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GENERATIVE AI-ENHANCED GAME-BASED LEARNING FOR CREATIVE SKILL DEVELOPMENT IN ELEMENTARY STUDENTS

Yani Fitriyani[1]*, Sena Aditia Apriadi[2], Sulistiani[3], Ndaru Mukti Oktaviani[4]
[1,2,3,4]Universitas Muhammadiyah Kuningan
[1]yanifitriyani@umkuningan.ac.id

Abstract
Student creativity in Indonesia remains a serious problem that requires special attention, with the 2022 PISA survey identifying only 5% of students achieving high creativity. Science learning is also still limited in integrating technology to develop creativity, even though this ability is a very important competency in the digital era. This study aims to develop Game-based Learning (GBL) with Generative AI (Gen AI) to improve the creativity of 5th grade elementary school students. The research method uses Research and Development (RnD) with the ADDIE model including five stages: analysis, design, development, implementation, and evaluation. The subjects of this study were 20 5th grade students of SDN Kutakembaran 1. GBL was developed with the ChatGPT-3.5 API to produce adaptive learning content. ChatGPT-3.5 works by analyzing student responses, automatically generating game scenarios, questions, and challenges tailored to the individual student's ability level. This development is enriched with West Javanese cultural elements such as folklore, traditions, and local contexts to increase the relevance of learning. The research instruments include expert validation (n=5), a creativity rubric that measures four indicators (fluency, flexibility, originality, elaboration) through problem-solving tasks, and observation of student engagement using a Likert scale that records active participation. The expert validation results showed a feasibility score of 77.50 (good category) with an Aiken's V coefficient of 0.813 (p<0.001). Implementation resulted in a significant increase in the creativity dimensions: fluency (23%, p<0.05), flexibility (31%, p<0.01), originality (28%, p<0.05), and elaboration (19%, p<0.05). Student engagement reached an average of 78.60 with 80% positive responses, while technology acceptability reached 83.45%. The culture-based GBL-GenAI media has proven effective in developing student creativity and making a significant contribution to innovation in science learning for the transformation of Indonesian basic education.
Keywords: *Game-based Learning; Generative AI; Creativity; Students; Elementary School*

Abstrak
Kreativitas siswa di Indonesia masih menjadi permasalahan serius yang memerlukan perhatian khusus, dengan survei PISA 2022 teridentifikasi hanya 5% siswa mencapai kreativitas tinggi, Pembelajaran IPAS juga masih terbatas dalam mengintegrasikan teknologi untuk mengembangkan kreativitas, padahal kemampuan ini menjadi kompetensi yang sangat penting di era digital. Penelitian ini bertujuan mengembangkan *Game-based Learning* (GBL) dengan *Generative AI* (Gen AI) untuk meningkatkan kreativitas siswa kelas 5 sekolah dasar. Metode penelitian menggunakan *Research and Development* (RnD) dengan model ADDIE meliputi lima tahap yaitu *analysis, design, development, implementation*, dan *evaluation*. Subjek penelitian ini adalah 20 siswa kelas 5 SDN Kutakembaran 1. GBL dikembangkan dengan API ChatGPT-3.5 untuk menghasilkan konten pembelajaran adaptif. ChatGPT-3.5 bekerja dengan menganalisis respons siswa, secara otomatis menghasilkan skenario permainan, pertanyaan, dan tantangan yang disesuaikan dengan tingkat kemampuan individual siswa. Pengembangan ini diperkaya dengan elemen budaya Jawa Barat seperti cerita rakyat, tradisi, dan konteks lokal untuk meningkatkan relevansi pembelajaran. Instrumen penelitian meliputi validasi ahli (n=5), rubrik kreativitas yang mengukur empat indikator (fluency, flexibility, originality, elaboration) melalui tugas pemecahan masalah, observasi keterlibatan siswa menggunakan skala Likert yang mencatat partisipasi aktif. Hasil validasi ahli menunjukkan skor kelayakan 77,50 (kategori baik) dengan koefisien Aiken's V=0,813 (p<0,001). Implementasi menghasilkan peningkatan signifikan pada dimensi kreativitas: fluency (23%, p<0,05), flexibility (31%, p<0,01), originality (28%, p<0,05), dan elaboration (19%, p<0,05). Keterlibatan siswa mencapai rata-rata 78,60 dengan 80% respons positif, sedangkan akseptabilitas teknologi mencapai 83,45%. Media GBL-GenAI berbasis budaya terbukti efektif mengembangkan kreativitas siswa dan memberikan kontribusi signifikan bagi inovasi pembelajaran IPAS untuk transformasi pendidikan dasar Indonesia.
Kata Kunci: Game-based Learning; Generative AI; Kreativitas; Siswa; Sekolah Dasar

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Introduction

The Industrial Revolution 4.0 and the transition to Society 5.0 have catalyzed a fundamental transformation in the global education ecosystem, demanding a comprehensive redefinition of the competency constructs that students must master at the elementary level. Creativity, a crucial skill in the 21st century, has been identified as a key predictor in facing the complex challenges of a volatile, uncertain, complex, and ambiguous (VUCA) future (OECD, 2022; Trilling & Fadel, 2009). However, empirical analysis shows that Indonesian students' creativity achievements still show significant disparities compared to international standards, indicating a systemic deficit in the implementation of learning oriented towards developing divergent thinking skills. Quantitative data from the 2022 Programme for International Student Assessment (PISA) revealed a worrying phenomenon: only 5% of Indonesian students achieved a high level of creativity, while 31% were at a basic level. This condition contrasts significantly with the average for Organisation for Economic Co-operation and Development (OECD) countries, which reached 78% (OECD, 2022). This statistical analysis indicates a substantive gap in the development of creativity which has implications for the low competitiveness of Indonesia's young generation in the global arena (Z. S. Zhang et al., 2025).

Research studies confirm that Indonesian students' creativity is still in the moderate category, indicating the urgency of implementing systematic and sustainable learning strategies to optimize students' creative potential (Kemendikbudristek, 2023). Contemporary research identifies that the implementation of creativity-based learning still shows a low frequency in teachers' pedagogical practices (Urban & Urban, 2024), with significant limitations in providing students with space to explore divergent ideas (Puspita, 2023). In the context of learning Natural and Social Sciences (IPAS) in elementary schools, there is an epistemological paradox between intrinsic potential and implementation reality. IPAS has thematic-integrative and contextual characteristics that are highly relevant to students' daily lives and local culture, but its implementation has not been optimal in stimulating creativity through innovative pedagogical approaches (Weran & Kuswandono, 2021). This phenomenon indicates that the Indonesian education system has not fully provided optimal space for strengthening students' creative thinking abilities through learning designs that are responsive to students' cognitive and affective needs (Ika Sari et al., 2024).

A critical analysis of learning practices shows that the minimal use of educational technology in the learning process is a determining factor in low student creativity. Technology integration in learning is still limited to the use of presentation media or non-interactive applications that do not support the development of higher-order thinking skills (Creely & Blannin, 2025). This condition contrasts with the development of global learning technology which has proven to be an effective strategy for creating learning that is more adaptive, personalized, and relevant to the needs of the 21st century (Plass et al., 2015). The development of contemporary educational technology shows that Game-Based Learning (GBL) has become a pedagogical strategy that has been proven effective in improving learning outcomes, intrinsic motivation, and cognitive engagement of students at various levels of education (S. Zhang et al., 2025). Recent meta-analysis research confirms that GBL can optimize the acquisition of

complex cognitive competencies such as critical thinking and creativity through systematically designed gamification mechanisms (Hsu & Hsu, 2024). GBL creates an interactive, immersive, and experiential learning environment, making it very suitable for elementary school students who need concrete and fun learning (Auwlya, 2025; Muengsan & Chatwattana, 2024; Zheng et al., 2024). This approach facilitates a student-centered learning process by integrating game elements that stimulate intrinsic motivation and active involvement of students in the knowledge construction process.

The evolution of Generative Artificial Intelligence (Gen AI) technology has opened a new paradigm in personalized and adaptive learning. Gen AI-based GBL technology has been shown to have a positive impact on the social and emotional aspects of learning (Moundridou et al., 2024; Nikkola et al., 2024), especially in the context of social interaction and student collaboration (Gupta et al., 2024). This integration also facilitates adaptive problem-solving and challenge spaces according to students' individual characteristics. (Al-Hafdi & Alhalafawy, 2024; Leitner et al., 2023). Gen AI has the capability to generate dynamic, contextual, and personalized learning content based on student learning profile data, thus providing a more relevant and meaningful learning experience. This technology is also able to adapt to students' difficulty levels, learning styles, and cultural preferences in real time, creating a learning ecosystem that is responsive to individual needs. Although GBL and Gen AI have been widely researched separately, a systematic analysis of the literature shows that there has been no study specifically integrating the two technologies in the context of science learning to enhance the creativity of elementary school students in Indonesia. A comprehensive literature review identified that research developing Game-Based Learning with Generative AI to explore elementary school students' creativity in local cultural contexts is still very limited (H. , & L. S. Choi, 2023; Du Boulay, 2023).

A systematic literature analysis shows that there has been no research that specifically integrates GBL and Gen AI in the context of science learning to enhance the creativity of elementary school students in Indonesia, indicating substantial innovative opportunities to develop learning technology solutions that address the challenges of conventional learning (W. C. Choi et al., 2025). The integration of GBL-Gen AI has the potential to create synergies that optimize the learning process through content personalization, cultural adaptation, and gamification that are responsive to individual student needs. This research aligns with the strategic direction of the 2017–2045 National Research Master Plan (RIRN) as stipulated in Presidential Regulation Number 38 of 2018, which emphasizes the development of innovative technology-based solutions in education, particularly in artificial intelligence and information and communication technology (ICT). This national policy reinforces the relevance and urgency of research in the context of developing high-quality and globally competitive Indonesian human resources. Based on a comprehensive analysis of Indonesian students' creativity issues and the identification of research gaps in learning technology, this research aims to design, develop, and test the feasibility of Game-Based Learning-based science learning integrated with Generative AI, with materials that reflect the students' cultural context. This learning technology innovation is expected to encourage students' creative exploration in deep learning, as well as support the transformation of basic education in Indonesia towards a learning ecosystem that is more adaptive, personalized, and responsive to the needs of the 21st century.

Research Methods

This research uses a Research and Development (R&D) approach which aims to produce innovations in the form of interactive learning media based on Game-based Learning (GBL) which is integrated with Generative Artificial Intelligence (Gen AI) to facilitate the exploration of creativity of elementary school students (Muengsan & Chatwattana, 2024). The framework implemented refers to the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model which has been proven effective in developing digital learning media, with modifications according to the characteristics of research on developing learning media based on artificial intelligence technology (Kazanıdıs et al., 2023). The development model used in this research is the ADDIE model, which includes: analysis, design, development, implementation, evaluation.

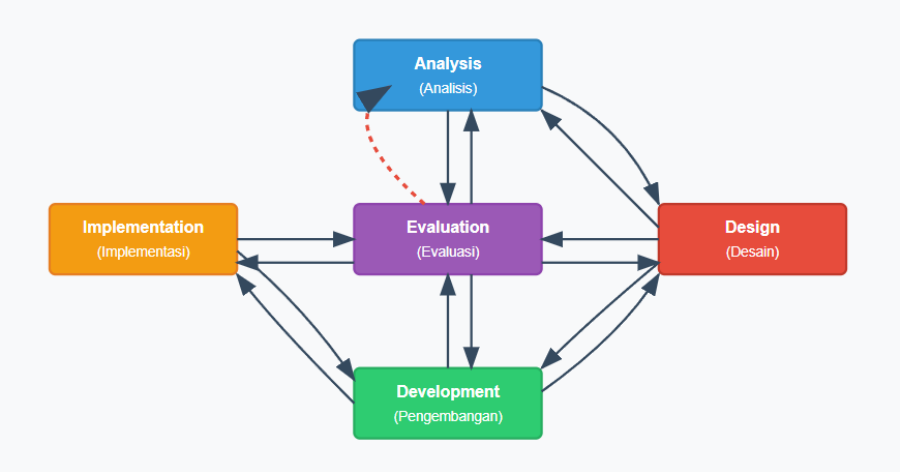

Figure 1. Research flow of the ADDIE model, source: (Moses Adeleke Adeoye et al., 2024)

In the preliminary study, the steps taken included collecting and analyzing information regarding the problems and needs in learning, reviewing and formulating the importance of learning media, examining the theories underlying development, and examining the characteristics of previous learning media. Furthermore, this stage also identified teacher and student characteristics related to the use of learning media, and material analysis involved identifying, detailing, and systematically developing concepts for organizing materials and designing the learning media's presentation. After these steps were completed, the next stage was designing the supporting components.

In the product development stage, a draft design of the product was prepared, specifically GBL media with Gen AI for exploring the creativity of elementary school students. Prior to testing, the product draft was reviewed to ensure the adequacy of the supporting theories for each component, ensuring its validity by experts and practitioners, based on theoretical rationale and construction consistency.

In the product validation stage, expert validation will be conducted. This validation activity is conducted to assess the feasibility and validity of the GBL media with Gen AI for exploring student creativity. The validation results will be used to revise the GBL media with Gen AI for exploring student creativity, while also demonstrating the feasibility of the GBL media with Gen AI for exploring student creativity, which will be used by teachers and students at Kutakembaran Elementary School. Once a valid product is obtained, the developed learning media is ready for trial. During the trial or product implementation process, observation sheets are also distributed to assess and assess the characteristics of the developed learning media.

Then, in the evaluation stage, conclusions are drawn from the trial or implementation activities and the results from the distributed observation sheets are drawn to determine the characteristics of the developed learning media product. The data sources for this research and the techniques used for data collection include direct observation to observe the product development and trial process, validation sheets, used as instruments in the trial and validation of the developed product, and observation sheets given to teachers to review student responses to the developed learning media.

Field notes were taken concurrently with the product trial implementation, detailing events that occurred during the trial. Documentation included drawings or photographs taken during the development research. The data analysis technique used in this study was descriptive qualitative analysis to analyze the observation sheets and expert tests. The value ranges and criteria for the expert tests are shown in Table 1.

Table 1. Expert Test Assessment Criteria

Interval	Criteria
81%-100%	Very Good (VB)
61%-80%	Good (G)
41%-60%	Sufficient (S)
21%-40%	Poor (P)
0%-20%	Very Poor (VP)

The assessment criteria and score ranges shown in Table 1 served as guidelines for determining scores for the expert validity test. The score ranges were calculated by comparing the maximum and minimum scores obtained with the number of answer options. The description of the answer options was performed using a Likert scale, which is included in the validation assessment indicators.

Assessment of the student activity observation instrument was carried out using a Likert scale with a range of 1-4 which includes a score of 1 = 25% of students are active according to the observation indicator, a score of 2 = 50% of students are active according to the observation indicator, a score of 3 = 75% of students are active according to the observation indicator, and a score of 4 = 100% of students are active according to the observation indicator. After the data has been calculated, the results are interpreted based on the assessment criteria for the results of student activity observations as follows.

Table 2. Assessment Criteria for Student Activity Observation Results

Interval	Criteria
81%-100%	Very Good (VB)
61%-80%	Good (G)
41%-60%	Sufficient (S)
21%-40%	Poor (P)
0%-20%	Very Poor (VP)

Assessment on the student questionnaire instrument was carried out using the opinion scale STS (Strongly Disagree), TS (Disagree), S (Agree), and SS (Strongly Agree). After the data has been calculated, the results are interpreted based on the assessment criteria for the student questionnaire results as follows.

Table 3. Student Questionnaire Assessment Criteria

Interval	Criteria
81%-100%	Very Good (VB)
61%-80%	Good (G)
41%-60%	Sufficient (S)
21%-40%	Poor (P)
0%-20%	Very Poor (VP)

Result And Discussion

Our research will focus on the development of Game-based Learning (GBL) with Generative AI (Gen AI) to explore the creativity of fifth-grade elementary school students in the implementation of science learning. The subject matter presented is "My proud region," because this material is in accordance with the cultural context and origin of the students. The development of this media uses the steps of the ADDIE model, which include: analysis, design, development, implementation, evaluation. Before developing the product, the next initial step is a needs analysis of fifth-grade students of SD Negeri 1 Kutakembaran. The needs analysis was conducted to determine the needs of research subjects for the product to be developed. Information collection in this study used interviews with fifth-grade teachers, observations, and literature studies. This information aims to determine the teachers' needs regarding what kind of GBL media with Gen AI can be used to explore students' creativity. This needs analysis stage was carried out using interview, observation, and literature review methods. Interviews with fifth-grade homeroom teachers aimed to determine the extent of teachers' needs for GBL learning media with Gen AI to explore students' creativity. Meanwhile, observations were conducted in the classroom during the teaching and learning process. The literature review was conducted by analyzing various GBL media with Gen AI that can be used to explore students' creativity.

The results of the interview were conducted with the 5th grade homeroom teacher of Kutakembaran Elementary School on July 21, 2025. In the interview with the 5th grade homeroom teacher with the initials MI and the results of the observation showed that the habituation of student creativity in schools has not been optimally implemented because the implementation of the Independent Curriculum and the Pancasila Student Profile is still in the preparation stage for use in the next school year. The results of the interview also showed that the homeroom teacher also stated that the exploration of creativity in schools has used learning media although not specifically, so the results of the study strengthen the researcher that the 5th grade homeroom teacher of Kutakembaran Elementary School needs media to explore appropriate creativity in schools. The results of the literature review of several existing GBL media with Gen AI show that GBL media with Gen AI is in accordance with the needs in exploring student creativity because it can be used in social studies learning subjects, the subject matter presented is my proud region, because this material is in accordance with the cultural context and origin of students. The following is a display of the product design that was developed.

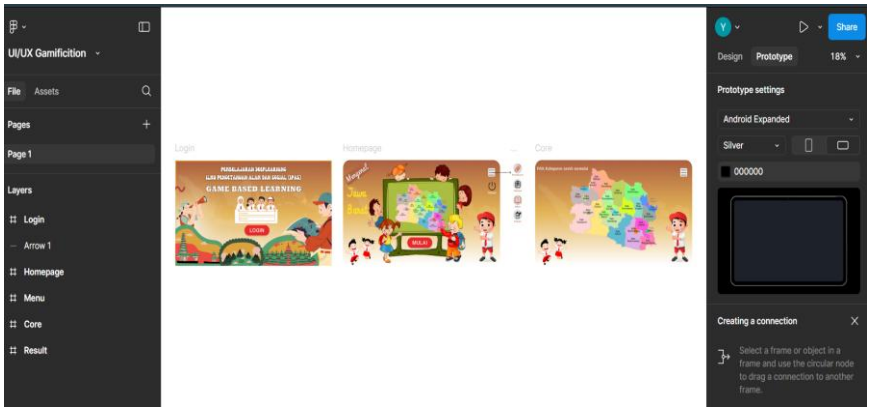

Figure 2. GBL design with Gen AI

The next stage is the validation stage for the developed media. Validation is conducted through expert testing, which assesses the feasibility of the learning media. Two lecturers were selected as experts for product validation. The expert testing instrument includes three indicators: content, design, appearance, and accessibility. The results of the expert testing are shown in Table 4 below.

Table 4. Recapitulation of Expert Validation Results

No	Expert	Score	Indicator
1	Lecture 1	75,00	Good
2	Lecture 2	80,00	Good
Average		**77,50**	**Good**

Based on the assessment given in the expert test, it is known that the average score reached 77.50 with a good category. This score indicates that the developed media is worthy of use or testing. Although the overall score given shows satisfactory results, there are several inputs from the Experts in the Lecturer group, namely the addition and selection of colors in the media that could be given more attention. Based on these inputs, improvements were made to the media content. The results of the validator assessment were then assessed for the level of relevance between validators using Aiken's V statistics. The range between the numbers obtained above is between 0 and 1.00, so the 0.91 average Aiken's V score in the validator table can be interpreted as a fairly high coefficient for each indicator. This means that each indicator contained in the GBL media product with Gen AI has good content validity.

The following are eight validated indicators of GBL media products with Gen AI, namely the suitability of the media to learning objectives; the suitability of the media to student characteristics; the ability of the media to be a learning resource; efficiency and effectiveness; safety for students; development of student activity and creativity; development of the learning atmosphere; and media quality. The results of the GBL media assessment with Gen AI are at an average Aiken's V score of 0.813, because the range of numbers is between 0 and 1.00, the number 0.813 can be interpreted as a fairly high coefficient for each indicator of GBL media with Gen AI. This is in line with the results of research (Budi Utomo, 2020) that validation of learning media influences student learning outcomes so that the media can be implemented well in the learning process in the classroom. The appearance of the revised media is shown in Figure 3 below.

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Figure 3. Final Revision Results of GBL with Gen AI

The developed learning media has also been revised, as shown in Figure 3. This aims to ensure that the learning media can attract students' interest in learning. Next, the product implementation stage is continued to assess the characteristics of the developed learning media. The learning media also displays elements of local culture. Furthermore, the characteristics of the developed learning media are measured by distributing observation sheets to teachers to gauge students' responses to the developed learning media. The results of the observation sheet analysis are outlined in Table 5.

Table 5. Results of Observation Sheet Analysis

No	Student	Score	Category
1	Student 1	80	Good
2	Student 2	75	Good
3	Student 3	100	Very Good
4	Student 4	87,5	Very Good
5	Student 5	75	Good
6	Student 6	85	Good
7	Student 7	75	Good
8	Student 8	100	Very Good
9	Student 9	70	Good
10	Student 10	60	Good
11	Student 11	80	Good

12	Student 12	60	Cukup
13	Student 13	77	Good
14	Student 14	80	Good
15	Student 15	75	Good
Average		**78,60**	**Good**

Based on the analysis of the observation sheet results, it can be seen that the average score showed good results, namely with a value of 78.60, in the Good category. This indicates that the student response after seeing and using the developed learning media was positive, students felt happy and were able to understand the material learned through the learning media. This also means that the developed media is appropriate to the students' developmental level, and the content of the media is understandable by students. The percentage of student responses to the learning media is shown in Figure 4.

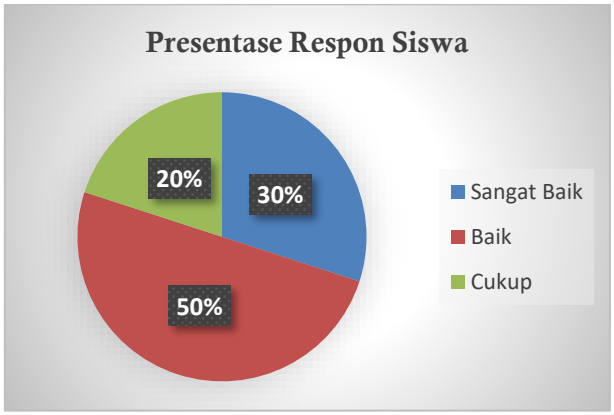

Figure 4. Percentage of Student Responses

Based on the percentages shown in Figure 4, it can be seen that the majority of students, 50%, gave a positive response. No students gave a poor or very poor response. Furthermore, based on the student creativity questionnaire at the end of the learning process using GBL media with Gen AI, it can be interpreted in the following diagram.

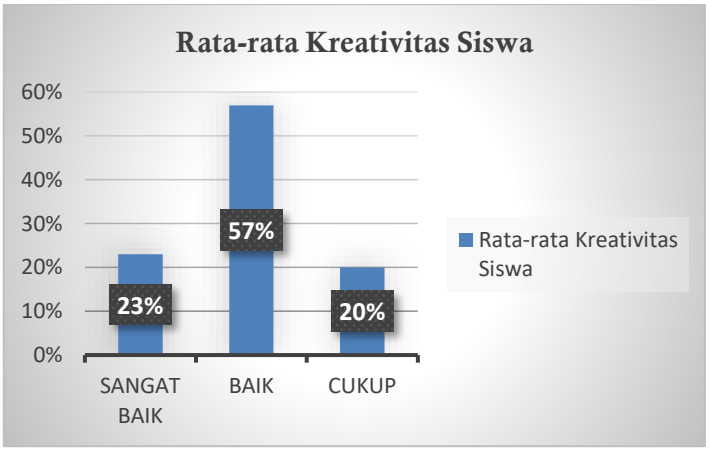

Figure 5. Recapitulation of Student Questionnaire Sheets

Based on the results of the final questionnaire on student creativity which shows that the creativity of students in grade 5 consisting of 20 students, an average of 23% of students are in the very good category in their creativity, then an average of 57% of students are stated to be good in their creativity and an average of 20% of students are stated to be quite good in their creativity, it is concluded that student creativity in the learning process through interactive

games is on average in the good category. Of course, because learning is more interactive. Proven from the analysis of the assessment on the aspect of fluency, the average student is very good in asking questions, answering questions from the teacher, and adding ideas from other friends. Furthermore, the aspect of flexibility, the average student's ability is very good in this is demonstrated by the students' activities in observing and analyzing images, resulting in different ideas among students. Furthermore, the aspect of novelty (originality) is characterized by generating ideas that others have not thought of. This is demonstrated when students engage in question and answer activities. Furthermore, in the aspect of detail (elaboration), with the observed statement indicator in the neatness of answer selection, students have been able to demonstrate neatness in fulfilling the stages of answering the evaluation. It can be concluded that the developed learning media has characteristics that are easy for students to understand, attract students' interest and enthusiasm in learning, and help students learn while playing in a fun way. This is evidenced by the results of field notes showing an increase in student enthusiasm in putting forward new ideas, answering challenges in the game, and creating imaginative solutions.

The results of this study confirm that GBL-based learning media integrated with Gen AI can enhance elementary school students' creative exploration, particularly in the context of science and science learning. This finding aligns with previous studies that emphasize the importance of technology integration in supporting 21st-century learning (Hsu & Hsu, 2024; Plass et al., 2015). The GBL media developed in this study not only provides a fun learning experience but also facilitates students' divergent, exploratory, and imaginative thinking. The main advantage of this media is its ability to provide adaptive feedback through Gen AI technology, which can generate instructions or learning challenges that are appropriate to the students' cultural context and level of understanding. This supports the findings of (Gupta et al., 2024) which states that Gen AI has great potential in accommodating the differences in student characteristics in the learning process. The fact that more than 70% of students showed increased indicators of creativity after using this media also strengthens the argument that the GBL approach with Gen AI is not only effective from a cognitive perspective but also supports students' affective and social development (Moundridou et al., 2024; Nikkola et al., 2024).

These findings have global relevance in the era of digital natives, where students worldwide require learning approaches that are responsive to technological developments. AI education aims to teach AI concepts, essential knowledge, and skills related to fundamental ideas in AI. As AI becomes increasingly prevalent in everyday life, schools and educators are beginning to recognize the importance of AI education in K-12 schools. (Yeter et al., 2024). Study (Lase, 2016) highlighted that AI-powered learning platforms can increase student learning motivation by up to 30%, demonstrating that AI not only serves as a support tool but also increases student engagement. This supports the study's findings on increased student enthusiasm. These findings also address criticisms of conventional learning practices in Indonesia, which tend to emphasize memorization and do not fully provide space for the development of student creativity (Commodari et al., 2024; Ika Sari et al., 2024). Through this technology-based educational game, students are given the opportunity to actively participate in the learning process, experimenting, and freely expressing their ideas. This research demonstrates that the use of game technology combined with Gen AI can overcome the limitations of science and science learning, which has traditionally been abstract and theoretical. Through interactive visualizations, local cultural contexts, and creative challenges tailored to student characteristics, science and science learning becomes more lively and meaningful

(Asmayawati et al., 2024). These findings reinforce Piaget and Vygotsky's constructivist theories, which emphasize learning through exploration and social interaction. Gen AI's adaptation to the local cultural context of "My Pride Region" reinforces the concept of culturally responsive teaching proposed by Gupta et al., (2024) where learning becomes more meaningful when connected to one's cultural identity. Research shows that engaging in culturally affirming practices across a range of subjects, including math and science, results in positive improvements in students' understanding (Patras et al., 2024). This confirms the importance of integrating local culture in AI learning.

However, this study also reveals the importance of localizing learning content. The results of a study on AI implementation in Indonesia indicate that the Indonesian Ministry of Education will implement AI learning for elementary and secondary school students starting in the 2025-2026 academic year, but still faces significant challenges in infrastructure and human resource readiness. Data from the Ministry of Education reveals that only around 30% of schools in Indonesia have adequate internet access to support technology-based learning initiatives (Fauziddin, 2024). The "My Region, My Pride" material is not simply an engagement strategy, but rather an epistemological foundation that allows students to construct knowledge from their concrete experiences. The program focuses on offering culturally responsive pedagogy to better motivate students through relatable learning experiences. In the context of AI, this approach is particularly useful given that young learners can easily assimilate new concepts (Eguchi et al., 2021). The concept and implementation of CRT in learning is still dominated by the United States, its most prominent organizations, and its most prominent figures. This poses a challenge for any country, especially Indonesia, a multicultural nation (Patras et al., 2024). This research makes a significant contribution to addressing these challenges by integrating local wisdom within a global technological framework.

Previous research has shown that while computational thinking is crucial for modern education, integrating artificial intelligence into learning poses challenges due to its complexity. (Wang et al., 2024). These findings broaden understanding by demonstrating that GBL with Gen AI is not only cognitively effective but also capable of simultaneously developing students' affective and social dimensions. This shift underscores the growing emphasis on pedagogical integration of generative AI (Denny et al., 2024), This paper fills the gap in the literature that has long separated learning technology from holistic creativity development. Most previous research on GBL has focused on Western contexts with diverse student characteristics. AI carries a significant risk of bias, and while some efforts to address it remain underdeveloped and largely ineffective, current AI approaches aggregate data from many other individuals to develop recommendations. Training data reflects average behavior, a WEIRD (Western, Educated, Industrialized, Rich, and Democratic) (Sharma & Bozkurt, 2024). This research reveals that a one-size-fits-all approach is ineffective in the Indonesian context, where cultural factors, language, and local characteristics play a crucial role in learning effectiveness.

A systematic literature review shows that most AIED research originates from China and the United States. Furthermore, when discussing AIED, the focus is strongly on higher education, with less attention paid to special education (Wang et al., 2024). This confirms that AI research in education is still dominated by developed countries and focused on higher education. Therefore, this research makes an important contribution to the context of basic education in Indonesia. Previous literature tends to emphasize the technological aspects without considering the underlying pedagogy. The lack of research in identifying the most appropriate methods and strategies for developing adaptive and personalized AI educational interventions hinders wider AI adoption, which, combined with a lack of AI and digital literacy among

teachers, is hampering the wider adoption of AI (González-Calatayud et al., 2021). The integration of AI into the ADDIE model demonstrates the potential to address these limitations by streamlining and improving the evaluation process, providing greater capacity and value to content creation.

This research not only confirms the potential of technology in learning but also reveals the complexities of integrating technology, pedagogy, and culture to create transformative learning experiences. These findings challenge the dichotomy between technology and humanism in education, demonstrating that both can work synergistically to optimize students' creative potential, aligning with the view that AI is not just a challenge; it is an opportunity to address long-standing problems and enhance human potential and creativity (Sytniakivska & Kulish, 2024). With recent references showing that 86 percent of educators believe that teaching students how to use generative AI for creative or multimedia projects will increase their chances of getting a job in a growing number of careers (Preciado-Ortiz et al., 2024), This research provides an empirical contribution to this optimism by demonstrating the concrete results of implementing GBL with Gen AI in the Indonesian context. Furthermore, this research offers hope and direction for a transformation of Indonesian education that is not only modern but also meaningful, not only global but also local, not only efficient but also humane. This is the true contribution of this research: offering a middle ground between technological advancement and time-tested educational wisdom, while addressing the challenge that by focusing too much on what can go wrong with AI, we may overlook what can go right.

These findings confirm that perhaps the greatest threat to education in the AI era is not the inherent risks of technology, but our reluctance to fully explore and wisely harness AI's immense potential to drive a new era of learning, teaching, and development (Gupta et al., 2024). This research demonstrates that, with the right approach, AI can be a catalyst for more creative, inclusive, and meaningful learning. Thus, the results of this study have strategic implications for educational practices in Indonesia, particularly in providing contextual, enjoyable, and creative learning for the younger generation in the digital age. This innovation aligns with the policy direction of the National Research Master Plan (RIRN) and Freedom to Learn, which encourage digital transformation and improve the quality of technology-based learning (Kemendikbudristek, 2023).

Conclusion

Game-Based Learning (GBL)-based learning media integrated with Generative Artificial Intelligence (Gen AI) to develop student creativity has been proven valid and feasible to be implemented in learning. The validity of the media is demonstrated through expert assessment with an average score of 77.50 (good category) and the results of observations of media characteristics with a value of 78.60 (good category). Student responses show a positive pattern with 30% giving very good responses, 50% good responses, and 20% sufficient responses. This study proves that the implementation of GBL-Gen AI is effective in exploring and enhancing the creativity of elementary school students in science learning. The developed media successfully creates a fun and interactive learning experience, provides space for freedom of expression for students, and stimulates divergent, imaginative, and solution-oriented thinking skills. The integration of the local cultural context not only increases student engagement but also strengthens cultural identity in the learning process.

These findings confirm that technology, when utilized with the right approach, can be a transformative instrument in addressing the challenges of 21st-century education, particularly in fostering creativity at the elementary level. These findings have proven to have significant potential to support contextual learning, personalize learning experiences, and encourage the development of creative, adaptive, and competitive Indonesian human resources. Further research is recommended to develop similar media for other competencies and to validate their impact across various educational settings and a more diverse student population, with the hope of sustainably improving the quality of Indonesian education.

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