Web: <http://www.uum.edu.my>

UUM/CAS/SMMTC/P-14
27 FEBRUARY 2019

Wan Razhizan Zulnasyreeq Bin Wan A Rahman,
No. 29, Jalan 24,
Taman Kluang Barat,
86000 Kluang,
Johor Darul Takzim.

Sir,

APPOINTMENT AS TECHNICAL EXPERTISE (DEVELOPER) FOR ASMAUL HUSNA MOBILE APPLICATION (AHMA)

Thank you for agreeing to involve as a technical expertise in a PhD study, particularly for designing and developing mobile applications with the following details:

Student Name : Arifah Fasha Binti Rosmani
Matric No. : 901959
School : Multimedia Technology and Communication (SMMTC), UUM
Research Title : Hybridization of Signalling Principle and Nielsen's Design Guideline for Mobile Application
Supervisor : Assoc. Prof. Dr. Ariffin Bin Abdul Mutalib

For your information, the student will use the mobile application for her research. Therefore, she needs the expertise to design and develop the proposed mobile applications in a few aspects as stated in the requirement.

Your cooperation, time and assistance are greatly appreciated.

Thank you.

"KEDAH AMAN MAKMUR – HARAPAN BERSAMA MAKMURKAN KEDAH"
"ILMU BUDI BAKTI"

Yours sincerely,

ASSOC. PROF. DR. MOHD SOBHI ISHAK

Dean,

School of Multimedia Technology and Communication (SMMTC),
UUM College of Arts and Sciences,
Universiti Utara Malaysia.

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Appendix E

Letter of Appointment as Content Reviewer for AHKAI AND AHMA



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UUM/CAS/SMMTC/P-14
27 FEBRUARY 2019

Prof. Dr. Puteh Binti Saad,
No. 24, Jalan Desa Pulaui 6,
Taman Desa Pulaui,
01000 Kangar,
Perlis.

Madam,

APPOINTMENT AS CONTENT REVIEWER FOR ASMAUL HUSNA KNOWLEDGE AND AWARENESS INSTRUMENT (AHKAI) AND ASMAUL HUSNA MOBILE APPLICATION (AHMA)

Thank you for agreeing to involve as an expert in a PhD study, particularly for reviewing and evaluating an instrument and mobile application with the following details:

Student Name : Arifah Fasha Binti Rosmani
Matric No. : 901959
School : Multimedia Technology and Communication (SMMTC), UUM
Research Title : Hybridization of Signalling Principle and Nielsen's Design Guideline for Mobile Application
Supervisor : Assoc. Prof. Dr. Ariffin Bin Abdul Mutalib

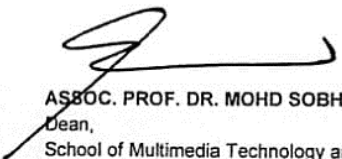
For your information, the student will use the instrument and mobile application for her research. Therefore, she needs the expertise to review the proposed instrument and mobile application in a few aspects as stated in the form.

Your cooperation, time and assistance are greatly appreciated.

Thank you.

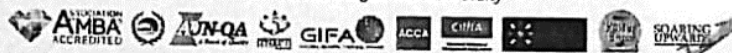
"KEDAH AMAN MAKMUR – HARAPAN BERSAMA MAKMURKAN KEDAH"
"ILMU BUDI BAKTI"

Yours sincerely,


ASSOC. PROF. DR. MOHD SOBHI ISHAK

Dean,
School of Multimedia Technology and Communication (SMMTC),
UUM College of Arts and Sciences,
Universiti Utara Malaysia

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UUM/CAS/SMMTC/P-14
27 FEBRUARY 2019

Dr. Noorhafidzah Binti Zawawi,
No. 87, Jalan Gemilang 4,
Taman Gemilang,
06000 Jitra,
Kedah.

Madam,

APPOINTMENT AS CONTENT REVIEWER FOR ASMAUL HUSNA KNOWLEDGE AND AWARENESS INSTRUMENT (AHKAI) AND ASMAUL HUSNA MOBILE APPLICATION (AHMA)

Thank you for agreeing to involve as an expert in a PhD study, particularly for reviewing and evaluating an instrument and mobile application with the following details:

Student Name : Arifah Fasha Binti Rosmani
Matric No. : 901959
School : Multimedia Technology and Communication (SMMTC), UUM
Research Title : Hybridization of Signalling Principle and Nielsen's Design Guideline for Mobile Application
Supervisor : Assoc. Prof. Dr. Ariffin Bin Abdul Mutalib

For your information, the student will use the instrument and mobile application for her research. Therefore, she needs the expertise to review the proposed instrument and mobile application in a few aspects as stated in the form.

Your cooperation, time and assistance are greatly appreciated.

Thank you.

"KEDAH AMAN MAKMUR – HARAPAN BERSAMA MAKMURKAN KEDAH"
"ILMU BUDI BAKTI"

Yours sincerely,


ASSOC. PROF. DR. MOHD SOBHI ISHAK

Dean,
School of Multimedia Technology and Communication (SMMTC),
UUM College of Arts and Sciences,
Universiti Utara Malaysia.

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Appendix F

Letter of Appointment as Expert Reviewer for AHKAI



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UUM/CAS/SMMTC/P-14
27 FEBRUARY 2019

Dr. Nadia Binti Abdul Wahab,
Senior Lecturer,
Faculty of Computer and Mathematical Sciences,
Universiti Teknologi MARA Cawangan Perlis,
02600 Arau, Perlis

Madam,

APPOINTMENT AS EXPERT REVIEWER FOR ASMAUL HUSNA KNOWLEDGE AND AWARENESS INSTRUMENT (AHKAI)

Thank you for agreeing to involve as an expert in a PhD study, particularly for reviewing and evaluating an instrument with the following details:

Student Name	:	Arifah Fasha Binti Rosmani
Matric No.	:	901959
School	:	Multimedia Technology and Communication (SMMTC), UUM
Research Title	:	Hybridization of Signalling Principle and Nielsen's Design Guideline for Mobile Application
Supervisor	:	Assoc. Prof. Dr. Ariffin Bin Abdul Mutalib

For your information, the student will use the instrument for her research. Therefore, she needs the expertise to review the proposed instrument in a few aspects as stated in the form.

Your cooperation, time and assistance are greatly appreciated.

Thank you.

"KEDAH AMAN MAKMUR – HARAPAN BERSAMA MAKMURKAN KEDAH"
"ILMU BUDI BAKTI"

Yours sincerely,


ASSOC. PROF. DR. MOHD SOBHI ISHAK

Dean,
School of Multimedia Technology and Communication (SMMTC),
UUM College of Arts and Sciences,
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HUM/CAS/SMMTC/14
 27 FEBRUARY 2019

Dr. Aznoora Binti Osman,
 Senior Lecturer,
 Faculty of Computer and Mathematical Sciences,
 Universiti Teknologi MARA Cawangan Perlis,
 02600 Arau, Perlis.

Madam,

APPOINTMENT AS EXPERT REVIEWER FOR ASMAUL HUSNA KNOWLEDGE AND AWARENESS INSTRUMENT (AHKAI)

Thank you for agreeing to involve as an expert in a PhD study, particularly for reviewing and evaluating an instrument with the following details:

Student Name : Arifah Fasha Binti Rosmani
 Matric No. : 901959
 School : Multimedia Technology and Communication (SMMTC), UUM
 Research Title : Hybridization of Signalling Principle and Nielsen's Design Guideline for Mobile Application
 Supervisor : Assoc. Prof. Dr. Ariffin Bin Abdul Mutalib

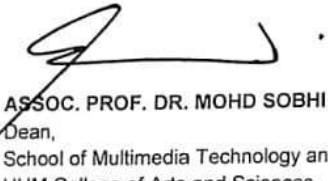
For your information, the student will use the instrument for her research. Therefore, she needs the expertise to review the proposed instrument in a few aspects as stated in the form.

Your cooperation, time and assistance are greatly appreciated.

Thank you.

**"KEDAH AMAN MAKMUR – HARAPAN BERSAMA MAKMURKAN KEDAH"
 "ILMU BUDI BAKTI"**

Yours sincerely,


 ASSOC. PROF. DR. MOHD SOBHI ISHAK
 Dean,
 School of Multimedia Technology and Communication (SMMTC),
 UUM College of Arts and Sciences,
 Universiti Utara Malaysia.

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Appendix G

Letter of Appointment as Expert Reviewer for NSPIxD Model and AHMA



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UUM/CAS(SMMTC)P-48
12 November 2019

Assoc. Prof. Dr. Wan Ahmad Jaafar Wan Yahaya,
Director,
Centre for Instructional Technology & Multimedia,
Universiti Sains Malaysia,
11800 USM, Penang.

Dear Dr.

APPOINTMENT AS EXPERT REVIEWER FOR AHMA MODEL AND MOBILE APPLICATION

Thank you for agreeing to involve as an expert in a Ph.D. study, particularly for reviewing and evaluating the model and mobile application with the following details:

Student Name : Arifah Fasha Binti Rosmani
Matric No. : 901959
School : Multimedia Technology and Communication (SMMTC), UUM
Research Title : Hybridization of Signalling Principle and Nielsen's Design
Guideline for Mobile Application
Supervisors : Assoc. Prof. Dr. Ariffin Abdul Mutalib, Dr. Siti Mahfuzah Sarif

For your information, the student will use the model and mobile application for her research. Therefore, she needs the expertise to review the proposed model and mobile application in a few aspects.

Your cooperation, time, and assistance are greatly appreciated.

Thank you.

Yours sincerely

DR. MOHD NIZAM SAAD
Head of Department
On behalf Dean
School of Multimedia Technology and Communication

Universiti Pengurusan Terkemuka
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UUM/CAS(SMMTC)P-48
12 November 2019

Dr. Hanif Baharin,
Research Fellow,
Institute of Visual Informatics,
The National University of Malaysia,
43600 Bangi, Selangor.

Dear Dr.

APPOINTMENT AS EXPERT REVIEWER FOR AHMA MODEL AND MOBILE APPLICATION

Thank you for agreeing to involve as an expert in a Ph.D. study, particularly for reviewing and evaluating the model and mobile application with the following details:

Student Name : Arifah Fasha Binti Rosmani
Matric No. : 901959
School : Multimedia Technology and Communication (SMMTC), UUM
Research Title : Hybridization of Signalling Principle and Nielsen's Design
Guideline for Mobile Application
Supervisors : Assoc. Prof. Dr. Ariffin Abdul Mutalib, Dr. Siti Mahfuzah Sarif

For your information, the student will use the model and mobile application for her research. Therefore, she needs the expertise to review the proposed model and mobile application in a few aspects.

Your cooperation, time, and assistance are greatly appreciated.

Thank you.

Yours sincerely

DR. MOHD NIZAM SAAD
Head of Department
On behalf Dean
School of Multimedia Technology and Communication

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UUM/CAS(SMMTC)P-48
12 November 2019

Ts. Dr. Shukor Sanim Mohd Fauzi,
Deputy Rector,
Research and Innovation Unit, Division of Research, Industry, Community, Alumni
and Entrepreneurship (RICAEN),
Universiti Teknologi MARA Perlis Branch,
02600 Arau, Perlis.

Dear Dr.

APPOINTMENT AS EXPERT REVIEWER FOR AHMA MODEL AND MOBILE APPLICATION

Thank you for agreeing to involve as an expert in a Ph.D. study, particularly for reviewing
and evaluating the model and mobile application with the following details:

Student Name : Arifah Fasha Binti Rosmani
Matric No. : 901959
School : Multimedia Technology and Communication (SMMTC), UUM
Research Title : Hybridization of Signalling Principle and Nielsen's Design
Guideline for Mobile Application
Supervisors : Assoc. Prof. Dr. Ariffin Abdul Mutalib, Dr. Siti Mahfuzah Sarif

For your information, the student will use the model and mobile application for her research.
Therefore, she needs the expertise to review the proposed model and mobile application in
a few aspects.

Your cooperation, time, and assistance are greatly appreciated.

Thank you.

Yours sincerely

DR. MOHD NIZAM SAAD
Head of Department
On behalf Dean
School of Multimedia Technology and Communication

Universiti Pengurusan Terkemuka
The Eminent Management University



Appendix H

AHMA Heuristic Evaluations

HEURISTIC EVALUATION FORM

Application Title: Asmaul Husna Mobile Application

PART A : EVALUATOR INFORMATION

Name : PROF. MADYA DR. WAN AHMAD JAAFAR WAN YAHAYA
 Pengarah
 Pusat Teknologi Pengajaran dan Multimedia
 Universiti Sains Malaysia
 11800 USM Pulau Pinang

Qualification : *PhD (Instructional Technology)*

Experience : *20 years*

Date : *19/11/2019*

PART B : EVALUATION

Please circle your responses based on the scale below:

1-Strongly Disagree 2-Disagree 3-Unsure 4-Agree 5-Strongly Agree

VISIBILITY OF SYSTEM STATUS						
1	It is clear what information is available at the current location.	1	2	3	4	5
	Notes:					
2	The current information matches what you expect to find.	1	2	3	4	5
	Notes:					
3	It is clear where you can go from the current location.	1	2	3	4	5
	Notes:					
4	It is always clear what is happening from each action you perform.	1	2	3	4	5
	Notes:					
NAVIGATION, USER CONTROL AND FREEDOM						
5	It is always easy to return to the Main Menu	1	2	3	4	5
	Notes:					

HEURISTIC EVALUATION FORM

Application Title: Asmaul Husna Mobile Application

PART A : EVALUATOR INFORMATION

Name : *Dr. Nur Farin Mohd Fari*
Qualification : *Phd*
Experience : *13 years / software engineering.*
Date : *18/11/19*

PART B : EVALUATION

Please circle your responses based on the scale below:

1-Strongly Disagree 2-Disagree 3-Unsure 4-Agree 5-Strongly Agree

VISIBILITY OF SYSTEM STATUS	
1	It is clear what information is available at the current location. Notes: _____
	1 2 3 4 5
2	The current information matches what you expect to find. Notes: _____
	1 2 3 4 5
3	It is clear where you can go from the current location. Notes: _____
	1 2 3 4 5
4	It is always clear what is happening from each action you perform. Notes: _____
	1 2 3 4 5
NAVIGATION, USER CONTROL AND FREEDOM	
5	It is always easy to return to the Main Menu Notes: _____
	1 2 3 4 5

HEURISTIC EVALUATION FORM

Application Title: Asmaul Husna Mobile Application

PART A : EVALUATOR INFORMATION

Name : *Ahmed Hanif Ahmed Baharin*

Qualification : *Ph.D. Interaction Design*

Experience : *13 years*

Date : *22/11/2019*

PART B : EVALUATION



Please circle your responses based on the scale below:

1-Strongly Disagree 2-Disagree 3-Unsure 4-Agree 5-Strongly Agree

VISIBILITY OF SYSTEM STATUS					
1	It is clear what information is available at the current location.	1	2	3	(4) 5
	Notes:				
2	The current information matches what you expect to find.	1	2	3	4 (5)
	Notes:				
3	It is clear where you can go from the current location.	1	2	3	(4) 5
	Notes:				
4	It is always clear what is happening from each action you perform.	1	2	3	(4) 5
	Notes:				
NAVIGATION, USER CONTROL AND FREEDOM					
5	It is always easy to return to the Main Menu	1	2	3	(4) 5
	Notes: <i>missing some links to sub menus</i>				

Appendix

Letter of Appointment as Graduate Research Assistant (FRGS)

	PUSAT PENGURUSAN PENYELIDIKAN DAN INOVASI RESEARCH AND INNOVATION MANAGEMENT CENTRE (RIMC) Universiti Utara Malaysia 06010 UUM SINTOK KEDAH DARUL AMAN MALAYSIA	 Universiti Utara Malaysia Tel: 604-928 4771 Faks (Fax): 604-928 4756 Laman Web (Web): www.uum.edu.my
		Ruj. Kami : UUM/RIMC/P-48/1 Jld. 21 Tarikh : 5 Jun 2021
<p>Puan Arifah Fasha binti Rosmani No. 38, Jalan Kayangan Indah 5 Taman Bukit Kayangan 01000 Kangar Perlis</p> <p>Puan</p> <p>PELANJUTAN TEMPOH PERKHIDMATAN SEBAGAI PEMBANTU PENYELIDIK SISWAZAH (GRA)</p> <p>Dengan hormatnya saya merujuk perkara di atas.</p> <p>2. Adalah dimaklumkan bahawa pihak RIMC telah bersetuju untuk melanjutkan tempoh perkhidmatan puan sebagai Pembantu Penyelidik Siswazah (GRA) bagi projek penyelidikan Geran FRGS bertajuk Interaction Design Model For Learning in IR4.0: Hybridizing Signaling Principles and Nielsen's Design Guidelines (Kod S/O: 14189) dengan upah/elaun bulanan sebanyak RM1,200.00 sebulan.</p> <p>3. Penyelidik yang mengendalikan projek penyelidikan ini ialah Prof. Madya Dr. Ariffin bin Abdul Mutalib dari Pusat Pengajian Teknologi Multimedia dan Komunikasi, UUM CAS.</p> <p>Syarat Pelantikan:</p> <p>i) Tempoh</p> <p>Pelanjutan puan berkuat kuasa mulai 1 April 2021 dan akan berakhir pada 31 Julai 2021. Tarikh mula kuat kuasa yang dinyatakan ini adalah dengan mengambil kira persetujuan penyelidik serta perkhidmatan puan sebagai GRA kepada projek penyelidikan (Kod S/O: 14189).</p> <p>ii) Kewajipan</p> <p>Sepanjang perkhidmatan puan dengan Universiti Utara Malaysia puan dikehendaki menjalankan kewajipan-kewajipan biasa bagi jawatan berkenaan serta tugas-tugas lain yang ditetapkan dari semasa ke semasa oleh pihak Universiti dan puan boleh diarah bertugas di mana-mana kawasan Kampus, Kolej atau Jabatan Universiti ini.</p>		
Universiti Pengurusan Terkemuka <i>The Eminent Management University</i>		
