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3D Game-Based Learning Design for Malay Language Literacy with Sarawak Cultural Anthropomorphism

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ABSTRACT: This study explores the development of a 3D game-based learning application for Malay language literacy among primary students by incorporating Sarawak cultural anthropomorphism into the game design. The advancement of technology has also influenced the use of digital games in education, particularly in creating more engaging learning experience. This study investigates how interactive digital games can support Malay language learning through the integration of cultural design concept that focuses on user-centered design method. A total of 30 students participated in the final user testing of the game prototype through observation. The findings show that enjoyment, challenge, game flow and visual engagement through anthropomorphic character design contributed to the students' learning experience. These elements were incorporated into the game concept and design to support learnability and create an engaging gamified environment that demonstrates its potential to support the digital transformation of education.

KEYWORDS: Game design, Art style, User interface design, User testing

INTRODUCTION

Recently, students are increasingly immersed in devices such as computers, mobile phones, and gaming consoles, which they often spend an average of seven hours per week engaged in gaming activities. The growing needs of technologies become crucial to adapt the traditional teaching and learning methods into digital transformation (Akhmetova et al., 2025; Diego Wisnu & Adelaide Gracegefa, 2025; Ortiz-Ospino et al., 2025). The presence of technology in education supports the learning experience effectively, specifically in language learning. Educational games integrate contextual learning with entertainment to enhance student motivation, engagement, and learning outcomes through edutainment. Previous research highlighted that digital educational games effectively employ multimedia elements, game mechanics, and gameplay to create more creative, immersive, and engaging experiences (Ng et al., 2025; Ong Long et al., 2025; Utami & Crescenzi-Lanna, 2025). Their adoption in education has attracted considerable interest due to their potential in promoting active learning and developing critical thinking skills among primary students.

The use of video games and digital technologies in education supports the development of cognitive skills and promotes cultural aspects of learning. Students are able to enhance their critical thinking, problem-solving, and strategic abilities by analyzing scenarios, making decisions, and solving challenges while engaging within the game. Poorly designed digital learning games could affect learners' motivation and lead to frustration (Kristensen et al. 2024; Ongoro and Fangjiang 2023). Due to the design inconsistency, lack of clarity of the game layouts and user interface design might affect their participation. Games that lack balance might decrease motivation and engagement among young learners, particularly the primary students to focus on enhancing their language literacy skills.

Historically, games have been designed and developed for both genders, girls and boys. However, both of them have different styles of preferences in terms of enjoyment to play games. In fact, their ways of thinking and interests often enter dimensions where boys prefer masculine games while girls prefer feminine ones. In game preferences, boys typically choose competitive, action-based games, whereas girls are more drawn to social and caregiving game genres. Some of the games are designed specifically for each gender according to their preferences.

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Hence, this research study emphasizes on designing a 3D game-based learning to foster language learning among the students based on their preferences. This game design focuses on improving the language proficiency that provides gameplay and game activities to develop the cognitive skills and problem solving through game levels.

RESEARCH MOTIVATION

A case study was conducted among primary school students in Sarawak, Malaysia. Research on digital game-based learning has shown that it can enhance engagement and motivation by providing gamified experiences. However, this research focuses on Malay language literacy, as primary students often face challenges in achieving proficiency due to limited foundational knowledge and the frequent use of dialects over standard Malay in daily communication (Banseng et al., 2023; Othman et al., 2022). This happens due to the lack of fundamental knowledge and the dominance used of dialect languages such as Bahasa Melayu Brunei, Bahasa Melayu Sarawak and other 40 more local dialects in their daily communication. The connection between digital game-based learning and pedagogical theory remains unclear, limiting its potential to improve language literacy skills. Therefore, this study seeks to explore the perspective of 3D game-based learning for language literacy in Sarawak, Malaysia through self-pace learning.

RELATED WORK

The importance of the research study on the digital game-based learning for education emphasized the user preferences contributing to the 3D game-based learning development. The potential and limitations of game-based learning design would be discussed in detail. Generally, the challenge of designing educational games is to engage students to learn continuously due to their short span of attention compared to adults. To achieve students' attention, the use of technology and game contents should be utilized as they have lived in the midst of advancement on digital innovations all their lives. Thus, gamified learning environments contribute to engagement where they are able to learn on operating the game system developed. Digital game-based learning enables the students to create a gamified learning culture that corresponds better with students' needs and preferences.

Digital Game-Based Learning Through Anthropomorphism

Digital games were designed to generate positive effects in players to interact with the system itself when they facilitate the flow experience. It is important to emphasize the elements that contribute to flow when designing the educational games. The relevant educational theories and gameplay have to be considered based on the user specifications. The educational theory and game design aspects should be analyzed in detail where these are closely linked to the engagement through the creation of game development, specifically for improving the language proficiency. The primary intention of this research study was to specify the game design that facilitates user experience and emphasized on the importance of game elements that are matched to players' cognitive skill levels. It was apparent that educational games that provided the possibility to experience learning in the gamified environments could enhance their language literacy skills.

Nowadays, students are significantly influenced by the digitalization and constantly handling the digital information in their daily lives. They formed their personalities, social interaction and learning preferences based on their experiences. Undoubtedly, modern students were not attracted to conventional education methods where they were closely seeking for more interesting, fun and engaging learning experiences within the gameplay (Campoverde-Durán et al., 2023; Pérez-González et al., 2023). The increasing popularity of digital games led to the applications being broadly utilized and applied in education strategies. In education, digital games were mostly designed for serious games, gamification and game-based learning which focused more on interactive learning environments and collaborative learning activities.

Hence, these digital games contributed as the proper educational tools for teaching and learning, which enhanced the learning methods that fulfilled the students' needs and preferences. The pedagogical approach of utilizing the digital educational games such as game-based learning could gradually convey the game concepts and guide the students to achieve the learning objectives (Bayrak, 2025; Yau et al., 2025; Zaini et al., 2025). For instance, the game concepts applied anthropomorphic character design and forestry environment design that related to the cultural aspects of certain district and city areas in Sarawak, Malaysia. As Sarawak State consists of diverse cultures and animal mascots representing different regions, these elements may help in exposing students to historical backgrounds.

Additionally, anthropomorphism referred to the practice of providing the human characteristics such as personalities, emotions and abilities to non-human entities. For instance, animals, objects or any mythical creatures. In game design, this anthropomorphism approach allowed designers to create characters that were expressive and relatable to the game concept, even when they were not human (Ekawardhani et al., 2025; Yang & Hong, 2025). This might offer the players an easy understanding easily on the character backstory, motivations, following game narratives and emotionally connected themselves into the virtual game world. One of the beneficial impacts of anthropomorphism was providing the ability to enhance player's engagement within the gamified environments. These characters that are designed with human-like behaviours and facial expressions with interesting gestures tend to attract attention and their interests, especially for the younger players. When the designers created these anthropomorphic characters, they could be as guidance, companions or role models that helped players in navigating the challenges while maintaining enjoyment throughout gameplay.

On the other hand, anthropomorphic character design contributed to usability and learnability in the game development. By providing the human-like behaviors such as gestures, instant feedback and facial reactions, these might help players to interpret the system responses and understand game mechanics effectively. Therefore, anthropomorphism offered visual design that might attract the players through the use of vibrant colours and aesthetic design (Li et al., 2024; Xia et al., 2023; Olubunmi, 2021). Since the character design emphasizes animal characters, by integrating a forestry environment design inspired by Sarawak, Malaysia would enhance the game concept. Sarawak is well-known for its rich rainforests and biodiversity such as trees, rivers and wildlife that reinforce cultural identity through familiarization of regional landscapes.

As the user interface design would be focused on this research study, the contextual learning should be taken into consideration as well. The game development emphasized on anthropomorphism art and specified more towards language literacy skills, these factors would be combined to engage the players. Both learning and playing at the same time would provide the enjoyment experience for the students to explore more on improving

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the language proficiency among the students in Sarawak, Malaysia. All the procedures of game design and development would be discussed comprehensively in the next section.

METHODOLOGY

This study emphasized on user-centered design method to design and develop the 3D game-based learning for improving language proficiency, comprising the four phases that consisted of i) analysis, ii) design, iii) implementation and iv) evaluation. The 3D game-based learning would be developed with a primary focus on three phases that emphasized on design, implementation and evaluation in this research study.

Analysis of User Specifications

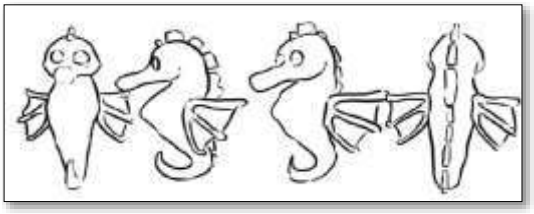
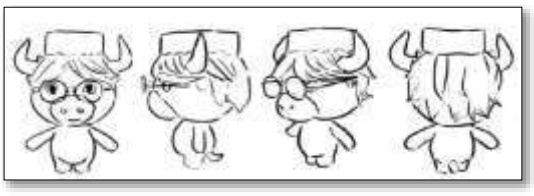
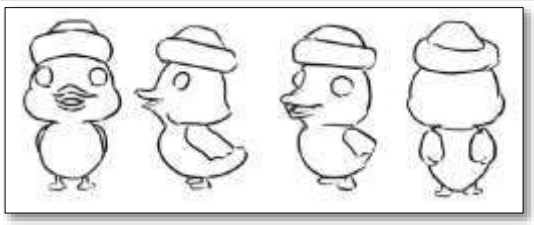
The process of analyzing the data comprised the initial investigation of existing language learning game mobile applications, ideation of sketches and finalizing the user specifications that highlighted the needs of primary students. The initial phase involved in assessing the users which were the 30 primary school students from private school in Sarawak, Malaysia as the participants at the age of 7 to 9 years old. These students were tech-savvy who familiarized themselves with the use of touchscreen technologies such as tablets, iPads and smartphones. They used technologies to learn and interact with the learning systems developed. Table 1 indicated the final user specifications to design and develop the high-fidelity prototype to validate the framework of game-based learning for language literacy skills.

Table 1. Final user specifications.

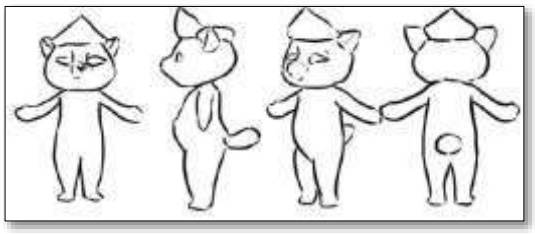
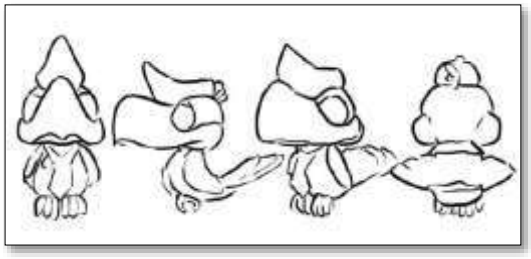
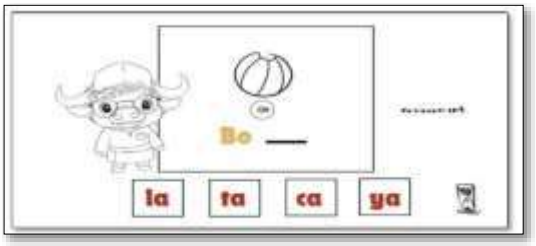
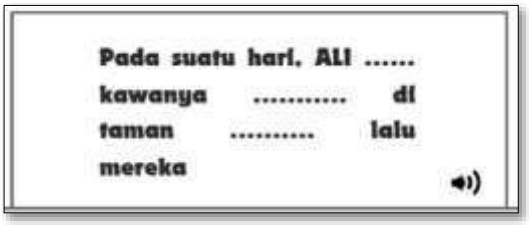
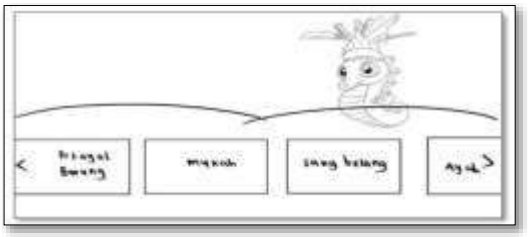
Specifications	Descriptions
Character Design	3D anthropomorphic characters
Environment Design	3D forestry design concept
Feedback Mechanism	Instant feedback
Type of Colours	Vibrant colours
Reward System	Badges, Reward system
User Interaction	Touchscreen interaction
Device Used	Smartphone or Tablet
User Experience	Engagement
Game Activities	Multiple Quizzes
Game Mechanics	Instructional design, Missions
Design Principle	Learnability

Based on the final user specifications obtained after the ideation and sketching process, which reflected users' preferences for character design, environment design, and other elements, thus a low-fidelity prototype was developed as shown in Table 2. This low-fidelity prototype highlighted the implementation of Malay language learning.

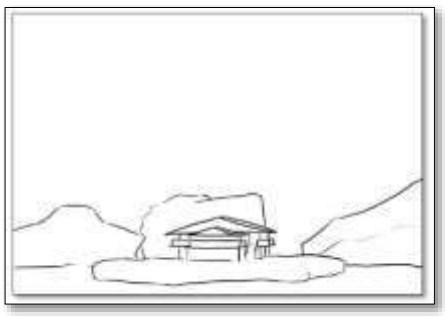
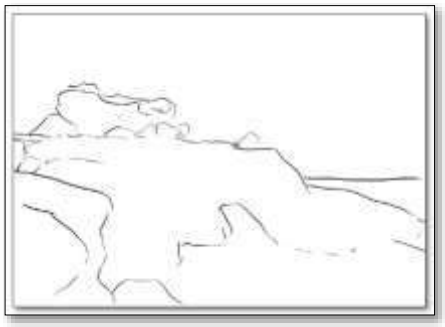
Table 2. Low-fidelity prototype.

Descriptions	Low-fidelity Prototype
Anthropomorphic Character Design (Miri's mascot: Seahorse)	
Anthropomorphic Character Design (Limbang's mascot: Cow	
Anthropomorphic Character Design (Sibu's mascot: Swan)	

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Anthropomorphic Character Design (Kuching's mascot: Cat)	
Anthropomorphic Character Design (Sarawak's mascot: Hornbill)	
Game Contents	  
Game Activities	 

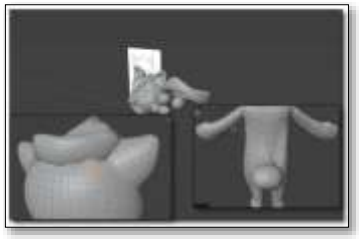
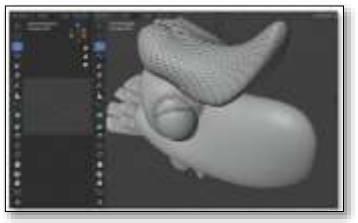
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Game Logo	
Environment Design (Animation for Game	 

The 3D game-based learning would be developed in detail for the specific production process through Blender software after the designing of low-fidelity prototype. Table 3 indicated all the processes of the 3D development of i) anthropomorphic characters, ii) environment designs with modelling and texturing processes.

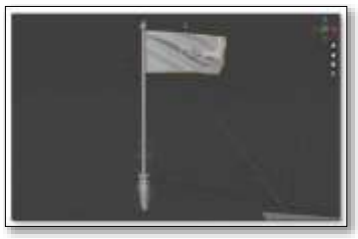
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Table 3. 3D modelling process.

Descriptions	3D Modelling	3D Texturing
Character Design		
		
		
		
		
Environment Design		
		

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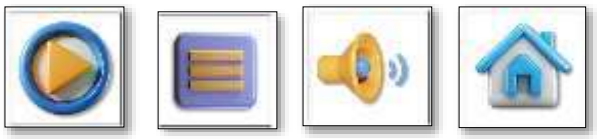






The environment design represented the natural and cultural elements of Sarawak, including Mount Santubong, the Limbang Museum, the Miri Horse Cliff, and the Sarawak Giant Flag in Kuching, which are featured in the game's animation trailer. Next, Table 4 showed the high-fidelity prototype development that applied vibrant colours, composition of layouts, user interface design of buttons, logo design and font typography design. The implementation of the game prototype was developed using Unreal Engine.

Table 4. High-fidelity prototype.

Descriptions	High-fidelity Prototype
User Interface Design (Buttons)	
Game Start Layout	
Game Levels	
Game Contents	

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Game Instructions



Reward



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The 3D high-fidelity game prototype was developed to validate the framework of game-based learning for language literacy skills. This high-fidelity prototype would be integrated into touchscreen technology such as tablets for better performance. The final user testing was conducted on the primary students to evaluate the learnability for linguistic approach where this 3D game-based learning would provide learning experience too. The findings would be discussed in the next section.

RESULTS AND FINDINGS

Based on the game-based learning framework for language literacy skills developed through comprehensive literature reviews, users' specifications and needs, Figure 1 illustrated the finalized framework. By integrating the highlighted main elements and user specifications that contributed to the effective development of 3D digital game-based learning, this finalized framework provided a foundation of practical implementation for learnability, specifically on improving language proficiency

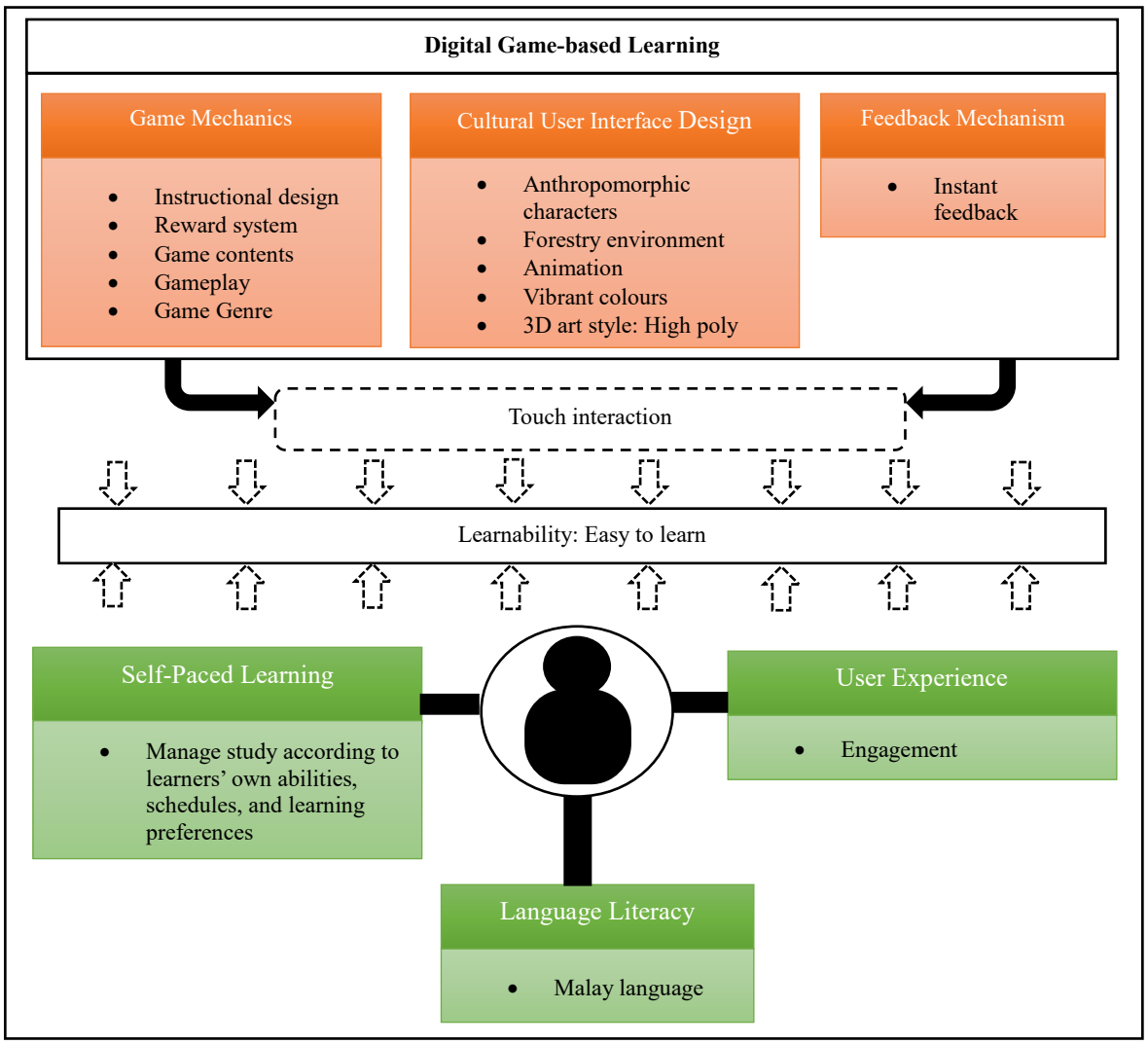


Figure 1. Cultural game design framework development

Therefore, an observational study was conducted with primary students at the age of 7 to 9 years old to evaluate on how they would interact with the game, respond through emotion and engage with the learning contents. All of the sessions were recorded and followed the procedures of conducting the user testing session. The thematic analysis was carried out using data obtained through the observation technique, which identifies the system interaction, complexities of user interface design in learning Malay language. The elements evaluated were based on learnability that specified consistency, feedback and visibility that led to engaging the students into playing continuously as shown in Table 5.

Table 5. Thematic Analysis.

Participants (P)	Theme	Descriptions
P1, P7 – P15	UI design of buttons	Some of the button icons were too small where it could cause difficulties to click them. Hence, they tend to simply click any buttons provided in the game layout.
P1 – P30	Anthropomorphic design	The user interface design of the game was attractive and eye-catching for the users due to the balancing of the colourful images and vibrant colours applied in the game. The cute and happy visual design of the anthropomorphic characters positively influenced the students' mood and

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		enhanced engagement during gameplay. The game trailer also introduced the cultural environment design, which sparked players' curiosity about certain areas.
P1 – P30	Instant feedback mechanism	The game contents provided learning activities with many game levels. Providing the instruction in game enables them to understand the game structure and flow. So, they knew how to interact with the game where instant feedback provided by the system reinforced correct actions and reduced confusion throughout the gameplay.
P1 – P30	Touch interaction	The game application was deployed on a tablet device to enable intuitive interaction through touchscreen such as tapping and dragging during the user testing session. They were excited to play the game where they used to explore more on touchscreen devices at home. So, they did not find any difficulties in terms of touch interaction because they knew how to operate the device themselves.
P13 – P17, P22, P27	Game mechanics (Reward)	They suggested providing more rewards in the game like collecting badges. These rewards may enhance their engagement in playing continuously.
P1 – P13, P18 – P21, P23 – P26, P28 – P30	Gameplay engagement	They displayed positive emotions when the system provided correct answers, with some clapping their hands in response to the excitement generated. Some of them probably shouted "Yeay!" to express excitement throughout the game.
P1 – P30	Self-paced learning	They felt more at ease while playing the game since questions did not have to be answered within a fixed time. So, this factor might avoid the pressure of a countdown among the users where they could learn at their own pace. It showed that the design feature without time limit support self-paced learning.

DISCUSSION

The development of 3D game-based learning emphasizes on the significant role of cultural user interface design to improve the language proficiency among the primary students. The analysis of the game-based learning prototype indicated that interface design plays an important role in enhancing both learnability and engagement of learning experience for improving language proficiency. The findings highlighted the appropriate sizes of buttons that showed visibility in the game development. This factor could avoid difficulties in interaction where the students could navigate the game and perform tasks without unnecessary errors. In fact, they could focus on the learning contents within the gameplay.

As anthropomorphic character designs influence player engagement, the cultural user interface design could be enhanced by including more animal mascots from Sarawak, Malaysia, each representing the symbols of specific areas. Meanwhile, by integrating prominent attractions of Sarawak into the environmental design acted not only to capture students' attention but also to facilitate informal learning about the district and cities. By embedding cultural and natural landmarks within the game environment, students were exposed to the geography, heritage, and local significance of Sarawak. Thus, these factors contributed to a richer understanding of the state and enhanced their cognitive skills to memorize (Ekawardhani et al., 2025; Husain & Prentice, 2025).

Despite its importance, both Malay and English language are formally used in Sarawak, Malaysia in education, administration, and public services. This dual-language system emphasizes the need for strong communication skills. This proficiency in these languages is essential for effective participation and interaction well within the society. Nevertheless, Sarawak, Malaysia is a home to diverse ethnic communities with rich cultural heritage and different local dialects for communication. The development of fundamental communication skills, particularly in Malay language literacy has emerged as a rising issue in this research study. Lack of basic language proficiency can result in difficulties where it would cause complex interaction to convey information clearly, lead to misunderstandings, and create challenges to communicate easily (Ali et al., 2022; I. W. Othman et al., 2022). Thus, the needs of strengthening these foundational skills are essential for improving students' ability to use formal language effectively.

On the other hand, the growing potential of game-based learning strategies in education highlighted how various gaming elements could foster learning and develop language literacy skills from an early age. Elements such as game mechanics, feedback system, user interface design, gameplay, user experience, and user interaction provided beneficial impacts in fostering students' engagement and interest in learning, specifically in enhancing language proficiency through self-paced learning. These highlighted gaming elements not only captured students' attention but also contributed to the development of effective learning approaches within gamified environments. Furthermore, incorporating virtual worlds through gaming environments into education transformed traditional teaching into gamified learning experiences.

CONCLUSION

Students who have grown up with rapid development of technologies tend to develop different attitudes towards the innovation in education strategies. Interacting with digital tools is intuitive and enables them to learn and communicate more easily, as well as to solve problems through the use of digital technology. Some people tend to approach technology with caution where they often view it as something to be feared. This is due to the concerns about addiction and the potential negative effects of excessive use especially in gaming. However, developing game-based learning for edutainment purposes can moderately enhance student engagement and improve academic performance through virtual activities. The potential of integrating gaming for educational aspects in terms of learning dynamics and digitalization approaches should be taken into consideration.

Thus, the use of 3D game-based learning was designed to address the needs of the students to learn effectively throughout the gameplay. Game-based learning offered alternative ways to engage with learning objectives to be achieved by providing various game activities. The students who have developed a solid foundation in language literacy skills are better equipped to communicate effectively. This strong linguistic foundation not only facilitates comprehension but also enhances their abilities to engage with more complex academic materials within tertiary institutions.

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In conclusion, digital game-based learning offers the potential to transform and enhance the fundamentals of language education, specifically in the linguistic field through self-paced learning. By shifting into interactivity, gamified environments and clear user interface design will encourage the students to engage actively and enjoy the learning process effectively. The transformation of digitized learning encourages the students to actively participate and enjoy the learning process through gamified environments. For future research, the study will explore more on the game design and development that integrates generative artificial intelligence that suit the needs of current learning dynamics.

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