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Jurnal Prima Edukasia, 13 (3), 401-414

Development of Unity-based smart board Media to Improve Science and Social Studies Learning Outcomes

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Received: 5 June 2025; Revised: 16 June 2025; Accepted: 30 September 2025

Abstract: The low learning outcomes of students regarding the material on changes in the form of objects and the limited application of learning media are issues that need immediate attention in teaching Science and Social Studies Learning in elementary schools. This study aimed to develop and evaluate the feasibility and effectiveness of Unity-based smart board media to enhance the learning outcomes of grade IV Science and Social Studies Learning students regarding changes in the form of objects. Data were collected through observation, surveys, interviews, and documentation. Non-test techniques used in this study included interviews, observations, documentation, and questionnaires. The results indicated that the Unity-based smart board media met the eligibility standards, with media expert scores of 92.5% and material expert scores of 90.04%, indicating high feasibility. The fourth-grade teacher's response rate averaged 93.75%, and the student response rate averaged 94.79%, both of which are considered feasible. The t-test results showed a significance value (2-tailed) of 0.000, which indicates that Ha is accepted while Ho is rejected. The N-gain is 0.6536, which falls within the moderate criteria. Based on the study's results, it can be concluded that the developed Unity-based smart board media is feasible and effective for improving the learning outcomes of grade IV Science and Social Studies Learning regarding the material on changes in the form of objects, so that it can be a reference for teachers in designing interactive learning on various Science and Social Studies Learning materials, increasing student motivation and engagement in learning.
Keywords: smart board, Unity, science and social studies learning, learning outcomes

How to Cite: Liani, S. A., & Tyas, D. N. (2025). Development of Unity-based smart board media to improve science and social studies learning outcomes. *Jurnal Prima Edukasia, 13*(3), 401-414. DOI: https://doi.org/10.21831/jpe.v13i3.86268

Introduction

Education is a conscious effort by educators and parents to guide students in developing their full potential to become well-rounded, high-quality individuals (Darma et al., 2025). Education is the foundation supporting a person's life and a major factor in developing human quality and national progress. According to Rakhmawati et al (2024), implementing systematic learning enables the teaching and learning process to run optimally, with teachers acting as facilitators who motivate and foster students' interest in learning. This view aligns with the pedagogical concept that emphasizes the importance of the teacher's role in directing learning interactions, but differs from the view of Osberg & Biesta (2021), who see education as an entity that emerges with its values and directions, not merely an instrument to achieve external goals. From this perspective, the educational process is not only guided by the teacher's plan but also develops naturally through interactions between teachers, students, and the learning environment, so that experiences, creativity, and learning objectives emerge dynamically. The teacher is a facilitator in developing students' higher-order thinking skills and teacher professionalism to optimize students' potential (Amin et al., 2025; Malik & Chusni, 2018).

Currently implemented in educational units, science and social science are integrated into a single subject referred to as Science and Social Studies Learning (IPAS in the Indonesian context). According to Masrifah & Setyasto (2024), IPAS is an integrated subject that examines living and inanimate objects,

DOI: https://doi.org/10.21831/jpe.v13i3.86268

their interactions, and the relationship between humans and their environment. However, in practice, IPAS learning in elementary schools remains ineffective because the material presented is informative and requires memorization, and teachers also face limitations in using various learning media (Putri & Wulandari, 2025). Evidence from the field indicates that, in elementary school science education, teachers still rely on conventional methods, with learning resources limited to books and pictures. Thus, the material delivery tends to be informative, does not involve students, and requires memorization (Wati & Sutikno, 2024). IPAS learning remains dominated by memorization of concepts, terms, and theories; therefore, thinking skills, value formation, and material application are not conveyed optimally. Despite these challenges, integrating the two subjects aims to foster students' awareness of their surroundings, including natural and social aspects. In addition, the objective of IPAS learning in the Merdeka curriculum is to build students' curiosity and interest in learning and deepen their understanding and knowledge of various learning concepts. This integration aligns with the curriculum's direction, which emphasizes developing thinking skills through meaningful learning experiences, thereby enabling elementary school students to more easily understand the material as a whole and apply it in everyday life (Putra & Suranata, 2025).

Various problems persist, especially the shortage of qualified teachers to design learning tools tailored to students' characteristics. This happened at Penggarit 01 Elementary School, Pemalang City. Based on research results from interviews and observations, the researcher identified several obstacles in the IPAS learning process among grade IV students. One problem identified is the low quality of IPAS learning, which remains suboptimal and needs improvement. IPAS learning activities in class IV have not actively engaged students because they remain oriented toward teacher-centered teaching methods. Limited learning resources make it difficult for students to understand the material, and a lack of motivation to learn further affects their learning outcomes in IPAS, particularly on the topic of "Changes in the Form of Objects". Evidence in the field indicates that creating an engaging and interactive learning environment is important for fostering student motivation and improving student learning outcomes (Zakiyyah, 2024). This is in line with Naseer & Rafique (2021). This shows that teacher support can increase student engagement in learning. Based on the learning outcomes analyzed, student learning outcomes remain below the completeness criteria, with only 37.93% of students scoring above it. Therefore, an appropriate solution is needed to overcome these problems and improve student learning outcomes. One way to actively involve students in learning activities is to use learning media.

Learning media play a crucial role in supporting teaching and learning in schools. One factor supporting successful learning is the availability of learning media, as its use can facilitate teachers' achievement of learning objectives (Putri & Prasetyaningtyas, 2025). Using appropriate media can increase student motivation, help teachers achieve learning objectives, and prevent boredom during the learning process (Annisa & Subiantoro, 2022). The use of learning media not only facilitates teachers' explanations of the material but also encourages students to be more enthusiastic and engaged in the learning process (Isnaeni et al., 2021). Therefore, learning media must be able to stimulate interest in learning and positively impact student learning outcomes. These findings indicate that digital media conveys material and encourages students' active participation, creativity, and a research-oriented attitude (Ansari & Khan, 2020). These problems can be overcome by developing innovative, creative, and interesting technology-based learning media. The use of this learning media is expected to improve student learning outcomes. One solution is to develop a material for smart board media, "Changes in the Form of Objects."

Smart board media is a platform that presents interactive menus, including Augmented Reality (AR) features, developed in Unity. To support the learning process more innovatively. This medium can help students better understand concepts by presenting material visually and interactively. Several studies that use learning media in the form of smart boards, such as Kühl & Wohninsland (2022) and Tombak & Ateskan (2019), show that Unity-based smart board media can improve student learning outcomes. Smart board media is an effective, high-quality learning medium that conveys messages clearly to the audience. Smart board media can increase student learning motivation and encourage more active involvement in the classroom. Interactive learning media with attractive visuals can help students understand the material more easily (Sulianto, 2025). In addition, recent research shows that interactive digital media convey information and encourage active participation, creativity, and research skills among students.

Based on the description above, the researcher will develop a Unity-based smart board media to improve IPAS learning outcomes. Several researchers who used smartboard learning media in this study reported improved student learning outcomes. Previous research by Akar (2020)Found That Smart boards can increase student motivation, participation, and concentration during learning, ultimately positively impacting academic achievement across various subjects. Through interactive media, learning materials become easier for students to understand. With increased student interest and participation, the learning process can be more interactive and effective (Cahyaningsih & Nahdi, 2025). Several researchers have studied the development of smart board media. In line with the findings of Zhao et al. (2023), Augmented Reality (AR) in education can improve conceptual understanding through animation, 3D graphics, and more meaningful digital interactions. However, research on Unity-based smart boards regarding materials for changing object form is scarce. Based on this, it is necessary to conduct further research on the development of Unity-based smart board media to improve IPAS learning outcomes on material related to changes in the form of objects. This research offers novel elements in media design, material content, and structural components of the developed media. Things that distinguish them from previous studies. This study aims to develop Unity-based smart board media and to test the feasibility and effectiveness of these media in IPAS learning.

Methods

This study was conducted as Research and Development (R&D), which was a type of research aimed at developing a product and testing its effectiveness (Sugiyono, 2021). The research employed a development design based on the Borg and Gall model. According to Sugiyono (2021), this development model consisted of ten stages: (1) potential and problems, (2) data collection, (3) product design, (4) design validation, (5) design revision, (6) product trial, (7) product revision, (8) usage trial, (9) product revision, and (10) mass production. In this study, the researchers applied nine stages due to time and cost limitations, and therefore, the mass production stage was not carried out. The sequence of steps in the Borg and Gall model was illustrated in Figure 1.

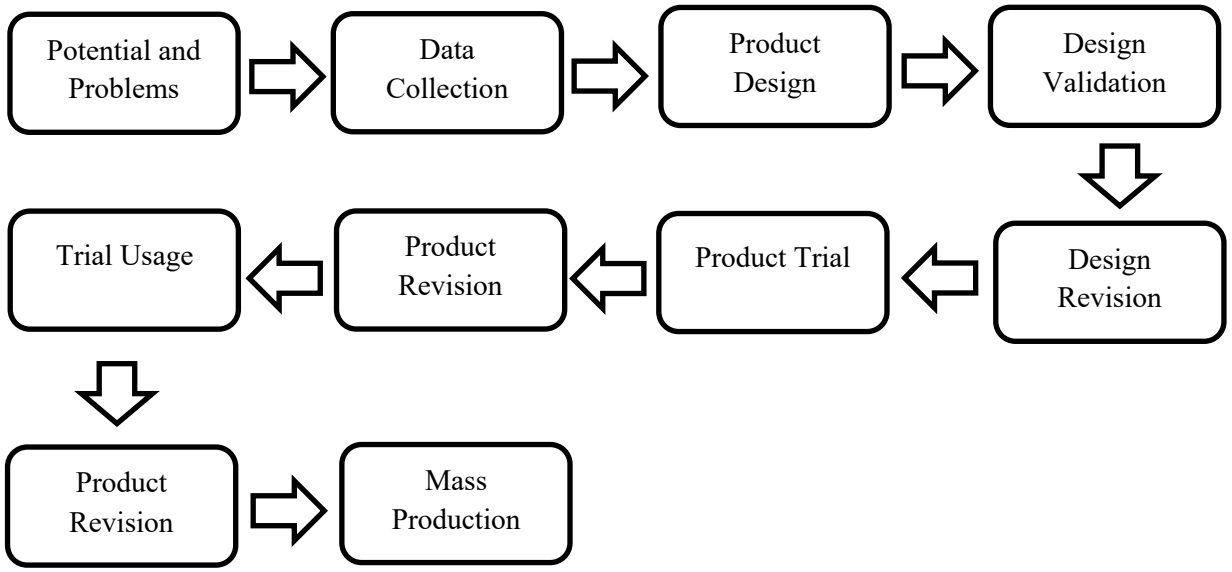

Figure 1. Stages of the Borg and Gall Development Model

The research aimed to develop and test the feasibility and effectiveness of the Unity-based smart board media. The study was conducted at Penggarit 01 Elementary School. The subjects in this study were media and materials experts, teachers, and students. To assess the effectiveness of the Unity-based smart board media, the study employed a one-group pretest–posttest design across both the product trial and usage trial stages. The population comprised all fourth-grade students at Penggarit 01 Elementary School. A total of 29 fourth-grade students were included in the sample: 6 in the product trial and 23 in the usage trial.

Data collection techniques included both test and non-test methods. Non-test data were obtained through observations, interviews, questionnaires, and documentation. Initial data collection was carried out through observations conducted prior to the study. The interview process involved the class teacher and was followed by a needs assessment for educators and learners. Questionnaires were used to assess the feasibility of the media, completed by media expert validators, material experts, and teachers and students after the product trial. The test instrument consisted of pretests and posttests administered before and after the use of the learning media in fourth grade. Instrument validity had been established, and reliability testing yielded an r-value of 0.816, indicating high reliability. The items were categorized as easy, moderate, or difficult, and 25 were deemed appropriate for measuring item discrimination.

The data were analysed using a normality test, a t-test, and an N-gain test. In this study, the N-gain test was used to evaluate the effectiveness of the media by examining the percentage improvement in students' learning outcomes. The N-gain values were classified according to the criteria presented in Table 1.

Table 1. N-gain score criteria

Gain Index	Criteria
N-gain ≥ 0.70	High
0.30 < N-gain < 0.70	Medium
N-gain ≤ 0.30	Low

Results and Discussion

Results

This study developed unity-based smartboard learning media to improve the learning outcomes of IPAS grade IV elementary school students. It used a development approach with the Borg and Gall model. The stages passed in this study include potential and problems, data collection, product design, design validation, design revision, product trial, product revision, trial use, final product revision, and mass production.

Potential and Problems

At this stage, researchers conducted preliminary observations to analyze various aspects of learning, including problems encountered in learning, teacher and student engagement, and the use of learning media. The observations showed that the use of innovative learning media remained very limited and that teachers had difficulty developing and effectively utilizing them. This condition leads to low student engagement in the learning process, resulting in suboptimal learning outcomes for the "Changes in the Form of Objects" material. The data shows that 18 students have not achieved the Learning Objective Achievement Criteria (KKTP in the Indonesian context), indicating a gap between the learning objectives and student achievement. This finding aligns with Rokhmani (2021), who found that appropriate learning media can increase student motivation and learning outcomes.

Data Collection

At this stage, researchers collect various information and data that will become the basis for the product design process as a follow-up to the first stage. After the problem was identified, researchers traced the causes. They collected various information needed to develop products that were expected to solve the problems that arose. Researchers employed various data collection techniques to support the research process, including observation, interviews, documentation, and teacher- and student-needs questionnaires.

Product Design

At this stage, product development entails synthesizing the results of identifying teachers' and students' needs through questionnaires and aligning them with learning objectives. The analysis results show the need for interactive, engaging, and information technology-based learning media. The initial design is a smart board prototype with Augmented Reality (AR) features. After the initial prototype is complete, the next step is to compile the media and learning materials. The Unity-based smart board media was designed in Canva, adding various supporting elements relevant to the material, resulting in

an engaging learning experience. The final product includes a front cover with an AR-based barcode that can be scanned via a mobile phone, media usage guidelines, developer profiles, learning outcomes and learning objectives, material on "Changes in the Form of Objects," students e-worksheets (E-LKPD in the Indonesian context), evaluation questions (quizzes), and a back cover. The effectiveness of Unity-based smart board media lies in its interactive and immersive features. The AR component actively engages students in learning, while attractive visual elements and interactive quizzes increase student motivation and focus. This interactive design allows students to more easily understand abstract concepts, such as changes in object shape, by visualizing and manipulating them directly. These findings align with the views of Prastika et al. (2023), who showed that immersive media significantly increases student engagement, and Makransky & Mayer (2022) who demonstrated that interactive media enhances student motivation and learning outcomes. The following is a sample of Unity-based smart board media design in Figure 2.

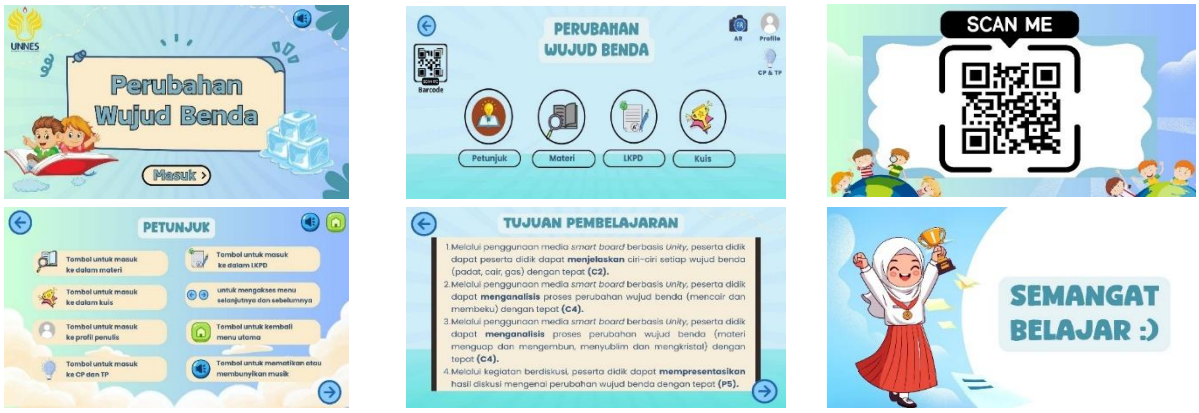

Figure 2. Smart Board Media Display Design

Design Validation

The Unity-based smart board media that has been developed will undergo a design validation process to assess its feasibility before it is tested with students. The feasibility of Unity-based smart board media is assessed by two experts, namely media experts and material experts, by referring to the assessment instrument prepared by the researcher. The aspects assessed will be examined by media and materials experts, who will provide feedback and suggestions to ensure the learning process can effectively use the created media and resources. Validation by media and materials experts is an important step to ensure a product's initial feasibility before it is implemented more widely. This aligns with the opinion of Tania & Tolino (2020), who emphasize that a high level of validation must be followed by sustainability testing, ensuring the media developed is valid in terms of design and can be applied consistently. The assessment results from media and material experts are shown in Table 2.

Table 2. Assessment Results of Media Experts and Material Experts

No.	Aspect Feasibility	Percentage %	Criteria
1.	Media Expert	92.5%	Very Feasible
2.	Material Expert	90.04%	Very Feasible

Based on Table 2, the media and material feasibility test results from media and material experts indicate that the criteria are "Very Feasible". Media experts assessed 92.5% as very feasible. While the material expert gave an assessment of 90.04% with the criteria "Very Feasible". These results indicate that Unity-based smart board media is highly practical for usage in IPAS education. This is reinforced in research conducted by Ariyanti et al. (2021). This shows that the smart board media achieved 93.6% in the "Very Feasible" category. Consequently, based on these findings, the developed media is deemed feasible in terms of media and materials to aid the educational process.

Other research shows that Unity-based smart board media can support learning activities, with media experts rating it 90.4% and material experts 89.8%, categorized as "very valid" (Moi et al., 2024). Validation results from researchers and prior studies indicate that Unity-based smart board media meet the eligibility criteria for use in learning activities.

Design Revision

Design revisions improve the Unity-based smart board learning media, based on evaluations from media and material experts. Some expert suggestions are used to revise and improve the learning media, making it more optimal. Media experts suggest that the quiz menu should include a feature that displays the number of correct and incorrect answers to provide students with feedback. In addition, a bibliography should be added as a reference to support the material presented. The material expert suggests that the examples in the learning media be improved and clarified, and that the writing be revised to standard language to improve clarity. Figure 2 shows changes in the appearance of the Unity-based smart board media design after revision.

Figure 3. Smart Board Media Display Revision

Product Trial

The product trial was conducted on a small scale in class IV. In the small-scale trial, six students were selected purposively. The Sugiyono (2021) purposive sampling technique was used to select participants based on predetermined criteria. Student selection criteria refer to differences in academic ability, including high-, medium-, and low-ability students. The product trial implementation consisted of three stages. The first stage began with a pretest given to students to assess their initial understanding before using the media. The second stage was carried out by implementing learning using Unity-based smart board media. The third stage involves administering posttests to students to assess how their learning outcomes have improved after using Unity-based smart board media. As a follow-up to learning, students are asked to complete a questionnaire to assess the media used during learning. At the same time, teachers complete a questionnaire to provide feedback on the use of Unity-based smartboard media in learning. The following are the results of the analysis of teachers' and students' responses to the learning media presented in Table 3.

Table 3. Results of Teacher and Student Response to Learning Media

Respondents	Percentage	Criteria
Teacher	93.75 %	Very Feasible
Students	94.79 %	Very Feasible

Based on Table 3, Unity-based smart board media was considered effective and received positive responses from 93.75% of teachers and 94.79% of students. These responses were used as evaluation material to identify the media's shortcomings, enabling improvements to produce more effective, optimal learning aligned with the objectives. This aligns with the findings of Fauzan & Arifin (2019), who found that digital media can be a relevant alternative for learning. In addition, Arifuddin et al (2022) also demonstrate that using augmented reality significantly improves students' creative thinking skills and learning outcomes through interactive technology.

Table 4. Results of the Paired T-Test on Product Trial

Average Difference	Sig.(2-tailed)	Criter
-26.000	0.002	Significant difference

Based on Table 4, the paired t-test results indicate a significant difference between the pretest and posttest means. (2-tailed) of 0.002, which means the Sig value. (2-tailed) of 0.002 < 0.005, the pretest and posttest results differ significantly.

Table 5. N-Gain of Product Trial Results

No.	Learning Outcomes	Number of students	Average	N-Gain Score	Criteria
1.	Pretest	6	53.33	0.5617	Medium
2.	Posttest	6	79.33		

Product Revision

After conducting product trials, the next step is to revise the media based on feedback from teachers and students obtained through a response questionnaire. Media revision will be done by considering the suggestions and input from the questionnaire results. Media revision was not done because neither teachers nor students provided suggestions or input. The questionnaire results show that the media is considered very feasible for use in the trial.

Trial Usage

Large-scale trials to assess the effectiveness of the media were conducted with the participation of 23 fourth-grade students from Penggarit 01 Elementary School. Using products in large-scale trials aims to measure the success rate of Unity-based smart board media through pretest and posttest results. Students took the pretest before using the Unity-based smart board media, and the posttest was conducted after they used the media in learning. Pretest and posttest results were analyzed using a normality test, N-gain, and a t-test to assess the effectiveness of Unity-based smart board media.

Table 6. Results of Pretest and Posttest Normality Tests

No.	Learning Outcomes	Statistics	Df Sig.
1.	Pretest	0.949	23 0.273*
2.	Posttest	0.937	23 0.158*

Based on the large-group normality test results, the normality test results for the pretest and posttest values are 0.273 > 0.00. At the same time, the results of the normality test of the posttest value are 0.158> 0.05. Thus, the pretest and posttest data are normally distributed.

The next stage is the T-test. The t-test analyzes the average difference in pretest and posttest results and tests the increase in learning outcomes after implementing Unity-based smart board media. The following are the results of the t-test analysis of the pretest and posttest scores in the large-scale trial.

Table 7. Pretest and Posttest T-Test Results

No.	Learning Outcomes	Statistics	Df Sig.
1.	Pretest	0.949	23 0.273*
2.	Posttest	0.937	23 0.158*

Based on Table 7, the T-test results indicate a significant difference between the pretest and posttest means. (2-tailed) of 0.000, which means the sig value. (2-tailed) of 0.000 < 0.005, the pretest and posttest results show a significant difference.

The next stage is the N-gain test, which measures changes in student learning outcomes before and after using unity-based smartboard media. The results of the N-gain analysis in the large-scale trial are shown in Table 8.

Table 8. N-gain Test Results of Pretest and Posttest

No.	Learning Outcomes	Number of students	Average	N-Gain score	Criteria
1.	Pretest	23	52.78	0.6536	Medium
2.	Posttest	23	82.96		

Table 8 shows an N-gain of 0.6536 for the "medium" criteria. The t-test and N-gain analysis results indicate that using Unity-based smartboard media can improve the learning outcomes of fourth-grade IPAS students at Penggarit 01 Elementary School.

Final Product Revision

Researchers did not make revisions at this stage because results from several trials showed that the products developed met the standards of feasibility and effectiveness in the learning process. According to Sugiyono, given the limited time and cost, researchers applied only 9 of the 10 stages in the development model, so the mass production stage was not carried out.

Discussion

Development of Unity-based smart board Media

This research produces Unity-based smart board media as a learning innovation. Previous research studies are the foundation of this media development (Afifa & Astuti, 2024). Learning media greatly encourage student learning, so their use can increase learning enthusiasm. The findings of this study align with Jati & Purwati's (2024) opinion that using appropriate learning media can create a more interactive learning process, improving students' understanding and helping them absorb material more effectively. The results of this study are also consistent with the opinion of Rustianti & Asih (2025, who found that increasing the effectiveness of IPAS learning by providing a more interactive and enjoyable learning experience for students. The development of Unity-based smart board media is designed to suit the needs and characteristics of elementary school students. According to Vinodhini & Fusic (2021, previous research shows that using a Smart Board increases students' interest in learning and academic performance through more interactive presentations of material. This reinforces the findings of Sari et al. (2025) that the use of digital media in learning, in line with modern technological advances, supports improvements in children's cognitive abilities. Therefore, the researchers designed digital learning media with visual displays containing images of real objects from the surrounding environment to support students in understanding the material more effectively. In addition, this media is designed to be engaging and interactive, increasing student involvement in the learning process.

The development of Unity-based smart board media is designed to align with the needs and characteristics of elementary school students. According to Auliah Dwiyanti & Arsyad (2024), utilizing digital media in line with modern technological advances can support the improvement of children's cognitive abilities. Therefore, researchers designed digital learning media with a visual display containing images of real objects in the environment to facilitate students' optimal understanding of the material. In addition, this media is designed to be interesting and interactive, to increase student involvement in the learning process. The development of this Unity-based smart board media is motivated by problems encountered in grade IV at Penggarit 01 Elementary School, where student learning outcomes on material changes in the form of objects remain low due to limited learning media. The development of this media is based on analyzing the needs of teachers and students, which shows that interesting and innovative learning media are needed. The development of Unity-based smart board media in response to changes in the form of objects received positive responses from teachers and students in Grade IV at Penggarit 01 Elementary School, indicating that this Unity-based smart board media is suitable for further development on this topic.

This Unity-based smart board media contains various components, including the front cover, media menu equipped with Augmented Reality (AR) based barcodes that can be scanned using a cellphone, instructions for use, developer profile, learning outcomes and objectives, material on changes in the form of objects, E-LKPD, evaluation questions, bibliography, and back cover on the media. This is in line with research by Tarmidzi et al. (2025), which states that the application of AR in this media can increase student interest and motivation to learn, as the display of material becomes more attractive and better aligned with the characteristics of elementary school students. In addition to being compared

with previous research on Unity-based smart board, the results of this study are also relevant to other learning media. Research on the electronic worksheet (E-Worksheet) according to Suryawati et al. (2020), evaluation due to the digital question practice feature and automatic feedback. In contrast, the Unity-based smart board offers an interactive, collaborative, and contextually rich learning experience, enriched with real-world visualization through AR features, which better aligns with the needs and characteristics of elementary school students.

Feasibility Test of Unity-based smart board Media

Two media and material experts conducted the Unity-based smart board media feasibility test assessment. Experts validate the media before conducting field trials to assess its feasibility. To assess the feasibility of the media, researchers used instruments compiled based on relevant references. Expert input and suggestions were provided as a follow-up to the assessment results for the developed media. Improvements made by researchers include adding features to the quiz menu that display the number of correct or incorrect answers to provide feedback to students, a bibliography, and clarifying examples in learning media using standardized language that students easily understand.

Based on assessments by media and materials experts, the Unity-based smart board media on the material, in the form of a Class IV bend, is considered feasible for field testing. The acquisition of values from media experts of 92.5% and material experts of 90.04% supports that the Unity-based smart board media is included in the "very feasible" category. The results of the feasibility assessment also show that an attractive design, appropriate colors, material suitability, alignment with the learning objectives, and ease of use are important factors in media development. By considering these factors, researchers also incorporated expert input to improve the overall quality of the media.

The feasibility of Smart Board media is supported by van Dijken (2023), who indicates that this medium can facilitate better interaction and direct student involvement in the learning process. The study also confirmed that this medium is valid and useful for learning because it is equipped with Augmented Reality (AR) features that make it easier for students to understand the material. The study results indicate that the smart board is effective for learning, as AR makes the material easier for students to understand. Research by Akcaoglu et al. (2022) and Cahyaningrum & Asih (2025) shows that using Unity 3D as a learning medium can increase student motivation and engagement through authentic game-based activities and interactive experiences, helping students understand concepts more effectively. Consistent with this, Yalman & Basaran (2021) found that 77% of Smart Board use positively affected students' learning achievement. This technology can enhance interaction, facilitate material visualization, and reduce time spent on the learning process.

Test the Effectiveness of Unity-based smart board Media

The effectiveness of Unity-based smart board media was tested through two stages of trials: small-scale tests and usage tests. In the small-scale trial, six students were selected using purposive sampling. Purposive sampling is a technique used to select samples based on predefined criteria (Sugiyono, 2021). In this study, samples were taken from the top 2 ranks, the two middle ranks, and the two lower ranks. As samples, the usage trial involved 23 fourth-grade students from Penggarit 01 Elementary School. At the product trial stage, average test scores increased: pretest results were 53.33%, and posttest results were 79.33%. The paired t-test results for the product trial showed a 2-tailed p-value of 0.002 (<0.05), indicating that Ha is accepted and Ho is rejected. The trial results showed an n-gain value of 0.5617 with a moderate category, increasing student learning outcomes by 29 points. Following the product trial, teachers and students were allowed to provide feedback on the developed media. Teachers were also asked to assess learning effectiveness using Unity-based smart board media. The analysis shows that teachers gave an average score of 93.75% and students an average score of 94.79%, indicating that the media is very suitable for use. At the usage trial stage, the percentage of pretest scores obtained was 52.78%, while the posttest score was 82.96%. Based on the paired t-test results from the usage trial, a significance level (2-tailed) of 0.000 < 0.05 was obtained, so the null hypothesis was rejected, and the alternative hypothesis was accepted. The trial results showed an n-gain of 0.6536 in the moderate category, indicating that media use in the usage trial positively impacts learning outcomes.

Unity-based smart board media have been shown to significantly improve student learning outcomes, as evidenced by paired t-test results across both trial stages. The results of the paired t-test analysis showed a difference in student learning outcomes before and after using learning media. Several

factors support the effectiveness of this medium. First, its interactive display encourages active student engagement. This is supported by research. Reipschlager et al. (2021) state that combining large interactive screens and personal Augmented Reality (AR) can directly increase student engagement, facilitate individual interaction, and minimize distractions between participants in the learning process, making the learning experience more effective and participatory. Second, the Augmented Reality (AR) feature, equipped with instructional videos, provides a more realistic and engaging learning experience, thereby improving conceptual understanding, consistent with the opinion. Anggraini et al. (2024) AR media is effective in improving student learning outcomes. Third, integrating images from everyday life facilitates students' connection of abstract concepts to real-life situations. These findings are in line with Pangestu et al. (2024), who reported that Smart Board media effectively improve learning outcomes if it is well-designed for classroom use.

The development of Unity-based smart board media makes it easier for teachers to learn because each slide consists of only one menu (Figure 2). This Unity-based smart board media is equipped with Augmented Reality (AR) features, which attract students' attention and increase student engagement during the learning process. In addition, the development of Unity-based smart board media also encourages teachers to design learning that is relevant to the digital era. Using this Unity-based smart board media makes the learning process more interactive and engaging, improving the quality of classroom instruction. For students, using Unity-based smart board media can also foster a more interactive learning environment and encourage active participation in learning activities. Supported by rigorous validation and improvements in learning outcomes, Unity-based smart board media is an effective innovation that supports the learning process in accordance with student needs.

Figure 2. Display of E-Folklore Learning Media

The assessment of material experts, media experts, teachers, and student responses is presented in Table 9.

Table 9. Result of Material Expert Assessment

No	Aspect	Indicator Count	Total Score
1.	Content Appropriateness	4	15
2.	Appropriateness of Material	2	7
3.	Language	3	11
4.	Image Appropriateness	1	4
Mean score = 92.5			

Table 9 presents the results of the material expert assessment, which indicate that the developed learning media achieved a high level of feasibility. All assessed aspects—including content appropriateness, material suitability, language, and image appropriateness—received high scores, resulting in a mean score of 92.5, which categorizes the media as very valid for instructional use.

Conclusion

Interactive learning media in the form of Unity-based smart boards have proven to be very feasible and effective in improving student learning outcomes. The feasibility of this media was obtained from media expert validation of 92.5% and material expert validation of 90.04%, as well as positive responses from teachers (93.75%) and students (94.79%). Its effectiveness is evident from the significant improvement in student learning outcomes, as shown by the t-test results with a value of 0.000 < 0.005,

which indicates that Ha is accepted and Ho is rejected. These results show a significant difference between the pretest and posttest scores. In addition, an N-gain value of 0.6536 was obtained, which is in the "moderate" category. This media has various interactive features, such as Augmented Reality (AR)-based barcodes, E-LKPD, and multimedia elements. In learning practice, this media facilitates teachers in facilitating learning, increasing motivation, participation, and student learning outcomes.

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