Journal of Advanced Sciences and Mathematics Education
Volume 4, Issue 2, 139 - 152.
e_ISSN: 2798-2351
DOI: 10.58524/jasme.v4i2.455

MathQuest: A powerpoint-based problem-based learning game for mathematical problem-solving

Reny Supartini
Universitas Pasundan
INDONESIA

Nenden Mutiara Sari
Universitas Pasundan
INDONESIA

In In Supianti
Universitas Pasundan
INDONESIA

Gina Dwi Septian
SMKN 2 Cimahi
INDONESIA

Article Info

Article history:

Received: Sept 25, 2024
Accepted: Dec 11, 2024
Published: Dec 25, 2024

Keywords:

Game-Based Learning;
Instructional Design;
Interactive Learning;
PowerPoint Games;
Problem Based Learning (PBL).

Abstract

Background: Mathematical problem-solving skills are crucial for academic success and everyday decision-making. However, many students struggle to develop these skills due to the lack of engaging and effective instructional tools. Traditional teaching methods often fall short in addressing these challenges, underscoring the need for innovative approaches that incorporate interactive and motivating elements into the learning process.
Aims: This study seeks to develop and validate a PowerPoint-based Problem-Based Learning (PBL) game, assess its practicality in classroom settings, and evaluate its effectiveness in enhancing students' mathematical problem-solving skills and motivation.
Methods: Following the ADDIE model, the study involved 33 tenth-grade students selected through purposive sampling. The game was rigorously validated by a team of six experts, including two media experts, two content experts, and two language experts, ensuring a high-quality design.
Results: Expert validation yielded high scores for content quality (91%), media design (89%), and language clarity (92%), indicating strong validity. The game achieved an 85% practicality score based on student feedback on usability. Its effectiveness was evident in a significant improvement in students' mathematical problem-solving skills, with average test scores rising from 65 to 85 after using the game. Furthermore, 70% of students reported increased motivation and engagement in learning mathematics.
Conclusion: The PowerPoint-based PBL game demonstrated strong validity, practicality, and effectiveness in meeting students' needs and improving their mathematical skills. Key features contributing to its success included immediate feedback, diverse question formats, and opportunities for group play, making it a promising tool for classroom application.

To cite this article: Supartini, R., Sari, R. M., Supianti, I. I. & Septian, G. D. (2024). MathQuest: A powerpoint-based problem-based learning game for mathematical problem-solving. *Journal of Advanced Sciences and Mathematics Education, 4*(2), 139 - 152.

INTRODUCTION

Mathematical problem-solving skills are essential competencies for students to navigate academic challenges and everyday life effectively (Burke & Stewart, 2024). However, many students continue to struggle in developing these skills. Studies highlight that a significant number of students face difficulties in solving mathematical problems (Nicolay et al., 2021), particularly in algebra, which is widely regarded as one of the most challenging topics (Anugerah et al., 2024; Asri et al., 2024; Widyatma & Ramadhani, 2024; Firda & Juandi, 2023). These difficulties not only impede students' conceptual understanding but also adversely affect their learning outcomes, critical thinking, and creativity (Sinaga et al., 2023; Subawo, 2022). Consequently, students with weak problem-solving skills often struggle to achieve optimal academic performance and to apply mathematical concepts in real-world contexts (Tan et al., 2023). This underscores the urgent need for innovative strategies

* **Corresponding author:**
Nenden Mutiara Sari, Universitas Pasundan, INDONESIA
nenden.mutiara@unpas.ac.id

to enhance students' mathematical problem-solving abilities and bridge the gap between conceptual knowledge and practical application.

Traditional teaching methods, such as lectures, often fail to foster critical thinking or actively engage students in the learning process. Teachers frequently encounter difficulties in explaining complex mathematical concepts and maintaining student motivation (Ahmed & Mikail, 2022). These limitations emphasize the need for teaching approaches that are both innovative and contextually relevant. One promising approach is Problem-Based Learning (PBL), which has been widely recognized for its ability to improve critical thinking and problem-solving skills among students (Erdem, 2022; Shongwe, 2024; Anggraeni et al., 2023; Wei et al., 2023). By focusing on real-world problems, PBL encourages students to construct their understanding and apply knowledge effectively (Marcinauskas et al., 2024; Serin, 2023). Additionally, the integration of technology into PBL, particularly through educational games, has been shown to significantly enhance student motivation, engagement, and learning outcomes (Hwang et al., 2019; Mao et al., 2021). However, while the use of advanced technologies in PBL is extensively studied, there remains limited exploration of simple, accessible tools such as PowerPoint to support PBL in mathematics education.

While much research on the integration of technology in PBL has concentrated on complex software or online platforms (Anggraeni et al., 2023; Hendarwati et al., 2021; Amin et al., 2021), limited attention has been given to the potential of PowerPoint as a straightforward yet impactful tool for facilitating PBL in mathematics education (Moradi & Noor, 2022; Rahman et al., 2020; Chang et al., 2020). This underexplored area presents an opportunity to investigate how PowerPoint-based PBL game designs can effectively enhance students' mathematical problem-solving skills (Anggraeni et al., 2023). Addressing this gap, the present study seeks to develop and evaluate a PowerPoint-based PBL game. By incorporating PBL principles, instructional design theories, and gamification elements, the game aims to provide an engaging, effective, and accessible learning experience adaptable to diverse educational settings.

METHOD

Research Design

This study employed a Research and Development (R&D) methodology using the ADDIE model, which consists of five systematic phases: Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model was selected for its structured and iterative nature, making it particularly suitable for the development of technology-based learning media. The focus of the research was to create and validate a PowerPoint-based Problem-Based Learning (PBL) game called "MathQuest," designed to enhance students' mathematical problem-solving skills. The stages of the research process are illustrated in Figure 1 below:

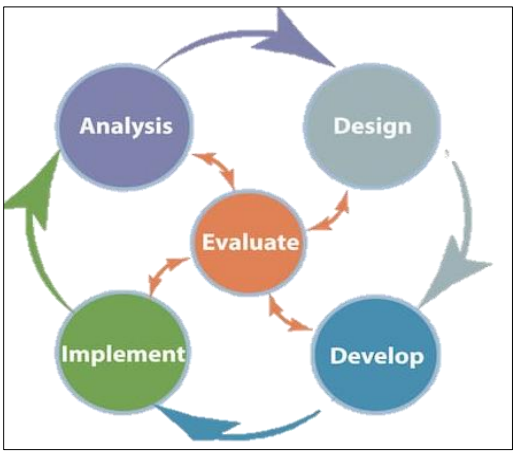

Figure 1. Research Methodology Flowchart

The flowchart provides a clear visualization of the research stages, ensuring coherence and systematic development throughout the study.

Participant

Participants in this study comprised two distinct groups. The first group consisted of six experts who were involved in the validation process. These experts included two content experts who assessed the accuracy and relevance of the mathematical content, two language experts who evaluated the clarity and appropriateness of the language used, and two media experts who analyzed the design and functionality of the game. The second group involved 33 tenth-grade students from a high school, selected through purposive sampling. These students participated in the evaluation stage, providing valuable feedback on the practicality and effectiveness of the game.

Instrument

Two main instruments were utilized in this study. The first instrument was an expert validation checklist, used to evaluate three key aspects of the game: content, language, and media. The content evaluation focused on the relevance and accuracy of the material in meeting educational objectives, the language evaluation assessed clarity and suitability for the target audience, and the media evaluation examined the design, interactivity, and functionality of the game. Results from the validation process were interpreted using a predefined validity category table, which categorized scores ranging from "Not Valid" to "Very Valid."

The second instrument was a student response questionnaire designed to collect feedback on the game's engagement, ease of use, and effectiveness. This instrument allowed students to rate their experiences quantitatively and provide qualitative feedback, offering a comprehensive perspective on the game's utility in a classroom setting.

Procedure

The research process followed the five phases of the ADDIE model. The initial phase, analysis, involved surveys to identify challenges and expectations in mathematics education. These insights provided a solid foundation for designing a learning tool tailored to students' and teachers' needs. In the design and development phase, the prototype of the "MathQuest" game was created by integrating Problem-Based Learning (PBL) principles, instructional design theories, and gamification elements. Key features, such as case-based challenges, interactive feedback mechanisms, and engaging visuals, were included to enhance students' engagement and understanding.

Validation of the prototype involved six experts who evaluated its content, language, and media design. Content experts focused on mathematical accuracy and relevance, language experts ensured clarity and appropriateness, and media experts assessed functionality and interactivity. Validation results were interpreted using predefined criteria to determine the game's quality. The interpretation of validation results is outlined in Table 1 below:

Table 1. Validity Category Interpretation

Score Range	Validity Category	Interpretation
85% – 100%	Very Valid	Can be used without revision
70% – 84%	Valid	Can be used with minor revisions
50% – 69%	Less Valid	Requires major revisions
0% – 49%	Not Valid	Not suitable for use

In the implementation and evaluation phase, the game was tested with 33 tenth-grade students. A structured questionnaire was used to gather their feedback on engagement, ease of use,

and the game's impact on their understanding of mathematical concepts. Quantitative data from this evaluation, along with qualitative feedback, provided insights into the game's practicality and effectiveness, guiding further refinements. This structured approach ensured the systematic development of "MathQuest," resulting in a high-quality educational tool that addresses students' needs effectively.

Data Analysis

Data analysis combined quantitative and qualitative techniques:

1. Expert Validation: Average scores for content, language, and media were calculated and interpreted using the validity categories in Table 1. Qualitative feedback from experts was analyzed to identify and address weaknesses.
2. Student Response Evaluation: Quantitative data from questionnaires were used to evaluate the game's practicality and effectiveness. Qualitative comments from students provided additional insights into their experiences and suggestions for improvement.

This dual approach ensured a comprehensive evaluation, enhancing the validity, practicality, and effectiveness of "MathQuest" as a teaching and learning tool.

RESULTS AND DISCUSSION

The survey conducted with 33 students provided valuable insights into their needs and expectations in mathematics learning. The findings highlighted specific challenges faced by students, including areas where they struggle and features they desire in a learning tool to enhance their engagement and understanding. These results serve as a foundation for designing a more targeted and effective educational intervention. A detailed summary of the key findings is presented in the following table:

Table 2. Results of student needs analysis for PBL-based Powerpoint Games

Aspect	Percentage	Analysis results
Difficulty in understanding mathematical material	75,8%	Most students had difficulty, indicating a need for more understandable and interactive materials.
The most difficult topic to understand is algebra	57%	Algebra is the most difficult topic for students to understand, making it a priority for educational game development. Therefore, arithmetic sequences and series were chosen as a form of algebra application.
Interest in the use of games in learning	87,9%	The majority of students are very interested in using games as a learning tool.
Desired features in the game:		
A variety of questions to choose from	36,4%	Students want a variety of questions to broaden and deepen their understanding of the material.
Attractive graphics and visuals	45,5%	Attractive graphics and visuals are important elements in creating an interesting learning experience.
Immediate feedback after each answer	39,4%	Immediate feedback helps students correct mistakes and learn effectively.
Ability to play in groups	51,5%	Group play features are a priority, demonstrating students' desire to learn collaboratively.
Satisfaction with current learning methods	2,73	Student satisfaction with current learning methods is low, indicating a need for improvement, especially in terms of interactivity.

In addition, the survey conducted with six mathematics teachers provided insights into the challenges and needs in mathematics teaching. A summary of the survey results can be seen in Table 3.

Table 3. Results of Teacher Needs Analysis for PBL-Based PowerPoint Games

Aspect	Percentage	Analysis Results
Challenges in teaching mathematics	83,4%	Most teachers face challenges, especially in explaining complex mathematical concepts and motivating students.
Belief in the use of educational games	100%	All teachers agree that educational games can be a useful tool in teaching mathematics.
Important features in educational games		
Ability to adjust difficulty level	100%	Teachers want games that can adjust the difficulty level to suit students' needs.
Integration with curriculum	100%	Integration with existing curriculum is essential to ensure game material is relevant to the lesson.
Features to monitor student progress	100%	The reporting and monitoring features of student progress are considered very important by teachers.
Ability to provide feedback	100%	Immediate feedback is considered a very important feature for student evaluation.
Perceptions of the effectiveness of current teaching methods	50%	The scores indicate that although current teaching methods are considered quite effective, there is room for improvement, especially with the use of educational technology.

The needs analysis of students and teachers indicates a significant demand for PBL-based PowerPoint games in mathematics education. Students expressed a desire for games that offer a variety of problems, interactive explanations, and immediate feedback to support their understanding. Recent studies by Sung et al. (2016) and Yu et al. (2022) emphasize the importance of integrating interactive elements and immediate feedback in educational games to enhance student engagement and comprehension. Meanwhile, teachers require games that can be aligned with the curriculum, provide student progress reports, and simplify the teaching of complex material. According to research by de-Marcos et al. (2014) and Bang et al. (2023), the use of game technology in education allows teachers to monitor student progress in real-time and tailor instructional materials to individual needs. Developing games that meet these needs has the potential to improve students' problem-solving skills, increase student engagement, and enhance the overall effectiveness of mathematics instruction (Nadeem et al., 2023). Research by Hwang et al. (2019) also demonstrates that well-designed educational games, particularly those using a PBL approach, can significantly enhance students' problem-solving abilities.

After the needs analysis phase, the design and development of the PBL-based PowerPoint game prototype commenced. This prototype was designed to integrate the principles of Problem-Based Learning (PBL) and instructional design theory to create an engaging and effective learning tool. The game prototype features an attractive interface design, as shown in Figure 2, which displays the main screen of the game.

Figure 2. Main view of powerpoint game

The main screen includes navigation buttons for selecting content. This design follows Sweller's Cognitive Load Theory (2024), which emphasizes the importance of reducing cognitive

load through a simple and clear interface. The design concept also aligns with the principles of Universal Design for Learning (Roski et al., 2024), focusing on accessibility and inclusion in learning.

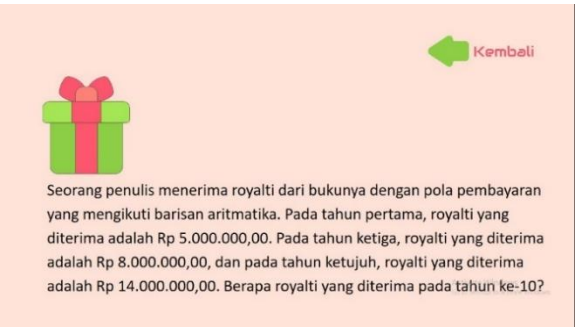

Figure 3. Example of a math challenge

Figure 4. Example of feedback in games

Figure 3 illustrates an example of a case-based mathematics challenge within the game. This challenge is designed to stimulate problem-solving and the application of mathematical concepts. Each challenge is accompanied by interactive feedback, in line with Piaget's Constructivist Learning Theory (Waite-Stupiansky, 2022), which emphasizes learning through direct experience and reflection. Research by Hernández-Ramos et al. (2021) also supports this approach, showing that problem-based learning environments can foster a deeper understanding of concepts.

The prototype of this game incorporates essential features designed to enhance student engagement and foster deeper learning. These features include case-based mathematics challenges, interactive feedback mechanisms, and gamification elements, all strategically integrated to support the development of problem-solving skills. Case-based learning, as emphasized by Gholami et al. (2021), provides students with real-world contexts that enhance their ability to apply mathematical concepts effectively. This approach not only makes learning more relatable but also encourages critical thinking and analytical reasoning. One of the standout features of the game is its ability to provide immediate feedback after each response. This feedback helps students identify and understand their mistakes, offering tailored guidance to improve comprehension and reinforce learning. The importance of such formative assessment practices is supported by Haruna et al. (2021), who highlight that timely and constructive feedback plays a critical role in improving student outcomes. By combining these pedagogical elements, the game ensures a learning experience that is both interactive and effective. A visual example of the in-game feedback feature can be seen in Figure 4, illustrating how students receive actionable insights as they progress through the challenges.

The design and development of this PBL-based PowerPoint game prototype integrates various learning theories and instructional design principles to create a tool that is both engaging and educational. The intuitive interface design and gamification elements, as shown in Figures 3 and 4, are expected to enhance student engagement by making mathematics learning more appealing and relevant. Overall, the design and development phase of this prototype demonstrates that by integrating PBL principles and instructional design theory, the PBL-based PowerPoint game can offer an innovative and effective alternative for improving students' mathematical skills. Further evaluation of this prototype will determine the extent to which the game meets the identified needs.

After completing the design and development phase of the prototype, the next step is to conduct validation by experts to ensure the quality and suitability of the developed learning media. This validation is carried out by media experts, content experts, and language experts to evaluate the technical aspects, content, and language clarity of the PBL-based PowerPoint game. The results of this validation will provide insights into the feasibility of the game from various perspectives and serve as a basis for further improvements to better meet the identified learning needs. The validation results are presented in Figure 5.

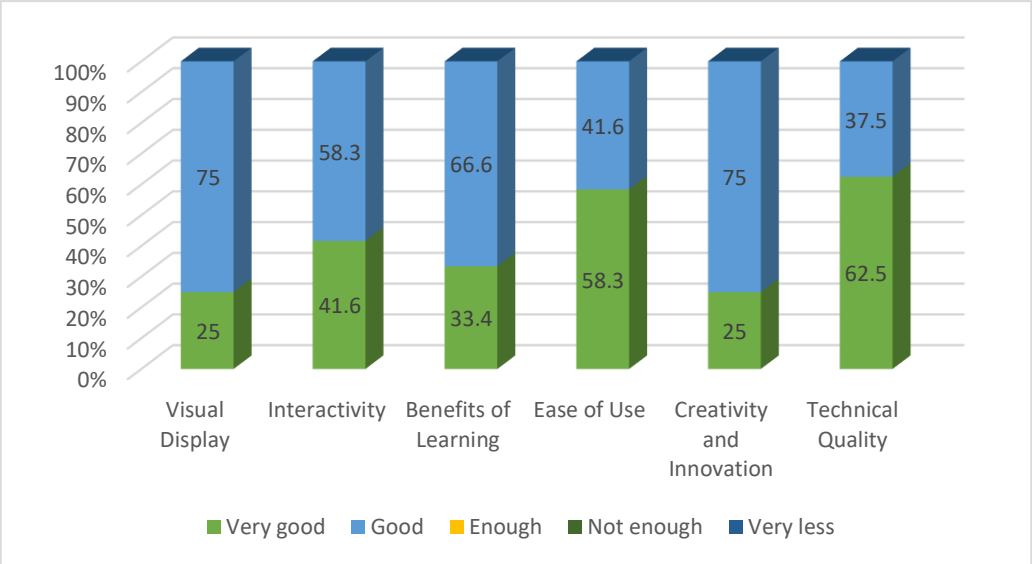

Figure 5. Results of game validation by media and material experts

Based on the validation results conducted by content and media experts, it can be concluded that the PBL-based PowerPoint game demonstrates good validity as a learning medium. The aspects that contribute most to the validity score include the relevance and accuracy of the mathematical content, the clarity and appropriateness of the language used, and the interactive and visually engaging media design. These elements ensure that the game aligns with the learning objectives and effectively supports student engagement and understanding. The evaluation from the content expert validators indicates that the game effectively enhances students' understanding of the subject matter, aligns with the learning objectives, and successfully integrates the PBL approach. Suggestions for improvement include increasing the variety of questions and improving the responsiveness of interactive elements for further enhancement. Meanwhile, the assessment from media expert validators reveals that the visual design, technical quality, and innovation presented by the game are commendable. The game was rated as stable without technical issues, featuring an attractive and user-friendly interface for students. The recommendation to improve interactive responsiveness also reflects attention to detail that could enhance the user experience. Therefore, this game can be implemented in problem-based learning in schools, with a few suggested improvements to optimize students' learning experience.

Additionally, to ensure that the PBL-based PowerPoint game uses language that is clear, precise, and appropriate for the learning context, a validation was conducted by two language experts. This validation aimed to assess the logic, readability, and accuracy of terminology used in the game, ensuring that the material is delivered effectively and is easily understood by students. The validation results from the two language experts regarding the linguistic aspects of the game can be seen in Figure 6.

The evaluation results indicate that the linguistic aspects of the game have met most of the expected criteria, although there are still some areas that can be improved. The clarity of the language used in the game is excellent and free from ambiguity. This aligns with the findings of Anggraini et al. (2022), who stated that clear and unambiguous language in educational media enhances the effectiveness of learning and improves students' comprehension of the material presented. Despite receiving a fairly good assessment, further review of certain text sections may be necessary to ensure that all students can easily grasp the messages conveyed in the game.

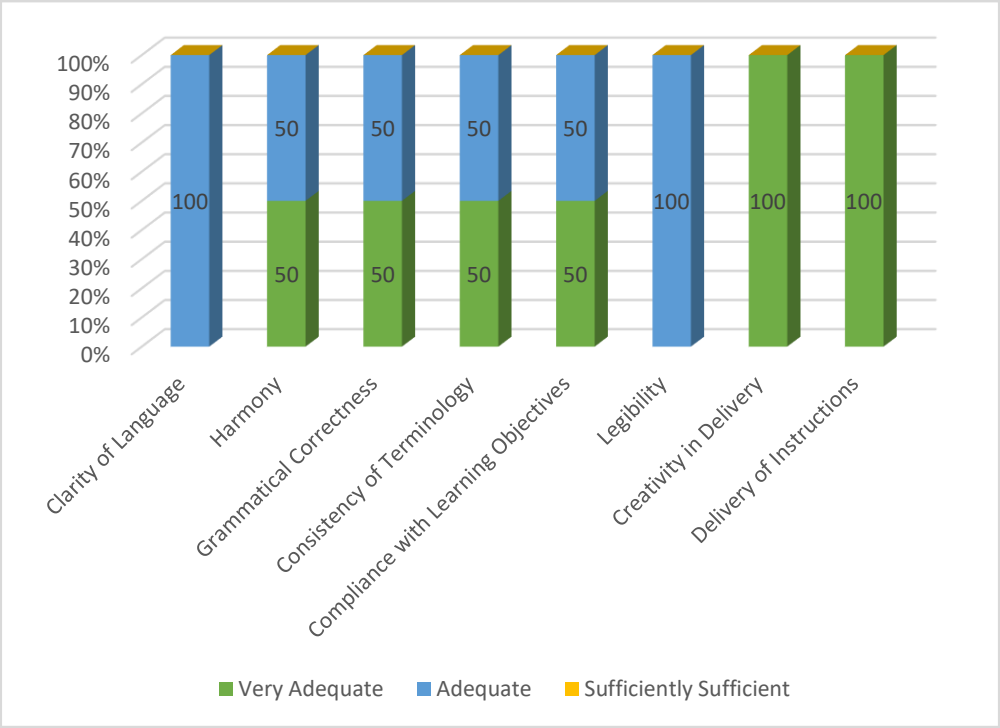

Figure 6. Game validation results by language experts

The alignment with the educational context has been adapted to the students' comprehension level. This is crucial, as Vygotsky (1978) emphasized that using language appropriate to students' cognitive development helps them construct meaning and deepen their understanding of concepts. Overly complex language can hinder students' ability to understand the material, while language that is too simple may not challenge them sufficiently.

The grammatical accuracy in the game is generally adequate, indicating that the grammar usage is largely correct, though there is room for minor improvements. This is important because correct grammar not only helps students better understand the material but also aids them in internalizing proper language use in academic contexts (Rahayu et al., 2024). Terminology consistency in the game shows that while the terms used are generally consistent, there are a few sections where the terminology could be further aligned. Consistency in terminology is a key element in educational media, as inconsistent use of terms can cause confusion among students (Lahirka & Gani, 2024). The Alignment with learning objectives indicates that, overall, the game successfully delivers the learning content through language that supports students' comprehension. According to Bruner (1966), the language used in educational media should align with the learning objectives being pursued. On the aspect of readability, both validators gave positive assessments. Readability in educational media is crucial to ensure that students can access and comprehend the information without difficulty. Factors such as font size, color contrast, and text layout play important roles in determining readability (El Chidtian & Renzina, 2024).

In terms of creativity, both validators provided an adequate assessment. This suggests that the language used in the game is sufficiently creative and engaging, although there is room for enhancing the appeal and innovation in language delivery. Creativity in language, particularly in game-based media, can boost student engagement and make learning more enjoyable (Lee, 2019). For the clarity of instructions, both validators gave high marks. Clear and easy-to-understand instructions are key factors in effective educational multimedia (Wei et al., 2018). Overall, the validation results from the two language experts indicate that the game has met most of the expected language standards for PBL-based educational media.

After the expert validation phase, the PBL-based PowerPoint game was tested with students to gather direct user feedback. This trial aimed to assess their perceptions of various aspects of the game, including design, ease of use, and the relevance of the learning material. The results of this survey will serve as a basis for evaluating student responses and providing input for further improvements.

Figure 7 indicates that the game successfully captured students' attention and actively engaged them in the learning process. Active student engagement is key to enhancing their understanding (Munna & Kalam, 2021), especially when students are given opportunities to participate in interactive and collaborative activities. This is further supported by 50% of students who felt that the game helped them collaborate with their peers, reinforcing the idea that social collaboration can improve conceptual understanding (Qureshi et al., 2023). In terms of material comprehension, 47% of students felt that the game helped them understand the material very well, while 39.4% rated it as good. The use of visual and interactive elements in the game can enhance students' understanding of complex concepts (Nurhikmah et al., 2023). Additionally, the application of concepts through gameplay received positive feedback from students, with 50% rating it as very good and 40% rating it as good. This suggests that the game not only aids in understanding theoretical concepts but also facilitates the application of these concepts in practical situations. The following is an overview of the student survey results regarding the tested game.

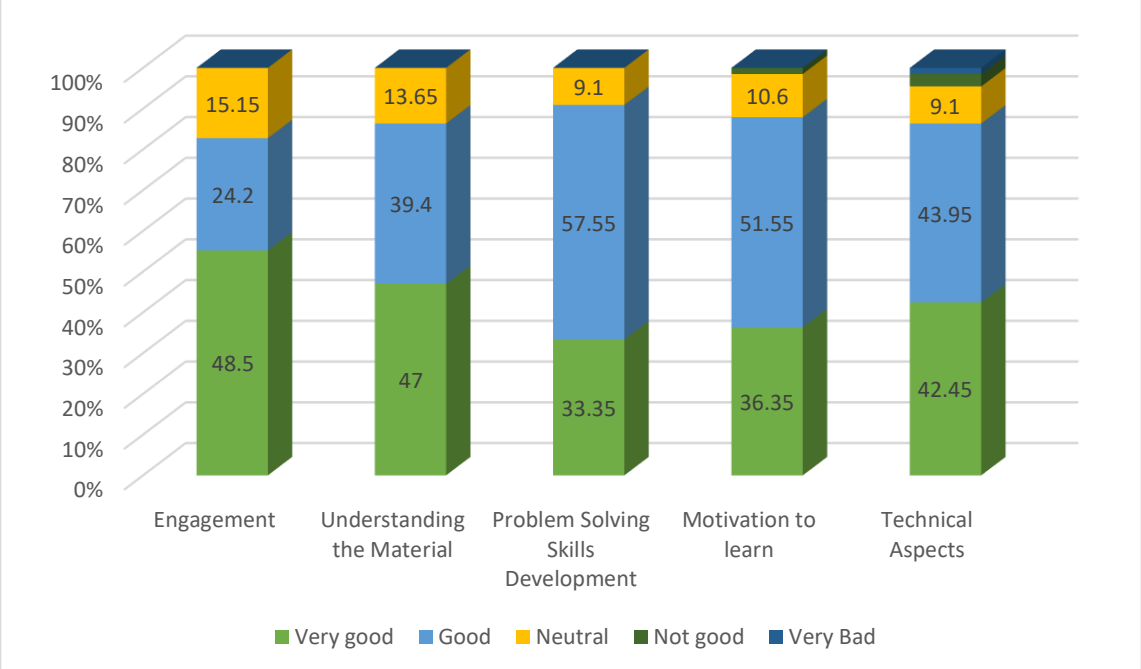

Figure 7. Student response survey results

In the aspect of Problem-Solving Skills Development, 65% of students rated the game as very good in training them to think critically when solving problems, while 60% indicated that the game encouraged them to think creatively in finding solutions. This supports previous research showing that problem-based games can enhance students' problem-solving skills by presenting scenarios that require critical and creative thinking (O'Grady-Jones & Grant, 2023). The use of a PBL approach in this game helps students develop critical and creative thinking skills, which are essential competencies for the 21st century. Student motivation significantly increased after using the game, with 70% of students rating it very good in terms of boosting their interest in learning. According to (Cho & Castañeda, 2019), students' intrinsic motivation increases when they engage in activities that are both engaging and enjoyable. Additionally, 65% of students reported feeling happy and not bored

while learning with this game. This indicates that the PBL-based game successfully created an enjoyable learning environment, which in turn fostered higher learning motivation.

The visual aspect of the game received excellent ratings, with 75% of students stating that the visuals were engaging and supported learning. Additionally, 70% of students found the game easy to use and not confusing. Ease of use is crucial in technology-based learning, as technical difficulties can distract students from focusing on the material. Overall, the survey results indicate that this PBL-based PowerPoint game successfully enhanced student engagement, material comprehension, problem-solving skills, and learning motivation. These findings support previous research showing that interactive and engaging game-based learning can significantly improve the quality of education (Videnovik et al., 2020). The use of games in learning not only makes students more active and motivated but also helps them develop critical and creative thinking skills, which are essential for facing future challenges.

The PowerPoint-based game "MathQuest" was specifically designed to enhance students' Problem-Based Learning (PBL) skills by integrating engaging, real-world mathematical problems into an interactive learning environment. The game presents scenarios requiring students to analyze, hypothesize, and solve challenges related to arithmetic and geometric sequences and series. For example, one level tasks students with planning the seating arrangement in a theater, requiring them to determine the total number of seats in rows that follow an arithmetic progression. Another level explores geometric series through a real-life scenario, such as calculating the total amount of water conserved in a multi-stage filtration system with diminishing returns. These problem contents simulate real-life situations, encouraging critical thinking and collaborative problem-solving. By providing immediate feedback, hints, and scaffolded problem progression, MathQuest supports students' engagement and fosters their ability to independently explore and resolve mathematical challenges. Research suggests that gamified environments like this can effectively motivate students and enhance their problem-solving skills by integrating active learning and collaboration (Hwang et al., 2019; Amin et al., 2021). The game's interactive elements, such as rewards for solving problems and penalties for incorrect attempts, encourage persistence and deepen understanding of mathematical concepts. This aligns with findings from PBL studies emphasizing the importance of engaging tasks in developing students' analytical and problem-solving skills (Marcinauskas et al., 2024; Serin, 2023). As a result, MathQuest not only improves students' mastery of arithmetic and geometric sequences and series but also develops transferable PBL skills, preparing them for complex problem-solving in real-world contexts.

Limitations

The development of the PBL-based PowerPoint game faced several limitations. PowerPoint's inherent constraints in terms of interactivity and the creation of complex animations posed challenges, especially as excessive animations led to a heavier file size and occasional unresponsiveness. The game also lacked capabilities for real-time feedback and automatic student progress tracking, limiting its utility in dynamic classroom environments. Additionally, challenges arose in enabling real-time collaboration and ensuring seamless distribution across various devices. To address these limitations, it is recommended to incorporate additional technologies, such as VBA or macros, to enhance interactivity, minimize animations to maintain a lightweight file, and consider integrating the game into online learning systems (LMS) or cloud-based platforms to support collaboration and progress tracking.

Contributions

Despite these limitations, this study highlights the potential of PowerPoint, a widely accessible and user-friendly tool, as a platform for developing interactive and educational games. The research demonstrates a practical and cost-effective approach to integrating Problem-Based Learning (PBL)

into classroom activities, particularly in settings with limited access to advanced educational technologies. Moreover, the systematic development and validation processes outlined in this study offer a replicable framework for educators and researchers to design similar instructional media. By focusing on arithmetic and geometric sequences and series, the game provides a practical example of transforming abstract mathematical concepts into engaging, real-world problem-solving scenarios. This contributes to improving students' mathematical problem-solving skills while fostering transferable PBL abilities.

CONCLUSION

The development of the PowerPoint-based Problem-Based Learning (PBL) game, "MathQuest," has demonstrated strong validity, practicality, and effectiveness as a learning medium for enhancing students' mathematical problem-solving skills and motivation. Expert validation results indicated high scores in content (91%), media design (89%), and language clarity (92%), classifying the game as "very valid" and suitable for use without significant revisions. Feedback from 33 tenth-grade students reflected a practicality score of 85%, highlighting the game's ease of use, engagement, and seamless integration into classroom activities. Additionally, 70% of students reported increased motivation and engagement during the learning process. This study underscores the potential of utilizing an accessible tool like PowerPoint to create innovative and effective educational games. By incorporating interactive elements, real-world problem-solving scenarios, and gamification features, MathQuest ensures a learning experience that is both engaging and pedagogically sound. Key features such as immediate feedback, diverse problem types, and options for group play enhance its practicality and adaptability for classroom implementation. Moreover, MathQuest provides a cost-effective solution for integrating Problem-Based Learning into mathematics education, particularly in contexts with limited access to advanced educational technologies. Future research is encouraged to extend the application of this approach to other mathematical topics and further enhance the game’s interactivity by integrating it with online learning systems or cloud-based platforms. These advancements would broaden its potential impact, making it a scalable and dynamic tool for diverse educational settings.

AKNOWLEDGMENT

This research is part of a master’s thesis conducted as a requirement for obtaining a Master of Education degree. The author would like to express gratitude to the Directorate of Research, Technology, and Community Service (DRTPM) of the Ministry of Education, Culture, Research, and Technology (Kemdikbudristek Dikti) for funding this research. Special thanks are also extended to the experts and students who participated in the validation process and the prototype testing of the game. Their assistance, guidance, and support greatly contributed to the smooth execution and success of this research.

AUTHOR CONTRIBUTIONS STATEMENT

RS, NM, and IS contributed to the conception and design of the study. RS performed the data collection and analysis, while NM and IS provided input on the methodology and contributed to the interpretation of the results. GD was responsible for the linguistic review and proofreading of the manuscript. All authors read and approved the final version of the manuscript.

REFERENCES

Ahmed, I., & Mikail, M. (2022). Interactive instructor for a synergistic student-centered and personalized teaching: A biosocial approach. *Education and Urban Society*, 55, 996 - 1018. https://doi.org/10.1177/00131245221106717

Amin, A., Degeng, I., Setyosari, P., & Djatmika, E. (2021). The effectiveness of mobile blended problem-based learning on mathematical problem solving. *Int. J. Interact. Mob. Technol.*, 15, 119-141. https://doi.org/10.3991/ijim.v15i01.17437

Anggraeni, D. M., Prahani, B. K., Suprapto, N., Shofiyah, N., & Jatmiko, B. (2023a). Systematic review of problem-based learning research in fostering critical thinking skills. *Thinking Skills and Creativity*, *49*, 101334. https://doi.org/10.1016/j.tsc.2023.101334

Anggraeni, E., Kriswandani, K., Deswita, Y., & Robithoh, S. (2023b). Pengaruh model problem-based learning berbantuan powerpoint interaktif terintegrasi geogebra terhadap kemampuan pemecahan masalah matematis. *Jurnal* Lebesgue*: Jurnal Ilmiah Pendidikan Matematika, Matematika dan Statistika, 4(1), 432-445.* https://doi.org/10.46306/lb.v4i1.280

Anggraini, F., Frima, A., & Valen, A. (2022). Pengembangan lembar kerja pada pembelajaran tematik berbasis kearifan lokal siswa sekolah dasar. *Jurnal Basicedu*, *6*(2), 2883-2891. https://doi.org/10.31004/basicedu.v6i2.2515

Anugerah, A. S., Husnah, A., Suryanti, S., Asmal, M., & Arsid, I. (2024). Profil kesalahan siswa dalam menyelesaikan masalah limit fungsi aljabar pada siswa sman 6 bone. *ELIPS: Jurnal Pendidikan Matematika*, *5*(1), 89-98.

Asri, K., Saragih, D. A. S., Ainun, N., Fahmi, C. N., & Sulastri, R. (2024). Analisis kesalahan pemahaman konsep materi bentuk aljabar pada siswa kelas VII SMP Negeri 14 banda aceh. *PERISAI: Jurnal Pendidikan dan Riset Ilmu Sains*, *3*(2), 256-267. https://doi.org/10.32672/perisai.v3i2.1877

Bang, H. J., Li, L., & Flynn, K. (2023). Efficacy of an adaptive game-based math learning app to support personalized learning and improve early elementary school students' learning. *Early Childhood Education Journal*, *51*(4), 717-732. https://doi.org/10.1007/s10643-022-01332-3

Bruner, J. S. (1966). *Toward a theory of instruction*. Harvard University Press.

Burke, A., & Stewart, S. (2024). Learning problem solving to manage school-life challenges: The impact on student success in college. *Active Learning in Higher Education*, *25*(2), 169-183. https://doi.org/10.1177/14697874221112879

Chang, C., Chung, C., & Chang, J. (2020). Influence of problem-based learning games on effective computer programming learning in higher education. *Educational Technology Research and Development*, *68*, 2651-2634. https://doi.org/10.1007/s11423-020-09784-3

Cho, M., & Castañeda, D. (2019). Motivational and affective engagement in learning Spanish with a mobile application. *System*, *81*, 90-99. https://doi.org/10.1016/j.system.2019.01.008

de-Marcos, L., Domínguez, A., Saenz-de-Navarrete, J., & Pagés, C. (2014). An empirical study comparing gamification and social networking on e-learning. *Computers & Education*, 75, 82–91. https://doi.org/10.1016/j.compedu.2014.01.012

El Chidtian, A. S. C. R., & Renzina, Y. D. (2024). Analisis tipografi pada poster film horor Indonesia tahun 2022. *Jurnal Desain Komunikasi Visual Asia*, *8*(01), 1-16. https://doi.org/10.32815/jeskovsia.v8i01.975

Erdem, C. (2022). A comparative meta-analysis of the effects of problem-based learning model on K-12 students' cognitive outputs. *Educational Studies*, *9*(2), 1-22.

Firda, N., & Juandi, D. (2023). Learning Obstacles Siswa Sekolah Menengah Pertama pada Materi Matematika. *Jurnal Pembelajaran Matematika Inovatif*, *6*(3), 1055-1070.

Gholami, M., Changaee, F., Karami, K., Shahsavaripour, Z., Veiskaramian, A., & Birjandi, M. (2021). Effects of multiepisode case-based learning (CBL) on problem-solving ability and learning motivation of nursing students in an emergency care course. *Journal of professional nursing*, 37 3, 612-619. https://doi.org/10.1016/j.profnurs.2021.02.010

Haruna, H., Zainuddin, Z., Okoye, K., Mellecker, R., Hu, X., Chu, S., & Hosseini, S. (2021). Improving instruction and sexual health literacy with serious games and gamification interventions: an outlook to students' learning outcomes and gender differences. *Interactive Learning Environments*, 31, 2392 - 2410. https://doi.org/10.1080/10494820.2021.1888754

Hendarwati, E., Nurlaela, L., Bachri, B., & Sa'ida, N. (2021). Collaborative problem-based learning integrated with online learning. *International Journal of Emerging Technologies in Learning*, *16*(13), 29-39. https://doi.org/10.3991/ijet.v16i13.24159

Hernández-Ramos, J., Pernaa, J., Cáceres-Jensen, L., & Rodríguez-Becerra, J. (2021). The effects of using socio-scientific issues and technology in problem-based learning: a systematic review. *Education Sciences, 11*(10), 640. https://doi.org/10.3390/educsci11100640

Hwang, G.-J., Sung, H.-Y., & Chang, Y.-L. (2019). A systematic review of the effects of digital game-based learning on student engagement, motivation, and achievement. *Journal of Educational Technology & Society*, 22(1), 81–92.

Lahirka, R., & Gani, E. (2024). Efektifnya kalimat terhadap karya siswa dalam teks eksposisi kelas VIII SMP Negeri 3 Gunung Talang. *Esensi Pendidikan Inspiratif*, *6*(2), 781-790.

Lee, S. (2019). Her Story or their own stories? Digital game-based learning, student creativity, and creative writing. *ReCALL*, 31, 238 - 254. https://doi.org/10.1017/S0958344019000028

Mao, W., Cui, Y., Chiu, M., & Lei, H. (2021). Effects of game-based learning on students' critical thinking: a meta-analysis. *Journal of Educational Computing Research*, 59, 1682 - 1708. https://doi.org/10.1177/07356331211007098

Marcinauskas, L., Iljinas, A., Čyvienė, J., & Stankus, V. (2024). Problem-based learning versus traditional learning in physics education for engineering program students. *Education Sciences*, *14*(2), 154. https://doi.org/10.3390/educsci14020154

Moradi, M., & Noor, N. (2022). The impact of problem-based serious games on learning motivation. *IEEE Access*, 10, 8339-8349. https://doi.org/10.1109/ACCESS.2022.3140434

Munna, A. S., & Kalam, M. A. (2021). Impact of active learning strategy on the student engagement. *GNOSI: an interdisciplinary journal of human theory and praxis*, *4*(2), 96-114.

Nadeem, M., Oroszlanyova, M., & Farag, W. (2023). Effect of digital game-based learning on student engagement and motivation. *Computers*, *12*(9), 177. https://doi.org/10.3390/computers12090177

Nicolay, B., Krieger, F., Stadler, M., Gobert, J., & Greiff, S. (2021). Lost in transition - Learning analytics on the transfer from knowledge acquisition to knowledge application in complex problem solving. *Comput. Hum. Behav.*, 115, 106594. https://doi.org/10.1016/j.chb.2020.106594

Nurhikmah, H., Aswan, D., Bena, B. A. N., & Ramli, A. M. (2023). Pelatihan gamifikasi dalam pembelajaran sekolah menegah atas. *CARADDE: Jurnal Pengabdian Kepada Masyarakat*, *6*(1), 146-155.

O'Grady-Jones, M., & Grant, M. (2023). Ready coder one: collaborative game design-based learning on gifted fourth graders' 21st century skills. *Gifted Child Today*, *46*, 84-107. https://doi.org/10.1177/10762175221149259

Qureshi, M. A., Khaskheli, A., Qureshi, J. A., Raza, S. A., & Yousufi, S. Q. (2023). Factors affecting students' learning performance through collaborative learning and engagement. *Interactive Learning Environments*, *31*(4), 2371-2391. https://doi.org/10.1080/10494820.2021.1884886

Rahayu, S. M., Marlina, R., Wahyuni, C. I., Hasan, F., & Nugraha, R. G. (2024). Pengembangan video animasi pembelajaran tentang tata krama bahasa anak di sekolah dasar. *Khazanah Pendidikan*, *18*(2), 298-312.

Rahman, F., Nugraha, N., & Sudarmiani, S. (2020). Application of problem-based learning (PBL) model by microsoft power point media to improve activities and results of learning social science of SMP in Madiun. *Social Sciences, Humanities and Education Journal (SHE Journal)*, *1*(2), 1-12. https://doi.org/10.25273/she.v1i2.6620

Roski, M., Sebastian, R., Ewerth, R., Hoppe, A., & Nehring, A. (2024). Learning analytics and the Universal Design for Learning (UDL): A clustering approach. *Computers & Education*, *214*, 105028. https://doi.org/10.1016/j.compedu.2024.105028

Serin, H. (2023). Teaching mathematics: The role of project-based learning. *International Journal of Social Sciences & Educational Studies*, *10*(2), 378-382. https://doi.org/10.23918/ijsses.v10i2p378

Shongwe, B. (2024). The effect of STEM problem-based learning on students' mathematical problem-solving beliefs. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(8), em2486. https://doi.org/10.29333/ejmste/14879

Sinaga, B., Sitorus, J., & Situmeang, T. (2023, February). The influence of students' problem-solving understanding and results of students' mathematics learning. In *Frontiers in Education* (Vol. 8, p. 1088556). Frontiers Media SA. https://doi.org/10.3389/feduc.2023.1088556

Subawo, M. (2022). The effect of creative thingking ability and basic mathematics ability toward students problem solving ability. *Journal of Mathematics Education*, *7*(2), 85-91. https://doi.org/10.31327/jme.v7i2.1845

Sung, Y. T., Chang, K. E., & Liu, T. C. (2016). The effects of integrating mobile devices with teaching and learning on students' learning performance: A meta-analysis and research synthesis. *Computers & Education*, *94*, 252-275. https://doi.org/10.1016/j.compedu.2015.11.008

Sweller, J. (2024). Cognitive load theory and individual differences. *Learning and Individual Differences*, *110*, 102423. https://doi.org/10.1016/j.lindif.2024.102423

Tan, A. L., Ong, Y. S., Ng, Y. S., & Tan, J. H. J. (2023). STEM problem solving: Inquiry, concepts, and reasoning. *Science & Education*, *32*(2), 381-397. https://doi.org/10.1007/s11191-021-00310-2

Videnovik, M., Trajkovik, V., Kiønig, L., & Vold, T. (2020). Increasing quality of learning experience using augmented reality educational games. *Multimedia Tools and Applications*, 79, 23861 - 23885. https://doi.org/10.1007/s11042-020-09046-7

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Waite-Stupiansky, S. (2022). Jean Piaget's constructivist theory of learning. In *Theories of early childhood education* (pp. 3-18). Routledge. https://doi.org/10.4324/9781003288077-2

Wei, P., He, F., & Huang, S. (2018). Effects of instructional multimedia integrated situational approach on students' learning achievement. *Eurasia journal of mathematics, science and technology education*, 14, 3321-3327. https://doi.org/10.29333/ejmste/91244

Wei, B., Wang, H., Li, F., Long, Y., Zhang, Q., Liu, H., Tang, X., & Rao, M. (2023). Effectiveness of problem-based learning on development of nursing students' critical thinking skills: A systematic review and meta-analysis. *Nurse educator*, *49*(3), E115-E119

Widyatma, Y. V., & Ramadhani, A. D. H. (2024). Analisis kemampuan pemecahan masalah matematis pada materi bilangan dan aljabar siswa kelas IV SDN 4 Piji. *Jurnal Pendidikan Dan Pembelajaran*, *3*(01), 335-349. https://doi.org/10.30598/jpmunpatti.v4.i3.p140-147

Yu, J., Denham, A. R., & Searight, E. (2022). A systematic review of augmented reality game-based Learning in STEM education. *Educational technology research and development*, 70(4), 1169-1194. https://doi.org/10.1007/s11423-022-10122-y