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Research Article

Development and Evaluation of the "Pico Party Adventure" Game to Measure Learning Experience for Special Needs Students

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Abstract

The present study aims to elucidate the development process of an interactive educational game titled "Pico Party Adventure," designed for special needs students, particularly those with learning difficulties. Furthermore, it reports on the levels of learning experience, referencing Kolb's experiential learning criteria concerning engagement, competence, emotional, and social aspects. The 2D adventure-based game was developed using Scratch, following the ADDIE model. A survey using questionnaires was employed to evaluate user experience among 30 seven-year-old students with learning difficulties. The findings indicate that user experience levels were high regarding engagement and competence, moderate for emotional experience, and low for social experience. The implications of this study suggest that interactive games have the potential to serve as effective educational tools for special needs students, particularly in enhancing student engagement and competency, underlining the significance of learning experiences in alignment with national inclusive education objectives.

Keywords: digital games, ADDIE model, learning disability, Kolb's experiential learning, special needs.

INTRODUCTION

Digital games have emerged as powerful tools in the educational landscape, transforming traditional learning environments into interactive and engaging experiences. The integration of digital games in education is supported by numerous studies that highlight their potential to enhance cognitive abilities, increase motivation, and improve overall learning outcomes (Yusof & Ibharim, 2024). Digital games offer a dynamic and immersive means of delivering educational content, which can be especially beneficial for children with special needs, particularly students with learning disabilities who may require alternative learning methods. Traditional teaching materials often lack the interactive and engaging elements to fully support the diverse learning needs of children with disabilities (Zolkipli et al., 2023). According to Dhiyaneshwari and Devi (2023), digital games enhance learning among children with learning disabilities by promoting interaction with virtual environments, aiding in complex concepts, and improving

educational outcomes in special education settings. These interactions can lead to improved information retention and a greater willingness to engage with learning materials.

In inclusive education settings, digital games, also known as educational games, have emerged as an effective tool for enhancing learning experiences, particularly for students with learning disabilities. These games integrate various elements that engage students in meaningful and enjoyable ways, which can facilitate better memory retention of information and development of digital literacy, thereby improving specific cognitive skills (Mikrouli et al., 2024). For students with learning disabilities, such as dyslexia (reading disorder) and dyscalculia (arithmetic disorder), educational games provide a dynamic and interactive learning environment that caters to their unique needs. Successful educational games for individuals with learning disabilities often incorporate several essential design principles, such as cognitive task types, engaging audiovisual aspects, and customisable features (Lämsä et al., 2018). These design elements ensure that the games cater to the individual needs of learners, with a focus on improving specific subskills. Elements such as clear and structured tasks, immediate feedback, and progressive difficulty levels are particularly beneficial, as they help students understand and master concepts at a manageable pace. Additionally, the use of visual and auditory stimuli in educational games has been shown to enhance attention and memory, crucial areas often affected in students with learning disabilities. The incorporation of gamified elements, such as rewards and achievements, also supports motivation and engagement, which are key factors in sustaining the interest of students who may struggle with traditional educational methods (Hardiyanti & Azizah, 2018). Thus, interactive games designed for special needs students can offer a multi-sensory, tailored learning experience that addresses their challenges and fosters a positive learning environment, aligning with the principles of inclusive education.

The experiential learning theory, developed by David Kolb in 1984, serves as an effective framework for educational games (Kolb, 1984). It delineates the process by which knowledge is created through the transformation of experience. This theory posits that individuals acquire knowledge more effectively when they engage actively in the learning process, rather than merely receiving information. Hence, this theory will be employed by the “Pico Party Adventure” game to ensure that students with learning disabilities are afforded an environment conducive to practical engagement and learning. Such students are able to engage in the game and, consequently, enhance specific cognitive functions related to object classification.

Despite the growing interest in educational games as tools for enhancing learning experiences, significant research gaps remain, particularly in their application to students with learning disabilities. While existing studies have explored the use of educational games in general education settings, there is limited research focused on how these games can be tailored to meet the unique cognitive, emotional, and social needs of students with intellectual disabilities. The primary aim of the present study is to develop and evaluate a digital game for learning disability students who encounter problems in reading and arithmetic. The study seeks to identify the learning experience of the students in terms of engagement, competence, emotion, and social aspects. By focusing on experiential learning theory, this study aims to contribute to the growing body of research on game-based learning in special education and provide practical insights for educators and game developers.

LITERATURE REVIEW

Experiential Learning Theory (ELT), introduced by David Kolb, focuses on learning through experience and reflection, which can significantly influence game design. ELT posits that effective learning occurs when individuals can engage in concrete experiences, reflect on these experiences, form abstract concepts, and then test these concepts in new situations (Kolb, 1984). In the context of game design, applying ELT

involves creating immersive and interactive experiences that encourage players to learn through doing and reflecting on their actions. Integrating ELT into game designs can enhance the educational value of games by making learning more engaging and meaningful. Games that use ELT principles typically include elements such as real-life simulations, problem-solving tasks, and scenarios that require active participation and decision-making. These elements help players to develop critical thinking, problem-solving skills, and the ability to apply knowledge in practical situations. For learning disability students, experiential learning through educational game features can be particularly beneficial, as presented in Table 1. It allows these students to learn at their own pace, provides immediate feedback, and offers a safe environment for practising new skills. The hands-on nature of experiential learning helps to maintain the students' interest and motivation, which can lead to better learning outcomes (Budiastuti et al., 2023; Kong, 2021).

Table 1: Kolb's experiential learning and game features for learning disabilities

Kolb's Experiential Learning Stage	Game Features	Relation to Learning Disabilities
Concrete experience	Exploration, immersive environments, and real-world simulations	Engagement Experience: Active interaction with game content provides hands-on learning experiences that aid cognitive development and engagement.
Reflective observation	Post-action reflections, in-game feedback, and scoring systems	Competence Experience: Reflective learning experiences enable students to analyse their actions and strategies with feedback.
Abstract conceptualisation	Problem-solving, strategy building, and resource management	Emotional Experience: Conceptual learning experiences enable students to form abstract ideas and strategies based on game feedback and challenges.
Active experimentation	Trial-and-error, dynamic interaction, and knowledge application	Social Experience: Active experimentation and interaction in the game create opportunities for social learning and collaboration.

Ranuharja et al. (2021) conducted a comprehensive study on the development of interactive learning media using the ADDIE model, aiming to enhance student engagement and learning outcomes through educational games. Their study targeted general primary school students and followed the systematic phases of the ADDIE model: Analysis, Design, Development, Implementation, and Evaluation. While the game effectively enhanced engagement and learning outcomes for general primary school students, their study did not address the unique requirements and challenges faced by students with special needs. This omission highlights the necessity for further research to explore how the ADDIE model can be adapted to develop educational games that cater specifically to students with special needs.

Calvo-Ferrer (2021) conducted a study on the effectiveness of different types and frequencies of feedback in digital game-based L2 vocabulary acquisition. The study underscored the significance of usability, defined as the ease with which users can interact with a game, as a crucial element in developing an inclusive and effective learning environment. The research highlighted that features such as intuitive controls, clear instructions, and visually appealing graphics tailored to students with special needs significantly enhance the usability of educational games. These features help reduce frustration, allowing students to focus more on the learning content rather than struggling with the game interface. Furthermore, the study underscored the importance of user-friendly interfaces, which ensure that students can navigate the game effortlessly, thereby enhancing their learning experience. Features like responsive feedback, custom avatars, and interactive storytelling play crucial roles in maintaining students' interest and motivation. By incorporating these usability aspects, developers can create educational games that are not

only engaging but also accessible to all students, including those with special needs. This approach ensures that educational tools are effective in providing a supportive and enriching learning environment, ultimately leading to better educational outcomes.

METHODOLOGY

The present study adopts a quantitative approach using a survey method with a questionnaire. This approach was chosen as it allows for systematic data collection from many respondents, providing a clearer and more objective understanding of their perceptions and experiences with the developed educational game. The questionnaire is designed to measure the students' learning experiences in terms of engagement and competence, as well as their emotional and social experiences while using the game. The respondents of this study consist of 30 students with learning difficulties in reading and arithmetic from schools in the state of Perak. Through the analysis of the collected data, this study aims to obtain accurate information to assess the impact of the educational game on the development of students with special needs.

The ADDIE model is a widely recognised instructional design framework that has been effectively employed to develop digital games tailored for children. Due to its systematic, structured, and iterative approach, the ADDIE model is particularly well-suited for the creation of educational games, ensuring that all aspects of the game development process are thoughtfully planned and executed. As noted by Adeoye et al. (2024), the ADDIE model provides a comprehensive methodology that is essential for designing effective educational tools. Its importance is further highlighted by its widespread adoption, serving as the foundation for over 100 instructional design models, showcasing its versatility and adaptability (Azman et al., 2024; Stapa & Mohammad, 2019; Yas et al., 2023; Zamzuri et al., 2024). Originally developed in the 1970s, the ADDIE model consists of five interconnected phases: Analysis, Design, Development, Implementation, and Evaluation, which together create a continuous feedback loop aimed at improving the instructional product (in this study's context, an educational game). This structured approach not only ensures the creation of effective educational content but also supports ongoing refinement, making it an ideal choice for designing educational games that meet specific learning objectives. As illustrated in Figure 1, each phase of the model plays a crucial role in creating engaging and impactful learning experiences.

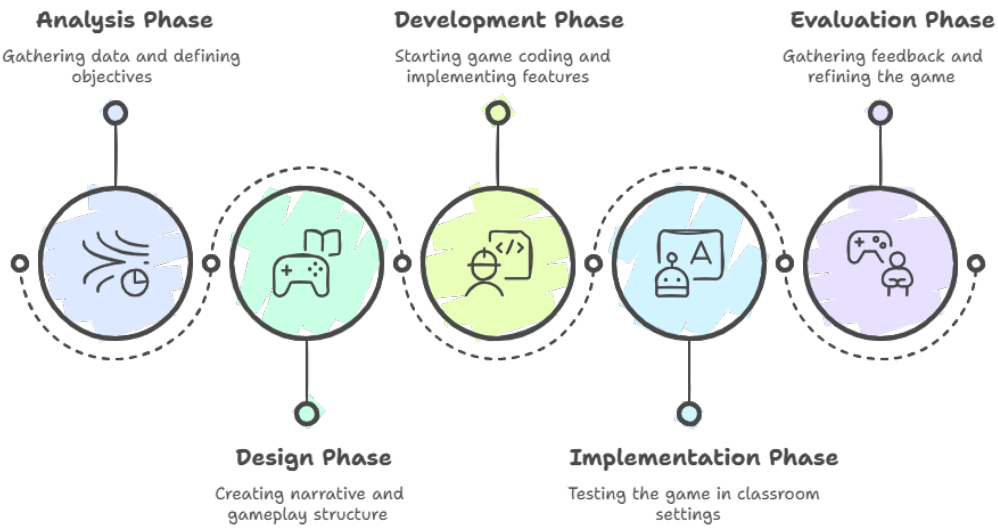

Figure 1: The "Pico Party Adventure" game development process based on the ADDIE

model

Analysis

During the analysis phase, data and information were gathered through brainstorming and interviews with primary school teachers. The purpose of the study was to estimate the educational requirements and choices of students with special needs. Consequently, these students frequently encounter challenges in assimilating knowledge imparted through traditional teaching methods, and they exhibit superior performance when engaged in games and other interactive activities. Considering these facts, a game titled "Pico Party Adventure" was proposed to be created, aimed at enhancing the cognitive skills of students with special needs by facilitating object recognition and classification. The target audience for the game consists of primary school students with special needs aged seven years and older. The primary objective is to create an engaging and educational environment that enhances students' learning experiences through interactive gameplay.

Design

The design phase is an important step in game development because it lays the foundation for the entire project. This phase involves planning, conceptualising, and designing the gamified experience; it is essential for several reasons. It sets the stage for the successful implementation and deployment of gamification strategies that can achieve specific objectives and drive user engagement and motivation. In this design phase, a game design concept has been made to understand the flow and synopsis of the game. A detailed game concept outlining the game mechanics, gameplay, levels, and user interface is also being created in this phase.

Scratch has been used to develop the game's characters, sound, and mechanics, ensuring alignment with the game's educational goals and thematic elements. All sprites, including the main character Pico and other assets, as well as multimedia elements such as sound and text, were carefully selected to be suitable for special needs students. These sprites and multimedia elements are readily available within Scratch, as shown in Figures 2 and 3. Moreover, the game's environment and background layout for the user interface were meticulously crafted using Adobe Photoshop, as shown in Figure 4, staying true to the immersive and educational experience intended for the "Pico Party Adventure" game. The careful integration of these tools and resources during the design phase ensures that the game provides a cohesive and engaging experience for its users.

Figure 2: The sprite for the main character named Pico

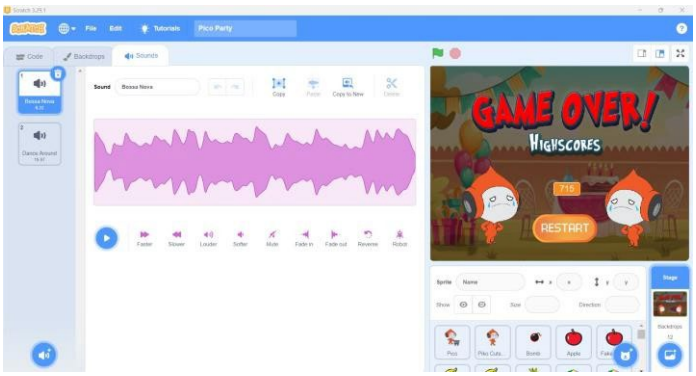

Figure 3: The multimedia element chosen from Scratch

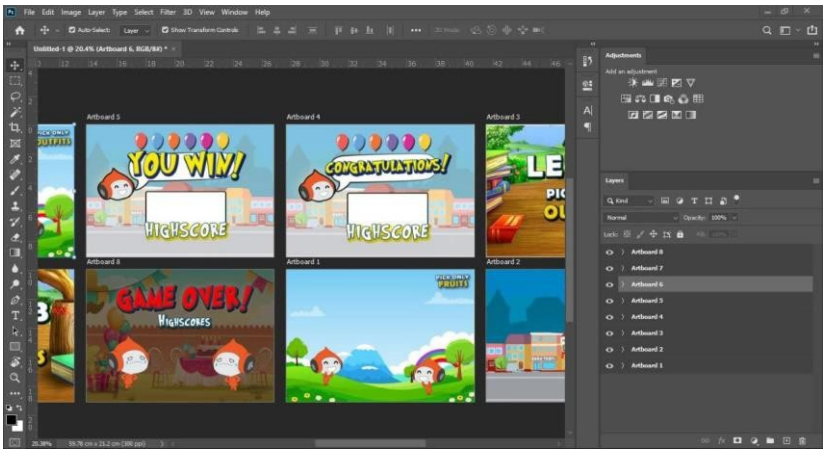

Figure 4: The user interface design in Adobe Photoshop

Finally, the determination of the PC platform and technology stack for development is crucial. During the design phase, the ideas and concepts of the game are translated into visual representations to enhance understanding, as illustrated in the Game Design Canvas of the "Pico Party Adventure" game and shown in Figure 5. Creating the storyboard and the game flow diagrams is essential to help programmers develop the game's functionalities and user interface, as shown in Figures 6 and 7.

Development

In this development phase, the game is implemented according to design specifications tailored to the characteristics of students with special needs, specifically those aged seven and older. The core mechanics, the controls, and the sprites' movements are designed based on preferences typical of this age group. The software used to create the game is Scratch. Scratch was chosen for several reasons. It is a highly user-friendly platform, especially suitable for beginner game developers, which aligns with the project's educational focus. Scratch offers a visual programming language that allows developers to create interactive stories, games, and animations through a simple drag-and-drop interface, as shown in Figure 8. This ease of use enables developers to quickly prototype and iterate on game design ideas without needing extensive programming knowledge.

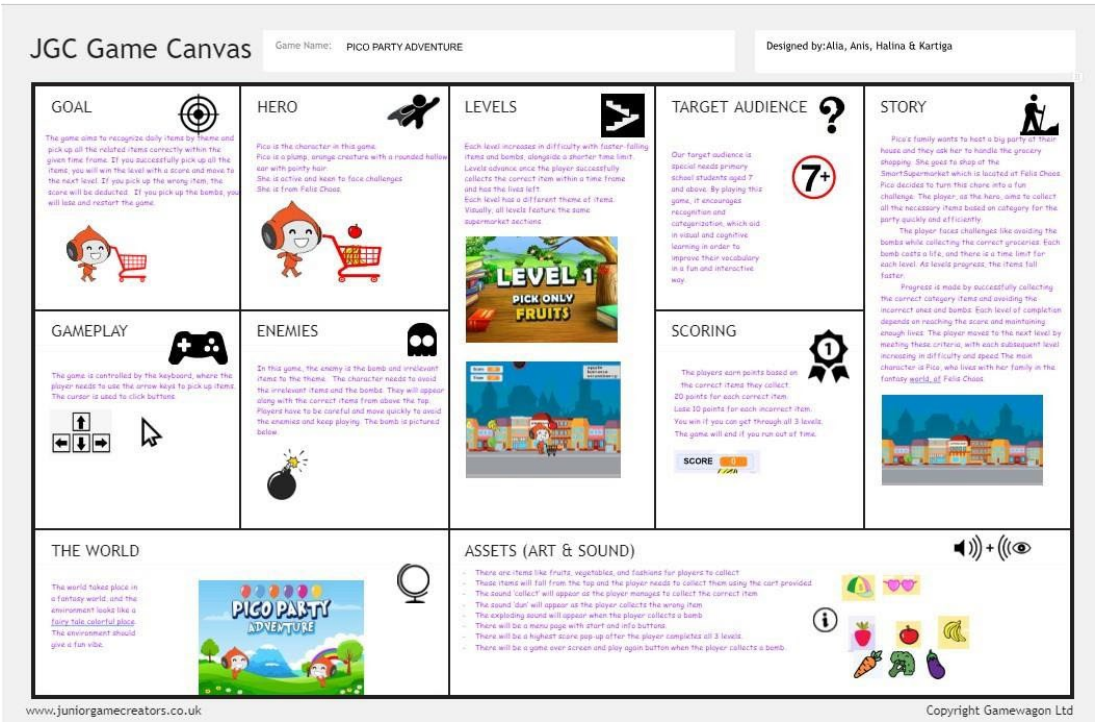

Figure 5: Game design canvas of the "Pico Party Adventure" game

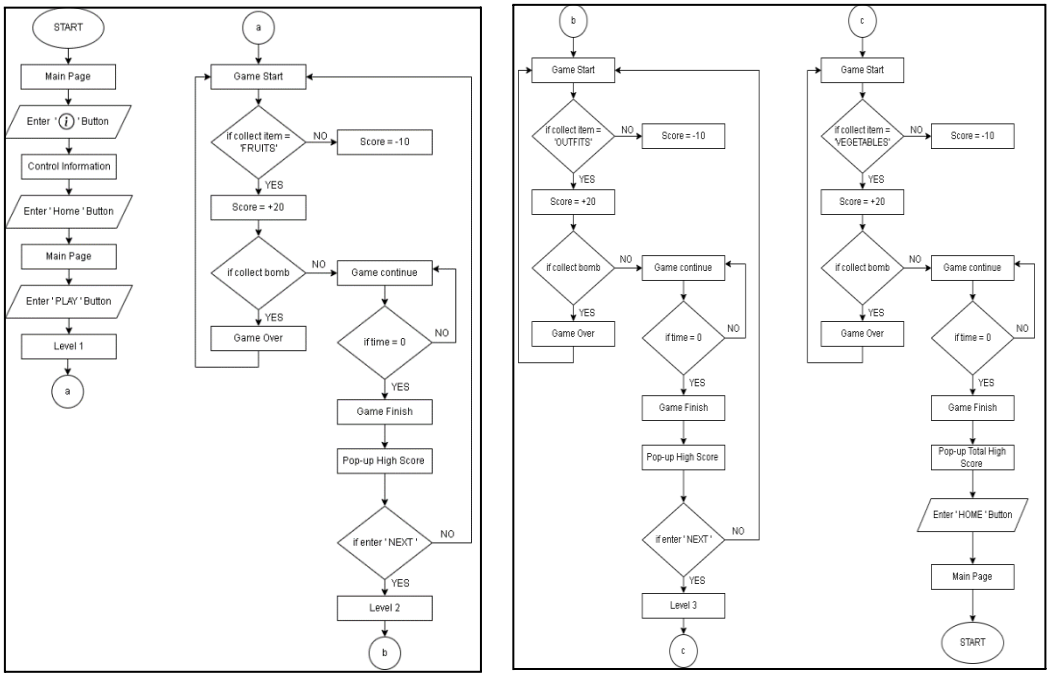

Figure 6: Game flow diagram

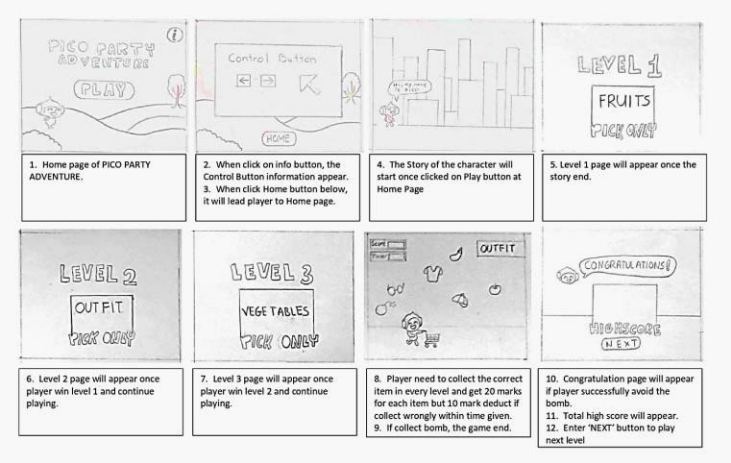

Figure 7: The storyboard of the game

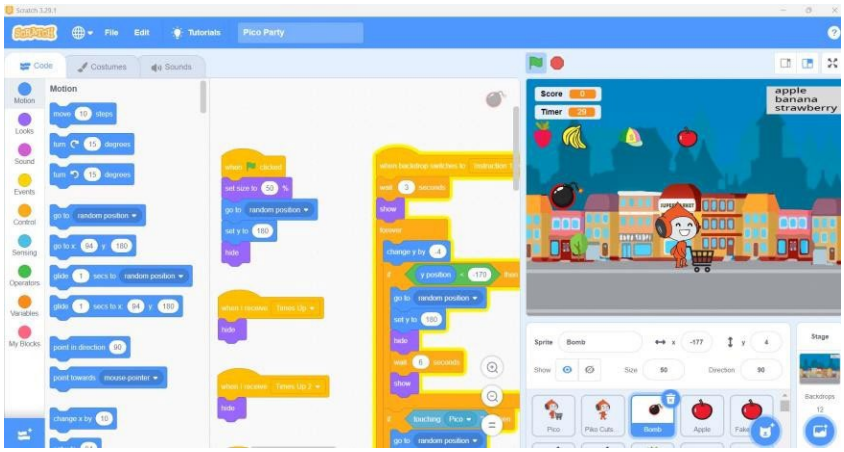

Figure 8: Scratch working space interface

Implementation

During the implementation phase, the "Pico Party Adventure" game is accessible via the Scratch platform so that it can be played online. Participants receive a link to the game, which they can use to access and play it directly on the Scratch website. At the beginning, the young participants receive explanations of the storytelling elements of the game and detailed instructions on how to play. Following this introduction, they will have the opportunity to try out the game and gain firsthand experience with the user interface. Participants can explore the narrative elements and information content of the game, ensuring they fully understand the game mechanics and learning objectives. This approach provides an immersive and interactive learning experience that allows students to engage deeply with the content of the game.

Evaluation

An evaluation was carried out to assess how the "Pico Party Adventure" game engages players and provides them with the intended learning objectives. A survey was employed by selecting a group of 30 players, all aged 7 years and older, to test the game, as shown in Figure 9. The evaluation tools included a questionnaire to assess the learning experience in terms of engagement, competency, emotion, and social

interaction. The usability feedback for the game was extremely positive, suggesting that the game has successfully engaged students and achieved its educational goals. However, there is always room for improvement. For the future, new ways need to be contemplated to make the game even more exciting by incorporating new game elements and exploring additional learning content.

Figure 9: A 9-year-old special needs student playing the game

RESULT

The usability test evaluated the game's effectiveness in four constructs: engagement experience, competence experience, emotional experience, and social experience. The feedback from 30 respondents was categorised into three responses: No, Maybe, and Yes, providing a comprehensive overview of the learning experience effect. Figure 10 shows the graph of the result in percentage.

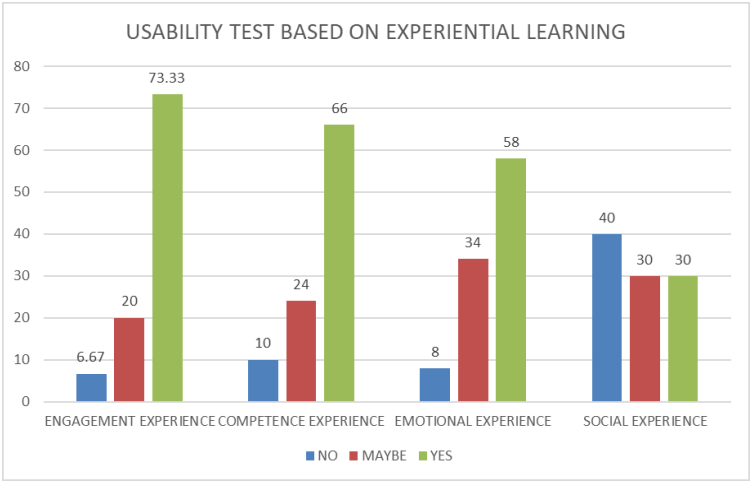

Figure 10: The result of the usability test

Engagement Experience

The engagement experience construct showed that only 6.67% of the respondents did not feel engaged, 20% were somewhat engaged, and a remarkable 73.33% felt engaged. This high level of engagement suggests that the "Pico Party Adventure" game is effective in engaging the interest of its users, which is

crucial for maintaining motivation and continued interaction with the game. Engagement is a key factor in learning, as it ensures that students remain focused and invested in the learning content. According to Kolb's experiential learning theory, active engagement in learning activities is crucial for transforming experience into knowledge. The game's ability to engage students supports this theory, as it provides an immersive environment where learners actively participate in their learning process.

Competence Experience

For the competence experience construct, 10% of the respondents did not feel competent, 24% felt somewhat competent, and 66% felt competent. The predominant sense of competence suggests that the game is accessible and offers users adequate support to enhance their skills. This observation corresponds with Kolb's assertion that effective learning occurs when individuals actively experiment and practise new skills in a conducive environment. By providing a platform where learners can repeatedly practise and improve, the "Pico Party Adventure" game reinforces their sense of competence and mastery, crucial elements of experiential learning.

Emotional Experience

Regarding the emotional experience construct, 8% of respondents had no positive emotional experience; 34% had somewhat positive, while 58% had a positive experience. Having most of the respondents experience positive emotion means that the fun factor is observed in the game, thereby encouraging more learning. Positive effects are important, as they boost one's motivation and help with memory. In the context of the categorisation of learning experiences put forward by Kolb, learners' affectivity when participating in learning activities is beneficial to meaningful understanding and retention. By embracing an analysis of the student responses, the impact of the " Pico Party Adventure" game resonates positively with students' emotions, significantly contributing to their more profound learning experiences.

Social Experience

In the social experience construct, the distribution of response options was more evenly spread: 40% of the respondents did not feel a positive social experience, 30% of the respondents had a somewhat positive social experience, and the rest 30% had a positive social experience. In terms of distribution, the fact that individuals are distributed evenly through the social experiences vertically underscores a development opportunity. Still, only half of the interviewed users found the game to be socially enhancing; others did not. Enhancing collaborative elements or multiplayer features could improve the social aspects of the game. Kolb's theory emphasises the importance of social interaction in learning because it allows learners to share experiences and reflect on them collaboratively. Improving the social components of the game could facilitate better peer-to-peer interaction and collective learning, thereby enhancing the overall educational impact.

DISCUSSION

The game's effectiveness in engaging students is demonstrated by 73.33% of respondents who reported feeling engaged. This result emphasises the importance of engagement in sustaining students' attention and participation, both of which are critical for effective learning. Recent research by Psyllou (2024) supports this finding, highlighting how gamified learning environments boost engagement through immersive and interactive experiences. However, a small percentage (6.67%) of students did not feel engaged, suggesting that while the game is generally engaging, there is room for improvement to increase its appeal for all learners. This aligns with the concrete experience stage in Kolb's experiential learning

model, where interactive game features such as exploration and immersion help maintain learner interest and involvement.

Regarding competence criteria, 66% of students reported feeling competent while playing the game, indicating that the game effectively supports skill development through feedback and clear goals. This finding mirrors research by Nodira and Qizi (2023), which underscores that well-designed educational games enhance learners' perceived competence and confidence. However, 10% of students did not feel competent, pointing to a need for additional support. The use of differentiated difficulty levels and adaptive learning pathways could help address this gap, ensuring that all students benefit from the game regardless of their starting point. This aligns with reflective observation in Kolb's model, where post-action reflection and feedback are essential for helping learners analyse and adjust their strategies.

58% of respondents reported positive emotional experiences, which aligns with research by Covrig et al. (2023), who found that enjoyable and engaging learning activities boost motivation and retention. However, 8% of students did not have a positive emotional experience, indicating that improvements can be made to make the game more emotionally engaging. Possible enhancements could include more varied storylines and frequent rewards. This phase corresponds to the abstract conceptualisation stage in Kolb's model, where students engage emotionally with the learning content, fostering motivation and deeper learning.

The social experience showed a mixed response, with 40% of students reporting no positive social experience and 30% each reporting somewhat or completely positive experiences. This data suggests a need for improvement in facilitating social interaction, which is a critical element of experiential learning. Zheng and Wang (2023) argue that educational games promoting collaboration and peer interaction improve social learning outcomes. By incorporating multiplayer features or collaborative tasks, the game could better support teamwork and communication. This concept relates to the active experimentation stage in Kolb's model, where learners collaborate and interact, sharing their experiences.

Finally, the integration of multimedia elements, such as graphics, sounds, and animations, is vital in enhancing learning outcomes for students, particularly those with special needs. These multimedia features capture attention and make abstract concepts more tangible, thereby improving comprehension. De Leon Pereira et al. (2021) affirm that multimedia in educational games serves a dual purpose: increasing interest and aiding memory retention. This aligns with the concrete experience and abstract conceptualisation stages in Kolb's model, where multimedia elements provide immersive experiences that support conceptual understanding through visual and auditory engagement.

CONCLUSION

In conclusion, this study contributes to the growing body of knowledge about the use of educational games in inclusive education, particularly for students with learning disabilities. The findings highlight the potential of game-based learning in providing an engaging, interactive platform that supports cognitive development, emotional engagement, and skill-building for students with special needs. By integrating the principles of Kolb's Experiential Learning Theory, the game effectively promotes hands-on learning, reflective observation, conceptual understanding, and active experimentation, which are essential for fostering a comprehensive learning experience.

The research offers valuable insights into how educational games can be designed to address the unique challenges faced by students with learning disabilities, highlighting the importance of incorporating adaptive learning pathways, multimedia features, and social interaction opportunities. The implications of

this study extend to both game developers and educators, providing a framework for creating educational tools that are not only engaging but also tailored to meet the diverse needs of learners.

This research contributes to the field of inclusive education by demonstrating that well-designed educational games can enhance learning outcomes for students with disabilities, offering a more inclusive and effective alternative to traditional teaching methods. It encourages the integration of game-based learning into educational practices, which can help bridge the gap in access to quality education for all students, regardless of their learning abilities. As the use of educational games continues to evolve, further research and development in this area will be crucial in shaping future inclusive educational strategies and tools.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Halina Ramli: Conceptualization and original draft preparation. **Laili Farhana Md Ibharim**: Supervision, reviewing, and editing. **Mehmet Akın Bulut**: Reviewing and editing. **Adem Yurdunkulu**: Reviewing and editing.

DECLARATION OF GENERATIVE AI

During the preparation of this work, the authors used ChatGPT to enhance the clarity of the writing. After using ChatGPT, the authors reviewed and edited the content as needed and take full responsibility for the content of the publication.

DATA AVAILABILITY STATEMENT

Data available within the article or its supplementary materials.

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