EXPLORING EXPERIENTIAL LEARNING WITH IMMERSIVE VIRTUAL REALITY AS A FRAMEWORK FOR TEACHING DELIVERY IN ARCHITECTURAL DESIGN STUDIO

By

ANNISA UMMIHUSNA BINTI ABDUL GHANI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

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Chair : Assoc. Prof. Ts. Mohd Zairul bin Mohd, PhD
Faculty : Design and Architecture

Architects' basic architectural understandings are derived from their personal experience gained since childhood. Thereby, a formal architecture curriculum cannot be comprehended merely from a classroom or studio; it requires students to observe and participate in outdoor architectural settings. Young designers, therefore, may struggle in the early stages of an architectural programme as most begin their education with little experience in perceiving and understanding spaces. Each of them may have a varied level of spatial understanding experience that influenced their approach to the design process. For this reason, site visit activities have been a key component in architecture education to provide students with experiential learning experiences. Nevertheless, challenges in managing site visits and limitations as the Covid-19 pandemic have hampered the overall learning experience. Therefore, this study aimed to explore how experiential learning (EL) with immersive virtual reality (IVR) as a learning tool can enhance first-year architecture students' spatial understanding experience during the architecture design process. An IVR simulation named Architectural Spatial Experience Simulation (ASES) which can actively enrich spatial understanding was designed, developed, and implemented in a first-year architecture design studio. Action research was employed by the practitioner-researcher in an architecture design studio environment for two consecutive semesters involving ten students undertaking the first-year design studio course in each cohort. The two cycles of action research involved multiple data collection strategies and instruments, such as desk reviews, observation, reflective memos, journals and textual records of design work. Data collected were then analysed using qualitative descriptive analysis and thematic analysis. The findings indicate that EL theory with IVR is recognised as a promising approach to support spatial understanding experiences among first-year architecture students during the architecture design process. ASES was established to enhance the participants' spatial understanding and encourage changes in their approach to learning from surface to deep learning. IVR with EL

was found to provide visual, experiential, versatility, and emotional attributes, thus enhancing the students' spatial understanding experience. The Experiential with IVR Architecture Design Learning (EVADL) framework was formulated in guiding the integrated application of EL with IVR during the design process and was recognised to provide structure in the architecture design studio learning activities. This study has established empirical exploration and enhanced the theoretical understanding of experiential learning in the architecture design education context. In practice, the study has developed ASES which can serve as an active tool in replacing the concrete experience in EL and resolving the difficulties of conducting site visit activities. ASES able to enrich students' spatial understanding experience and encourages a deep learning approach. The EVADL framework can serve as a guideline for ILT intervention in architecture design studios for educators during the planning stage of the studio course. Future studies may be implemented on a broader scale to validate the appropriateness of the applications in different architecture schools. The potential for collaborative action research to be performed among educators in other higher institutions that might have similar interests or concerns on first-year architecture students.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

PENEROKAAN PEMBELAJARAN BERASASKAN PENGALAMAN BERSAMA TEKNOLOGI PEMBERLAJARAN EMERSIF SEBAGAI RANGKA KERJA UNTUK PENYAMPAIAN PENGAJARAN BAGI STUDIO REKABENTUK SENIBINA

Oleh

ANNISA UMMIHUSNA BINTI ABDUL GHANI

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Pengerusi : Prof. Madya Ts. Mohd Zairul bin Mohd PhD
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Pengetahuan asas senibina arkitek diperolehi daripada pengalaman peribadi seseorang sejak zaman kanak-kanak. Dengan itu, kokurikulum rasmi senibina tidak hanya boleh difahami dari dalam bilik kelas atau studio tetapi memerlukan pelajar untuk memerhati dan mengambil bahagian dengan pengalaman senibina dan tetapan luar bangunan. Pereka bentuk muda mungkin merasa susah untuk menyesuaikan diri dengan pembelajaran senibina semasa peringkat awal program senibina kerana kebanyakkan mereka memulakan pengajian tanpa dengan pengalaman yang mencukupi untuk mempersepsikan dan memahami ruangan dan bentuk. Setiap pelajar baru mempunyai tahap pengalaman spatial yang berbeza di mana ia akan mempengaruhi pendekatan di dalam proses rekabentuk. Isu ini kebiasaannya akan ditangani dengan aktiviti lawatan tapak sebagai komponen yang penting dalam pengajian senibina kerana ia memberikan pembelajaran berasaskan pengalaman kepada pelajar. Namun begitu, kesukaran untuk menguruskan lawatan tapak seperti semasa pandemik Covid-19 menyukarkan pengalaman pembelajaran secara keseluruhan. Oleh itu, kajian ini bertujuan untuk mengetahui bagaimana pembelajaran berasaskan pengalaman bersama teknologi pembelajaran imersif sebagai alat pembelajaran dapat mempertingkatkan pemahaman pengalaman spatial pelajar tahun pertama senibina semasa proses rekabentuk senibina. Simulasi virtual maya emersif yang dinamakan “Architectural Spatial Experience Simulation” (ASES) yang akan mempertingkatkan pengalaman spatial peribadi perekabentuk baru direka, dibangunkan dan dilaksanakan di dalam studio senibina tahun satu. Kajian secara tindakan telah dilaksanakan oleh pengkaji-pengamal di dalam konteks studio rekabentuk senibina untuk dua semester berturut-turut melibatkan sepuluh pelajar di dalam setiap kohort yang menjalani kursus studio senibina tahun pertama. Dua kitaran kajian secara tindakan melibatkan

beberapa jenis strategi dan alatan untuk pengumpulan data seperti kaedah kajian literatur, pemerhatian, memo reflektif, jurnal dan rekod teks kerja rekabentuk. Data yang dikumpul di analisa dengan menggunakan cara analisis deskriptif kualitatif dan analisis tematik. Penemuan penyelidikan mendapati teori pembelajaran berasaskan dengan pengalaman realiti maya emersif telah dikenalpasti sebagai pendekatan yang untuk membantu pemahaman pengalaman spatial pelajar tahun pertama senibina semasa proses rekabentuk senibina. ASES telah dibuktikan dapat memperbaiki pemahaman spatial peserta kajian dan menggalakkan perubahan terhadap pendekatan pembelajaran daripada pendekatan cetek kepada pendekatan pembelajaran yang mendalam. Penggunaan teknologi pembelajaran emersif di dalam pembelajaran berasaskan pengalaman didapati menyediakan ciri-ciri secara visual, pengalaman, kepelbagaian dan emosi yang seterusnya memperbaiki pemahaman pengalaman spatial para pelajar. Rangka kerja “Experiential with IVR Architecture Design Learning” (EVADL) dirumuskan sebagai panduan untuk mengintegrasikan penggunaan teori pembelajaran berasakan pengalaman dengan pengalaman realiti maya emersif yang dikenalpasti untuk memberi struktur di dalam aktiviti pembelajaran studio senibina. Kajian ini telah mengesahkan penerokaan empirikal dan mempertingkatkan pemahaman secara teori pembelajaran berasakan pengalaman di dalam konteks pembelajaran senireka senibina. Secara praktikal, kajian ini telah membangunkan ASES yang bertindak sebagai alatan secara aktif bagi menggantikan pengalaman konkrit di dalam pembelajaran berasakan pengalaman dan menyelesaikan kesulitan untuk menjalankan aktiviti lawatan tapak. ASES dapat memperkayakan pemahaman pengalaman spatial para pelajar dan menggalakkan pendekatan pembelajaran yang mendalam. Rangka kerja EVADL dapat bertindak sebagai panduan untuk penggunaan teknologi pembelajaran imersif di dalam studio senireka senibina bagi tenaga pengajar semasa peringkat perancangan kursus studio. Kajian masa hadapan boleh dilaksanakan pada skala yang lebih luas untuk mengesahkan kesesuaian penggunaan di pusat pembelajaran senibina yang berbeza. Potensi untuk menjalankan kerjasama bagi kajian secara tindakan di antara tenaga pengajar di institusi pengajian tinggi yang lain yang mempunyai kepentingan atau isu serupa bagi pelajar senibina tahu pertama

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Declaration by the Graduate Student

I hereby confirm that:

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

AC	Abstract conceptualisation
ADLA	Architecture Design Learning Assessment
AE	Active experimentation
AR	Augmented reality
ALA	Approach to Learning Assessment
ASES	Architectural Spatial Experience Simulation
CAD	Computer-aided design
CE	Concrete experience
DA	Deep approach
EL	Experiential Learning
ELA	Experiential Learning Assessment
EVADL	Experiential with IVR Architecture Design Learning
FGD	Focus group discussion
ICT	Information and communication technology
ILT	Immersive learning technology
IVR	Immersive virtual reality
PARCM	Personal Architectural Reflection & Conceptualization Memo
PSES	Personal Spatial Experience Survey
RO	Reflective observation
RQ	Research question
VR	Virtual reality

CHAPTER 1

INTRODUCTION

1.1 Preamble

This chapter begins by discussing the research's motivation, the background of the study, and the research problem. Next, this chapter also addressed the research questions, aims, and objectives. The chapter also discusses the rationale for action research methodology, significance, scope, and limitation of the study. Finally, the key definition and structure of the thesis are provided at the end of this chapter.

1.2 Background of the Study

This research was prompted by the desire to increase teaching and learning innovation within a curriculum, improve students' learning experiences, and connect learning effectively with practice. Such impetuses correspond with the fourth target of the United Nations' Sustainable Development Goals (SDG), which is to provide quality education by ensuring inclusive and equitable quality education for all (United Nations 2021). In response to the SDG, the Malaysian Ministry of Education (MOE) has been committed to transforming the country's higher education system in the Malaysian Education Blueprint 2013–2025. One of the aims stated in the blueprint is for the students to benefit from high-quality learning that uses experiential and technology-enabled learning models, as well as from more personalised and engaging learning experiences, in order to optimise their full potential. The blueprint also highlights the importance of technology-enabled innovation in delivering and personalising the learning experience for all students (MOE 2015). Moreover, the Malaysian Ministry of Higher Education has mandated the introduction of 'Cybergogy,' virtual-based learning for Learning and Teaching 4.0, in embracing the Fourth Industrial Revolution (MOHE 2018).

In addition, educators must understand the type of learners involved in the current education system to stimulate quality education with a better learning environment. Born between 1981 to 1994, the Gen Y or millennials are the generations known as mobile nomads who are used to being technologically facilitated throughout their childhood, connected by cell phones and laptops and demand this connectivity in their higher education (Martin and Monaco 2007). As time progressed, the world began to receive Gen Z or the digital natives generation (born between the year 1995 to 2010) in higher education institutions (Mohr and Mohr 2016). Digital Natives are beyond what the Millenials used to be since the former are native technology users and never know a world without smart devices and the internet (Cameron and

Pagnattaro 2017). Increasing the students' enthusiasm in their studies consequentially necessitated innovative methods to maintain a high rate of responsiveness between the students and the subjects, avoid a decrease in the number of students in the early stages of their studies, and prevent high dropout rates (Dav Fonseca et al. 2017). In architecture studies specifically, students do not receive the education in the way they are better at receiving with the current conventional teaching method (Maghool, Moeini, and Arefazar 2018). Subsequently, the student-centered learning approach was introduced to accommodate the new needs.

While research related to information and communication technology (ICT) innovation in the Malaysian education context is increasing and abundant, little does it inform on the use of ICT in the architecture education field. Nonetheless, several Malaysian scholars (e.g., Rahimian and Ibrahim, 2011; Abdullah et al., 2017) have begun to address immersive technology implementation in architecture education. The latest Covid-19 pandemic has also prompted the Council of Architectural Accreditation and Education Malaysia (CAAEM) to adopt virtual design studios that use ICT as a pedagogical instrument in the teaching and learning in an architecture design studio (CAAEM 2020). Yet, available research in this area is inadequate, thus necessitating further investigation to support the conditions of virtual learning. The focus of the present study, therefore, is on ICT innovation or technology-enabled learning in the context of architecture education.

1.2.1 Diagnosis for Research Issue

A diagnosis study was conducted in June 2018 to understand architecture education's current situation and issues. The participants consisted of students and educators from architecture schools/faculties in higher education institutions in Malaysia. The primary data sources were derived from a focus group discussion (FGD), whose participants were selected via purposive sampling. According to Merriam (2009), purposeful sampling is carried out based on a researcher's desire to learn and understand. Hence, the samples selected were from the ones that can be studied. In the case of the current study, the sample consisted of three (3) academic members who specialise in teaching architecture design subjects and 20 students from different architectural study levels in bachelor years 1, 2, and 3, as well as master-degree years 1 and 2. Such variability served as a measure to include the widest possible range of the qualities of interest for the research (Merriam 2009).

The FGD protocol contains the purposes, research questions, introduction, and questions on the perception and awareness of experiential learning using immersive virtual reality technology in architecture study and how it will assist the learning process. All interviews were semi-structured, and conducted using an interview guide, as attached in Appendix A of this thesis.

The following three categories of questions respond to the objective of the FGD:

1) Awareness and perception of ILT or VR technology in general

2) Issues or difficulties in any subject/area of architecture study that are faced with the current delivery method,

3) Opinion on the suitability of using ILT/VR technology in architecture study

Apart from the standardised questions, the respondents were queried further based on their responses. All sessions were conducted in English, each lasting between 15 minutes and 30 minutes. Each interview was audio-recorded, and the transcription was prepared.

1.2.2 Findings from Focus Group Discussion (FGD)

This section presents the conclusions of the FGD (The original data from the FGD can be referred to in appendix M). First, the participants highlighted the issues or difficulties they faced in any subject/area of architecture study with the current delivery method. They emphasised the need for them to have experience in understanding building, details, and space quality. However, it was mentioned that buildings with such required quality are usually inaccessible.

Difficulties in understanding building constructions, details and space quality. Existing building with the quality of space is inaccessible (FGD A1)

Architecture needs to be experienced. It cannot be taught by secondary knowledge, from books and also by a person who never been to. (FGD B1)

The architecture discipline requires the students to grasp specific characteristics of space quality to allow them to design fluently. The best method for doing so is to experience it firsthand or directly from an existing building. However, this issue is commonly encountered by advising students to refer to other sources such as books, magazines, or websites, which don't provide an immersive experience compared to the actual experience. Accordingly, a learning tool is appropriately needed to encounter the issues highlighted. For example, a learning tool will provide architecture students with an immersive experience of building that offers specific details and space quality without worrying about unattainability, consequently easing the learning process directly.

The second finding is the participant's opinions on the suitability of using ILT/VR technology and what is required to encounter their difficulties in learning architecture study.

> *For me, if we can have a catalogue or library of buildings for case study and precedent studies exercise, it would be very helpful. (FGD A3)*

> *It will be very beneficial to have an archive or library of different types of spaces and architectural components in virtual reality. A new type of documentation for experience use and learning space in architecture. A form of archive or library for different spaces, for example, a space to test claustrophobics (FGD B2)*

> *We need a tool that can make us understand and experience space more. It can make us consider the details such as lighting, openings, and materials (FGD A20)*

The participants believed that difficulties in learning and understanding space in architecture could be encountered using ILT/VR technology. They stressed the need for a learning tool that is able to archive spaces that can be immersively experienced to understand certain building elements or characteristics (lighting, opening, materials, size, shape). It is similar to having a range of references or documents in a two-dimensional view of content either printed or digitally, where different types of space/ building components would be available as a case study of precedent studies.

Therefore, based on the findings obtained from the diagnosis stage, it might be suggested that a new learning tool of ILT is needed to encounter the difficulties in learning and understanding space in architecture. The method can provide experience simulation of an existing or non-existing inaccessible reality or environment. These findings align with Shamalinia (2017), who advocated the potential of IVR for architecture learning and as a new source of documentation and materials for references.

1.3 Problem Statement

Lacking spatial understanding experience is a concern that affects the new generation of architecture students, specifically new first-year architecture students who have just joined the program. The reason is the architectural experiences gained during one's life serve as the foundation of architectural and spatial understanding. Gained throughout life since childhood (Türkmenoglu Berkan et al. 2020; Zumthor 2010), these experiences must

be used by architecture students thoughtfully through their personal architectural experiences. New architecture students have diverse spatial abilities (Türkmenoglu Berkan et al., 2020), and most of them begin their education with little experience in noticing and comprehending spaces and forms (Abdullah et al., 2011). They may struggle with challenges requiring complex spatial concepts or manipulation of space (Sutton and Williams 2011). As Unwin (2007) emphasised, architects' intellectual resources for design come from their experience of the world, particularly their experience and critical appreciation of buildings they have visited or studied. The architectural journey for spatial understanding experience as active or unstructured learning environments is an essential aspect of the architectural studio's learning process, just as vital as learning in the studio. However, this concern has not been debated in architectural educational science, and this statement was also supported by Kesim and Yöney (2021) in their recent study.

The above concerns are critical as the architecture learners progress through a formal architecture education; they must observe their experience and environment, which cannot be comprehended only from the classroom (Ummihusna and Zairul 2022). Architectural spaces need to be experienced and cannot be understood by only looking through images since space communicates with volumes and other elements, such as tactility, temperature, and colours (Pozzi 2010). Therefore, one's personal experience is significant to the spatial design process and is commonly addressed with site-visit activities (Mahdavinejad, Shahrigharahkoshan, and Ghasempourabadi 2012; Pozzi 2010).

Accordingly, architecture learning requires looking beyond the classroom and interchangeably between indoor and outdoor environments (Ummihusna and Zairul 2020). Site visits and field trips are a crucial component and instrumental in architecture design learning, as it provides students with experiential learning (Jose, Patrick, and Moseley 2017; Kesim and Yöney 2021; Ng 2013). However, the challenges in using outdoor sites as part of the learning activities such as lack of administrative support, complex planning logistics, student management issues, lack of skills and knowledge regarding teaching outdoors, and safety concerns have all affected the decision to implement site visit activities in an architectural curriculum (Jose et al., 2017). The Covid-19 pandemic further impacted the learning experience when physical movement is restricted, and learning is mostly done digitally. The Royal Institute of British Architects highlighted from Covid-19 Student Survey 2020 that most architecture education curriculum components are inappropriate for digital teaching and learning and emphasized that planning for the digital future is crucial (RIBA 2020). Therefore, there is a need to explore the potential of learning technology as a learning tool to enhance students' personal experiences in the current architectural learning setting.

Previous studies in the architecture education context have shown that implementation of immersive learning technology (ILT) in architecture education was found to receive positive feedback regarding users' satisfaction level, degree of motivation, adaptation to the technology, and ILT performance (Abdullah et al., 2017; Sánchez Riera et al., 2015). Several studies have also established the benefits of ILT as a supportive teaching and learning tool in architecture education (Abdelhameed 2017; González 2018; Moleta 2016). More importantly, numerous previous studies have looked into the effect of the ILT on learning performance for architecture education. Those existing studies highlighted that ILT increased users' participation, improved performance and efficiency, aided decision-making and allowed users to envision data (Abu Alatta and Freewan 2017; Ayer, Messner, and Anumba 2016; Bartosh and Krietemeyer 2017; Hong and Lee 2018; Lin and Hsu 2017; Pamungkas, Meytasari, and Trieddiantoro 2018; Redondo Domínguez et al. 2014; Şahbaz and Özköse 2018; Sun, Hu, and Xu 2018). However, existing studies which are conducted in architecture design studio are mostly for higher levels of architecture study, which are for the second year and above (Abdelhameed 2017; Abu Alatta and Freewan 2017; Hong and Lee 2018; Lin and Hsu 2017; Moleta 2016; Pamungkas et al. 2018). Fewer studies are available on implementing ILT in learning architecture design in the early stage of architecture study, specifically for first-year students. Given this shortcoming, the present study aims to explore the means for enhancing first-year architecture students' spatial understanding experience by using ILT as a learning tool in the architecture design studio.

1.4 Research Question

The specific main research questions with three sub-research questions were formulated:

How to enhance first-year architecture students' spatial understanding experience in Experiential Learning (EL) with immersive learning technology (ILT) as a learning tool during the architecture design process?

1. **Which learning theory and type of ILT is best suited to support spatial understanding experience during the architecture design process among first-year architecture students?**
   The first question seeks the most appropriate learning theory and tool to support spatial understanding for novice architecture designers. A systematic literature review was performed to answer this question from a theoretical perspective.

2. **How does EL with IVR as a learning tool enhance the spatial understanding experience during the architecture design process among first-year architecture students?**
   The second question would pursue its answer from the action research findings by understanding the influence of IVR in EL as a

learning tool designed to enhance the spatial understanding experience during the architecture design process.

3. **How to formulate a framework for EL with IVR as a learning tool to enhance the spatial understanding experience during the architecture design process among first-year architecture students?**
   The third question would pursue its answer on the framework formulation for EL with IVR as a learning tool to enhance the spatial understanding experience during the architecture design process grounded on the finding from RQ2.

Table 1.1 summarises the research questions, objectives and method to further visualise the research's continuity.

Table 1.1 : Research question of the research

Main Research Question How to actively enhance first-year architecture students' spatial understanding experience in Experiential Learning (EL) with immersive learning technology (ILT) as a learning tool during the architecture design process?		
Research Question (RQ)	**Research Objective (RO)**	**Method**
RQ1: Which learning theory and type of ILT is best suited to support spatial understanding experience during the architecture design process among first-year architecture students?	RO 1: To explore existing learning theory and type of ILT that is best suited to support spatial understanding experience during the architecture design process among first-year architecture students	Desk review
RQ 2: How does EL with IVR as a learning tool enhance the spatial understanding experience during the architecture design process among first-year architecture students?	RO: To explore how EL with IVR as a learning tool enhances the spatial understanding experience during the architecture design process among first-year architecture students	Reflective memo, textual record, observation
RQ 3: How to formulate a framework for EL with IVR as a learning tool to enhance the spatial understanding experience during the architecture design process among first-year architecture students?	RO 3: To formulate a framework for EL with IVR as a learning tool to enhance the spatial understanding experience during the architecture design process among first-year architecture students	Framework formulation

1.5 Research Aim and Objective

This study aimed to explore the means for enhancing first-year architecture students' spatial understanding experience in Experiential Learning (EL) with immersive learning technology (ILT) as a learning tool during the architecture design process.

The main objective is further elaborated into the following three research objectives:

1. To explore existing learning theory and type of ILT that is best suited to support spatial understanding experience during the architecture design process among first-year architecture students

2. To explore how EL with IVR as a learning tool enhance the spatial understanding experience during the architecture design process among first-year architecture students

3. To formulate a framework for EL with IVR as a learning tool to enhance the spatial understanding experience during the architecture design process among first-year architecture students

1.6 Rationale for Action Research Methodology

This study attempts to explore the means for enhancing the spatial understanding experience of first-year architecture students and encouraging a deep learning approach with a learning tool (ILT in EL) during the architecture design process. The action research was employed for its suitability in answering research questions in educational practice. Moreover, the researcher is a practising educator whose interest in the current study was prompted by her encounter with issues among first-year architecture students in an architecture design studio.

Comparison was made between phenomenology research and action research in rationalizing the decision. Whereby phenomenology study describes the common meaning of participants' lived experience (Creswell 2012), and the outcome is on the essence of the experience, what and how they experience it (Merriam and Tisdell 2016). Meanwhile, action research appears to serve the purpose since it is when a practitioner defines research problems, conducts the study, and the outcomes are directly helpful to the educational situations (Creswell 2012; Lune and Berg 2017; McAteer 2014b). The action research method is considered to be more relevant to the study due to (1) the objective of the study: to find the means to improve students learning experience, (2) practical research: researcher as the practitioner-educator, (3) the educational setting: requires continuous improvement of teaching & learning method and (4) benefit outcome: for the

classroom/educational setting. Hence, an action research approach was chosen.

1.7 Significance of the Study

This research acknowledges the suitability of EL and ILT to support spatial understanding experience. The findings may promote a better understanding of ILT in EL as a learning tool for enhancing spatial understanding experience during the architecture design process, particularly among first-year architecture students. The findings may also expand the existing knowledge on the influence of ILT in EL and facilitate recognition of the different impacts provided by both methods in enhancing spatial understanding experience and encouraging deep learning, particularly among first-year architecture students.

With regard to architecture education practice, this research contributes by proposing a framework on the presence of spatial understanding experience and ILT as a learning tool that influences the learning process and students' approach to learning (SAL). The framework can serve as a guideline for ILT intervention in an architecture design studio across higher institutions. Another outcome of the study is a learning tool that can serve as an active tool in enriching the personal experience of first-year architecture students who may lack spatial understanding experience. The learning tool can actively replace the concrete experience in EL as it resolves the difficulties of conducting site visit activities, a crucial component in architecture learning. The research is also anticipated to enhance the understanding of AR as educators' professional development and architecture syllabus enrichment approach.

1.8 Scope and Limitation of the Study

The scope of the study is to explore the means for enhancing the spatial understanding experience of first-year architecture students and encouraging a deep learning approach in Experiential Learning (EL) by using immersive learning technology (ILT) as a learning tool during the architecture design process.

This study limits its scope to immersive virtual reality (IVR), which was found as the most appropriate immersive learning technology for enhancing spatial understanding. Furthermore, this study limits its scope to the most cost-efficient and affordable IVR solution (smartphone-based IVR) for reachability of use among students and lecturers.

Additionally, the research applies an action research approach, a form of practitioner research (Newton and Burgess 2016). The study was conducted in Architecture Design 2 studio and occurred throughout the semesters of study. The researcher is the teaching lecturer, while the participants are the students' cohort enrolled on the design studio throughout the research duration. Due to this, the study limits the scope of the data collection process to participants who are the designated students' cohort only. As a result, the number of participants is predicate and modest. However, the study was conducted for two cycles to increase the depth and validity of action research. Cycle one was performed in the cohort of March 2019, involving 10 participants and cycle two was conducted in the cohort of August 2019, with another 10 participants. Therefore, findings may not be generalised to every architecture student in all higher education institutes. However, the research provides essential details from the participants that may allow readers to generalise the findings to their context.

1.9 Key Definition

In presenting the topic in question, it is essential to clarify some key terms used in the context of this research. These terms are further discussed in the subsequent literature review chapter.

Immersive learning technology:

Immersive technology refers to technologies such as virtual reality environment, immersive virtual reality, augmented reality, mixed reality, and virtual learning in a gaming platform (Handa, Aul, and Bajaj 2012; Soliman, Peetz, and Davydenko 2017; Suh and Prophet 2018). While immersive learning technology refers to technology that can enhance the quality of the learning experience and is used as an intervention in the learning process (Ummihusna and Zairul 2020).

Spatial understanding experience:

Refer to experience that provides the awareness and essential information about the surrounding space and how the individual comprehends it, translating into an understanding of the space or area (Seladi-Schulman 2020).

Learning Tool:

Refers to mediational means or tools used in teaching and learning, such as machines, writing, speaking, gesture, language, music, works of art, diagrams, maps and mechanical drawings (Daniels 2001). These tools are externally oriented towards the learning outcome and can abolish several unnecessary natural processes. (Vygotsky in Daniels, 2001).

Design Process:

It comprises a series of distinct and recognisable designing activities, which happen in some predictable logical sequence (Lawson 2006).

1.10 Structure of the Thesis

This thesis is organised into five chapters as follows and the following Figure 1.1 visualised outline of the research.

Chapter One introduces the background of the study, motivation and problem that triggered the study at hand. It also informs the research question, aim, significance, and limitation of the study.

Chapter Two presents a literature review examining the existing learning theory that supports spatial understanding experience and the potential of ILT as a learning tool in enhancing the spatial understanding experience during the architecture design process. The chapter particularly the constructivist learning theory, the experiential learning theory, and the student approach to learning theory. Then, the experiential learning theory is further addressed using virtual experience as a learning tool based on the existing intervention in the architecture education context. Finally, a conceptual framework is developed based on the findings from the review.

Chapter Three provides the details of this research project's research design and methodology. It begins by introducing the research and explaining the qualitative and action research. Then, it discusses the data collection strategies and data analysis techniques. The research validation approach is presented in the final section.

Chapter Four displays and organises the data collected in answering the three sub-RQ, which are on theory and tool for spatial understanding (answering RQ1), the EL with IVR (answering RQ2), and framework formulation (answering RQ3).

Chapter Five relates the findings identified to the literature and provides the research implications, recommendations for further research, and conclusions.

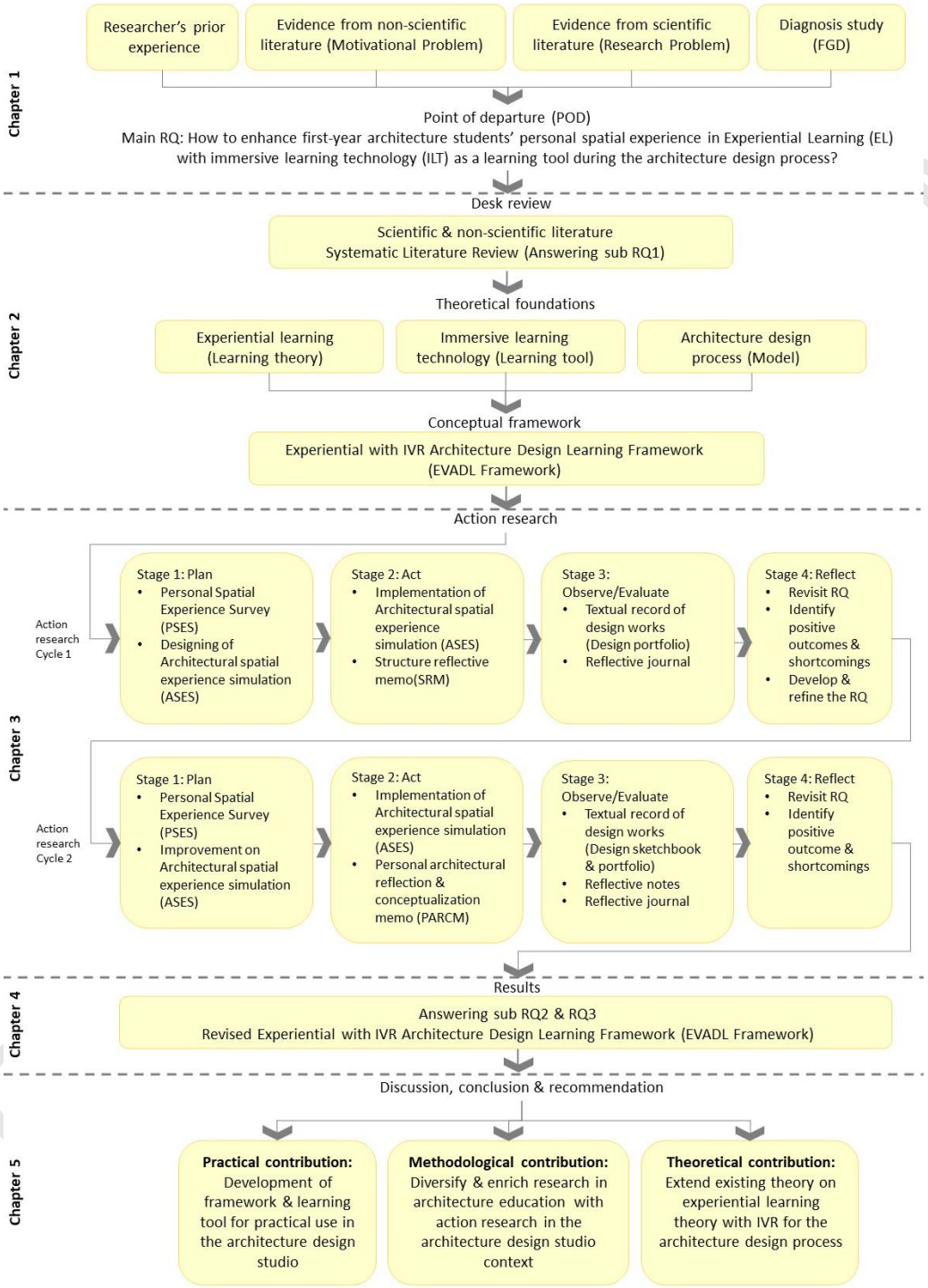

Figure 1.1 : Outline of the research
(Author, 2022)

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