AUGMENTED REALITY MOTIVATIONAL DESIGN FRAMEWORK TO ENHANCE PRESCHOOLER'S LEARNING MOTIVATION

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ABSTRACT

This study aims to formulate a motivational design framework for augmented reality (AR) in early childhood education (ECE) in Malaysia. A design and development research (DDR) approach was adopted, comprising three distinct phases. In the analysis phase, findings revealed a research gap in the context of ECE, particularly regarding motivational design frameworks for AR. The design and development phase involved formulating the Augmented Reality Motivational Design Framework (ARMDF) based on previous research findings, preschool children' feedback, and the ARCS Motivational Model. The ARMDF was validated through expert consensus involving 14 specialists in AR and ECE using the Fuzzy Delphi Method (FDM). Following validation, an AR application, *Pengembaraan Ali & Dino: Siri COVID-19*, was developed based on the ARMDF specifications. In the evaluation phase, a qualitative study was conducted with eight preschool children through observations and interviews, with data analyzed thematically using NVivo. The findings identified four key themes: attention, relevance, confidence, and satisfaction. The attention theme encompassed indicators such as focus, boredom, leg swinging, confusion, gaze shifting, dizziness, scanning difficulty, and impatience. The relevance theme was reflected in behaviors such as happiness, smiling, giggling, self-expression, and imagination. The confidence theme was associated with experiences of errors, issues, or problems, as well as frustration, help-seeking, disturbance of others, and self-touching. Lastly, the satisfaction theme was demonstrated through hand clapping and providing help to friends. The evaluation findings indicate that applying the ARMDF in *Pengembaraan Ali & Dino: Siri COVID-19* successfully enhanced preschool children's learning motivation. This study contributes new knowledge to multimedia design, augmented reality, child-computer interaction (CCI), and early childhood education (ECE) by integrating AR and motivational elements. Additionally, it provides practical guidelines for designing AR applications that enhance children's learning motivation, highlighting the transformative potential of technology in creating more engaging and effective learning experiences.

KERANGKA KERJA REKA BENTUK MOTIVASI REALITI TERIMBUH BAGI MENINGKATKAN MOTIVASI PEMBELAJARAN KANAK-KANAK PRASEKOLAH

ABSTRAK

Kajian ini bertujuan untuk membangunkan satu rangka kerja reka bentuk motivasi bagi realiti terimbuh (AR) dalam pendidikan awal kanak-kanak (PAKK) di Malaysia. Pendekatan kajian reka bentuk dan pembangunan (PRP) telah digunakan yang merangkumi tiga fasa utama. Dalam fasa analisis, penemuan kajian menunjukkan jurang penyelidikan dalam konteks PAKK, khususnya berkaitan dengan rangka kerja reka bentuk motivasi bagi AR. Fasa reka bentuk dan pembangunan melibatkan pembentukan kerangka kerja reka bentuk motivasi realiti terimbuh (ARMDF) berdasarkan dapatan kajian terdahulu, maklum balas daripada kanak-kanak prasekolah, serta Model Motivasi ARCS. ARMDF telah disahkan melalui konsensus 14 pakar dalam bidang AR dan PAKK dengan menggunakan kaedah *Fuzzy Delphi* (FDM). Selepas pengesahan, satu aplikasi AR, Pengembaraan Ali & Dino: Siri COVID-19, telah dibangunkan berdasarkan spesifikasi yang ditetapkan oleh ARMDF. Dalam fasa penilaian, kajian kualitatif telah dijalankan dengan melibatkan lapan kanak-kanak prasekolah melalui pemerhatian dan temu bual, dengan analisis data dilakukan secara tematik menggunakan NVivo. Penemuan kajian mengenal pasti empat tema utama: perhatian, kesesuaian, keyakinan, dan kepuasan. Tema perhatian merangkumi penunjuk seperti fokus, kebosanan, ayunan kaki, kekeliruan, perubahan pandangan, pening, kesukaran mengimbas, dan ketidaksabaran. Tema kesesuaian ditunjukkan melalui tingkah laku seperti kegembiraan, senyuman, ketawa kecil, ekspresi diri, dan imaginasi. Tema keyakinan dikaitkan dengan pengalaman menghadapi kesilapan, masalah atau isu, serta kekecewaan, pencarian bantuan, gangguan terhadap orang lain, dan sentuhan diri. Akhir sekali, tema kepuasan ditunjukkan melalui tepukan tangan dan bantuan kepada rakan-rakan. Dapatan penilaian menunjukkan bahawa penerapan ARMDF dalam Pengembaraan Ali & Dino: Siri COVID-19 berjaya meningkatkan motivasi pembelajaran dalam kalangan kanak-kanak prasekolah. Kajian ini menyumbang kepada perkembangan ilmu dalam reka bentuk multimedia, realiti terimbuh, interaksi kanak-kanak-komputer (CCI), dan pendidikan awal kanak-kanak (PAKK) dengan mengintegrasikan elemen AR dan motivasi. Selain itu, kajian ini turut menyediakan garis panduan praktikal untuk mereka bentuk aplikasi AR yang dapat meningkatkan motivasi pembelajaran kanak-kanak, sekali gus menonjolkan potensi transformatif teknologi dalam mewujudkan pengalaman pembelajaran yang lebih menarik dan berkesan.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AR	Augmented Reality
ARMDF	Augmented Reality Motivational Design Framework
CCI	Child Computer Interaction
ECE	Early Childhood Education
GUI	Graphic User Interface
HCI	Human Computer Interaction
HMD	Head Mounted Display
IJDSP	International Journal Sustainable Development and Planning
IJIM	International Journal of Interactive Media
IUCEL	International University Carnival on E-Learning
MR	Mixed Reality
MOE	Ministry of Education
PAI	Participant-Application Interaction
PPI	Participant-Participant Interaction
QR	Quick Response
RO	Research Objectives
RQ	Research Questions
RV	Reality-Virtuality
SLR	Systematic Literature Review

SME	Subject Matter Experts
SUS	System Usability Scale
UI	User Interface
VR	Virtual Reality
WARMDF	Without Augmented Reality Motivational Design Framework
2D	Two dimensional
3D	Three dimensional

LIST OF APPENDIXES

CHAPTER 1

INTRODUCTION

1.1 Introduction

Over the past few years, technological advancements have significantly transformed the way young children engage with the world, and this transformation is particularly evident in the field of education. Early childhood education has witnessed the integration of technology, notably augmented reality (AR), which has much potential for enriching learning experiences for preschoolers. By superimposing digital content onto physical objects, AR creates an immersive and interactive learning environment that can enhance the motivational aspects of young children. Despite the promising educational benefits of AR for preschoolers, successful integration into the learning process necessitates a thoughtful examination of various motivational factors.

To gain a deeper understanding of how AR can boost young children's motivation in learning, this research will create a motivational design framework. This framework will help researchers explore and harness the potential of AR technology to motivate and engage young learners in learning effectively. To start with, this chapter will provide an overview of the research study and explain its background, problem statements, research questions, and objectives. Additionally, it emphasizes the significance of the study, outlines the research scope, and introduces the conceptual framework guiding the investigation. This chapter exposes the issues, theories, and flow of the research.

1.2 Research Background

Education is one of the important events in everyone’s life experiences. In Malaysia, children enter their first school session as young as 4 years old, where the Ministry of Education (MOE) has provided preschool education facilities for all children aged between 4 and 6 years. In preschool, the young children not only make a new friend, but also they learn a lot of new things, such as about: (1) attitude and values, (2) spiritual, (3) communication, (4) humanity (5) physical and aesthetic development, and (6) personal skills (Bahagian Pembangunan Kurikulum, 2017). Thus, the aim of preschool education is to nurture children’s potential in all areas of development, mastering basic skills and fostering positive attitudes in order to prepare young children for entering primary school.

In order to ensure young children succeed in their learning, it is not only based on their intelligence. The success, however, also depends on the young children's motivation in learning (Abnisa, 2020; Ozbey & Daglioglu, 2017). Motivation is defined as a process whereby a goal-directed activity is instigated and sustained (Pintrich & Schunk, 1996), often being an indicator of the success of any individual learning (Cevallos, Peñafiel & Marchán, 2024; Setiawan, 2023; Abnisa, 2020; Motevalli, Perveen & Michael, 2020). Children with high motivation are easily identified. They are more enthusiastic, having more interest, enjoying getting involved in any activity, and having a high level of curiosity (Bergin, 2022; Skinner & Belmont, 1993). They often try hard in learning and actively cope with challenges and setbacks. These children will stay in school longer, learn more, feel better about themselves, and continue their education after high school.

However, young children's motivation changes as they mature. According to Saracho (2019), children have different motivation during preschool; whereas their motivation is high at the beginning of school, it will decline when children have finished elementary school. There is evidence that indicates the young children's motivation is likely to decrease during school time (Lubis & Hisbuan, 2022; Saracho, 2019). Over the school years, many young children's motivation in learning decreases due to changes both in themselves and in the school environments they experience. However, if their motivation stabilizes during the first school years, this will maintain across long periods of time (Laitinen, Lepola & Vauras, 2017). Therefore, the early childhood years are crucial for establishing robust intrinsic motivational orientations that will last a lifetime (Saracho, 2019).

Several questions emerged regarding strategies to motivate children in learning. Additionally, questions were raised about how to sustain their learning motivation once it has been established. In these recent years, there is evidence that technology can foster young children's motivation (Montrieux, Schellens, & Landeghem, 2016). Being a digital native has made the young children exposed to the use of technology almost every day at home and at school. At home, young children not only rely on the technology that belongs to their parents, considering the technology ownership among children has spiked in the past decade in many countries. For example, in Malaysia, 78.3 percent of parents allowed their children to own a gadget (Parzi, 2019). Meanwhile, in the school settings, young children will have easy access to the technology once they enter preschool (Churchill, Pegrum & Churchill, 2018). Although there are few concerns about the negative effect of technology on young children's development, if used cautiously, it has many benefits to offer. A technology called AR, for example, is designed to facilitate and motivate young children's learning. The innovative and interesting expression of AR technology can effectively attract children's interest and achieve the goal of learning. This has become a main reason to attract the attention of researchers and educators in the field of children's education (Han, Jin & Ding, 2019). However, in Malaysia, the implementation of AR is growing slowly (Saidin, Dayana, Halim & Yahaya, 2015).

Therefore, we have been motivated to conduct research regarding AR in Malaysian early childhood education in order to ensure all Malaysian children will have the opportunity to attain an excellent education, as stated in Malaysia Education Blueprint 2013-2025 (Kementerian Pendidikan Malaysia, 2013). The learning process

will be more enjoyable if a child can understand the content through their experiences using AR technology.

1.3 Problem Statement

The field of education has experienced a significant surge in the adoption of technology, with AR emerging as a powerful tool for enhancing learning experiences at various educational levels, including primary, secondary, tertiary, and higher education (Chang et al., 2022; Shan, 2021). AR has been shown to augment traditional pedagogical methods, boost motivation, foster interactive engagement, and deepen understanding of complex subjects. In educational settings, AR applications would be accessible and effective for all educational levels, including early childhood education, to maximize learning outcomes and motivation among young learners. Designing AR experiences for preschoolers should align with their developmental characteristics, such as cognitive and motor skills and attention, while catering to their preferences and abilities.

Despite the proven potential of AR in education, its integration into preschool learning remains primarily neglected and unexplored (Kayaduman & Sağlam, 2023; Zhang, Huang, Feng & Luo, 2022; Chen, Cheng & Huang, 2017; Murat & Akçayır, 2017; Bacca, Baldiris, Fabregat & Graf, 2014). Existing AR design guidelines primarily target older children and adult learners, failing to account for the unique developmental needs of preschoolers (Tuli & Mantri, 2021; Plowman, 2016). Preschoolers require tailored AR designs that consider their cognitive development (Pakpahan & Saragih,

2022), motor skills (Razali, Aziz, Rasli, Zulkefly & Azmi, 2019), attention spans (Yilmaz, Topu & Tulgar, 2022), and preferences (Zhou, Sun, Shi & Lu, 2020). For instance, young children have distinct fine motor skills, making multitouch gestures like rotation, pinch, and scale challenging for them (Razali et al., 2019). Furthermore, many AR applications fail to integrate motivational design frameworks, leading to disengagement or boredom due to repetitive animations or extended durations (Hacer & Fatih, 2022). These limitations undermine AR's efficacy as an educational tool for preschoolers (Zhou et al., 2020).

The lack of a well-designed AR framework tailored to preschoolers leads to inadequate learning experiences and a lack of sustained engagement. Without addressing the unique developmental and motivational needs of preschool learners, AR applications risk becoming ineffective or even counterproductive in educational settings. Current AR features, when not carefully designed, can hinder learning or disengage young children (Hacer & Fatih, 2022; Zhou et al., 2020). This gap in research and practice not only limits the potential of AR technology but also hinders educators and developers from leveraging it to its fullest extent in early childhood education.

Therefore, this research aims to formulate an Augmented Reality Motivational Design Framework (ARMDF) tailored for preschoolers. The framework will integrate motivational principles such as attention, relevance, confidence, and satisfaction (ARCS) to enhance engagement, learning outcomes, and the overall educational experience. The proposed framework will serve as a guideline for educators and developers in creating AR-based educational tools (Hwang et al., 2022; Ibáñez, Di-serio, Villarán-molina & Delgado-Kloos, 2014).

1.4 Research Objectives

The main purpose of this research is to develop an AR motivational design framework, which is specifically for use at the early childhood education level. The framework was applied in the design and development of AR applications for children aged 5-6 years by focusing on the 8i factors: (1) intrinsic and extrinsic rewards, (2) information, (3) instruction and goal, (4) interface, (5) imagination, (6) interaction, (7) internal control, and (8) immediate feedback.

Based on the discussion above, four research objectives (RO) to guide the research were formulated as follows:

RO 1: To identify the current trends of AR application design in early childhood education

RO 2: To formulate an AR motivational design framework (ARMDF) for the early childhood education setting

RO 3: To validate the motivational design framework for the design and development in AR application for early childhood education

RO 4: To evaluate the early childhood children's motivation in learning while using the ARMDF augmented reality application

1.5 Research Questions

To address the research objectives, the researcher formulated five research questions (RQ) as follows:

RQ 1: What are the current trends of AR application design in early childhood education?

RQ 2: What are the motivational elements that can be used to formulate a motivational design framework for AR application in the early childhood education setting?

RQ 3: How can the motivational design framework be applied to the design and development in AR applications for early childhood education?

RQ 4: Does the ARMDF augmented reality application motivate early childhood students in their learning?

1.6 Significance of the Study

The purpose of this research is to have an influence on various fields, including Child Computer Interaction (CCI), early childhood education, and specifically, AR technology. The thesis provides the following contributions that can be advantageous to instructional designers, instructors, teachers, and policymakers.

a) Child-Computer Interaction (CCI)

This application aims to boost young children's motivation in learning. The study incorporates various methods, procedures, and tools specifically designed for engaging young children. By actively involving young children as informants in the evaluation process, their experiences, insights, and information can be utilized to create an innovative and immersive AR application. The knowledge gained from this research will aid developers in creating learning tools that are well-suited to the unique learning needs of children.

b) Early childhood education

Educators may be able to improve children's motivation in terms of attention, relevance, confidence, and satisfaction in their learning experience by considering 8i design factors: (1) intrinsic and extrinsic rewards, (2) information, (3) instruction and goals, (4) interface, (5) imagination, (6) interaction, (7) internal control, and (8) immediate feedback. Young children's motivational semi-structured interview questions based on the ARCS model can be used by other researchers in AR application evaluation and other fields of research that relate to children's motivation. Other than that, educators and school leaders will have access to the latest educational technology knowledge and could use this to inform strategic planning.

c) AR research field

The existing literature reveals a noticeable gap in research (population gap) that specifically targets the young children user group in relation to AR technology. Despite the widespread utilization of this technology at various educational levels, there has been limited exploration of its potential impact and effectiveness on young children's learning experiences. Consequently, it is imperative to conduct research that focuses on this particular group of users.

The significance of undertaking such research cannot be overstated. By conducting studies dedicated to understanding and optimizing the design of motivational AR experiences for young children, instructional designers can gain valuable insights into effective strategies and approaches. This knowledge will enable them to create engaging and impactful AR learning experiences tailored specifically to the needs and characteristics of young children.

1.7 Scope and Limitation

The scope of this study has been limited from the beginning as follows:

a) It only focuses on a motivational design framework for preschool children by emphasizing children aged five and six years old.

b) The theoretical underpinning for this study was grounded in the ARCS Model.

c) This study was limited to the evaluation of motivational design frameworks towards young children's motivation, which is based on four variables: (1) attention, (2) relevance, (3) confidence, and (4) satisfaction.

d) This study was limited to marker-based AR technology.

e) The evaluation on the usability and validation of the framework is conducted in preschool in Malaysia. More specifically, the research focus was for 5-6 year-old children; thus, the motivational design framework may not be appropriate to the design and development of learning tools for the use of children of other different age groups.

1.8 Conceptual Framework

A conceptual framework, whether presented visually or through written description, outlines the primary elements to be examined, the crucial components, constructs, or variables, and the assumed connections between them (Miles & Huberman, 1994). In this research, the formulation for developing an AR motivational design framework for young children is based on a strong foundation motivational model. In order to understand the potential of AR technology in enhancing preschoolers' motivation in

learning, the present study was influenced by a motivational design theory named the ARCS Model and Jean Piaget's Cognitive Development Theory.

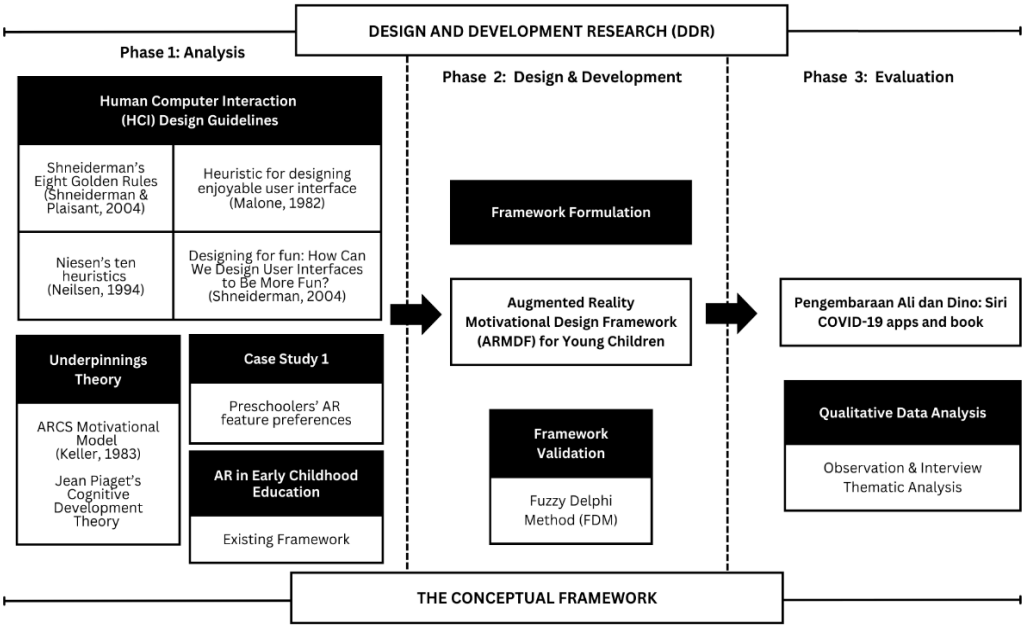
According to Keller (2010), motivational design refers to the process of rearranging resources and procedures to bring about changes in user motivation. The primary focus of this model is on motivation in learning by specifying principles, strategies, and processes for making instruction more appealing and eye-catching. As mentioned by Keller (2010), motivational design involves the systematic rearrangement of resources and procedures to elicit changes in user motivation. This model primarily concentrates on enhancing motivation in learning by delineating principles, strategies, and processes aimed at making instructional content more engaging and visually appealing.

Jean Piaget's Cognitive Development Theory (1964) is essential in this research as it emphasizes the need to align educational tools with the developmental stages of children. Piaget identified four phases: (a) sensorimotor, (b) preoperational, (c) concrete operational, and (d) formal operational, which are each characterized by unique cognitive abilities. AR can support these stages by providing age-appropriate, interactive, and immersive learning experiences. For example, in the preoperational stage, AR can enhance symbolic thinking and language development through interactive storytelling. Piaget's constructivist approach, which highlights active learning and sensory exploration, aligns seamlessly with AR's interactive nature, allowing children to construct knowledge through hands-on experiences.

For the development of the augmented reality motivational design framework (ARMDF), design guidelines from existing literature from various databases such as Web of Science, Scopus, IEEE Xplore, and Google Scholar were reviewed. Other than that, the conceptual framework also is based on the existing framework and guidelines from Human-Computer Interaction (HCI), AR framework and guidelines, and children's preferences on AR features. Based on that, eight main factors or themes that contribute to the AR design have been categorized, and they are: (1) intrinsic and extrinsic rewards, (2) information, (3) instruction and goal, (4) interface, (5) imagination, (6) interaction, (7) internal control, and (8) immediate feedback. Figure 1.1 presents the conceptual framework for this study.

Figure 1.1

The Conceptual Framework



1.9 Operational Definitions

The following is an operational definition that comprehensively describes the main concepts, variables, methods, and processes to which this dissertation refers, elucidating the fundamental framework and parameters for understanding and conducting the research.

a) ARCS Model

The ARCS Model, originally introduced by John Keller in 1984, stands for attention, relevance, confidence, and satisfaction, encompassing these four crucial elements as the central components of this motivational design model, which has gained significant recognition and extensive utilization across various research domains, attesting to its enduring impact and practical applicability over the years.

b) Augmented Reality (AR)

AR technology is a medium where information is applied to the physical world for actual world registration. This technology enables users to scan an object to view virtual objects such as text, images, audio, video, and animation in the real world. Since there are several definitions of AR, Azuma (1997) stated that the technology has three characteristics to define the technology.

i) Combines real and virtual

ii) Interactive in real-time, and

iii) Registered in 3D

In this study, AR refers to a technology that integrates virtual objects (such as images, texts, and animation) into the real world, enabling the user to experience enriched and attractive real-world scenarios.

c) Child-computer interaction (CCI)

Child-computer interaction (CCI) is a multidisciplinary field that focuses on the interaction between children and computational and communication technologies (Baykal, Eriksson & Torgersson, 2023). The research community dedicated to this field integrates viewpoints from diverse scientific disciplines to inform their investigations and industrial applications. Their focus lies in the design, evaluation, and implementation of interactive computer systems tailored for children, as well as examining the broader consequences of technology on both children and society (Giannakos, Markopoulos, Hourcade & Antle, 2022).

d) Children

Malaysia's National Child Policy defines a child as a person below the age of 18, as enshrined in the Convention on the Rights of the Child and the Child Act, 2001. Since the usage of child terms covers a wide range of ages, it is important to stress here that

our primary emphasis in this study is on young children, who are between five and six years of age.

e) Early childhood education

This terminology refers to formal and informal educational programs that serve children in their preschool years, before entering primary education. In the context of the Malaysian educational system, early childhood care and education is divided into two age groups, which are 0-4 years and 4-6 years old (preschool). This study focused on research with preschoolers aged 5 and 6 years old.

f) Extrinsic motivation

An individual carries out any activities that will benefit them for as long as they are given a prize or reward. When extrinsic reward is used in the classroom, children are often unmotivated to complete a task or try again until they are offered another prize (Deci, Vallerand, Pelletier & Ryan, 1991), and this will reduce a child's natural intrinsic desire to learn (Frank, 2010; Swann & Pittman, 1977).

g) Intrinsic motivation

An individual interest to perform an activity without expecting any rewards from other people. Compared to extrinsic motivation, intrinsic motivation is associated with better learning achievement in children. This is because intrinsically motivated students are

more inspired in their learning and use various approaches to promote deeper understanding and future application of that learning (Carlton & Winsler, 1998).

h) Framework

A framework generally represents a structure, overview, outline, system, or plan consisting of various descriptive categories like concepts, variables, and constructs, including the relations between them that are presumed to account for a phenomenon (Nilsen, 2015). This study focuses on the formulation of the framework, which contains the guidelines for designing motivational AR for young children.

i) Marker

A marker is a sheet of paper or card with a specific symbol or a distinct pattern. When the user scans the marker with a tablet or smart device by using an AR application, the user can see several virtual objects in registration with the fiducial symbols.

j) Motivational design

Motivational design refers to the process of arranging resources and procedures to bring about changes in motivation. An example of motivational design is the ARCS Model, which was introduced by John Keller in 1985. It has been well-known among scholars and has been used in this study as the main theory to guide the path of this research.

k) Preschool

According to the Ministry of Education (MOE), preschool education is a program that provides learning experiences for children aged four to six years for a period of one year or more before entering Standard One at a primary school. However, in this study, this study emphasizes children learning from age five to six years old.

1.10 Structure of Thesis

The subsequent chapters of this thesis are meticulously organized and thoughtfully structured to provide a comprehensive and coherent presentation of the research findings, theoretical frameworks, analytical methodologies, and practical implications, effectively guiding the reader through a systematic exploration of the subject matter.

a) Chapter 1: Introduction

In this chapter, a comprehensive overview is presented, focusing on the research issues and background related to children's motivation in learning. It emphasizes the contextual backdrop of the research, addresses the specific issues that arise within this study or the problem statement, outlines the research objectives and questions, and underscores the significance of the study. Additionally, the chapter provides an examination of the scope and limitations, delves into the theoretical and conceptual

framework, and elucidates the operational definitions utilized, thereby offering a thorough foundation for the subsequent exploration.

b) Chapter 2: Literature review

This chapter serves as an introductory exploration into the realm of AR technology, encompassing its definition, underlying concepts, and its implementation within educational settings. Furthermore, this chapter undertakes a comprehensive review of existing literature, rigorously examining previous works and identifying issues and suggestions for designing AR applications specifically tailored for preschoolers. This meticulous review culminates in the formulation of the 8i factors, which comprise a motivational framework for designing AR experiences for young children. Additionally, the chapter delves into the theoretical background, discussing the influential ARCS Motivational Model, and revisits existing guidelines such as Shneiderman's Eight Golden Rules, Nielsen's ten heuristics, heuristics for designing enjoyable user interfaces, and approaches for designing user interfaces to enhance enjoyment, among others.

c) Chapter 3: Methodology

This chapter explores the research methodology employed in the study, such as the adaptation of design and development research (DDR) in the research design, framework formulation and expert validation using the Fuzzy Delphi Method (FDM), sample composition and size, sampling procedures, experimental procedures, and an examination of the research instruments and materials. Furthermore, this chapter aims

to accentuate and underscore the significance of the analysis method employed in order to effectively scrutinize and interpret the data that has been meticulously collected throughout the course of the study.

d) Chapter 4: The Augmented Reality Motivational Design Framework (ARMDF) Formulation and Validation

Within this chapter, a comprehensive explanation is presented regarding the formulation of the framework. Furthermore, this chapter endeavours to rigorously analyze the data obtained, employing a thorough and meticulous approach. The data, organized thematically, is then presented in order to emphasize and shed light on the design factors that significantly contribute to enhancing the motivation of young children when engaging in learning activities utilizing AR applications.

e) Chapter 5: The Development of Augmented Reality Application Based on Augmented Reality Motivational Design Framework (ARMDF)

This chapter discussed the design and development of AR applications for preschoolers aged 5 to 6. A key aspect of this development entails adhering rigorously to the Augmented Reality Motivational Design Framework (ARMDF) for preschoolers, a meticulously formulated framework that serves as a guiding compass throughout the entire development journey. All application features are derived from the framework, ensuring a coherent design that meets the needs of the target audience.

Moreover, this chapter delves into a comprehensive discussion of the procedure involved in conducting an evaluation, a vital component during the implementation phase of the project. The primary objective is to assess the impact of the application on the motivation levels of young children. By systematically evaluating the usability aspects and examining the influence on motivation, valuable insights are obtained, fostering a deeper understanding of the effectiveness and efficacy of the AR application for preschoolers aged 5 to 6 years.

f) Chapter 6: Discussions and Conclusions

In this chapter, a comprehensive summary is provided of the research findings, elucidating their significant contribution to the domains of multimedia design, early childhood education, Child-Computer Interaction (CCI), and AR research. Additionally, the chapter accentuates the strengths and limitations inherent in the study, offering an insightful analysis. Furthermore, the chapter outlines the prospective future direction of the field and presents a few recommendations for future endeavours, setting the stage for further research and exploration.

1.11 Conclusion

This chapter presents the overview of the research study. This chapter illustrated the research background, problem statements, research questions, the research objectives, the significance of the study, research scopes, and its conceptual framework. This

chapter is significant in order to recognize the issues regarding the problems, theories related, and the direction of the study. In conclusion, this study is worthy for the community of researchers and educators as well as the AR application industry in general. Next, Chapter 2 will provide an overview of AR technology, including the definition and a detailed explanation about the concept that lies behind it, including its types and benefits. The chapter also will discuss the technology evolution in early childhood education and the design factors for preschooler AR apps, revisiting existing design guidelines in Human Computer Interaction (HCI) and from CCI perspectives.