THE EFFECTS AND RELATIONSHIP OF MOTIVATION AND ACHIEVEMENT IN STEM LEARNING AMONG ORANG ASLI STUDENTS USING AUGMENTED REALITY APPLICATIONS

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ABSTRACT

Augmented reality (AR) applications are increasingly gaining attention in education due to its ability to create interactive and engaging learning. However, there are limited studies on their effect towards motivation and achievement in STEM learning among Orang Asli students. As such, this study aims to: i) identify the effects of using AR applications to assess the level of motivation among Orang Asli students in STEM learning; ii) establish the effects of using AR applications on the achievement level of Orang Asli students in STEM learning; and iii) measure the strength of the correlation between motivation and achievement in STEM learning among Orang Asli students when using AR applications. A total of thirty (30) Form 1 Orang Asli students from a school in Perak. This study employed a quasi-experimental design involving control and treatment groups, where the data were collected through pretest and posttest, as well as from questionnaires based on the Attention, Relevance, Confidence, and Satisfaction (ARCS) Model of Motivation and achievement scores. In this research, two (2) AR applications that were developed by previous researchers, which are ARSiGaSTEM and AR-Tradisi, were used for the integration of traditional game elements with STEM concepts to create a more engaging and contextual learning experience. Data analysis involved the use of descriptive statistics and Spearman's correlation tests, as the data were non-parametric and did not meet normality assumptions. Three results were obtained; the first and second objectives indicated increased level of motivation in terms of attention, relevance, confidence, and satisfaction, along with significant improvement in academic achievement with the adoption of AR applications. Meanwhile, the third result revealed a strong positive correlation between student motivation and achievement (Spearman's $r = 0.781$, $p < 0.01$). This study provides meaningful insights into the role of AR applications in enhancing STEM education among Orang Asli students, aligning with the aspirations of the Malaysia Education Blueprint 2013–2025 to provide inclusive and quality learning opportunities.

KESAN DAN HUBUNGAN ANTARA MOTIVASI DAN PENCAPAIAN PEMBELAJARAN STEM DALAM KALANGAN PELAJAR ORANG ASLI MENGGUNAKAN APLIKASI REALITI TERIMBUH

ABSTRAK

Aplikasi Realiti Terimbuh (AR) semakin mendapat perhatian dalam bidang pendidikan kerana keupayaannya menyediakan persekitaran pembelajaran yang interaktif dan menarik. Namun begitu, kajian mengenai kesannya terhadap motivasi dan pencapaian dalam pembelajaran STEM, khususnya dalam kalangan pelajar Orang Asli, masih terhad. Kajian ini bertujuan untuk mengkaji penggunaan aplikasi AR dalam merapatkan jurang pencapaian akademik dan meningkatkan motivasi pelajar, seterusnya menyediakan akses pembelajaran moden yang lebih saksama kepada komuniti Orang Asli. Objektif kajian ini adalah i) untuk mengenal pasti kesan penggunaan aplikasi AR terhadap tahap motivasi dalam kalangan murid Orang Asli dalam pembelajaran STEM; ii) untuk mengenal pasti kesan penggunaan aplikasi AR terhadap tahap pencapaian murid Orang Asli dalam pembelajaran STEM; dan iii) untuk mengukur sifat dan kekuatan perkaitan antara motivasi dan pencapaian dalam pembelajaran STEM apabila menggunakan aplikasi AR dalam kalangan murid Orang Asli. Kajian ini menggunakan reka bentuk kuasi-eksperimen yang melibatkan ujian pra dan pasca serta kaedah tinjauan mrnggunakan soal selidik yang merangkumi tahap motivasi berdasarkan Model Motivasi ARCS dan skor pencapaian pelajar. Seramai 30 pelajar Orang Asli Tingkatan 1 dari sebuah sekolah di Perak telah dipilih melalui persampelan bertujuan. Aplikasi AR yang digunakan dalam kajian ini adalah AR-SiGaSTEM dan AR-Tradisi. Aplikasi ini menggabungkan elemen simulasi permainan tradisional dengan konsep STEM bagi mewujudkan pengalaman pembelajaran yang lebih menarik dan kontekstual. Data dianalisis menggunakan statistik deskriptif dan analisis korelasi Spearman. Dapatan menunjukkan wujudnya korelasi positif yang kuat antara motivasi dan pencapaian pelajar (Spearman's $r = 0.781$, $p < 0.01$), yang menunjukkan bahawa peningkatan motivasi berkait rapat dengan peningkatan pencapaian dalam pembelajaran STEM. Kajian ini memberi sumbangan bermakna terhadap pemahaman tentang peranan aplikasi AR dalam memperkasakan pendidikan STEM dalam kalangan pelajar Orang Asli, sejajar dengan aspirasi Pelan Pembangunan Pendidikan Malaysia 2013–2025 untuk menyediakan peluang pembelajaran yang inklusif dan berkualiti.

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3D	3 Dimension
AR	Augmented Reality
AUREL	Augmented Reality Learning
COVID-19	Coronavirus Disease 2019
CTML	Cognitive Theory of Multimedia Learning
GEN-Z	Generation Z
ICT	Information and Communication Technology
MCMC	Malaysian Communication and Multimedia Commission
PPPM	The Malaysia Education Blueprint
QR	Quick-Response
SDT	Self - Determination Theory
STEM	Science, Technology, Engineering and Mathematics

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The twenty-first century has seen a significant advancement in educational modernisation, which has improved the quality of Malaysia's educational system (Kamini Karthigesu, & Maslawati Mohamad, 2020). Technological innovations in education reflect Malaysia's commitment to global relevance. The Digital Education Policy is a fundamental aspect of Malaysia's educational strategies, demonstrating a proactive embrace of technology. This policy exemplifies the government's commitment to enhancing educational quality in Malaysia (Aminamul Saidah Mad Nordin et al, 2023).

Information and Communication Technology (ICT) is vital in the educational landscape, impacting teaching and learning (Koushik Das, 2019). ICT is essential in modern education as it facilitates the blending of various technologies and multimedia resources. A key aspect of ICT is its ability to merge different technological forms,

enhancing communication effectiveness and information dissemination (Tariq Zafar, 2019), otherwise known as technology integration. In fact, ongoing technological advancements have been reported to significantly alter knowledge application and cognitive processes (Nurin Nuha Zakeri et al., 2023).

ICT enhances education by providing dynamic and interactive experiences to students. Multimedia content through ICT engages diverse learning styles and offers interactive opportunities absent in traditional methods (Chen, 2020). This combination creates a productive learning environment. In particular, integrating multimedia elements such as text, audio, video, and interactive elements through digital platforms can enhance learning experiences (Salma Almira Hamdani et al., 2022).

In education, multimedia and technology help create engaging learning materials like digital presentations, e-books, and online courses (Lai et al, 2019). Moreover, research shows that self-guided mobile learning tools help students explore nature, emphasising the role of textual prompts in enhancing observation (Chen, 2020). Supporting this perspective, positive findings indicate that multimedia blended learning approaches yield better outcomes than traditional teaching methods (Vagg et al., 2020).

Advancements in new media technology have enabled teachers to utilise multimedia learning environments effectively. Today, Augmented Reality (AR) has been identified as a significant learning facilitator that amplifies comprehension through the application of virtual enhancements of scientific realities (Chen, 2024). The growing interest in AR within academia is linked to its proficiency in merging diverse

multimedia formats including audio tracks, pictures, written material, video content, animations, and three-dimensional (3D) objects (Yilmaz & Göktaş, 2018).

AR represents a significant leap in technology, greatly improving both teaching methods and the educational journey (Laurens-Arredondo, 2022). In line with this technological evolution, adolescents have demonstrated a high level of familiarity with AR due to their frequent engagement with AR-based applications and digital games (Chang et al., 2020). This makes AR a suitable educational learning tool for students. Furthermore, a multitude of AR platforms have been utilised in classrooms, encompassing smartphones, tablets, and personal computers. For instance, the essential functionality of AR can be discerned in secondary school textbooks that incorporate Quick Response (QR) codes, which have notably augmented students' motivation throughout the educational process (Tan & Chee, 2021).

However, the fruitful implementation of AR within Science, Technology, Engineering, and Mathematics (STEM) education has encountered difficulties, particularly in countryside regions where the setup for ICT could be inadequate (Jin, 2021). The acceptance of such technologies by the Orang Asli community is characterised by persistent scepticism regarding their authenticity. This demographic also faces considerable obstacles attributable to the digital divide, which limits their access to advanced technologies such as AR (Mohamad Subaidi Abdul Samat & Azlina Abdul Aziz, 2020). This inequality in ICT access not only limits the application of AR in educational settings but also impairs the efficacy of STEM education in these regions, thereby exacerbating educational disparities (Bala & Chong, 2021).

STEM is an educational approach based on the fields of science and mathematics, which utilises the advantages offered by technological and engineering methodologies (Asigigan & Samur, 2021). In Malaysia, STEM serves as a pivotal component of the national education system. The Malaysia Education Blueprint (Pelan Pembagunan Pendidikan Malaysia, PPPM) 2013-2025 emphasises the critical importance of STEM, highlighted by the execution of various initiatives designed to fortify STEM education within academic institutions by enhancing the curriculum to be more relevant and contemporary, as well as by providing superior educational resources (Rashidin Idris et al., 2023). For instance, the 2022 PPPM Annual Report highlights the establishment of the "STEMforALL" initiative that was designed to collaborate with the industry, with the aim to ensure that STEM education is accessible to all students across Malaysia (Kementerian Pendidikan Malaysia, 2022).

STEM is important for Gen Z students' success in education and their future career paths (Nurin Nuha Zakeri et al., 2023). A key factor contributing to this is students' motivation and proactive engagement in STEM, which impacts it significantly (Luo et al., 2019). Innovative teaching methods that incorporate STEM have been reported to markedly increase students' enthusiasm (Nurin Nuha Zakeri et al., 2023), which include technologies like AR that is particularly effective in educational settings, enhancing the learning experience and improving academic performance (Parmaxi & Demetriou, 2020). Moreover, AR offers considerable educational benefits in STEM by improving spatial skills, practical abilities, conceptual comprehension, and inquiry-based learning (Ibáñez & Delgado-Kloos, 2018).

AR is a technology that merges 3D virtual objects into the real-world environment, creating an artificial setting (Zsila et al., 2018). It enhances the physical environment by integrating virtual information in real-time (Pellas et al., 2019). This combination facilitates interaction with simulated objects and helps students comprehend complex phenomena. As a result, AR technology enhances the understanding of abstract concepts, thereby promoting cognitive development and learning efficacy (Pellas et al., 2019). Consequently, this study aims to explore the effect of AR applications on Orang Asli students' motivation and achievement in STEM learning.

1.2 Research Background

Through the evolution of technology, the traditional approach to teaching has changed to digital approaches (Buabeng-Andoh, 2018). Nowadays, the effectiveness of the traditional approach to learning alone is no longer adequate in the classroom. Digital teaching not only facilitates the learning process but also plays a critical role in maintaining the attention of students who are no longer responsive to traditional methods of instruction (Moraes et al., 2022).

Moreover, traditional pedagogical practices such as drill-and-practice and textbook-centric activities have been associated with diminished interest in learning science (Chen, 2020). To overcome these challenges, the integration of practical, student-centred teaching strategies has been shown to significantly enhance student engagement, academic competence, and the development of essential soft skills,

including critical thinking, creativity, and problem-solving (Noor Anita Rahman et al., 2021). Importantly, existing research underscores the critical importance of educational advancement, as the strength and progress of a nation are intrinsically linked to the quality of its education system and the intellectual capacity of its citizens (Pellas et. al, 2019).

The COVID-19 pandemic has led to the increased use of computers in Malaysia, especially in secondary schools (Rajantheran Muniandy et al., 2022). This trend is further evidenced by the normalised use of computers and other technologies in education through the efficient implementation of digital teaching. Statistics also show that the internet usage rate in Malaysia reached 88.7% in 2020, a 1.3% increase from 2018, according to the Malaysian Communication and Multimedia Commission (MCMC) (Siti Noor Ismail et al., 2022). This data reflects the reality that the computer has been used more broadly and has become a standard in conventional approaches. As a result, the expectation that computers and other technologies will increase innovations in digital education and the practical learning system continues to rise.

The advancement of the Malaysian education system is crucial to ensuring equitable access for all segments of society, including the Orang Asli communities (Muhammad Fuad Abdullah et al., 2023). One effective approach to achieving this goal is through the integration of technology in education. In line with this vision, Malaysia has incorporated technology-driven lessons into its national curriculum to enhance students' familiarity with current global educational trends (Kamini Karthigesu, & Maslawati Mohamad, 2020).

However, as a minority group, the Orang Asli have historically lagged behind the mainstream population in terms of educational attainment, and the implementation of technology-based lessons within Orang Asli communities remains limited (Mohamad Subaidi Abdul Samat & Azlina Abdul Aziz, 2020). Despite continuous efforts by the Malaysian government to improve educational opportunities for the Orang Asli since independence, significant disparities still persist (Muhammad Fuad Abdullah et al., 2023).

STEM education is a specialised pedagogical approach that emphasises the integration of science and mathematics disciplines to prepare students for careers in science, technology, and engineering (Mohd Azry Abdul Malik et al., 2021). As a core element of education in developed nations, STEM plays a critical role in Malaysia's educational agenda. In alignment with this, the Malaysian Ministry of Education introduced the 60:40 Policy, which targets a student ratio of 60% in the science and technical stream and 40% in the arts and non-technical stream (Ahmad Ismail, 2023). Consequently, STEM education significantly influences the formulation of students' learning objectives (Nurin Nuha Zakeri et al., 2023).

However, STEM subjects, particularly mathematics, are often perceived as challenging. A study by Nurin Nuha Zakeri et al. (2023) revealed that mathematics involves various subtopics that require creative thinking, such as mathematical reasoning, probability, and geometry. For instance, many students face difficulties in visualising 3D objects, which is a crucial skill required mainly in geometry. A lack of understanding of mathematics can cause students to lose confidence and perform poorly. One study found that incorporating STEM into mathematics instruction

promotes active learning, which requires a constructivist-based teaching method that encourages dynamic student participation over passive involvement (Ješková et al., 2022).

Orang Asli students still face numerous challenges in STEM subjects, especially in science, physics and mathematics. Studies indicate that many Orang Asli students in Malaysia encounter difficulties in solving mathematical word problems, which demand strong literacy skills encompassing contextual comprehension and accurate procedure-following (Zaleha Ismail et al., 2020). This challenge is compounded by the fact that mathematics requires visualisation abilities, especially in geometry (Nurin Nuha Zakeri et al., 2023). This contributes to challenges in learning mathematics, leading to unsatisfactory outcomes in students' learning and achievement (Ruzlan Md-Ali et al., 2021). Innovative approaches such as AR, therefore, can enhance students' motivation and engagement in learning (Ahsan et al., 2019).

AR combines the real and virtual world, producing the simultaneous interaction between the two (Bursali & Yilmaz, 2018). This makes AR a practical learning approach that is suitable for STEM education, as elements within STEM do not exist independently without interaction; instead, they cohesively coexist in a multidimensional, skilful approach (Pimthong & Williams, 2018). For example, the AUREL mobile application exemplifies how AR can project mathematical objects onto real-world images, enhancing comprehension and retention (Ang & Lim, 2019). This proves that AR facilitates hands-on learning experiences, allowing students to experiment and solve real-world problems, which is crucial for developing critical thinking skills in mathematics (Ahmad Syawaludin et al., 2019).

AR is a 3D technology that helps increase users' sensory perception of the real world through a contextual layer of information (Pratama & Sukirman, 2023). AR can increase student enthusiasm and participation, as evidenced by positive feedback from both students and teachers (Ahmad Syawaludin et al., 2019). For example, AR applications enable students to interact with 3D models by making abstract mathematical concepts more tangible (Hasnain Ali Poonja et al., 2023). AR therefore improves the learning experience, enabling digital content to exist in the real world, enhance understanding, gain attention and improve the knowledge of reality (Pinto et al., 2017).

This study focuses on measuring both the effects of AR applications on motivation and achievement and the correlation between these two variables when AR is used as a teaching tool in STEM learning. Additionally, the study focuses on understanding how AR can serve as an effective educational tool to improve learning outcomes for Orang Asli students. The AR applications that are used in this study are ARSiGaSTEM and AR-Tradisi. The study employs a quantitative approach with a quasi-experimental design, involving pre- and post-tests to evaluate the effect of AR applications.

1.3 Problem Statement

The absence of a new and practical educational approach is a primary concern that holds significant importance in STEM education. This problem arises due to the limited

availability of innovative teaching techniques related to STEM, particularly with regards to Orang Asli students (Habibah Norehan Haron et al., 2019). Mathematics a STEM subject that Orang Asli students around the world face learning difficulties with (Ruzlan Md-Ali et al., 2021).

Regarding learning achievements, particularly in mathematics, Orang Asli students have displayed a persistent pattern of underperformance within the educational environment, falling behind their peers from other student groups (Abdul Halim Abdullah, 2022). Studies have indicated that Orang Asli students in Malaysia face challenges when attempting to solve mathematical problems (Zaleha Ismail et al., 2020). This struggle is further compounded by a decline in the motivation of these students to engage in learning. In addition, STEM subjects, including mathematics, present considerable challenges, resulting in a consistent generation of unsatisfactory outcomes in mathematics (Jin, 2021). The reasons for this gap are complex and multifaceted, with factors such as inadequate resources, lack of access to quality education, and cultural barriers playing a role (Ruzlan Md-Ali et al., 2021). Without a doubt, creative approaches to teaching are important to implement in the classroom (Nurin Nuha Zakeri et al., 2023).

AR technologies can be effective creative approaches in the classroom, especially in mathematics, as it requires the visualisation of abstract concepts more than other subject areas. This helps increase students' motivation and understanding levels compared to traditional methods (Türkan & Çetin, 2022). On the other hand, the lack of practical teaching aids poses a significant concern, particularly for Orang Asli students who face limited access to innovative teaching tools in STEM education (Jin,

2021). However, while AR technology has the potential to provide unique educational experiences to engage students, its effectiveness for Orang Asli students remains a topic of discussion (Nor Intan Adha Hafit et al., 2021).

The increasing use of technology in education, including AR applications, can be insufficient in meeting the needs of Orang Asli students due to factors such as limited access to reliable internet connections, inefficient technology devices, and a need for digital literacy skills (Nam et al., 2020). In this context, it is essential to consider factors such as students' interests, access to technology, cultural relevance, and the overall quality of AR experiences when introducing AR tools to Orang Asli learners (Martin et al., 2021). The limited awareness and understanding of AR's educational potential may contribute to a lack of interest among Orang Asli students in using such applications (Cherubini, 2020).

The lack of knowledge about the effect of AR technology towards the motivation and achievements of Orang Asli students is a significant challenge that needs to be addressed (Habibah Norehan Haron et al., 2019). Therefore, this thesis focuses on exploring the multifaceted effect of AR interventions on the motivational aspects and achievements of Orang Asli students in the STEM field. By conducting quantitative analysis and the quasi-experimental research design, this study aims to contribute to the discourse on inclusive educational practices in Malaysia. It also seeks to provide valuable insights and recommendations for creating a more enriched learning environment that caters to the unique needs of the Orang Asli community.

1.4 Research Objectives

The objective of this study is to investigate the effect and correlation of incorporating AR in STEM learning on the motivation and achievement levels of Orang Asli students:

1. To identify the effect of using AR applications for STEM learning towards the level of motivation of Orang Asli students.

2. To identify the effect of using AR applications for STEM learning towards the level of achievement of Orang Asli students.

3. To measure the strength of the correlation between motivation and achievement in STEM learning among Orang Asli students when using AR applications.

1.5 Research Questions

1. What is the effect on Orang Asli students' motivation level when using AR applications in STEM learning?

2. What is the effect on Orang Asli students' achievement level when using AR applications in STEM learning?

3. What are the strength of the correlation between student motivation and achievement in STEM learning when using AR applications?

1.6 Research Hypothesis

1. H_0: $\rho = 0$: There is no significant correlation between motivation level and achievement in using AR applications in STEM learning among Orang Asli students.

2. H_1: $\rho \neq 0$: There are significant correlations between motivation level and achievement using AR applications in STEM learning among Orang Asli students.

1.7 Conceptual Framework

Figure 1.1 shows a conceptual framework that demonstrates how AR applications contribute to motivation and achievement in STEM learning. The figure shows the framework connecting AR applications with STEM learning, motivation, and achievement. It highlights how AR integrates multimedia elements, interactive features (such as exploration and game-based applications), and types like marker-based and marker-less AR to enhance STEM education. These applications are based on learning theories such as the Cognitive Theory of Multimedia Learning, designed using the 5E Instructional Model, which includes the stages of Engage, Explore, Explain, Elaborate, and Evaluate. In addition, AR-based learning experiences aim to boost student motivation through the Attention, Relevance, Confidence, Satisfaction (ARCS) model,

which directly influences achievement or academic performance. The diagram shows a positive correlation between motivation and achievement, where AR applications in STEM learning are designed to engage students and improve both their motivation and learning outcomes.

AR applications are central to this framework. It is described as a tool that enhances learning through various multimedia elements and specific AR features. Moreover, AR applications is a new media technology that consists of multimedia elements that can help enhance students' motivation in learning and contribute to improved achievement (Khan et al., 2019). Specifically, multimedia elements consist of text, audio, video, graphics and animation, which can provide a practical and multi-sensory learning experience (Valarmathie Gopalan et al., 2018).

Figure 1.1

Conceptual framework of the effect and correlation of Orang Asli students' motivation and achievement in STEM learning using AR applications

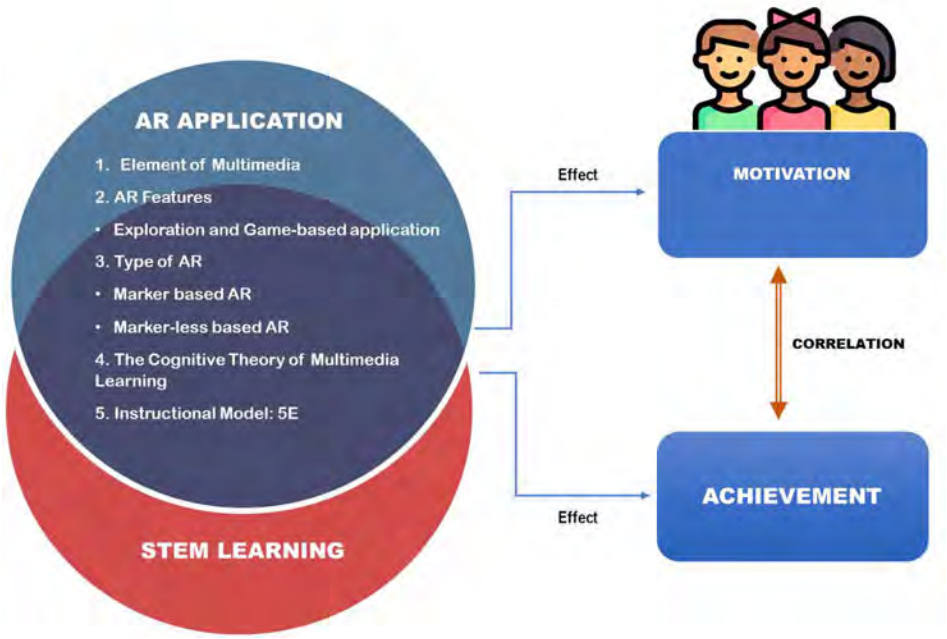

Figure 1.1 shows AR features including simulation and game-based applications. Simulation replicates real-world phenomena through AR. Students can interact with 3D models or animated content to understand scientific principles, visualise abstract concepts, or explore otherwise invisible elements (Ibáñez & Delgado-Kloos, 2018). In AR-Tradisi, students are introduced to traditional games such as *gasing*, where through these AR applications, they can view the 3D model of *gasing* clearly. Meanwhile, with game-based AR applications, students can play the *gasing* virtually using AR-SiGaSTEM.

Game-based AR applications utilise gamification elements, offering immediate feedback and rewarding correct actions (Ibáñez & Delgado-Kloos, 2018). The score after playing the virtual *gasing* appears as how many *gasing* units enter the *gasing* court. Through this game, students can understand the prediction and calculation of angle and distance which can be applied in their mathematical knowledge. This approach enhances STEM education by making it more interactive and engaging for students. At the same time, it encourages active participation and a deeper understanding of complex concepts.

The framework identifies two types of AR technologies: marker-based AR, which uses physical markers to trigger digital content, and marker-less AR, which operates without physical markers, offering greater flexibility and accessibility in various learning environments (Tan & Chee, 2021). For AR-SiGaSTEM, marker-based AR is essential, as it ensures precise interaction and enhanced experiences. In contrast,

AR-Tradisi leverages the flexibility of marker-less AR to provide a more adaptable and engaging user experience.

The development of the AR application is grounded in the Cognitive Theory of Multimedia Learning (CTML), which posits that effective learning occurs when individuals are able to actively process and integrate information presented through both verbal and visual modalities (Keller et al., 2021). This theory emphasises the importance of designing instructional materials that support dual-channel information processing, promote cognitive engagement, and reduce extraneous cognitive load to enhance comprehension and retention (Mayer, 2024). Additionally, the instructional approach within AR applications follows the 5E Model (Engage, Explore, Explain, Elaborate, and Evaluate); a structured and iterative method widely recognised in STEM education for fostering deeper understanding (Pacala, 2024).

AR applications are perceived as an interactive and captivating approach to impart STEM disciplines, which are congruent with contemporary pedagogical strategies. The synthesis of AR and STEM education has been demonstrated to exert a direct influence on learners' motivation. Motivation is analysed using the ARCS model, which emphasises the design of educational experiences that sustain student engagement. It is anticipated that AR applications will cultivate enhanced motivation by rendering learning more pertinent, engaging, and fulfilling, particularly for marginalised populations such as the Orang Asli students (Pinto, et al., 2017).

Additionally, the framework underscores the importance of student achievement, which is evaluated through scores in achievement assessment. It proposes

that the use of AR in the classroom will have a direct positive effect on students' achievement, suggesting that a more interactive and engaging learning environment will lead to better learning outcomes (Khan et al., 2019).

Figure 1.1 shows a correlation between motivation and achievement, implying that as students become more motivated through the use of AR, their achievement in STEM subjects is also likely to improve. The framework proposes that the use of AR in STEM learning affects Orang Asli students by enhancing their motivation, which in turn improves their achievement. The interactive and immersive nature of AR technology offers an innovative approach to education that could address motivational challenges and improve learning outcomes for underserved communities like Orang Asli students.

1.8 Operational Definition

The operational definition is based on several key components, as elaborated below.

1.8.1 AR Applications

AR is a technology that combines real-world and virtual objects, allowing for simultaneous interaction with the physical environment and digital elements (Sirakaya & Cakmar, 2018). There are two types of popular AR: marker-based AR and marker-less-based AR. Both types are used in this study. Marker-based AR relies on specific

triggers, such as QR codes or images, to activate the display of digital content (Tan & Chee, 2021).

Meanwhile, marker-less AR is known as location-based or location-aware AR, which does not require specific markers. Instead, it uses GPS, compass, accelerometer, and other sensors in devices to determine the user's location and orientation (Cheng et al., 2017). The digital content is overlaid onto the real world based on these parameters. The AR platforms used are AR-TRADISI and AR-SiGaSTEM. The AR application is an Android application, which can be used using mobile phones and tablets. AR-SiGaSTEM uses marker-based AR, while AR-Tradisi employs marker-less AR technology.

1.8.2 Motivation

Motivation refers to the inner drive that stimulates individuals to pursue and achieve their goals. In the context of AR, research has indicated that AR-based learning can enhance learners' motivation and reflective thinking (Sabbah et al., 2023). The motivation theory applied in this study is based on the ARCS model. ARCS is the acronym for Attention, Relevance, Confidence, and Satisfaction. It is an instructional design framework developed by John Keller that focuses on strategies to enhance and sustain learner motivation in educational settings (Dinçer, 2020). These four key elements guide learning to enhance motivation and improve learning outcomes (Keller, 2010).

1.8.3 Achievement

Achievement in education refers to students' learning outcomes, which is assessed through examinations and is crucial for evaluating education quality and guiding policy and interventions (Tian & Sun, 2018). Achievement is often quantified through academic outcomes, such as grades and test scores, which serve as indicators of a student's success in educational settings (Muhammad Saidi Rahman & Yusup Indra Wijaya, 2023). In this study, a quiz-based achievement indicator is used, known as a geometry assessment. The geometry assessment is used to indicate students' scores after answering a question given to them.

1.8.4 STEM Learning

STEM learning refers to an interdisciplinary approach to education that integrates concepts and skills from four key disciplines: Science, Technology, Engineering, and Mathematics (Nurin Nuha Zakeri et al., 2023). STEM learning encourages students to explore real-world problems, conduct experiments, engage in design challenges, and use technology to find solutions (Siti Hamizah Aspin et al., 2022). This approach emphasises a hands-on, inquiry-based methodology to teach and apply knowledge in these areas, fostering critical thinking, problem-solving, creativity, and innovation among learners (Aida Suraya Md. Yunus, 2020). The approach used in this study is interdisciplinary, hands-on learning and inquiry-based learning.

1.8.5 Orang Asli

The Orang Asli refers to the Orang Asli people in Malaysia. While direct studies on the effect of AR on the Orang Asli community may be scarce, research on the effects of AR on achievement and motivation among secondary school students in Malaysia provides valuable insights (Özeren & Top, 2023). For this study, the Orang Asli are Form 1 students, and most of them are from Suku Temiar in Perak.

1.8.6 Conventional Method

The conventional method is the traditional way of teaching, which primarily uses the lecture method (Dange, 2018). Conventional methods use traditional assessment and evaluation techniques focusing on summative assessments, academic knowledge, and memory skills, often lacking adaptability and inclusivity (Meylani, 2024). This method of teaching is textbook-centred, teacher dominant and exam-oriented (Dange, 2018). In this study, the conventional method uses the textbook and slide presentation.

1.9 Study Limitations

This study aims to determine the effect of AR applications towards motivation and achievement among Orang Asli students. Additionally, the study was conducted in Perak, Malaysia, focusing on Form 1 students, which may limit the generalisability of

the findings to other populations. The students are from Suku Temiar. This study specifically emphasises on Orang Asli students, which is vital for addressing their educational needs; however, this may lead to potential limitations in generalising the findings to a broader context.

Moreover, this study focuses on quantitative data collection; incorporating qualitative data, however, could provide valuable insights into participants' experiences and perceptions of AR technology (Marrahi-Gomez & Belda-Medina, 2023). The study implements two AR applications: AR-SiGaSTEM and AR-Tradisi. The AR application used is an Android application, which can be accessed using mobile phones and tablets. The traditional game in this application is *gasing.* The syllabus in this study is in the Mathematics Form 1 textbook, Chapter 10, on Parameter and Area.

However, it is important to acknowledge that this study has some limitations that could affect the AR applications and its compatibility with participants' devices, potentially influencing the study outcomes. The specific device chosen for generating the AR applications is crucial for ensuring the functionality and accessibility of the AR experience.

1.10 Importance of Research

Based on the study, the importance of this study varies across different groups, including Orang Asli students, teachers, the Orang Asli community, and the Ministry of Education. Each of these groups stands to benefit significantly from the findings.

1.10.1 Orang Asli Students

The rise in the development of AR applications, along with growing research into their use in STEM education, has not yet extended significantly to the Orang Asli. The interactive features of AR applications hold great potential for enhancing students' engagement in STEM subjects that may be perceived as challenging. This is particularly relevant for Orang Asli students, as teaching and learning can often be difficult, ultimately hindering their motivation and involvement. Integrating AR applications in STEM learning can create a significant opportunity to improve engagement, motivation and achievement among these students in demanding fields. Therefore, this study aims to address educational gaps by equipping Orang Asli students with innovative learning tools that can cater to their needs and challenges.

1.10.2 Teachers

This study offers valuable insights into innovative teaching methods, encouraging teachers to integrate AR applications into their lessons. These tools can help simplify and clarify challenging STEM concepts. The research also supports professional development by broadening teachers' instructional approaches, enabling them to better address the diverse needs of their students. Furthermore, by recognising the motivational and achievement-enhancing effects of AR, teachers can refine their teaching strategies to make learning more engaging and effective, ultimately improving their overall teaching efficacy.

1.10.3 Ministry of Education Malaysia

This study offers crucial data that can aid in developing more inclusive and effective educational policies. By demonstrating the success of AR applications in engaging and improving learning outcomes for marginalised communities like the Orang Asli, the Ministry of Education can use these findings to shape policies that ensure equitable access to educational tools and resources. This study aligns with the Ministry of Education's broader goals of integrating technology into the national curriculum and supporting the modernisation of the education system in Malaysia. Additionally, the study provides a framework for monitoring and evaluating the success of digital tools in improving educational outcomes, particularly in rural and underserved regions, ensuring that the benefits of technological advancements are extended to all students.

1.10.4 Orang Asli Community

This study has broader implications beyond the classroom. It empowers the community through education by improving access to quality learning resources that can foster better opportunities in the future, especially in STEM fields. The use of culturally relevant AR applications can also help bridge the gap between traditional knowledge and modern education, allowing Orang Asli students to connect with their cultural heritage while embracing new technological tools. This not only promotes educational

growth but also supports the preservation of their cultural identity within an evolving educational landscape.

1.11 Summary

Malaysia's education system has been modernised through the Digital Education Policy, integrating multimedia and AR technology. AR in STEM education has resulted in superior outcomes, especially for Orang Asli communities. The study aims to identify the effect of AR integration in STEM learning on Orang Asli students' motivation level and achievement in STEM learning. The study employs a correlation research design and quantitative data collection method with a sample of 30 Orang Asli Form 1 students at Sungai Siput, Perak. This study investigates the effect of AR applications on the motivation and achievements of Orang Asli students in STEM learning. The study addresses concerns related to student achievement, emphasising the importance of evaluating learning outcomes. It highlights the significance of AR applications as effective teaching tools to improve motivation and learning outcomes in STEM education for Orang Asli students.