

Development of gamification-based interactive media in natural and social science subjects in elementary schools

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Submitted:
26-12-2025

Accepted:
07-03-2026

Published:
10-10-2026

Abstract: This study aims to develop gamification-based interactive media for the Natural and Social Sciences (IPAS) subject in elementary schools. The study employs the Research and Development method. The subjects were 19 fourth-grade students at State Elementary School 5 Lakudo. A needs analysis revealed that both students and teachers required interactive, multimodal, and gamification-based IPAS learning media to accommodate visual, auditory, and kinesthetic learning styles and to enhance engagement, conceptual understanding, and learning effectiveness. Validation results indicated scores of 83% (highly valid) from media experts and 72% (valid) from content experts. Practicality analysis showed that the product was highly practical based on student and teacher feedback. The developed media demonstrated a positive impact on student learning outcomes. The results indicate that the gamification-based interactive media was effective in improving student learning outcomes in IPAS (N-gain = 0.85). Thus, the development of this gamification-based interactive media proved valid, practical, and effective in enhancing elementary school students' learning outcomes. Direct feedback in gamification, in the form of scores, challenge completion, or visual indicators of success in the media, has provided positive reinforcement that maintains students' motivation to complete each stage of the learning process.

Keywords: Interactive media, learning style, motivation, science and social learning

Abstrak: Penelitian ini bertujuan untuk mengembangkan media interaktif berbasis gamifikasi untuk mata pelajaran Ilmu Pengetahuan Alam dan Sosial (IPAS) di sekolah dasar. Penelitian ini menggunakan metode Penelitian dan Pengembangan. Subjek penelitian adalah 19 siswa kelas IV di SD Negeri 5 Lakudo. Analisis kebutuhan menunjukkan bahwa baik siswa maupun guru membutuhkan media pembelajaran IPAS yang interaktif, multimodal, dan berbasis gamifikasi untuk mengakomodasi gaya belajar visual, auditori, dan kinestetik, serta untuk meningkatkan keterlibatan, pemahaman konsep, dan efektivitas pembelajaran. Hasil validasi menunjukkan skor 83% (sangat valid) dari ahli media dan 72% (valid) dari ahli materi. Analisis kepraktisan menunjukkan bahwa produk tersebut sangat praktis berdasarkan umpan balik dari siswa dan guru. Media yang dikembangkan memberikan dampak positif terhadap hasil belajar siswa. Hasil penelitian menunjukkan bahwa media interaktif berbasis gamifikasi tersebut efektif dalam meningkatkan hasil belajar siswa pada mata pelajaran IPAS (N-gain = 0,85). Dengan demikian, pengembangan media interaktif berbasis gamifikasi ini terbukti valid, praktis, dan efektif dalam meningkatkan hasil belajar siswa sekolah dasar. Umpan balik langsung dalam gamifikasi, baik berupa skor, penyelesaian tantangan, maupun indikator visual keberhasilan pada media, telah memberikan penguatan positif yang menjaga motivasi siswa untuk menyelesaikan setiap tahapan proses pembelajaran.

Kata kunci: Media interaktif, gaya belajar, motivasi, pembelajaran sains dan sosial

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INTRODUCTION

Natural and Social Sciences (IPAS) is a subject that plays a crucial role in developing students' understanding of natural and social phenomena and their relevance to everyday life. Learning natural and social sciences in elementary schools often faces various challenges, ranging from a lack of student interest to limited learning media that can present

the material in an engaging and easy-to-understand manner (Fitriyanti et al., 2025; Oktaviani et al., 2026). The abstract nature of science material and the richness of social studies concepts and facts often make it difficult for students to understand and relate them to everyday life (Nasir et al., 2024; Wanti & Chastanti, 2023). Furthermore, conventional learning methods that lack active student participation tend to make the learning process monotonous and boring.

Based on empirical findings obtained at one elementary school, students' learning outcomes in IPAS showed low achievement. This indicates the need for innovation in more engaging and interactive learning methods. Furthermore, there is potential for adequate use of information technology at the school, such as the availability of laptops, projectors, and a stable network. However, these technological devices are still rarely used in the learning process. This situation indicates an opportunity to optimize the use of technology in science and studies of learning. Furthermore, observations at other elementary schools found that the learning process in both schools was still dominated by the use of conventional learning media such as whiteboards, videos, and simple PowerPoint presentations. Despite this, both schools have supporting facilities in the form of Chromebooks (laptops) provided to support technology-based learning. However, the use of these devices is still very minimal and has not been optimally integrated into the classroom learning process.

Learning in elementary schools plays a crucial role in forming the foundation of students' understanding of various science concepts (Nasir et al., 2024; Noryanto et al., 2026), including science and studies. At this stage, students tend to understand material more easily if it is presented in an engaging, concrete manner and involves direct experience. However, in many cases, learning in elementary schools is still dominated by lecture methods and the use of textbooks as the primary source, which can lead to a lack of active student engagement (Aminah & Dwi Setyowati, 2024; Haryanti et al., 2026; Nabila et al., 2025). Consequently, students often struggle to understand the material in depth, especially when the material being taught is abstract (Syahrir et al., 2025).

The appropriate learning media is crucial in supporting elementary school learning because it helps students understand the material and provides concrete experiences (Misrianah et al., 2026). Various studies have shown that interactive multimedia is valid, practical, and effective in improving understanding of science concepts because it adapts to students' learning characteristics and increases interaction in learning (Hermita et al., 2022; Sarira et al., 2025). The advantage of interactive media also lies in its ability to increase the interest, motivation, and learning outcomes of elementary school students, as demonstrated by increased learning outcome scores (Barus et al., 2025; Damopolii, 2025; Sipahutar & Harahap, 2025), as well as providing a significant positive influence on students' science learning outcomes (Ulya et al., 2024). Therefore, the development of gamification-based interactive media is a strategic alternative for creating science learning that is interesting, challenging, and in accordance with the characteristics of elementary school students' cognitive development (Budiarto & Jazuli, 2021; Oktaviani et al., 2026).

Gamification is a learning approach that integrates game elements into the learning process to increase student motivation and engagement (Ahmad et al., 2026). Elements such as points, badges, challenges, rankings, and prizes can create a more enjoyable and competitive learning experience, so students feel more motivated to complete tasks and achieve learning goals (Sucipto et al., 2026; Toda et al., 2019). The application of

gamification provides an interactive, fun learning experience and social interaction tailored to the needs and improves elementary school student performance (Arif et al., 2026). Gamification in elementary school science learning effectively improves learning outcomes, scientific literacy, motivation, and student engagement through digital-based interactive media (Aji et al., 2025; Mulyaningsih et al., 2026; Novitasari et al., 2026; Sebayang & Tarigan, 2026). Thus, gamification-based media has the potential to improve elementary school student learning outcomes. Gamification-based interactive media is an innovation in learning that combines interactive features with game elements to create a more engaging and effective learning experience. This media allows students to actively participate in learning through challenges, points, badges, and various other game features designed to increase their motivation and engagement. With gamification elements, students not only passively acquire knowledge but are also encouraged to explore, complete challenges, and achieve learning targets in a more enjoyable way. Thus, gamification-based interactive media not only improves students' understanding but also helps them develop critical thinking, problem-solving, and independence skills in learning. This media is a more effective and engaging solution in improving student learning outcomes. This study aims to develop gamification-based interactive media for natural and social science subjects in elementary schools.

METHOD

The type of research used was Research and Development (R&D). This research was conducted in the odd semester of the 2025/2026 academic year at Lakudo 5 Public Elementary School. This research was conducted from September to November 2025. The school was chosen as the research location because it has low science learning outcomes, limited learning media, and openness to innovation. The characteristics of its students are in line with the targets of gamification media that emphasizes fun and interactive learning, so this school is considered appropriate for testing the effectiveness of the media developed.

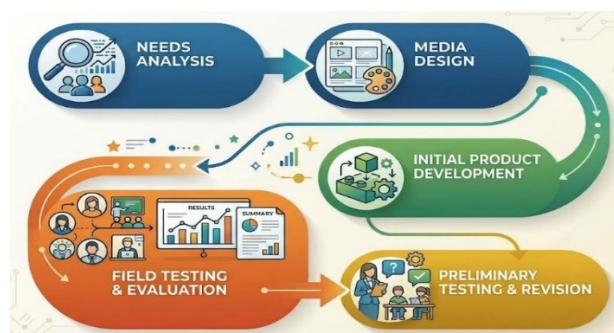


Fig. 1. Development procedure

The participants in this research were 19 4th grade students at Lakudo State Elementary School 5 in the 2024/2025 academic year, as well as one science teacher and two media experts. The sampling technique used in this study was purposive sampling, considering that the selected subjects were deemed capable of providing appropriate and relevant data to the research objectives.

Data collection techniques used in this study included observation, questionnaires, and learning outcome tests. The initial observations were conducted to determine the need

for gamification-based interactive learning media and to provide supporting information for the research conducted at Lakudo State Elementary School 5. The data collection questionnaires used in this study included a material and media validation questionnaire by experts to determine the validity of the media, as well as teacher and student response questionnaires. The questionnaires were administered to determine the practicality of using gamification-based interactive learning media. The tests included a pretest and a posttest. The tests consisted of multiple-choice questions about the fourth-grade science subject in the even semester.

The data analysis process was carried out after the data were obtained from the research results. A qualitative descriptive analysis was performed by classifying information derived from qualitative data, which included feedback, comments, critiques, and recommendations for improvement gathered via questionnaires. The findings from this investigation were then used to modify the gamification-oriented interactive educational media product. Statistical data analysis was used to evaluate data represented as scores or numerical values derived from validation questionnaires completed by material and media/design experts, teacher response surveys, student response surveys, and assessments of learning outcomes. Three categories of quantitative descriptive analysis were employed: validity analysis, practicality analysis, and effectiveness analysis. The effectiveness analysis used was the N-Gain (Normalized Gain) test.

Table 1. Expert validation and practicality assessment categories

Achievement Criteria Value (%)	Ideal Level
80% - 100%	Very valid/practical
60% - 79 %	Valid/practical
40% - 59 %	Quite valid/practical
20% - 39%	Less valid/practical
0 % - 19 %	Not valid/practical

(Dita et al., 2023; Nusantara et al., 2021)

RESULTS AND DISCUSSION

Based on empirical data from the needs analysis at the UPT SDN 5 Lakudo, diverse student learning styles were identified, indicating a need for a multimodal pedagogical approach through the development of gamification-based interactive media. Visually, the majority of students understand material more easily through images, diagrams, videos, and animations, so learning media should prioritize dynamic and concrete visualizations. Auditorily, the role of the teacher and verbal interaction remain crucial, so the developed media should be complemented with narrative elements or audio explanations to support learning. Meanwhile, kinesthetically, students tend to be more active and require direct involvement through practical activities, games, and interactions to prevent boredom. Therefore, students at UPT SDN 5 Lakudo require adaptive, interactive learning media that integrates visual, auditory, and kinesthetic elements to enhance student understanding and engagement in the learning process.

The needs analysis indicates that elementary school students require more visual, interactive learning media that allows for direct involvement due to their predominantly visual-kinesthetic learning characteristics. Teachers also require practical, engaging media

that can explain science concepts concretely to address the current tendency for monotonous learning. Taking into account the objectives of science learning and the real-world conditions in schools, gamification-based interactive media is a relevant and appropriate solution to support the learning process. Analysis of teacher perspectives at the Lakudo Elementary School Technical Implementation Unit (UPT SDN Lakudo) indicates that the need for innovative learning media stems not only from students but also from teachers as managers of the learning process. Empirical data demonstrates teachers' awareness of the limitations of conventional science learning methods and their readiness to transition to gamification-based digital media. Teachers assess conventional learning as insufficiently engaging students, and they require media that supports a more contextual exploration of natural and social concepts. In terms of technological readiness, teachers have access to digital devices, are confident in using technology, and are motivated to learn interactive media. However, specialized training is required for optimal implementation of gamification. Teachers also expect supporting features such as automated evaluation to improve assessment efficiency. Therefore, the development of gamification-based interactive media is a strategic step that must prioritize two main aspects: pedagogical reliability in presenting science material in an integrated manner and technical efficiency through user-friendly design that supports teachers' tasks. The design phase for gamification-based interactive media for Natural and Social Sciences subjects in elementary schools is based on the results of a needs analysis conducted on students and teachers, and refers to the basic competencies that must be achieved. At this stage, the media design is developed by determining the learning flow, navigation structure, gamification elements used, interface display, and types of interactive activities that are appropriate to the learning characteristics of elementary school students. The design process also includes the preparation of storyboards, learning scenarios, and the selection of visual content that supports student engagement. This section presents in detail the design concepts that form the basis for media development, so that the resulting product is not only visually appealing but also aligned with the objectives of science learning and easy to use by both teachers and students (Ahmad et al., 2026; Arif et al., 2026). The following is a prototype of gamification-based interactive media for Natural and Social Sciences subjects in elementary schools.

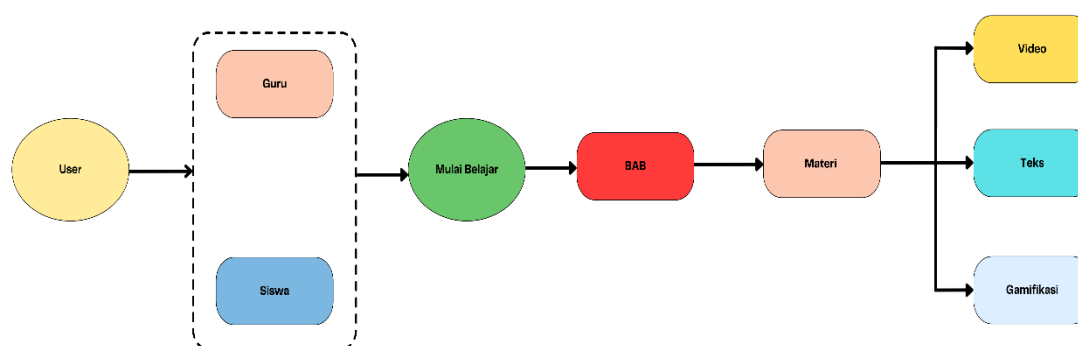


Fig. 2. Gamification-based interactive media prototype

This interactive media design utilizes Google Sites as the primary platform, enabling the integration of text, visuals, audiovisuals, and gamification activities into a single learning flow. Visual content was developed using Canva, while supporting videos and animations

were taken from YouTube and embedded directly into the learning pages. The gamification component was developed through Wordwall, which provides interactive games with a points system, timer, and levels, providing a competitive and enjoyable learning experience for students. The selection of these platforms and tools was made to ensure the media is easily accessible through commonly used school devices, such as Chromebooks, with vertical scroll-based navigation that suits the access characteristics of elementary school students. The media display is designed using a brightly themed template with child-friendly, semi-realistic cartoon illustrations. Each page has a consistent layout structure consisting of a visual header, a brief explanation section, a video or animation playback area, and a gamification activity section. The use of thematic icons in each chapter, such as leaves, ice cubes, magnets, and lamps, serves as visual markers that facilitate orientation and strengthen concept associations in the science subject. The color palette used is light blue, bright green, soft yellow, and orange, adjusted to increase student focus while maintaining an attractive feel.

No	Sketch	
1.		
Text, Images and Video	Description	Action
Text, Image	Home Page The Home Page is the initial interface of the application, serving as the user's entry point. The design is simple, clean, and focused on one main button. The "Start Learning" button is prominently placed for immediate visibility and directs users to the next page. The background and visual elements are selected to create a user-friendly and user-friendly experience for elementary school students.	1. The "Start Learning" button serves as the primary navigation to the Menu Page. 2. The user presses the button to begin learning. 3. The system responds by redirecting to the next page without delay.

Fig. 3. Example of storyboard

The developed storyboard comprehensively depicts the user interaction flow, from the homepage to the learning content pages. Each section of the storyboard demonstrates that the media is designed with a linear and intuitive navigation structure, where users are first guided through the "Start Learning" button to a menu page displaying a list of chapters in the form of easily recognizable icons. This navigation pattern demonstrates a systematic effort to guide students through the learning flow without confusion, while ensuring logical and efficient transitions between pages.

The design of the gamification-based interactive media in this study was based on the results of a needs analysis and empirical findings in three elementary schools, and reinforced by the principles of instructional design and gamification design. The integration

of Google Sites, Canva, YouTube, and Wordwall into the media structure is a design decision that aligns with student characteristics, the objectives of science learning, and the curriculum's demands for active and contextual learning.

The findings indicate that students have a high reliance on visual displays, with a dominant percentage choosing images, illustrations, and attractive displays as the media that best aid conceptual understanding. This aligns with the view that designing learning media must consider students' abilities to acquire information and their tendencies in processing material (Handaryani et al., 2026). To address this need, Canva was used as the primary platform for developing visual components, including icons, illustrations, and page layouts. This consistent aesthetic element also reflects the characteristics of technical elements in game design, which emphasize the importance of visual aesthetics and user experience (Ahmad et al., 2026).

Google Sites was chosen as the primary media platform because it supports structured learning planning and development. This choice aligns with the view that design areas should include effective material planning that is relevant to learning objectives (Mustofa et al., 2024). The integration of YouTube videos was used to strengthen students' understanding of abstract science concepts. Research findings indicate that students benefit greatly from audiovisual presentations, making video embedding an essential part of the design. This decision aligns with the view that interactive multimedia supports a multi-sensory environment that can help students understand material more easily (Volpe & Gori, 2019). Furthermore, teachers' need for practical and easy-to-use media is also met through embedded videos that do not require additional applications.

Wordwalls are a core component in gamification implementation. Field findings indicate that students enjoy challenges, points, level-based games, and activities that provide immediate feedback. These elements align with the concept of gamification as a systematic process of implementing points, badges, levels, and leaderboards (Ahmad & Khan, 2024). Wordwalls offer game formats such as matching, maze chase, grouping, and multiple choice that are not only engaging but also include challenges, rewards, a point system, and opportunities for trial and error (Siregar et al., 2025). Thus, the use of Wordwalls directly addresses students' needs and strengthens their motivation to learn.

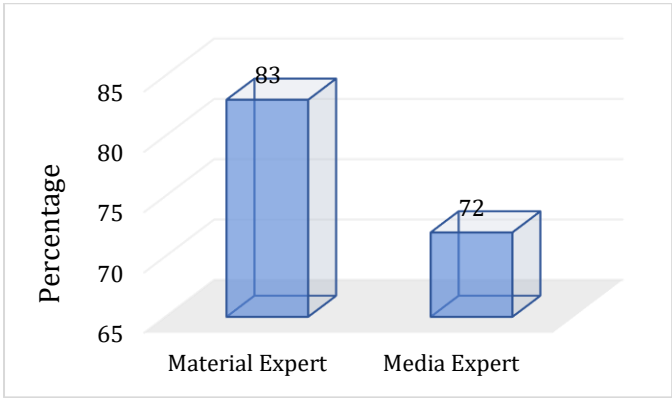
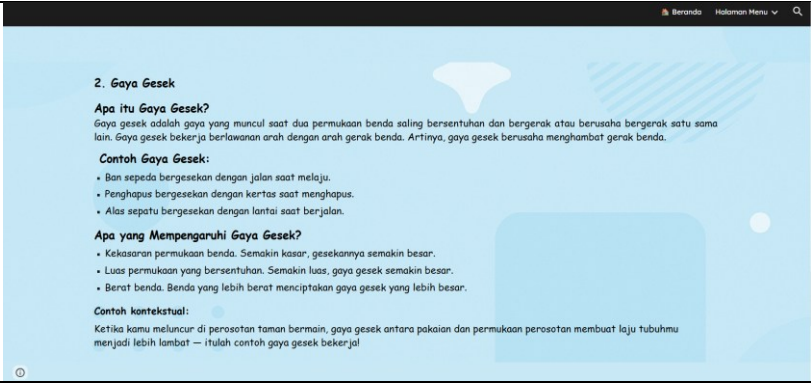


Fig. 4. Outcomes of validation by material and media experts

Based on the assessment results from material experts, this media obtained a total score of 50 out of 60 with a feasibility percentage of 83%, which places it in the very valid category and is suitable for use as a learning resource. These results indicate that the

material has met the objectives of learning science, is arranged with the correct sequence of concepts, and is in accordance with the level of cognitive development and characteristics of elementary school students. The linguistic aspect is also considered very good because the presentation of the material uses communicative, clear, and easy-to-understand language for students, thus helping them connect concepts with real experiences in a more contextual way. Based on the results of the media expert assessment, the product obtained a total score of 55 out of a maximum score of 76, with a validity percentage of 72%. This percentage places the media in the "Valid" category, which means that the media has met most of the feasibility criteria, but still requires improvements in several visual components to achieve optimal quality.

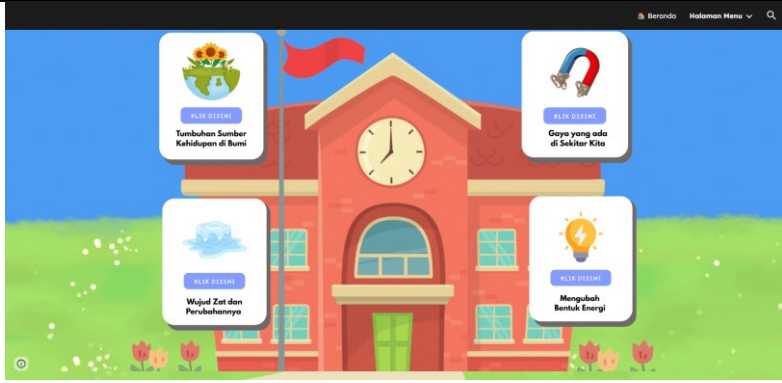
Table 2. Comments and revisions based on the results of validation by material experts

No	Suggestion
1	The material described needs to be more coherent. Appearance after revision
	
2	Create a more contextual and less confusing example. View after revision
	

The validator assessed that the presentation of the material needed to be made more coherent so that the flow of concepts was easily understood by students. This indicated that the previous material structure was not fully systematic, necessitating a reorganization of the discussion sequence. The validator emphasized the need to provide more contextual and less confusing examples, so that students could relate the concepts learned to real-life situations. All of this input has been followed up

through a revision process so that the material appears clearer, more structured, and more suited to the characteristics and needs of elementary school students.

Table 3. Comments and revisions based on media expert validation results

No	Suggestion
1	On the "Menu Page" page, the title of the material located below the white box is small and cannot be read clearly due to the background. It would be better to place the title in the white box.
Tampilan sesudah revisi	
	
2	In the artificial propagation of plants section, images describing propagation methods should be replaced with a white background to make it easier for users to read the information and procedures.
View after revision	
	

First, the validator assessed that the material title on the menu page was not clearly visible due to its small size and low contrast against the background. Therefore, it was recommended that the title be placed directly within a white box for greater visibility and readability. Second, in the material on artificial plant propagation, the validator suggested changing the image background to white to improve information clarity and make it easier for students to understand the propagation steps.

The validity of gamification-based interactive media was assessed through validation by material experts and media experts, a crucial step in development research. Several notes were provided for improvement, such as the need to clarify

the sequence of materials, explicitly state learning objectives, and add contextual examples and additional visualizations to strengthen student understanding. These notes were technical in nature and did not reduce the material's feasibility but rather reinforced the direction of product improvement. These results align with previous findings showing that interactive media tend to achieve high validity levels in terms of material substance (Putri et al., 2024).

Empirical data indicates that the developed gamification-based interactive media met feasibility standards in both material and media aspects. The validation of the material, which reached the very valid category, and the validation of the media, which fell into the valid category, indicate that the product can be used in science learning, while also providing a clear direction for improvement before entering the practicality and effectiveness testing phase. Thus, these validation results confirm that the media has a strong foundation of quality and is ready to be tested in the context of real-world classroom use.

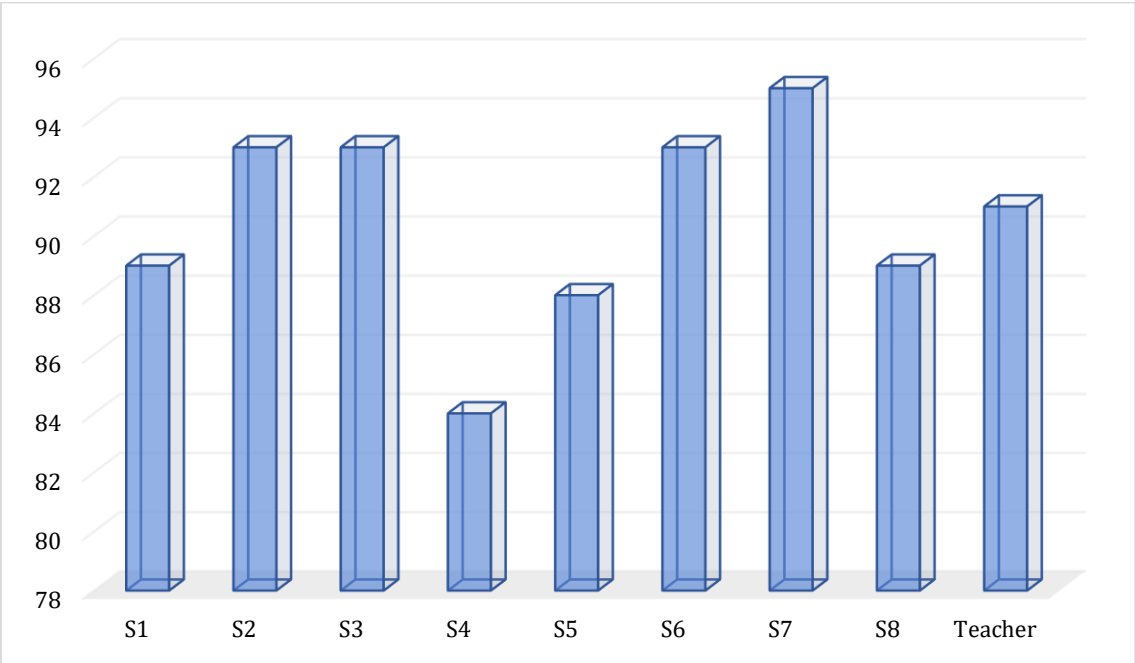


Fig. 5. Results of practicality test

Based on the recapitulation of the eight respondents (S1-S8), the gamified interactive media can be considered extremely practical, with an individual achievement percentage between 84% and 95% (Figure 5). Thus, based on the assessment results, the gamified interactive media can be placed in the category of “Very Practical.” The analysis of the indicator of Practicality also showed that the developed media does not have significant barriers to use. The media is characterized by a high degree of learnability; that is, the respondent-managed students quickly grasped the essence of the media functioning without the need for additional explanations and training. From the perspective of modern pedagogy, such a high level of learnability is associated with the growing need for

independent learning. A teacher’s assessment of the practicality of the developed gamified interactive media was 51 out of 56, which corresponds to 91%. Thus, the media can be classified as “very practical.” The practicality assessment also showed that students considered the media easy to use, intuitive, and clear in terms of information perception. Most respondents indicated that they could work with the developed media without the teacher’s assistance, which highlights the high usability of the product. In addition, the indicator of Affective has proven to be extremely high and has received high marks from the respondents for the media’s ability to make learning more enjoyable, exciting, and challenging. Moreover, students indicated that using the developed media is associated with increased motivation and interest in learning and a desire to use it again. These findings indicate that the media is not only practical but also capable of creating engaging and meaningful learning.

The practicality results obtained in this study are consistent with previous findings. Ahmad et al. (2026) stated that the average practicality rating of the media by teachers and students exceeded 80%, indicating a very practical category. The consistency of these findings with the empirical data in this study indicates that gamification-based interactive media tends to be well-received by users due to its ease of use, attractive appearance, and benefits in supporting the learning process. Therefore, it can be concluded that the gamification-based interactive media developed in this study meets the criteria of practicality, from both teachers' and students' perspectives. This media is suitable for use in science learning, although improvements in the flexibility aspect of online-offline access need to be considered for further development.

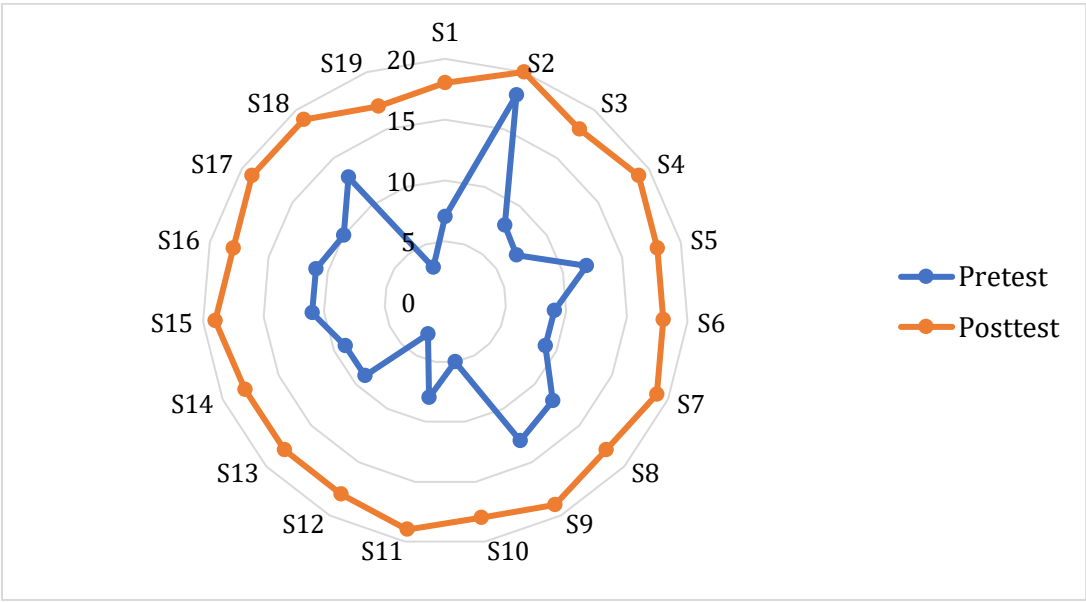


Fig. 6. Students' pretest and posttest scores

The effectiveness of gamification-based interactive media was demonstrated by measuring improvements in students' cognitive competence using the Normalized Gain (N-Gain) parameter, comparing scores before and after treatment (posttest). Based on quantitative data from 19 respondents, the developed media demonstrated a proven intervention impact on student learning outcomes. The average N-Gain achieved by the

class was 0.85. Referring to Hake's (1998) criteria, this figure places the media's effectiveness in the "High" category ($g > 0.7$). This means that the improvement in learning outcomes was not merely a statistical coincidence, but rather a direct result of the efficacy of the implemented learning media. This consistency of effectiveness is also evident in the distribution of individual N-Gains, where all students (100% of the sample) achieved N-Gains above 0.70, with a range from 0.75 to 1.00.

The results of the study indicate that gamification-based interactive media is effective in improving student learning outcomes in science subjects. This effectiveness is evident not only in the significant improvement in grades but also in the positive responses of students. Thus, the developed media is suitable for use as an innovative alternative to support science learning in elementary schools. Improved learning outcomes with a high N-Gain indicate that interactive media effectively supports conceptual understanding (Kasman et al., 2026). The N-Gain value in this study confirms that the developed gamification-based media has excellent effectiveness. Furthermore, the media's effectiveness is also supported by an increase in the number of students achieving learning mastery.

Technology-based learning has also been shown to improve students' abilities to search for, evaluate, and use information (Abdan et al., 2026; Pratiwi et al., 2026). This is evident in the learning process using gamification media, where students are required to understand instructions, complete challenges, and navigate features independently. These skills support improved understanding, which is then reflected in posttest scores. The media's effectiveness is also inseparable from the use of gamification, which has been shown to increase participation, knowledge retention, and critical thinking skills (Gacus & Juangco, 2026). This media also provides elements of challenges, points, and feedback that keep students more engaged and enthusiastic about completing learning activities. Gamification also creates a fun and interactive learning environment, making content easier to access and understand. This is reinforced by the findings of student practicality in this study, where the majority of students considered the media engaging, easy to use, and made learning more enjoyable. This increased motivation has a direct impact on learning outcomes.

From a multimedia perspective, Sarira et al. (2025) found that interactive multimedia at the elementary school level is highly feasible, practical, and engaging. Products that utilize multisensory elements can also assist students with learning difficulties (Komalasari et al., 2019; Volpe & Gori, 2019). The gamification media developed in this study uses a combination of visuals, audio, and interactive activities, thus helping various types of students understand the material more effectively. This benefit is reinforced by research by Tampubolon and Tampubolon (2026), who explained that interactive learning media increases motivation and engagement because it provides students with the flexibility to learn according to their individual learning styles. In our study, students felt more enthusiastic and focused during gamification-based learning.

Immediate feedback in the form of scores, completed challenges, or visual displays of success in this study's gamification media provides positive reinforcement that keeps students motivated to complete each stage of learning. Furthermore, research by Kasman et al. (2026) also shows that interactive technology-based media is considered effective and easy to use by both teachers and students. This indicates that responsive, simple, and

intuitive media design has a significant potential to positively impact various student characteristics.

CONCLUSION

Research findings indicate that elementary school students require visual and interactive learning media that foster direct engagement, aligning with their visual-kinesthetic learning styles. Teachers seek practical and engaging media to explain Natural and Social Sciences (IPAS) concepts concretely, aiming to overcome the monotony associated with current teaching methods. Expert validation confirms the validity of the gamification-based interactive media. Feedback from students and teachers regarding its implementation demonstrates a high level of practicality. Gamification-based interactive media is effective in improving IPAS learning outcomes for elementary school students; this effectiveness is evident not only in significant grade improvements but also in the students' positive responses during the learning process.

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