User Requirements of Adaptive Learning Through Digital Game-Based Learning: User-Centered Design Approach to Enhance the Language Literacy Development

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***Abstract*—This study aims to elicit the user requirements of digital game-based learning among the primary students through adaptive digital game-based learning, with a focus on enhancing language literacy. Hence, acquiring the user requirements through user-centered design approach is emphasized to identify the specifications and provide practical insights for language learning and digital literacy skills. Further, the requirement specifications are specifically aligned to promote the quality of education for designing the digital game-based learning of language literacy, considering the game elements such as feedback mechanism, player's profile, game rules, game genre, game environment, rewards, adaptive language learning contents, integration of virtual tutor through artificial intelligence, activities and challenges. This paper presents a qualitative analysis of the results from a controlled study that investigates the potential of digital game-based learning through adaptive learning for the enhancement of language proficiency. Thus, it can contribute to the broader field of digital game-based learning by expanding the understanding of adaptive learning for language literacy as an optimal strategy where the primary school students can experience the influence of artificial intelligence technology development nowadays.**

***Keywords*—Digital game-based learning; adaptive learning; artificial intelligence; language literacy; optimization; primary students; user experience**

I. Introduction

Digital game-based learning of language literacy has gained prominence as an innovative approach that leverages engagement and interactivity in adaptive learning systems. The adaptability of learning should maintain the students' engagement based on their needs and how students benefit from the contextual learning through educational games implemented [1], [2], [3]. Additionally, the digital game-based learning offers a dynamic and captivating platform for students in language learning by providing the immersive environments and interactive narratives. Thus, this study examines the rationale for incorporating the optimization of digital game-based learning into language learning by analyzing relevant theories, game mechanics, game elements, adaptive digital game-based learning and artificial intelligence from pertinent studies [1], [4], [5], [6], [7], [8]. Furthermore, acquiring the user specifications will be aligned with the users' needs, fostering the positive impacts on the adaptive learning through edutainment approaches.

To illustrate this contextualization of adaptive learning through digital game-based learning, considering the learning contents are needed which align to the syllabus and features embedded in the existing language learning applications. These features incorporated gamified elements that offer an enjoyable and motivating experience for the learners, specifically the primary school students. They could engage with the learning contents provided through the gaming environment, yet enhancing the language literacy skills [6], [9], [10], [11], [12]. Moreover, the integration of digital game-based learning extends the benefits of adaptive learning by fostering gamified elements and specific language learning contents. In such, digital game-based learning engages the primary school students in terms of interactivity and enjoyable learning experience, where they are able to enhance the cognitive skills but also support the diverse learning styles. Despite the growing attention on digital game-based learning, there is a limited understanding of how adaptive learning strategies can be effectively applied to the language literacy among the primary school students. By emphasizing on the beneficial impacts of educational games, however, the important aspects such as cognitive, linguistic, feedback mechanisms and digital literacy development remain insufficiently addressed.

Recently, there has been increased interest in the potential use of adaptive learning systems due to the transformation of the educational paradigm, particularly during COVID-19, which has enforced a shift to virtual learning systems [13], [14], [15], [16]. The adaptation of technology became a crucial aspect of ensuring continuity in education and the consistency of information deliverance. With the limitations of conventional teaching methods, adaptive learning tools were implemented. These tools enable virtual personalization of the learning experience and communication for students. However, with the surge in digital activities, there were challenges highlighted such as limitations on the deliverance of information, disparity of access to high-speed internet in rural

areas, digital literacy among students and teachers, and adaptivity of virtual learning [17], [18], [19], [20]. Google Classroom, Google Meet, Microsoft Team and other mobile learning applications were focused on, in which these platforms were designed to facilitate remote and hybrid learning environments.

Additionally, over the past few decades, Malaysia, as a developed country, has made substantial investments in education and technology development. To meet the demands of the 21st century, Malaysia has initiated a strong emphasis on Science, Technology, Engineering and Mathematics (STEM) education to increase the students' interest and proficiency starting from primary to tertiary levels [21], [22], [23], [24]. Thus, recognizing the importance of digital literacy among the students, transformation plans and strategies are developed to equip them with digital skills and promote virtual learning. Malaysia has focused on leveraging education and technology while facing challenges in reforming the education system, including the implementation of Artificial Intelligence (AI) to enhance learning tools [25], [26], [27]. The country has prioritized education as a key to success by improving access, quality, equity and efficiency, thereby producing students who are competitive, creative and proficient in both languages, such as Malay and English.

Malay language is the primary language of Malaysia, where it serves as the national and official language used in various sectors such as government, laws, public communication and education too. As the Malay language is being used extensively in schools, all Malaysian students need to be proficient in the language to improve their vocabulary and literature aspects. Despite the dominance of Malay, Malaysia is a multilingual nation in which Malaysians are bilingual or even trilingual [28]. This linguistic diversity is especially pronounced in the state of Sarawak, Malaysia, where multiple languages and dialects are commonly spoken [29]. However, the proficiency of the Malay language remains limited due to the dominant use of local dialects, considering the lack of foundational understanding in that language [24], [30], [31], [32], [33].

Thus, students may not be exposed to standard Malay frequently enough, and this inconsistency can affect their ability to understand and use standard Malay in their daily lives. Therefore, the difficulties in understanding lessons and applying them in daily lives should be considered, where a good command of standard Malay is often required, specifically for primary school students. Limited practice in standard Malay may affect the development of comprehensive language literacy skills, such as reading, writing and speaking [29]. Hence, there is a need to improve the strategies of learning the Malay language through the implementation of technologies to potentially develop strong foundational skills in standard Malay among the primary school students. In fact, it encourages them to communicate more efficiently [34], [35]. Hence, it is beneficial for their future learning, as establishing strong foundational skills in standard Malay contributes to sustained language development and communicative competence. Such proficiency provides a critical basis for advanced literacy acquisition, academic achievement, and lifelong learning.

With the rapid digital transformation of educational institutions, specifically for schools, students can access learning materials at their convenience and learn at their own pace. Hence, this flexibility is particularly beneficial for improving their digital literacy and enhancing their language literacy skills through the integration of digital game-based learning, which is the focus area of this research study. Correspondingly, the digital game-based learning provides various subjects on mobile and other platforms where the primary school students are exposed to a diverse number of learning contents [34], [36], [37]. However, due to the notion and concerns that educational stakeholders, such as teachers, might also not be conversant with the use of digital game-based learning to be conducted in the classroom environment. Therefore, the exposure of 2D and 3D digital game-based learning applications may not deliver the full learning potential due to not focusing on the systematic process of design and development that attracts students in language learning [23], [38], [39], [40], [41]. Thus, digital literacy plays a critical role for teachers, particularly in ensuring that information can be delivered effectively. Research should place equal emphasis on both user interface design and the quality of learning content, rather than prioritizing interface design only.

Numerous studies have discussed the implications of digital game design and development with the use of technologies that can address the concerns of parents, teachers and students. Explicitly, some of the games were designed with various themes of war and vengeance as the main contents that may cause harm for the young learners [6], [42], [43], [44], [45]. Therefore, they might be exposed to the potential distractions of inappropriate language. In fact, the negative implications of game concepts should be avoided as the young learners tend to observe and imitate what they see. Thus, designing and developing the digital game-based learning that emphasizes learning objectives that align with the curriculum would serve as the major source of learning. Contrary to gamification, digital game-based learning focuses on a particular learning skill that makes use of the gaming environment and game design for a specific learning purpose [46], [47]. It emphasizes the development of specific learning skills by focusing on learners within a structured gaming environment that aligns educational objectives with gameplay. Through the deliberate use of game design, digital game-based learning ensures that learning outcomes are explicitly defined and systematically assessable.

Meanwhile, digital game-based learning employs game mechanics and game dynamics that enable learning to become more interactive and presentable, thereby enhancing language proficiency. However, the limitation of feedback mechanisms in digital game-based learning development has become one of the major issues in the research study. The classification of feedback mechanisms for designing and developing has remained unaddressed. Based on psychological perspectives, designing the games involves game elements, such as feedback mechanisms which relate to the students' overall development and psychological experiences [48], [49], [50], [51], [52]. The growing interest in research on feedback mechanisms is becoming increasingly ubiquitous, thus influencing the gamified experience among primary school students in the

field of adaptive learning systems through the integration of gamified learning environments [45], [53]. There is growing research interest in how feedback mechanisms apply in learning, showing just how important they are for students' experiences. For primary school learners, feedback has become an important aspect of gamified environments, especially when used to support adaptive learning.

Thus, integrating the digital game-based learning into the school curriculum is crucial for addressing the challenges and issues in the context of language learning among the primary school students. The learning technique specified on the use of games embraces the design of interactivity that progressively teaches the concept to achieve the learning objectives [6], [31], [48], [80], [81], [82]. Games often incorporate elements such as rewards, challenges and interactivity to encourage students to participate actively. Therefore, enhancing the cognitive skills among the students often requires active problem-solving and decision-making, thus influencing a better understanding of learning, specifically on language learning [54]. Through learning milestones or game levels provided as the game goals might help the students to increase their motivation and engagement in the educational field [40]. Besides, engaging them through educational games offers a range of benefits that can enhance the educational experience, adaptive learning and develop digital literacy skills by using technology effectively [42], [55], [56], [57], [83], [84]. Learning milestones and game levels embedded in the game development can help to boost students' motivation and keep them engaged in their studies. The implementation of educational games in learning strategies also bring wider benefits by supporting adaptive learning and building digital literacy skills through technology use among the learners.

This research study aims to examine the potential of digital game-based learning through adaptive learning systems among the primary students by acquiring the user specifications for enhancing their language literacy skills. All of the specifications are emphasized to improve adaptive learning in educational systems and the impact of digital game-based learning that influences the gamified experience in the field of digital learning technologies. Hence, the educational outcomes of digital game-based learning, particularly in the context of language learning, would be investigated in detail through the method of user-centered design.

The structure of this paper is designed through a systematic investigation of digital game-based learning for enhancing language literacy in primary students. Based on the research problems obtained, there is a need to explore a deep understanding of the related issues of digital literacy and language literacy among the primary students. Then, the literature review first examines existing studies on adaptive learning and digital game-based learning as the research focus. The methodology section describes the qualitative methods and user-centered design process used to define specific user requirements. Results and analysis present data from a controlled study which evaluates on how adaptive game features influence the language skills. The discussion section reflects on these findings, connecting them to broader educational technology trends. The conclusion summarizes the implications for classroom integration using technology and outlines future research opportunities in adaptive learning.

II. Related Studies

A. Digital Game-Based Learning

Digital game-based learning has been widely explored as a learning method to enhance the students' engagement and improve their learning outcomes in language literacy. Previous studies suggested that this method could effectively integrate the cognitive and emotional aspects of the students through the combination of traditional instructional methods with the implementation of interactive game elements [58], [59]. By focusing on the game mechanics, such as missions or challenges, game activities, rewards, and progress tracking have been implemented to motivate students and maintain their interest in the educational process and learning content. Conversely, conventional methods of learning remain relevant to be applied to the learning style of the students, but the dynamics of learning have evolved due to technological advancement nowadays [44]. Therefore, the revolution of technologies enabled the digital game-based learning to be designed based on the students' needs and preferences for educational purposes. Thus, digital game-based learning could foster collaborative learning, critical thinking and problem-solving skills by providing them opportunities to learn in diverse and engaging strategies for language literacy skills.

Additionally, the empirical studies have demonstrated that digital game-based learning could significantly improve the learning outcomes in language literacy skills. For instance, an experimental analysis found that students who integrated educational games had higher levels of engagement and showed better performance compared to focusing only on conventional ways of learning [60], [61], [62]. In fact, digital game-based learning has been effectively enhancing the vocabulary, reading comprehension and grammar skills, specifically in mastering the language literacy skills among the students.

Despite the benefits, there are challenges and rising concerns in the research studies regarding the implementation of digital game-based learning in language literacy. Considering these few factors of challenges, such as poor interface design, difficulty in balancing the educational contents with engaging gameplay, misalignment of learning contents with curriculum, varying levels of digital literacy skills among students and teachers [6], [48], [53]. Addressing these challenges requires effective strategies to be developed that optimize the educational value of integrating digital game-based learning while ensuring the accessibility of technologies. Effective strategies should emphasize the integration of adaptive learning to personalize the learning needs, enhance their user experience while interacting with educational games and manage the technology in alignment with the dynamics of learning [42].

Adaptive learning systems can dynamically adjust the learning contents, students' learning pace and complexity of lessons based on the students' progress and preferences. Hence, they can experience personalized learning through the customization of educational experience in adaptive digital

game-based learning. The development of adaptive learning systems is designed to continuously evaluate the students' performance, offering them the benefits of refined contextual language contents and exercises based on their strengths and needs [42], [57], [63], [64], [65], [66]. Innovative learning strategies encourage students to move beyond conventional methods and engage with more diverse approaches to improve knowledge and create more learning styles.

B. Adaptive Learning System

Consequently, the optimization in adaptive digital game-based learning to create an effective gamified learning environment for each individual is important, as it dynamically adjusts the learning contents and instructional approach in response to the personalized learning. Understanding the diverse learning preferences of students plays a crucial role in designing the educational framework and game development, specifically in language learning aspects. There is a need in identifying the students' preferences to enhance the learning experience and overall efficiency of performances in personalized and gamified learning environments [63]. Therefore, the needs of the player's profile in the game development as the character customization was emphasized for the engagement and beneficial impacts on the educational games development [67], [68]. The important aspects of the player's profile as the representative of the player in the virtual game environment may help students feel connected to the game. Thus, it can increase motivation, sustain attention, and encourage active participation throughout the learning process.

On the other hand, the digital game-based learning offers the feedback mechanisms that provide students with immediate responses. As the interaction is needed to interact with the system developed, the needs and preferences of students are highlighted in the research study. Research on digital game-based learning consistently stated that the feedback mechanisms improved the language literacy skills among students [6], [7], [48], [53]. Studies showed that the feedback mechanisms within the digital environment increased the motivation and engagement during the gameplay. By providing them the immediate responses to students' interaction on the system, either positive reinforcement or corrective cues enabled them to be consistently and actively involved in the learning process through the gamified learning environment [48]. This continuous engagement was beneficial in mastering the language proficiency, in which the consistent practice and interaction were particularly improving their social skills development too.

However, the efficiency of feedback mechanisms of explicit, implicit and social feedback remains unaddressed [61], [69], [70]. As the implicit feedback provided the procedure of the digital game-based learning developed, students were able to interact well with the system. Yet, they were provided with clear instructions through texts or audio as the guidance on the gameplay. Meanwhile, the explicit feedback particularly informed the students on right or wrong actions, often accompanied by explanations or instructions to improve their performances during learning sessions through the digital game-based learning. Alternatively, some systems did not provide the feature of feedback mechanism for incorrect actions, in which leaving the users without necessary justifications or explanations that they might need to understand and learn from their mistakes, specifically for improving their language literacy skills [48], [71]. Feedback is crucial in digital learning games, particularly for effective language learning. The effectiveness of explicit, implicit, and social feedback within digital game-based learning can be systematically integrated to enhance the language learning skills of the students.

Several studies have emphasized the importance of integrating the effective feedback mechanisms in digital game-based learning to improve students' learning outcomes and understand their mistakes during learning sessions. If the students did not receive adequate feedback mechanisms during the gameplay, they tended to stop playing the games [53], [72]. It happened due to boredom and losing interests where they would not engage in a dull learning environment through the digital game-based learning developed. In fact, they would suspend from using the digital game-based learning entirely, which would affect their user experiences in the gamified learning environment [48], [53], [69]. Thus, developing the feedback mechanisms that align well with game mechanics and educational learning objectives are technically challenging especially for the game designers that must work within the constraints and limitations to achieve the edutainment goals [49]. Insufficient feedback mechanism integrated in the game design and development may affect the engagement of learning and reduce the enjoyment in the gameplay. In fact, both game mechanics and learning objectives should be aligned with the needs, preferences, and abilities of the students to ensure that the gamified learning environment can be conducted effectively.

Moreover, the adaptive learning platforms rely heavily on the technology of Artificial Intelligence (AI) and machine learning to assess the students' performances during learning sessions [64], [73], [74], [75], [76]. The development of the system enables users to track user inputs, for instance, the quiz results, time spent on tasks to be completed, types of mistakes made to be detected, and adjust the difficulty of learning for the questions or activities conducted. Therefore, with the implementation of Artificial Intelligence in educational activities, a virtual tutor system is designed to provide personalized educational support to the students [64], [77]. It serves as a human tutor, as an adaptive learning system can be enhanced through the integration of AI in the gaming environment to expose the students to various learning experiences of language literacy.

Besides, the Natural Language Processing (NLP) of a virtual tutor allows students to understand the learning process, provide responses to them through questions and feedback. With that, it creates engaging interactions between the students and the system of virtual tutor integrated. While AI virtual tutor as an avatar representation can address the challenges faced by the students who are shy or introverted by providing personalized learning with instant feedback, the lack of direct human interaction becomes a significant limitation for them to interact well [64], [67], [68]. This absence may impact the development of social and communication skills, reducing their motivation due to the lack of two-ways communication

between teacher and students in the conventional learning environments.

III. METHODOLOGY

This research study consisted of 30 primary school students from Sarawak, Malaysia and aged between 7 and 9 years old for the user-centered design activities conducted. By integrating a user-centered design approach ensures the design is guided by learners' actual needs and preferences, which may contribute to these factors of engagement, learning relevance, and the usability of the educational games. The first activity involved all of the students to test the three existing digital game-based learning, such as mobile applications of the Malay language developed for enhancing the language proficiency through observation. Meanwhile, the second activity involved the ideation in sketching the digital game-based learning based on their preferences in terms of learning style and their needs. All of the students were Information Technology (IT) literate and familiar with the use of tablets and smartphones. Therefore, informed consents were obtained as the participants involved are below 18 years old.

Next, the third activity consisted of six teachers that were involved in this experiment to obtain their perspectives on the syllabus contents of the Malay language subject, as the learning contents needed to be simplified in the digital game-based learning development. To obtain the requirements, interview sessions had been conducted among the teachers who were teaching the Malay language subject at primary school. All of them were well-versed in pedagogy, with teaching experience ranging from 5 to 20 years. As they have expertise in implementing various teaching strategies, they were also skilled in both conventional and modern educational practices. All of the experiments conducted are based on the user-centered design method to acquire the user specifications in the research study as shown in Fig. 1 [78].

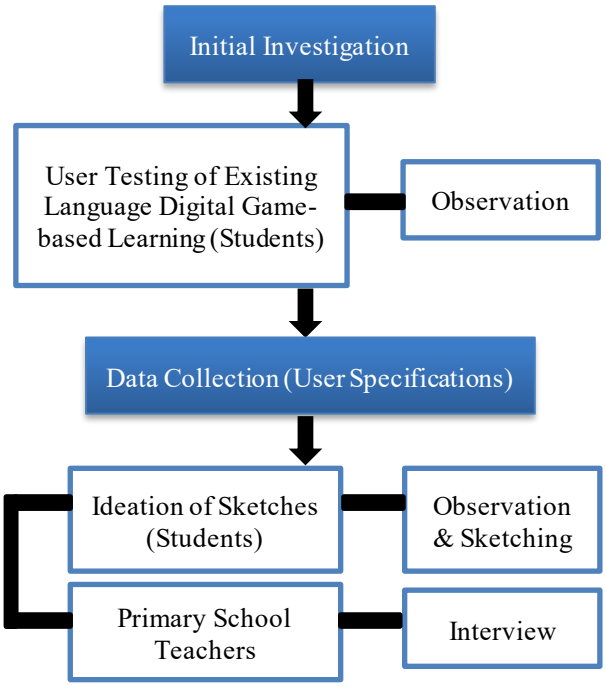

Fig. 1. Process of obtaining user specifications.

A. Experiment 1: User Testing the Existing Digital Game-Based Learning of Language Literacy

This activity involved the three existing digital game-based learning applications of Malay language learning, namely, 1) Mari Belajar Bersama Arif, 2) Belajar Menulis ABC, Suku Kata, and 3) My Latihan – BM T1: Suku Kata I. All of the students were given 30 minutes to explore all of the existing mobile applications by using tablets. They were free to ask the questions regarding activities conducted in the gameplay. The students were required to play and complete the tasks given and experience on using these existing mobile applications.

The evaluation session was carried out based on an observation technique to obtain their responses. Next, the four main highlighted aspects were observed that consisted of feedback mechanisms, game design, user experience and game elements of existing digital game-based learning. The highlighted elements were on the items of character design, use of colour, gameplay, learning contents, game environment, game genre, responses towards the game developed, the needs of a virtual tutor and rewards. Checklist was used as the main instrument to record their preferences and expectations while exploring the existing mobile applications. However, to ensure that unbiased data were obtained throughout the experiment conducted, the students were free to state their preferences, which were not listed in the checklist provided.

The procedure was carried out as follows:

- The respondents were briefed about the objectives of the experiment conducted.
- The respondents were briefed about the three existing digital game-based learning applications of Malay language.
- The respondents were briefed about the items on the checklist form to acquire the needs of them.
- The respondents were given 30 minutes to explore and play with the digital game-based learning applications individually. All of their actions will be recorded.
- The respondents were given the tasks to be completed in each game.
- Throughout the gameplay activities, the respondents would be observed on their digital literacy, Malay language literacy and their needs. They could also give their opinions related to the game design, gameplay and strategies to accomplish the mission for obtaining the rewards.
- Finally, the respondents were given a 10-minutes break before conducting another brainstorming session to sketch their ideas related to the preferences of digital game-based learning.

B. Experiment 2: Ideation of Sketching the Digital Game-Based Learning for Language Literacy

This activity involved all of the students to sketch their ideas in terms of player profile, game environment, game genre, and colour theory that are specified to acquire the user requirements. These requirements would be emphasized in

developing the digital game-based learning for language proficiency. All of the students were tested by using three existing digital game-based learning experiences on the gameplay. Therefore, this experiment was also identifying better understanding among them in mastering the language literacy skills. An observation technique is conducted to evaluate the drawings by the students.

The procedure was carried out as follows:

- The respondents were provided with visual examples to apply in their drawings based on the given instructions.
- The respondents were provided with the wireframe template to draw.
- The respondents are given 30 minutes to draw five main components that they prefer to be included in the digital game-based learning development. These components consisted of character designs (player character, non-player character of a teacher), game environment, gameplay, and colour theory.
- The respondents might draw and colour the drawings based on their preferences.
- The respondents were allowed to ask freely about their drawings.
- Throughout the drawing activities, the respondents would be observed on their preferences to develop the digital game-based learning user interface design through the checklist provided.

C. *Experiment 3: Interview Session with Primary School Teachers to Obtain the User's Needs for Language Literacy*

This activity involved six primary school students who have teaching experience ranging from 5-20 years. The teachers were interviewed on the basis of language learning, learning techniques, integration of technology, students' learning characteristics, feedback mechanisms, language dialect among Sarawakians, digital literacy and language literacy.

The procedure was carried out as follows:

- The interview session would be conducted within 30 - 40 minutes either in person or online.
- The respondents were answering the questions based on their teaching experience in primary school.
- The respondents were asked on the related matters of language literacy, digital literacy, the integration of technology, feedback mechanisms, dominant use of local dialect, impacts of lack of proficiency in mastering Malay language and strategies to enhance language learning.
- All of the interview sessions were being recorded to identify the problems among primary school students in Sarawak, Malaysia.

Hence, all of the experiments were conducted to identify the specific user requirements for designing and developing the digital game-based learning for the primary students. Through observation, interviews and checklists would acquire the needs of the students in identifying the gaps, challenges, approaches and strategies to improve the language literacy skills among them.

IV. Findings and Results

A. *Experiment 1: Analysis and Discussion (Quantitative Data)*

Fig. 2 shows the analysis of quantitative data gathered from the checklists of the experiment. There are 13 items listed in the checklists to identify the usability problems when using the three existing mobile game applications for language learning. There are four categories highlighted when the experiment is carried out. The categories are as follows: 1) game elements, 2) user experience, 3) feedback mechanisms, and 4) game design. The collected data will be analyzed and presented as percentage-based graphs to provide clear visual representation of comparisons of the findings.

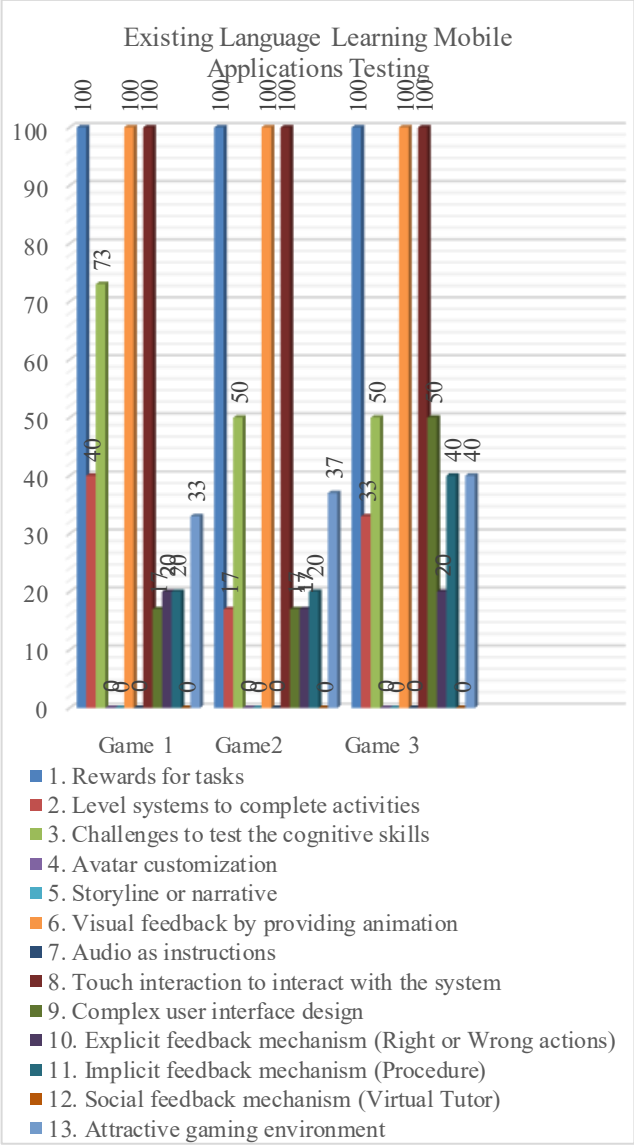

Fig. 2. Comparisons of existing language learning mobile applications.

Based on Fig. 1, the analysis data for Game 1, 2, and 3 show the game elements which are rewards, level systems, challenges, avatar customization, storyline or narrative, audio, and gaming environment needed in the language learning mobile game applications for the primary students. They are exposed to learning the digitized version of the Malay learning language applications through the use of tablets. However, some of the level systems to complete activities are not provided in the game design and development, but only provide them with different tasks to be accomplished. The purpose of level systems enables students to advance through the levels as they complete all the activities from the game itself, where they can unlock the new challenges based on their progress. While the challenges to test cognitive skills are included in the game design, they can be aligned to different levels of knowledge. So, the students may improve their language literacy skills from the lower level to the higher level.

Besides, all of the games do not provide the avatar customization as the profile player in the game design where it shows 0%. The implementation of player profiles through personalized avatars aims to enhance player engagement and improve the interaction with the game where currently the students are well-exposed the avatar customization. Not only that, storyline or narrative shows 0% too in which, the element is essential in game development where it serves to enhance the cognitive skills within educational games. However, these existing mobile game applications do not integrate storyline in guiding the students about the game flow. In fact, the students have a variety of knowledge levels and different skills, where some of them may have difficulties in reading and understanding. Hence, the use of audio to give instructions to the students about the game flow is needed too, where all of the games do not provide any of it.

As the main focus of the study is the feedback mechanisms that are categorized into implicit, explicit, social and visual feedback. Visual feedback, such as animation is provided in the game design. Meanwhile, the implicit, explicit and social feedback indicate the lower percentage when the students are operating all of the games. The inadequate feedback mechanisms may lead them to suspend the learning process of language literacy during the gameplay. It may occur when the absence of timely and effective responses hinders the students' progress, unlike the more responsive interaction provided in the classroom environments. Therefore, complex user interface design may affect the interaction of the students because they do not understand how to navigate and accomplish the tasks efficiently. Based on the analysis, it shows that 17% of the students are having difficulties in understanding the complex user interface design. Misinterpretation of non-clickable images as buttons can result in user frustration, where some of them are just clicking all the images randomly. This may occur due to unclear differentiation between actionable and non-actionable components in the user interface design. Not only that, this problem of usability happens due to their cognitive abilities being limited compared to adults.

B. Experiment 1: Analysis and Discussion (Qualitative Data)

After conducting the session of Experiment 1, Table I shows the analysis of students' preferences for the four main highlighted aspects of existing digital game-based learning of the Malay language, considering the feedback mechanisms, game design, user experience and game elements to be specified in detail through observation technique. The analysis will be conducted by using thematic analysis.

TABLE I. ANALYSIS OF OBSERVATION

Respondents (R)	Remarks
R1 – R30	Respondents prefer the learning environments to be designed in 2D and 3D such as jungle, zoo, outer space and flower gardens. They are also expressing interest in customizing the player profiles as the game character.
R7 – R25	Respondents prefer an active game genre such as adventure game with different levels of difficulties to ensure they engage and enjoy the learning session.
R1 – R30	The game shall not take up a lot of space or storage in the device such as tablets or smartphones. Additionally, the respondents suggest no advertisement showing up while playing which may lead to uninstalling the application and distraction.
R1 – R20	Respondents did not understand the gameplay of the existing mobile applications where they tend to stop playing the games. They are requesting an English version where it is more fun and easier to understand rather than using Malay language. There is no instruction of audio or verbal provided to them, but only focusing on reading the descriptions on how to play only.
R1 – R30	Respondents express themselves that they do not like to read books because of static images, where there is no interactivity at all. Thus, they tend to be bored in reading and learning Malay language.
R1 – R30	The needs of non-player character (NPC) shall be created and developed in the game. So, the avatar will be the representative of a virtual tutor or teacher to help in monitoring their progress track. Due to no feedback interaction between teacher and students in the existing game, lack of active engagement in the learning environment will occur.

Most of the digital game-based learning focuses primarily on visual and audio elements without aligning with the learning objectives and satisfying the students' needs. Given the varying preferences of students, it can be challenging to determine which aspects of the game design should be emphasized. During the experiment conducted, students found the user interface design of digital game-based learning confusing, struggling to understand the functionalities of the buttons in the game layout. This confusion leads them to press the icon images randomly, limiting the usability and reducing their engagement in learning the Malay language through the digital game-based learning.

The inclusion of game elements such as rewards, game instructions, challenges or activities, multimedia elements, avatars, non-player characters for teachers, player profiles, and gameplay can provide a beneficial learning experience in a gamified environment, enhancing the digital and language literacy. However, as the experiment progressed, it became apparent that the students were unable to understand the game learning contents due to a lack of instructional design in the game development. The students tend to stop playing, making it impossible to track their progress in the gameplay which leads to frustration and boredom to explore the game efficiently. Hence, there is a need to emphasize on the learning

contents that align to the learning objectives of the syllabus for improving the Malay language.

Therefore, feedback mechanisms are mainly focused in the research study, as every action taken by the students was recorded to highlight the limitation of the existing digital game-based learning developed. Lack of feedback mechanisms in the game development led to decreased concentration among students during the learning session. They also keep repeating the same mistakes in the gameplay. Additionally, lack of feedback mechanisms can lead to confusion about the flow of the game, thereby the students would lose interest in continuing to play the games. The students do not understand the reasons for their mistakes because they are still in the learning process with cognitive skills that are less developed compared to adults. Hence, there is a need to highlight the feedback mechanisms that can enhance their learning performance in mastering the Malay language proficiency.

Meanwhile, some of the students suggest having a non-player character (NPC) that serves as a teacher in the digital game-based learning environment. They believe this feature will help in monitoring the students' progress and provide instant feedback, as the NPC can answer questions during the learning process. Implementing such an NPC can potentially enhance student engagement by replicating real-life classroom interactions in a virtual learning environment. The integration of NPC in language learning sessions allows students to focus more by offering the interactive functionalities that respond to their questions and provide explanations on various learning topics such as reading, writing and speaking. For their own player's character, the students suggest the customization of avatar where they can design based on their preferences.

As a result, the analysis shows the critical need for enhancing the feedback mechanism, user interface design, functionalities, and learning content related to language literacy within a digital game-based learning environment. These improvements will be beneficial for students to improve their digital and language literacy by following the preferences of their learning style and addressing their specific needs.

C. Experiment 2: Analysis and Discussion (Idea Sketching)

After conducting the experiment, the data collection will be emphasized on the students' drawings based on four primarily main components. Fig. 3, 4, 5 and 6 show the analysis of drawings created by the students through sketching their ideas based on their preferences for digital game-based learning design and development.

Based on Fig. 3 indicates that students prefer to represent themselves as human-form characters in the digital game-based learning development. They can customize the details of these human avatars to play as their in-game representative. Meanwhile, the non-player character representing the teacher can also be developed as a human-form character, as one of the user requirements in the gameplay. Fig. 4 emphasizes the design of various environments, including the zoo, jungle, space and underwater. These environments can be customized as their background theme according to the students' learning preferences, allowing for a more personalized and engaging experience in the virtual world.

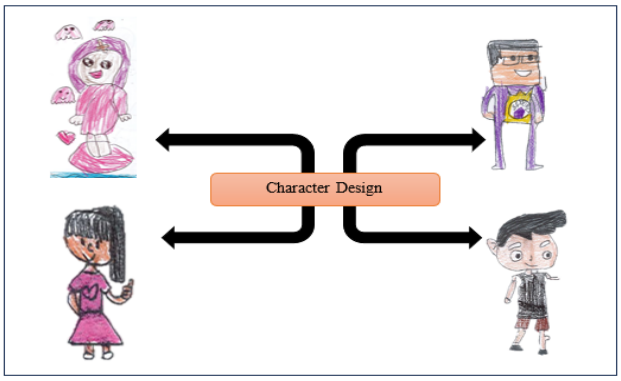

Fig. 3. Character design.

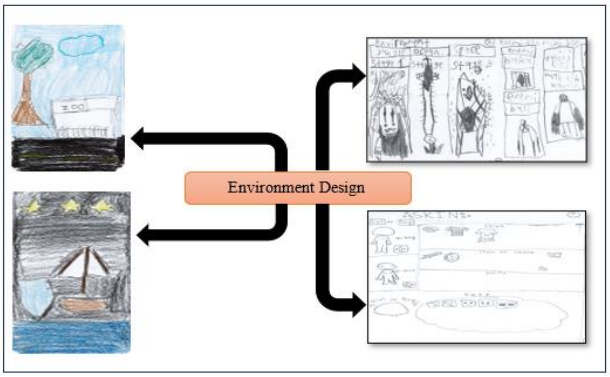

Fig. 4. Environment design.

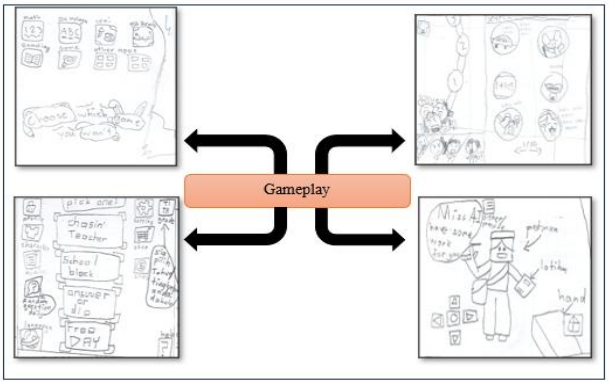

Fig. 5. Gameplay.

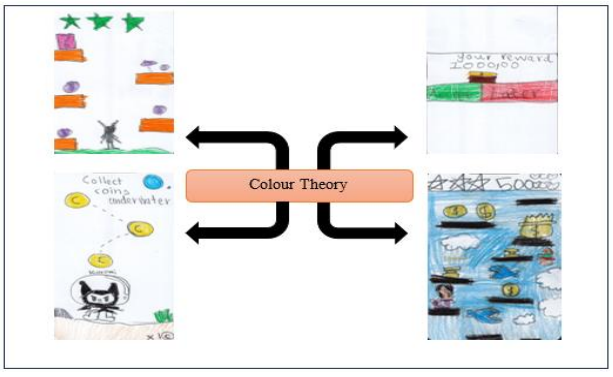

Fig. 6. Colour theory.

Fig. 5 highlights the various elements of gameplay in terms of interaction, user interface design, virtual tutor of artificial intelligence, game mechanics, game objectives, activities, challenges and learning context. This figure provides a comprehensive overview of how these elements may contribute to the overall gaming and learning experience. The ideation sketches focus on the game levels, mini games to be explored by the students in mastering the language proficiency. These game levels provide a structured way to increase the difficulties in the gameplay and maintain the engagement to ensure the players are continually challenged. Through the game levels provide the assessments to help them understand their strengths and areas of improvement in language learning. Therefore, feedback mechanisms as the main focus elements such as explicit, implicit, visual and social feedback will be emphasized based on their needs. Meanwhile, the instant and haptic feedback will be added as complementary features. These mechanisms aim to enhance a better understanding and proficiency in system interaction and digital literacy among the students.

Through the application of colour theory in Fig. 6, every factor of the digital game-based learning design will utilize the colour strategically to capture students' attention and create an engaging learning environment. This use of colour will not only attract them but also support their learning by enhancing the visual appeal. Thus, the learning contents developed will be more accessible and enjoyable as affecting their user experience by the integration of technology. Moreover, the use of bright and vibrant colours can be used to signify progress and rewards for the students' achievements or levels completed. This might boost the motivation and create a sense of accomplishment among the students to engage in learning language by using digital game-based learning.

D. Experiment 3: Analysis and Discussion (Interview Session)

The data collected through the interview session will be presented in thematic analysis as shown in Table II.

TABLE II. ANALYSIS OF INTERVIEW SESSIONS (TEACHERS)

Respondents (R)	Remarks
R1	Respondent 1 states the primary reason for lack of proficiency among students to master the language literacy is due to inadequate foundational knowledge in the Malay language. The dialectal variations significantly impact the language proficiency in terms of speaking, writing and reading. Therefore, the importance of technology implementation, as the learning process should align with technological advancements. However, when educational game applications fail to provide adequate feedback mechanisms during learning sessions, it can lead to challenges such as maintaining the students' engagement and managing their behaviour due to the absence of effective two-ways communication between students and teachers. Given that students are still in a formative stage of cognitive and social development, consistent interaction and structured supervision are crucial as the approaches provide them with proper guidance and support. Although educational games have the potential to stimulate their interest and motivation in enhancing learning, it is important to highlight the clear boundaries on the use of technology. This is due to the risk of gadget dependency, which could negatively impact the students' attention spans and social interactions in the real world. Consequently, these applications are beneficial in enhancing the learning outcomes, the use of the tools must be considered to be implemented. To ensure the complement, rather than replacing the conventional pedagogical methods, this approach will provide a holistic educational experience that nurtures both academic and personal growth in students.
R2	Respondent 2 adopts a diverse array of technology that can enhance the teaching strategies, including the utilization of computer labs and interactive educational game applications in such Kahoot and Wordwall. Relying exclusively only on a single conventional teaching approach can lead to short-span of attention and boredom among the students, thereby their focus on learning will be easily shifted. As the integration of Artificial Intelligence (AI) technology has begun to be introduced to the teachers, whereby the in-house training courses are also being conducted, these may help in improving the teaching and learning efficiently. Correspondingly, R2 states that by incorporating AI technology into educational game applications can help to ease the teachers' workload while also allowing students to be monitored as well. Therefore, by integrating innovative teaching methods with the implementation of technology, the learning contents and game design should align and be relevant with the educational objectives for the students. These methods are crucial as the technological tools are effectively utilized to enhance the teaching and learning process, ultimately promoting better academic performance among students.
R3	Respondent 3 prefers to implement the syllable method in teaching strategies due to its ease of memorization and enhancing pronunciation accuracy. This method is not only supporting vocabulary proficiency but also providing a strong basis for language development. Therefore, the integration of phonics is also beneficial to help students in developing the language literacy skills in alignment with primary education standards. However, the use of the syllable method is primarily recommended for developing the game. R3 emphasizes that students are increasingly attracted to use technology for learning tools, in which they are familiar with current technological advancements. However, it is important that clearer and explicit instructions should be provided before initiating the digital exercises. R3 indicates that verbal instructions are more effective than written ones, as they enhance the clarity of interaction between teachers and students. This may improve communication effectively with an engaging learning environment, which allows for dynamic interaction and active student participation during class sessions. Consequently, by implementing the feedback mechanisms will not only focus on students' engagement, but also contribute to better comprehension and educational outcomes. It proves that an effective instructional method as an approach to teaching, aligns well with educational practices.
R4	Respondent 4 emphasizes that educational game applications have the potential to significantly engage the students through interactive learning in the virtual gaming environment. This approach ensures that the time spent is more beneficial compared to merely playing regular games only for entertainment. Students preferred to use characters of Avatars or specifically implement the player profiles, as these existing game applications allow them to choose their preferences and

Respondents (R)	Remarks
	personality styles. Therefore, the integration of feedback mechanisms in educational games enable the students to respond well with the system developed. These feedback mechanisms are crucial for the game development as needed by the students to understand the game procedure, learning contents and responses towards the system too. By implementing the interactivity and responsive feedback mechanisms enable to maintain the students' attention and reinforce the learning outcomes. If these feedback mechanisms are not adequately integrated, students may less engage and not focus on learning, as the feedback mechanisms are supposed to be mirroring the interactive and responsive nature of traditional classroom environments. Effective feedback mechanisms are important for reinforcing the contextual learning and monitoring the students' progresses throughout the learning process.
R5	Respondent 5 indicates the necessity of prioritizing the teacher's role in giving instructions during the teaching and learning process. Especially when teaching the students that are categorized as introverts, who may struggle with social interactions. They are often hesitant to ask and answer the questions in a traditional classroom environment. Hence, providing additional support and attention to these students are essential, as they are able to participate openly during the learning progress. Additionally, the educational game applications that integrate Artificial Intelligence (AI) offer a potential solution by providing the feature of a virtual tutor that represents a teacher in a virtual world. These AI-driven systems enable the introverted students to express their queries and engage with the learning contents without pressuring them for direct classroom interaction. The use of AI technology provides an alternative method to assist the introverted students in overcoming the communication barriers that occur in the traditional classroom environment. Establishing this clarity of the virtual tutor feature embedded in the game development should also align with pedagogical objectives. Hence, it ensures to effectively complement the efforts of real-life educators to be implemented in the form of virtual tutor, rather than replacing the role of teacher itself. Thus, the use of AI technology fosters personalized learning experience in which, aligns with educational practices to enhance the digital and language literacy as well.
R6	Respondent 6 indicates the importance of incorporating the engaging visuals and vibrant colours in the teaching and learning process. It shows that these elements significantly enhance the students' interest and captivate their attention too. The interactive visuals are integrated into the touch screen mobile technologies, such as tablets and smartphones, students are more inclined towards the engagement with the learning content. This strategy of learning can be particularly effective in promoting interactivity with better visuals that align with the learning objectives. Especially, when compared to the conventional learning of using textbooks, which may lead to boredom and lack of engagement among the students. Consistent and structured practice in mastering the language literacy skills by using technology nowadays is crucial to enhance the learning experience. However, R6 raises concerns about the alignment of digital educational game content development with the Malay language curriculum. If the learning content is not properly synchronized with the curriculum, the effectiveness of the educational activities may be significantly compromised. It may lead to inconsistency of engagement during the learning session and hinder the learning objectives to be achieved. Therefore, it is important to highlight the digital learning application to be developed specifically on curriculum alignment. This is to ensure that the learning contents are engaging and pedagogically relevant. Thus, the educators can optimize the use of technology in the classroom as the learning tool that accommodates the diverse learning preferences and needs of the students.

E. Final Specifications of User Requirements

Following a comprehensive analysis of data collection through observation and interview sessions, the final user requirements are systematically refined and simplified. As adaptive digital game-based learning has gained momentum as a key to educational strategy, user requirements are acquired through a comprehensive analysis that reflects the specific needs of users, as shown in Table III.

TABLE III. SPECIFIC USER REQUIREMENTS OF DIGITAL GAME-BASED LEARNING DEVELOPMENT

Category	Requirements	Features
Character design	Human-form character as the player's profile. Human-form character as the virtual tutor representative (NPC).	Customization on player's profile. Allow users to choose and edit the avatar based on their preferences.
Environment design	Various learning environments of jungle, space, zoo and underwater. Immersive learning experience through a well-designed gaming environment.	Provide the users with different background themes.
Gameplay	Provide interactive and experiential aspects of game design to achieve the game goals. Provide game elements to enhance the user experience during the gameplay.	Rules Game mechanics such as game levels, challenges and rewards. Mini games. Navigation menus. Instructional texts and voice Exploration game genre (adventure)
Feedback mechanisms	Provide information to players about their performance, progress tracking and understanding the learning contents. To guide and maintain the engagement of the users.	Explicit feedback Implicit feedback Social feedback Visual feedback Instant feedback Haptic feedback
Use of colours	Influence the player's emotion and user experience. Provide colours and tones on the characters, objects, buttons and environment design.	Bright colours Pastel colours Gradient colours Additive and subtractive colours
Adaptive learning contents	Following the course syllabus of Malay language for primary school students.	Reading Writing Speaking
Functionality	Include animation, pop-up messages. Interactive buttons. Images and icons as non-functional static elements	Display animation Display pop-up messages Buttons Audio

Category	Requirements	Features
	only Include listening and speaking practices.	
Interaction	Touch interaction	Touchscreen technology: Tablet or smartphone
User Experience	Enable to track the performance of adaptive learning.	Progress tracking Leaderboards
Optimization	Integrate Artificial Intelligence (AI) for NPC. Provided automated reply to the player	Virtual tutor (teacher)

V. Discussion

Through the proposed user-centered design method, this research study emphasizes the importance of acquiring the specific user requirements of primary school students by conducting the observation, interview and checklists approaches that are significantly highlighted in the research study [78]. This study employs a mixed-methods approach by combining qualitative and quantitative data to obtain a comprehensive understanding of user preferences for designing and developing the digital game-based learning.

Similarly, this study contributes to the language literacy skills by providing learning tools such as incorporating the adaptive learning features into digital games. Hence, it provides the immersive and effective learning experience in a gamified learning environment for the students to master the language proficiency [47], [67], [68]. Therefore, the integration of personalized learning of the students enables the systems to track students' performances based on varying levels of skills. As a dynamic approach to learning, adaptive learning contents should be aligned with the curriculum to ensure the relevant and structured learning experiences correspond to the academic standards and objectives for students [42], [57], [66], [77]. This study also helps to improve language literacy by integrating adaptive learning features into digital games. The students will be provided with engaging and effective ways of gamified learning approaches to practice and strengthen their language literacy skills.

Therefore, the usability problems of game design led to resulting poor satisfaction among the students to improve the language literacy during the gameplay of digital game-based learning [43], [44], [58], [79]. Thus, there is a need to improve the game design and development based on the students' preferences and needs by acquiring their user specifications. There are 10 categories highlighted components for emphasizing the enhancement of adaptive digital game-based learning for language acquisition, which are character design, environment design, gameplay, feedback mechanisms, use of colours, adaptive learning contents, functionality, interaction, device, user experience, optimization of artificial intelligence. Each requirement specification that is listed has different features to support the causes of usability problems that are related to game design and development [6], [30], [48], [53], [64], [67], [77]. Poorly designed game mechanics can prevent learners from focusing on educational content. Besides, the usability issues in game design can reduce student satisfaction and limit the effectiveness of digital game-based learning for enhancing language literacy skills among them.

As a result, the findings of this research study concludes that students are more inclined to gaming environments rather than focusing on conventional learning due to interactivity where it offers them a more enjoyable interactive learning environment to be experienced. In fact, active interaction between the students and the system developed has beneficial impacts on improving their communication and digital literacy, specifically through the integration of advanced touch interaction technology that provides more features and functionalities for the students to enhance the language learning skills. Therefore, this user specifications highlighted will also be used to develop the conceptual framework for future research. This conceptual framework development will be validated through the expert evaluation and final user testing from both educators and students.

VI. Conclusion

A user-centered design method is essential in understanding and acquiring the preferences and needs of primary school students for language proficiency through digital game-based learning. The involvement of students from the design phase enables them to emphasize the user specifications that are aligned to develop the digital game-based learning based on their learning styles for improving the language literacy skills and cognitive skills too. In fact, the enhancement of learning outcomes should be emphasized on the development of digital game-based learning that provides feedback mechanisms, clear instructions, good navigation of application, uncluttered user interface design, use of colours, environment and character designs, artificial intelligence optimization, gameplay, user interaction and user experience.

Furthermore, the user-centered design approach plays a critical role in identifying usability challenges and enables developers to iteratively refine digital game-based learning tools based on students' feedback. This process ensures that learning experiences are closely aligned with students' preferences, needs, and learning styles, which can enhance both engagement and learning outcomes effectively.

Effective educational games rely not only on UCD but also on the integration of adaptive learning elements. By emphasizing the learning contents, feedback mechanisms, and gamified environment strategies to individual learners, the system can provide targeted guidance, correct misconceptions in real time, and support progression at varying skill levels. Hence, it ultimately contributes to improving language literacy and supporting cognitive development among the students.

For future research, the conceptual framework will be further developed and validated to guide the design of adaptive digital game-based learning for language literacy. Studies could focus on empirically testing its effectiveness across diverse learning style of the students, examining the long-term impact on language proficiency, cognitive development, and engagement to improve the educational strategies.

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