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Usability and Educational Impact of A Gamified Board Game in Secondary Education

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ABSTRACT
Gamification has emerged as an effective strategy for enhancing student engage Demo-4976-Article text Demo-4976-Article textment and learning experiences. Board games, as a gamified approach, provide interactive learning opportunities by integrating subject content with structured gameplay. The Global Kesihatan Game (GKG) was developed to improve students' understanding of science, physical education, and health while promoting active participation. This study evaluates the usability and educational value of GKG as a teaching aid. A descriptive cross-sectional study was conducted over two months at a Malaysian secondary educational institution affiliated with a government university. A total of 42 students aged 13 to 16 years participated in the study. Students engaged in the GKG board game in groups, following predefined rules that encouraged collaboration and strategic thinking. Data were collected via an online survey, assessing the game's design, usability, engagement, and impact on learning. The findings indicate that GKG effectively enhances student engagement, with participants reporting increased interest and enjoyment in learning. The game was perceived as visually appealing, easy to understand, and well-integrated with curriculum content. While GKG facilitated knowledge acquisition in science and health, some students suggested further refinement to improve conceptual depth and clarity. The game also encouraged social interaction and collaborative learning. The GKG board game is a valuable educational tool that promotes engagement and enhances learning in science and health subjects. While the game demonstrates strong usability, minor refinements in content complexity and instructional depth could further optimize learning outcomes. Future research should explore long-term impacts of gamification on academic performance and cognitive skills.

Keyword: *Gamification, Educational Games, Student Engagement, STEM Education, Health Education*

1. INTRODUCTION

Gamification in education has garnered increasing attention in recent years. According to Dichev and Dicheva (2017), gamification refers to the integration of game elements into the learning environment to enhance student engagement. This approach incorporates game design, mechanics, and a game-based mindset into non-game activities to inspire and engage participants. The primary objectives of gamification in education include enhancing cognitive abilities, setting meaningful learning goals, engaging students, optimizing the learning process, supporting behavior change, and fostering social interaction (Knutas et al., 2014; Krause et al., 2015).

Educational gamification is an instructional strategy that requires learners to engage in structured competitions based on predefined rules. Zaranis et al. (2013) highlight that educational games are effective tools for improving linguistic skills, mathematical logic, and motivation to acquire new skills. Games serve as a medium for guiding users in problem-solving and encouraging them to explore optimal solutions. Due to their unique presentation style, games not only convey

Moreover, board games provide students with opportunities to apply acquired concepts while promoting teamwork, curiosity, and analytical thinking. By integrating curriculum-aligned games, educators can create an engaging learning environment that fosters both enjoyment and academic achievement. Robson et al. (2016) note that gamification has evolved into a widely adopted interdisciplinary tool in education. With the rapid advancement of technology, students increasingly expect educators to incorporate digital tools and interactive approaches, such as gamification, into their learning experiences (Rondon et al., 2013).

STEM (Science, Technology, Engineering, and Mathematics) education plays a crucial role in secondary schools in Malaysia, as it equips students with essential skills to navigate the challenges and opportunities of the 21st century. Emphasizing STEM subjects at this educational level is critical in preparing a skilled workforce capable of contributing to technological advancements and economic development (Kazu & Yalcin, 2021). STEM education builds a strong foundation in critical thinking, problem-solving, and analytical skills, fostering innovation and adaptability. However, some students perceive STEM subjects as challenging, which can discourage them from pursuing STEM-related careers. Therefore, creating a supportive learning environment that nurtures resilience and a growth mindset is essential.

Recent research indicates that students who engage in gamified learning approaches achieve significantly higher academic performance than those who follow conventional learning methods (Smiderle et al., 2020). Therefore, the first step in implementing game-based learning is to design a game that aligns with the interests and needs of the target student population. This aspect is particularly relevant in exploring the potential of gamification as a strategy to enhance student engagement in STEM education at the secondary school level. Hence, this article aims to explore the concept of gamification in education, focusing on its role in improving student engagement and the importance of establishing a supportive learning environment, particularly in STEM subjects.

The Global Health Game (GKG)

The Global Kesihatan Game (GKG) represents an innovative response to a pressing issue in Malaysia: the declining interest in Science, Technology, Engineering, and Mathematics (STEM) education. Recent reports highlight that Malaysian students continue to show low enthusiasm and engagement in STEM fields, which poses a significant challenge to the country's vision to become a developed nation (Berita Harian, 2022). STEM education is crucial not only for individual career opportunities but also for fostering a knowledgeable and innovative workforce essential for national progress.

Globally, educational games have improved student engagement, fostered critical thinking, and promoted collaborative learning. Studies have shown that gamified learning environments can enhance problem-solving skills, creativity, and teamwork among students (Hamari et al., 2016). In Malaysia, however, traditional pedagogical methods in schools often fail to sustain student interest, particularly in science subjects (Ministry of Education Malaysia, 2021). This gap underscores the need for alternative approaches, such as gamification, to reignite students' passion for learning.

The GKG was developed as a tool to enhance health literacy while simultaneously addressing gaps in STEM education through a gamified learning platform. Designed to integrate core health and science topics, the game aims to make these subjects more approachable and engaging. It aligns with global trends in education that emphasize the importance of digital tools and interactive methods in creating effective learning environments. By combining educational content with interactive gameplay, the GKG offers a novel approach to delivering complex scientific concepts in an enjoyable format.

This study evaluates the usability of GKG to assess its suitability as a teaching aid in health and science education. Specifically, the study aims to increase student awareness of health and diseases through an engaging and scientific medium. Additionally, it seeks to enhance students' understanding of Science and Physical Education (PJK) subjects and to provide an alternative teaching aid for educational institutions in Malaysia. By addressing these objectives, the research hopes to contribute to the growing body of evidence supporting the use of serious games as valuable educational tools in both local and global contexts.

MATERIALS AND METHODS

This study employed a descriptive cross-sectional design to assess students' engagement and perceptions of gamification in teaching and learning. The research was conducted over two months, from September to October 2023, at a Malaysian secondary educational institution affiliated with a government university. A total of 42 students aged 13 to 16 years participated in the study.

Participants were selected using purposive sampling, as facilitators identified students who met the criteria for engagement in the gamified learning experience, including prior exposure to gamified learning methods, interest in interactive learning approaches, and active participation in classroom activities. This selection ensured a targeted group of students who had been exposed to gamification within their learning environment.

The gamified learning activity was conducted in groups of four, with each player taking turns according to predefined rules set by the facilitators. The gameplay was designed to foster collaboration, strategic decision-making, and active participation

among students. Upon completion of the game session, data collection was carried out using an online survey administered through Google Forms, which consisted of three sections. The first section, demographic information, collected details such as age and gender of the participants. The second section analyzed the physical characteristics of the GKG game across clarity, complexity, and design. Clarity assessed information accessibility, including language, text size, and instructions. Complexity evaluated the difficulty level, gameplay duration, waiting time, and player interaction, while design examined graphics, color schemes, and board size. This framework provided a structured assessment of usability and areas for improvement. The final section focused on the perceived impact on teaching and learning, assessing students' perceptions of gamification's influence on their learning experience, motivation, and academic performance. The survey was self-administered by students under the supervision of facilitators in a classroom setting and took approximately 10 to 15 minutes to complete.

RESULTS

Table 1 presents the demographic characteristics of the respondents in this study. The gender distribution shows that 11 respondents (26%) were male and 31 respondents (74%) were female. Regarding age distribution, the majority of participants were 13 years old (21 respondents, 50%), followed by 15-year-olds (16 respondents, 38%). A smaller proportion included 14-year-olds (3 respondents, 7%) and 12-year-olds (2 respondents, 5%).

Table 1 Demographic data

Demography	**Frequency**
Gender	
Male	11 (26%)
Female	31 (74%)
Age	
12 years	2 (5%)
13 years	21 (50%)
14 years	3 (7%)
15 years	16 (38%)

The analysis of the physical characteristics in second section of the GKG game categorizes its attributes into three key aspects such as clarity, complexity, and design. The design aspects of the GKG game received positive feedback from respondents. The graphics and illustrations were well-received, with over 70% of respondents expressing satisfaction, while the color selection was appreciated by 66.7% of participants. However, the board size was rated as neutral by 66.7%, indicating that it was perceived as neither too large nor too small. These findings suggest that while the game's visual appeal is strong, minor modifications to the board size could further enhance user experience.

The clarity aspects of the game were also well-received. 59.5% of respondents rated the clarity of information positively, while 45.2% found the language used to be highly understandable. However, the text size received mostly neutral ratings (76.2%), indicating that while it is generally acceptable, slight adjustments could enhance readability. Furthermore, the game instructions were perceived as moderately clear (38.1%), yet 23.8% of respondents found them too simple, highlighting the need for a better balance between clarity and complexity.

In terms of game complexity, the difficulty level was perceived as moderate by 42.9% of respondents, suggesting that it is accessible to a wide range of players. The duration of gameplay was also rated as moderate (45.2%), although 9.5% of respondents felt it was too long. The waiting time for turns was considered reasonable by 38.1% of respondents, yet 14.3% preferred shorter waiting periods. Notably, the level of interaction among players was highly rated, with 54.8% of respondents finding the game highly engaging, underscoring its effectiveness in fostering social interaction.

Table 2 Effectiveness of the GKG Game in Teaching and Learning

NO.	ITEMS	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
	The GKG game is highly engaging and interactive	0	0	7 (16.7%)	20 (47.6%	15 (35.7%)
	My knowledge of science, physical education, and health has improved after using GKG.	0	1 (2.4%)	5 (12.2%)	22 (53.7%)	13 (31.7%)
	GKG is suitable for revising science, physical education, and health subjects.	0	0	8 (19%)	16 (38.1%)	18 (42.9%)
	I have become more interested in gaining in-depth knowledge of science, physical education, and health after playing the GKG game.	0	0	14 (33.3%)	15 (35.7%)	13 (31%)
	The content of GKG covers the curriculum for science, physical education, and health.	0	1 (2.4%)	7 (16.7%)	19 (45.2%)	15 (35.7%)
	I am able to master both theoretical and practical knowledge of science, physical education, and health.	0	3 (7.1%)	15 (35.7%)	16 (38.1%)	8 (19%)
	The use of GKG in the teaching and learning process is an effective method to enhance knowledge of science, physical education, and health.	0	1 (2.4%)	9 (22%)	19 (46.3%)	12 (29.3%)
	I can learn while playing through the GKG game.	0	0	5 (12.2%)	14 (34.1%)	22 (53.7%)
	The GKG game makes the teaching and learning process more enjoyable.	0	0	5 (12.2%)	18 (43.9%)	18 (43.9%)

Table 2 presents the effectiveness of the GKG game in teaching and learning. The results indicate that the GKG game is engaging and interactive, with 83.3% of respondents agreeing. Most participants (85.4%) reported improved knowledge, and 81.8% found it suitable for revising science, physical education, and health subjects. While 66% expressed increased interest in deeper learning, some remained neutral. The game aligns with the curriculum (81%), though 42.9% were neutral or disagreed on mastering theoretical and practical knowledge. Additionally, 75.6% found GKG effective for teaching, and 87.8% agreed it enhances learning and enjoyment. Overall, GKG is an effective educational tool, though improvements could enhance deeper learning engagement.

2. DISCUSSION

The findings of this study provide strong evidence for the suitability of the Global Kesihatan Game (GKG) in enhancing student engagement and learning outcomes. Gamification has been widely recognized as a pedagogical strategy that improves motivation, engagement, and knowledge retention (Dichev & Dicheva, 2017). The results indicate that GKG successfully fosters interactive and engaging learning experiences, aligning with previous research on the benefits of incorporating game-based elements into traditional educational settings (Hamari et al., 2016).

Effectiveness of GKG in Teaching and Learning

The study demonstrates that GKG is an effective tool for learning, as most students found it engaging and interactive. Student engagement plays a crucial role in education, as actively involved learners exhibit higher motivation, retention, and cognitive development (Hamari et al., 2016). Moreover, improvements in student knowledge following game-based learning have been reported in various studies (Smiderle et al., 2020), further reinforcing the effectiveness of GKG as a supplementary educational resource. In line with previous studies, gamification is found to enhance subject mastery by making learning more enjoyable and interactive (Zaranis et al., 2013). A substantial number of respondents found GKG suitable for revising science, physical education, and health subjects, supporting its role as an alternative and engaging learning tool. However, some students remained neutral regarding their increased interest in gaining in-depth knowledge, suggesting that while GKG aids in knowledge acquisition, additional enhancements may be required to foster deeper conceptual understanding and independent learning.

Perceived Clarity and Usability

The clarity aspects of GKG were generally well-received, with students finding the information clear and the language used in the game understandable. Effective educational games require structured and accessible content that enhances comprehension without overwhelming learners (Robson et al., 2016). However, text size remains an area for improvement, as some students provided neutral ratings regarding readability. Previous research suggests that readability plays a crucial role in ensuring that educational materials are accessible to a diverse range of learners (Krause et al., 2015).Similarly, while game instructions were perceived as moderately clear, some students found them too simple, indicating a need for a more balanced instructional approach. Well-designed instructional elements in gamified learning environments enhance usability and improve student comprehension (Smiderle et al., 2020). To optimize GKG's instructional design, developers could consider integrating adaptive learning pathways that allow players to engage with customized instruction levels based on their proficiency (Backlund & Hendrix, 2013).

Complexity and Gameplay Experience

The difficulty level of the game was generally perceived as moderate, aligning with findings that well-balanced educational games enhance learning without overwhelming students (Knutas et al., 2014). Similarly, the duration of gameplay was considered reasonable, though a small proportion of students felt it was too long. Prior research indicates that game duration affects engagement, as extended playtime may reduce motivation, while overly short sessions may limit learning opportunities (Rondon et al., 2013). These findings imply that GKG offers an engaging learning experience, though minor refinements in game duration and difficulty adjustments could further optimize usability. Waiting times during gameplay were also found to be reasonable, yet some students preferred shorter turns, which is consistent with findings that long wait times in educational games can reduce engagement levels (Kazu & Yalcin, 2021). Notably, the level of interaction among players was highly rated, emphasizing GKG's effectiveness in fostering social interaction and collaborative learning. Prior research highlights that gamification promotes teamwork, communication, and problem-solving skills, making it an effective tool in interactive learning environments (Robson et al., 2016).

Implications for Educational Practice

The findings suggest that GKG effectively supports the teaching and learning process, as most students agreed that it enhances knowledge acquisition. This aligns with previous research showing that students benefit from game-based learning due to its interactive and immersive nature (Dichev & Dicheva, 2017). Additionally, the majority of respondents reported that they could learn while playing, reinforcing the educational value of gamification in STEM subjects. Furthermore, students reported that GKG makes the learning process more enjoyable, which is consistent with findings that gamified learning environments increase motivation and reduce learning anxiety (Krause et al., 2015). However, while GKG successfully enhances engagement and supports curriculum-based learning, some students remained neutral or disagreed on whether they had mastered both theoretical and practical knowledge. This suggests that while the game serves as an effective engagement tool, it should be complemented with structured debriefing sessions, reflective discussions, and problem-solving exercises to strengthen its educational impact (Smiderle et al., 2020).

3. CONCLUSION

Overall, the GKG game is an effective tool for promoting engagement, active learning, and knowledge acquisition in science, physical education, and health subjects. The findings highlight strong support for its usability, particularly in enhancing student motivation and making the learning experience more enjoyable. However, minor refinements in text readability, instructional depth, and gameplay mechanics could further optimize its impact. As gamification continues to evolve as a pedagogical strategy, GKG represents a valuable innovation in educational gaming, offering significant potential for enhancing learning experiences and fostering student interest in STEM-related subjects.

CONFLICT OF INTEREST

The authors declare that there is no conflict of interest regarding the publication of this article. The Global Kesihatan Game (GKG) was developed solely for educational purposes, and the authors do not have any financial or personal interests that could have influenced the outcomes of this study. No commercial or financial support was received from any organization that could be perceived to have influenced the content or conclusions of this research.

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