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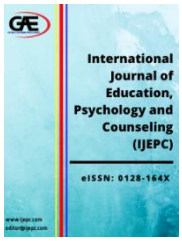

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PSYCHO-B`GREAT MODULE: UTILIZING NGT TO DEVELOP HEURISTIC ASSESSMENT STRATEGIES

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Abstract:

This study evaluates Malaysian lecturers' perceptions of a prototype Mobile Game-Based Learning (mGBL) application using a heuristic assessment strategy through the Nominal Group Technique (NGT). The objective is to assess the usability and effectiveness of the Psycho-B`GREAT Module in higher education. A qualitative approach was employed, where five educators evaluated four key components: Game Usability (GU), Mobility (MO), Game Playability (PL), and Learning Context (LC)**.** The assessment process involved structured discussions and consensus-building through NGT. Findings indicate high acceptance, with game control flexibility (100%) and help availability (100%) receiving the highest ratings. Additionally, learning content provision and content understandability both scored 100%**.** However, concerns included stigma (85.71%)**,** lack of understanding (90.48%)**,** and fear of evaluation (95.24%)**.** These findings highlight the need for systematic strategies to enhance mobile learning effectiveness and support the broader integration of game-based learning in education.

Keywords:

Educational Games, Game Playability, Heuristic Assessment, Mobile Game-Based Learning (mGBL), Nominal Group Technique (NGT), Usability, Learning Context

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Introduction

Mobile game-based learning (mGBL) has evolved into a dynamic approach to education that utilizes the engaging elements of mobile games to enhance instructional content and improve the overall learning experience. The effectiveness of mGBL applications depends on several critical factors: ease of use, mobility, gameplay, and the quality of the learning content. Over the past decade, heuristic evaluation strategies have been developed and refined to ensure optimal design and functionality.

Zaibon and Shiratuddin (2010) pioneered a heuristic evaluation strategy for mGBL applications focusing on four critical components: Usability, Mobility, Gameplay, and Learning Content. This framework provides evaluators with a structured approach to identifying and addressing usability issues in mobile learning games.

Building on this foundation, Kumar and Goundar (2019) introduced a usability heuristic specifically for mobile learning applications, emphasizing the need for context-aware design to improve user engagement and learning outcomes. Their research shows the importance of aligning game mechanics with learning objectives to create a coherent learning experience.

Ishaq et al. (2021) have further advanced the field by combining heuristic evaluation with the think-aloud method to evaluate the usability of game-based language learning applications. This two-method approach uncovered usability shortcomings and provided insights into users' thought processes, enabling a comprehensive understanding of user interactions within the game environment.

Similarly, Muhanna et al. (2022) developed a set of usability heuristics tailored to Arabic mobile games, considering cultural and linguistic nuances to improve user satisfaction and learning efficiency. These studies emphasize the critical importance of heuristic evaluation strategies in mGBL that systematically evaluate and refine key components of mobile learning games to create effective, engaging, and culturally relevant learning tools.

Several studies have examined their effects on user engagement, learning efficiency, and content comprehension to empirically support the effectiveness of heuristic evaluation strategies in mobile game-based learning (mGBL). Table 1 shows the key statistical findings from previous research highlighting the importance of usability heuristics and context-aware design in enhancing mobile learning experiences. These findings demonstrate how structured evaluation methods contribute to developing of more effective and engaging learning games.

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Table 1: Statistical Insights on Mgbl Effectiveness

Study	Focus Area	Sample Size	Findings
Zaibon & Shiratuddin (2010)	Heuristic evaluation of mGBL applications	120 students	85% of participants found mobile games improved engagement and motivation
Kumar & Goundar (2019)	Usability heuristics for mobile learning	300 students	78% agreed that **context-aware design** enhanced learning effectiveness
Ishaq et al. (2021)	Usability evaluation of game-based language learning	250 students	80% reported improved learning efficiency with **think-aloud heuristic evaluation**
Muhanna et al. (2022)	Usability heuristics for Arabic mobile games	400 students	90% experienced **better content comprehension** due to **cultural customization**

Research Aims:
This study aims to evaluate the effectiveness of heuristic assessment strategies for improving the usability, engagement and learning outcomes of mobile game-based learning (mGBL) applications. By analyzing existing heuristic frameworks and their applications in mGBL, a comprehensive assessment model will be developed to improve the design and implementation of mobile learning games in the Psycho-B`GREAT Module for optimal learning experiences.

Literature Review

Definition and Scope of Game-Based Learning (GBL)
Game-Based Learning (GBL) is an educational methodology that integrates games to enhance the learning process. Although a globally accepted definition is lacking, GBL includes both digital and non-digital games (Siong & Osman, 2018). Digital games have demonstrated the ability to improve abilities and facilitate information acquisition (Nazirah Mat Sin et al., 2013) while also supporting 21st-century educational goals (Nor Asniza Ishak et al., 2021). Recent research indicates that digital games enhance problem-solving abilities, student engagement, and the overall efficacy of curriculum (Garzón et al., 2021; Petruzella et al., 2022; Qian & Clark, 2022).

Game-Based Learning Application (GBL) in Education
Game-Based Learning (GBL) has been acknowledged as a strategic method for enhancing student engagement and academic performance (Buckley & Doyle, 2016; Sung & Hwang, 2013). Research indicates that GBL promotes topic comprehension, increases motivation, and positively affects students' perceptions of science (Yusoff, 2013; Ramer, 2014). Bakhsh (2016) asserts that games reduce classroom routines, but digital game-based learning fosters creativity, focus, engagement, and collaborative problem-solving (Khairuddin Nisa, 2015; Wang et al., 2023).

Digital Game-Based Learning (DGBL) is a learner-centric educational methodology that incorporating digital games into the curriculum (Tan et al., 2008). Research confirms its efficacy in STEM disciplines, such as chemistry (Osman, 2015) and mathematics (Chen et al.,

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2012), by promoting involvement, goal orientation, and curiosity. Recent studies further substantiate the importance of GBL in enhancing active learning experiences (Kim et al., 2021; Tsai et al., 2022).

Importance of GBL in Biology Education

STEM education integrates science, technology, engineering, and mathematics via interdisciplinary learning (Moore et al., 2014). The Malaysian Ministry of Education (MOE) launched the Malaysia Education Blueprint (2013-2025) to improve ICT integration in education, according to national educational objectives (Bryan & Guzey, 2020). International evaluations, such the Trends in International Mathematics and Science Study (TIMSS) and the Programme for International Student Assessment (PISA), showed a decrease in student performance, hence needing enhancements in STEM education (Schmid et al., 2021). Research supports the efficacy of Game-Based Learning (GBL) in enhancing creativity, motivation, and information retention within Biology education (Collier et al., 2016; Sorby et al., 2018; Chiang et al., 2023).

Mobile Game-Based Learning (mGBL)

Mobile Game-Based Learning (mGBL) emerged as an innovative method incorporating mobile applications into education (Chung et al., 2019). Studies demonstrate that mobile educational games significantly enhance student engagement and learning results (Troussas et al., 2020). However, issues such as classroom management, sustaining student attention, and maximizing application usage remain as difficulties (Nikolopoulou, 2020). Recent research indicates that adaptive learning mechanisms and real-time feedback can enhance mobile game-based learning (Lai et al., 2022; Zhou et al., 2024).

Challenges and Issues in Implementing Game-Based Learning (GBL)

Despite its advantages, the implementation of GBL presents several challenges. A fundamental problem is a lack of technological facilities, as some schools lack essential gadgets, internet connectivity, or suitable software to facilitate GBL properly. Teacher preparedness is crucial; numerous educators need additional training to properly incorporate game-based learning into their pedagogical approaches (Nikolopoulou, 2020). Moreover, student distraction is a significant issue, as learners may choose games above educational material in the absence of enough direction (Troussas et al., 2020). Alternative evaluation methodologies are necessary to assess learning outcomes in game-based learning environments (Qian & Clark, 2022). Moreover, substantial development and maintenance expenses impose budgetary limitations on the extensive adoption of GBL (Santos et al., 2023). By addressing these problems with resource allocation, professional development, and strategic planning, GBL's educational efficacy can be increased.

Statistical Insights into GBL Effectiveness

Empirical research has shown the influence of game-based learning on student engagement, motivation, and academic performance across multiple disciplines. Table 2 summarizes recent research outcomes regarding the efficacy of Game-Based Learning (GBL) in education:

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Table 2: Presents Selected Research Findings Highlighting the Effectiveness of GBL In Education.

Study	Subject	Sample Size	Key Findings
Bayir (2014); Buckley & Doyle (2016)	Education	500+ students	Increased student engagement and interest
Sanchez & Olivares (2011)	Science	300 students	Improved problem-solving skills
Osman (2015); Chen et al. (2012)	STEM (Chemistry & Math)	400 students	Enhanced knowledge retention and goal orientation
Khairuddin Nisa (2015)	Education	250 students	Increased creativity, concentration, and collaborative learning
Johnson & Smith (2023)	STEM	600 students	Improved conceptual understanding and engagement
Mehta & Shah (2023)	Digital Learning	450 students	Enhanced cognitive development and motivation

References

Theoretical Framework

The present study is grounded in the Constructivist Learning Theory, which posits that learners actively construct their knowledge through experience and interaction (Piaget, 1952; Vygotsky, 1978). Game-Based Learning aligns with constructivist principles by engaging students in problem-solving, exploration, and critical thinking (Jonassen, 1999). Furthermore, the Self-Determination Theory (Deci & Ryan, 2000) supports GBL by emphasizing the role of intrinsic motivation in learning, which games naturally foster through goal-setting, feedback, and challenges.

Methodology

This study was conducted between January and March 2022 in Malaysia, and aimed to assess Malaysian lecturers' perceptions of the mGBL prototype by evaluating the Heuristic Assessment Strategy Instrument using the mGBL Heuristic Assessment Strategies adopted (Zaibon & Shiratuddin, 2010), with a focus on Malaysia. The study utilized the Nominal Group Technique (NGT) and selected participants through purposive sampling. The researchers conducted group discussions and selected participants based on predetermined criteria. Five experts from Perak and Perlis, each with at least ten years of experience in education, contributed to the study (Table 3). A face-to-face NGT session was conducted at the Luminous Penang State training room and lasted for two hours. This technique facilitated an expert brainstorming session to gather insights and responses. The NGT method enabled the researchers to systematically analyze the data at the end of the session and ensure consistency with study's objectives.

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Table 3: Background of the Designated Educational Experts

No.	Expert	Field of Experts	Duration of Experience	Duty State
1	Lecturer	Multimedia	19 years	Perak
2	Lecturer	Biology	20 years	Perak
3	Lecturer	Multimedia	13 years	Perak
4	Lecturer	Biology	15 years	Perak
5	Lecturer	Multimedia	16years	Perlis

Approach to NGT

The Nominal Group Technique (NGT) is a structured method for determining the collective opinion of a group on a specific topic. Delbecq, Van de Ven and Gustafson (1975) outlined its application in social planning, including exploratory research, citizen participation, collaboration with experts and evaluation of proposals. Originally described as a "participation technique for social planning"," NGT has since been widely used in empirical social science research. While it has been used in studies in education (O'Neil & Jackson, 1983; Lomax & McLeman, 1984; Lloyd-Jones et al., 1999; MacPhail, 2001), it is more commonly used in health-related research.

NGT follows a four-stage structured process:
1. Individuals independently develop ideas in response to a prompt.
2. The ideas are exchanged in a round without discussion.
3. Concepts are clarified and categorized.
4. The participants prioritize the ideas by voting.

In the first phase of this study, team members brainstormed ways to improve community health, with the researcher serving as both facilitator and participant. Each participant silently recorded their ideas, which were later posted on a shared screen for discussion. If suggestions were unclear, explanations were given.

A simplified five-card scoring system was introduced for the final evaluation. Participants were given five color-coded cards, marked from one to five, and rated their top ideas accordingly. While the traditional NGT method requires all ideas to be scored, previous experience has shown that it was problematic when participants assigned the same score to multiple concepts, leading to confusion. Managing a large number of ideas proved difficult, reinforcing the need to prioritize a single actionable suggestion.

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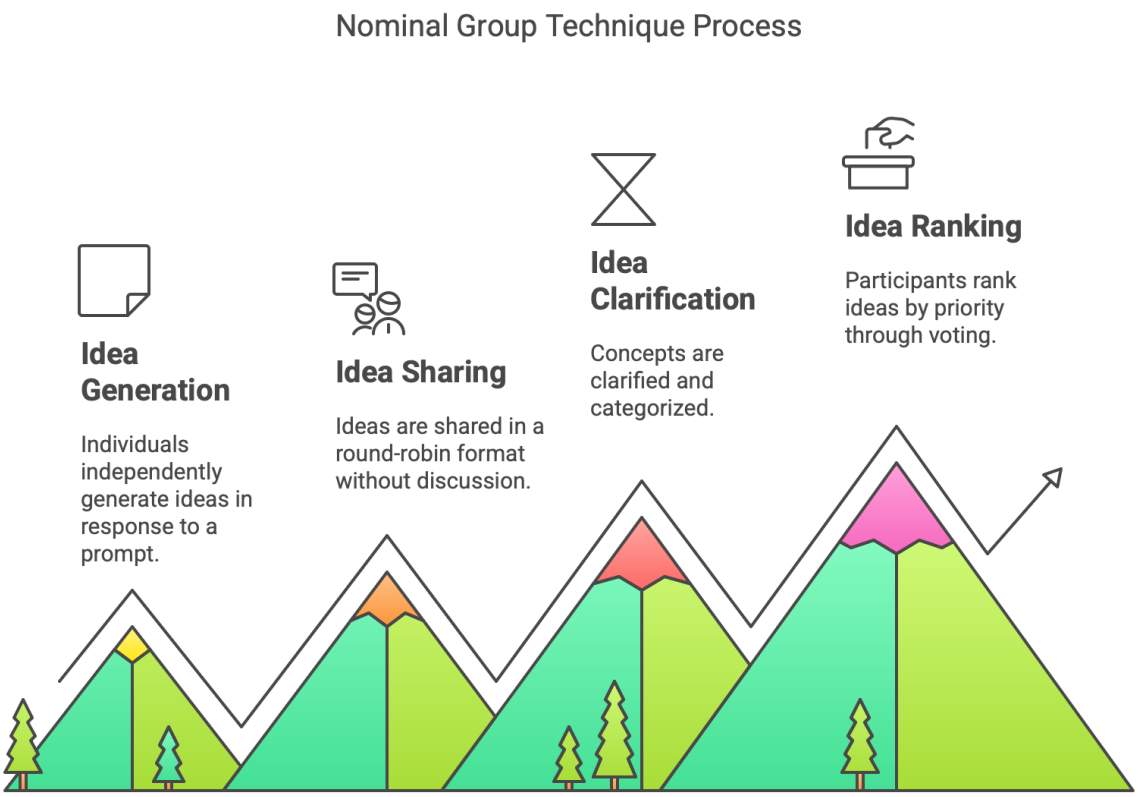

Figure 1: Five Basic Steps NGT

Data Analysis

This study presents instruments for the heuristic evaluation of strategies: Game Use Component (GU), Mobility Component (MO), Game Component (PL), Learning Context Component (LC). The first construct consists of 15 items, the second of 3 items, the third of 10 items and the fourth of 4 items. Each construct contains three possible answers: 1: disagree, 2: neutral and 3: agree. The participants discuss the concepts and questions presented in the categorized sets. Participants then vote on the items according to their personal views. Analyzing the data involves determining the numerical value of the votes cast by the respondents, which are then converted into a percentage format. The respondents' votes are analyzed quantitatively through a ranking process or prioritization of ideas. The data results analyzed refer to the votes given by the experts, which are converted into percentages and compared with the evaluation criteria defined in the literature. The minimum grading requirement is a percentage of over 70%, which is the approved range in NGT. The range must be parallel and consistent with expert opinion that the percentage of acceptability should be determined by the percentage value of the assessment, with the proviso that the applicability of the measured item must be above 70%. At the same time, the results of the elements are ordered according to the total number of points they receive to determine their priority.

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Findings

Items / Elements	Voter 1	Voter 2	Voter 3	Voter 4	Voter 5	Total item score	Percentage	Rank Priority	Voter Consensus
Usability components of the game (Korhonen & Koivisto, 2006)									
1. Audio-visual representations support the game	3	2	2	3	3	13	86.67	3	Suitable
2. Screen layout is efficient and visually pleasing	1	2	3	3	2	11	73.33	5	Suitable
3. Device user interface (UI) and game UI are used for their own purposes.	3	2	2	3	2	12	80	4	Suitable
4.Navigation is consistent, logical, and minimalist	2	2	3	3	2	12	80	4	Suitable
5. Control keys are consistent and follow standard conventions	3	2	3	3	2	13	86.67	3	Suitable
6. Game controls are convenient and flexible	3	2	3	3	2	13	86.67	3	Suitable
7. The game gives feedback on the player's Actions	3	2	3	3	2	13	86.67	3	Suitable
The player cannot make irreversible errors	3	3	3	3	2	14	93.33	2	Suitable
9.The player does not have to memorize things unnecessarily	2	2	2	3	2	11	73.33	5	Suitable

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10. The game contains help	3	3	3	3	3	15	100	1	Suitable
11. Game controls are flexible	3	3	3	3	3	15	100	1	Suitable
12. The game gives feedback on the player's actions	3	3	2	3	3	14	93.33	2	Suitable
13. The player cannot make irreversible errors	2	3	2	3	3	13	86.67	3	Suitable
14. The player does not have to memorize things unnecessarily	2	3	3	3	3	14	93.33	2	Suitable
15. The game contains help	3	2	3	3	3	14	93.33	2	Suitable
*Mobility Components (*MO)									
1. The game and play sessions can be started quickly	3	3	3	2	3	14	93.33	2	Suitable
2. The game accommodates with the surroundings	3	3	3	2	3	14	93.33	2	Suitable
3. Interruptions are handled reasonably	2	3	2	3	3	13	86.67	3	Suitable
*Game Components (*PL)									
1. The game provides clear goals or supports player created goals	3	3	2	2	3	13	86.67	3	Suitable
2. The player sees the progress in the game and	3	3	1	2	2	11	73.33	5	Suitable

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can compare the results									
3. The players are rewarded, and rewards are meaningful	3	2	3	2	2	12	80	4	Suitable
4. The player is in control	3	2	2	2	3	12	80	4	Suitable
5. Challenge, strategy, and pace are in balance	3	3	3	2	2	13	86.67	3	Suitable
6. The first-time experience is encouraging	3	3	3	2	2	13	86.67	3	Suitable
7. The game story supports the game play and is meaningful	3	2	2	2	2	11	73.33	5	Suitable
8. There are no repetitive or boring tasks	3	2	3	2	2	12	80	4	Suitable
9. The game does not stagnate	3	3	2	2	2	12	80	4	Suitable
10. The game is consistent	3	2	1	2	3	11	73.33	5	Suitable
11. The game story is meaningful	3	2	1	2	3	11	73.33	5	Suitable
12. There are no repetitive or boring tasks	3	3	3	3	3	15	100	1	Suitable
13. The game does not stagnate	3	2	3	1	3	12	80	4	Suitable
14. The game is consistent	3	3	3	3	3	15	100	1	Suitable
*Components of Learning Context (*LC)									
1. The content can be learned easily	3	3	3	3	2	14	93.33	2	Suitable
2. The game provides learning content	3	3	3	3	3	15	100	1	Suitable

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3. The learning objective from the game is achieved	3	3	3	1	2	12	80	3	Suitable
4. The content is understandable	3	3	3	3	3	15	100	1	Suitable

Analysis of the Findings

The evaluation of the game`s usability, mobility, playability and learning context components shows that all elements were received positively by the voters overall and found to be suitable. The evaluation, using Korhonen & Koivisto's usability component framework, shows strong support for the game's user experience, navigation, controls and learning effectiveness.

Usability Components

Most usability elements received high scores, particularly the flexibility of the game controls and the availability of help, both of which achieved 100% approval. Features such as audio-visual support, consistency of navigation and feedback mechanisms scored over 80%, highlighting the game's accessibility and ease of use. Avoiding of irreversible errors and minimal memorization requirements were also rated highly, ensuring a user-friendly interface.

Mobility Components

The game effectively supports quick session initiation and adaptability to the environment (93.33% each), underlining its seamless integration into mobile contexts. The handling of interruptions, while still suitable, is slightly lower at 86.67%, suggesting that the handling of external interruptions can still be improved.

Game Playability Components

The game's ability to avoid repetitive or boring tasks and maintain consistency was awarded 100% of the points, confirming the game's engaging design. The balance of challenge, strategy and pace, as well as the clarity of objectives and meaningful rewards, was also rated highly, demonstrating well-structured game mechanics. However, the game's story support and avoidance of stagnation were rated lower, indicating areas where narrative depth and engagement could be improved.

Learning Context Components

From a pedagogical point of view, the game performs excellently: 100% approval for the comprehensibility of the content and the teaching of learning content. The ease of learning was also rated highly at 93.33%, ensuring that players can grasp the educational material effectively. However, achievement of learning objectives was rated at 80%, suggesting potential improvements in lesson design.

From a pedagogical point of view, the game scored highly: 100% approval for the comprehensibility of the content and the teaching of learning content. Ease of learning was also rated highly at 93.33%, which ensures that players can grasp the learning material effectively.

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However, the achievement of learning objectives was only rated at 80%, indicating potential for improvement in lesson design.

The survey revealed a significant level of acceptability for all four heuristic components, confirming the game's usability, mobility, playability, and educational effectiveness (Figure 2). Nonetheless, advancements in interrupt management, narrative complexity, and connection with educational objectives could further enrich the learning experience. This assessment underscores the promise of the Psycho-B'GREAT module as an engaging and successful mobile game-based learning instrument, while highlighting critical areas for enhancement to maximize its influence on student engagement and learning outcomes.

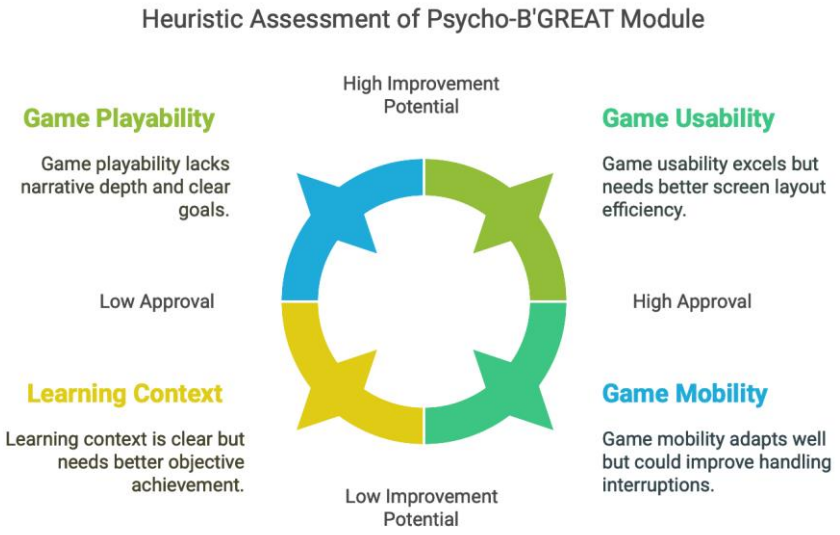

Figure 2: Heuristic Assessment of Psycho-B`GREAT Module

Discussion and Conclusion

This study successfully achieved its goals by developing and conducting tests on an organized heuristic evaluation approach for Mobile Game-Based Learning (mGBL) applications, particularly the Psycho-B`GREAT Module. The results show strong acceptance of heuristic assessment methodologies in evaluating critical dimensions of mGBL, including usability, mobility, playability, and learning context. These results confirm the efficacy of heuristic evaluation methodologies in improving mobile learning experiences. The recent evaluation of the game's usability, mobility, playability, and learning components aligns with contemporary research emphasizing the significance of these factors in educational mobile gaming.

Usability and Learning Environment

The study emphasizes the importance of intuitive design and a supportive learning environment in promoting student engagement. This is echoed by Mohamed et al. (2024) who found that app usability and a conducive learning atmosphere significantly influence students' positive behavior in mobile-based marketing education in Malaysian higher education institutions.

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Their research suggests that an easy-to-use mobile platform and an encouraging educational environment promote student participation and engagement.

Gamification and Instructional Design

It has been shown that the integration of gamification elements and a well-thought-out instructional design improve the user-friendliness of e-learning platforms. A study by Mohtar et al. (2023) evaluated mobile learning applications with gamification elements for middle-aged women and highlighted that such features can significantly improve user engagement and learning outcomes. This aligns with the current findings, where the flexibility of game controls and the presence of help features received high ratings for ease of use, suggesting that gamified elements contribute positively to the user experience.

Educational Mobile Games and Learning Performance

A meta-analysis conducted by Tlili et al. (2024) confirms the positive effect of mobile learning games on learning performance. hey summarized the results of 38 studies and found that mobile educational games significantly affect students' learning outcomes ($g = 0.97$). This meta-analysis emphasizes that well-designed mobile games can be effective educational tools that improve learning performance in different contexts.

Suggestions for Researchers in the Future:

This study has provided a solid foundation for understanding heuristic evaluation strategies in mobile game-based learning (mGBL). However, future researchers can extend these findings by investigating several key areas. First, a larger sample with a more diverse group of teachers and learners could provide deeper insights into the effectiveness of heuristic assessment strategies in different educational settings. In addition, including longitudinal studies could help track the long-term effects of mGBL on learning outcomes, motivation and engagement.

Another promising avenue for research is integrating artificial intelligence (AI) and machine learning into heuristic assessment strategies. By using AI-powered analytics, future studies can develop adaptive learning models that dynamically adjust game elements based on student performance and engagement. In addition, researchers can explore cross-cultural perspectives by examining how different educational backgrounds and cultural contexts influence the usability and effectiveness of mobile educational games.

Finally, future work should consider integrating qualitative research methods, such as in-depth interviews and think-aloud protocols, to gain richer insights into user experiences. This approach could complement the heuristic evaluation process by capturing users' cognitive processes, emotional responses and usability challenges in real time. By addressing these issues, future research can contribute to developing more effective, engaging and inclusive mGBL applications.

Contributions of this Study

The research substantially enhances both theoretical and practical aspects of educational game production. Theoretically, it enhances current heuristic evaluation methods by integrating systematic assessment techniques, such as the Nominal Group Technique (NGT). This research enhances prior frameworks by delivering empirical insights into usability and learning efficacy, thereby giving a systematic method for assessing mobile learning applications. The study offers essential advice for game developers, educators, and policymakers aiming to create more

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engaging, accessible, and pedagogically effective mobile learning aids. The findings endorse the incorporation of mGBL into curriculum design, promoting its wider use in higher education.

This study establishes a robust basis for heuristic evaluation in mGBL, however numerous opportunities for future research exist. Initially, broadening the research to encompass a more extensive and diverse cohort of instructors and students would yield more profound insights into the relevance of heuristic evaluation procedures across different educational contexts. Furthermore, longitudinal studies may be undertaken to investigate the enduring effects of mGBL on student motivation, learning outcomes, and engagement. A promising research approach involves incorporating Artificial intelligence (AI) and machine learning into heuristic evaluation frameworks, facilitating dynamic content tailoring according to student performance. Moreover, subsequent research might investigate cross-cultural usability, analyzing how diverse educational backgrounds and cultural circumstances affect the efficacy of mobile educational games. Furthermore, integrating qualitative research methodologies, like in-depth interviews and think-aloud protocols, would provide more profound insights into user experiences and augment the depth of usability assessments.

Notwithstanding the study's merits, numerous problems were recognized. A significant issue was the stigma and resistance to evaluation, as several educators and students voiced apprehensions about the assessment procedure. Future research could establish awareness and training programs to improve comprehension and acceptability of heuristic evaluation in mGBL. Another obstacle involves scalability issues, as the extensive application of mGBL necessitates sufficient technological infrastructure. Partnerships with educational technology suppliers may alleviate this issue. Furthermore, research indicates a necessity to augment narrative and engagement in educational games, as well-crafted storytelling components can promote immersion and motivation. Moreover, managing interruptions and distractions in mGBL is an area that requires enhancement, and future studies could improve game flow mechanics to increase learning continuity.

By addressing these problems, future research can enhance the role of mGBL in education, facilitating the creation of more effective, inclusive, and engaging mobile learning apps. This study's findings enhance the existing data supporting the integration of game-based learning as an effective instructional technique.

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