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Article

Visual Novel Game Bima's Adventure: Development of Learning Media on the Topic of Earth Atmospheric Layers in Elementary School

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ABSTRACT

Several concepts in science subjects are abstract, making it difficult for students to understand the material and resulting in low learning outcomes. This issue is further exacerbated by the limited use of engaging learning media that support deep conceptual understanding. To address this issue, a visual novel-based learning media titled "Bima's Adventure" was developed for the topic of Earth's atmospheric layers. This study aims to determine the feasibility of the visual novel game "Bima's Adventure" as a learning medium to improve students' learning outcomes on the topic of Earth's atmospheric layers. The research employed a Research and Development (R&D) approach using the ADDIE model. The validation results showed a score of 93% (very valid) for media validation and 87% (very valid) for material validation. The trial results indicated that the media was efficient, based on teacher response questionnaires (96.9%) and student response questionnaires (92.89%). In addition, using this media significantly improved student learning outcomes, as evidenced by an N-Gain score of 0.71 (high) and a Mann-Whitney U-Test significance value of 0.000. Beyond improving academic performance, "Bima's Adventure" fostered student engagement through a problem-based learning approach.

INTRODUCTION

The rapid development of technology has significantly impacted human life, including in the field of education (Salsabilla & Agustian, 2021). Technology in learning helps students explore topics from various learning resources, as space and time are no longer limited (Fricticarani et al., 2023; Sanita & Saparia, 2023). By integrating learning materials with computers or Android devices, teachers can improve the quality of instruction (Latifah et al., 2024). Currently, technology implementation has been integrated into all subjects, including science. The application of technology plays an important role in science education, as it enhances learning effectiveness and efficiency (Astuti et al., 2023).

Science is a subject that studies natural concepts and has a broad connection to human life and the surrounding environment (Sari et al., 2024). In the Merdeka Curriculum, science is a subject that explores a series of events, facts, concepts, and everything related to phenomena occurring in the natural and social environment of society (Yasir & Dwiyanti, 2024). Science

plays an important role in education because all aspects of human life are closely connected to nature and the surrounding environment (Syaflin, 2022). Daily mastery of scientific concepts and principles is essential for developing students' cognitive skills (Sintiawati et al., 2021). However, most students perceive science as a difficult and boring subject (Lestari & Saputra, 2022). This negative perception may be caused by the use of teacher-centered learning models, low student motivation, an unsupportive learning environment, and limited use of effective learning media (Yitu et al., 2023).

Based on observations and interviews at SDN Sambikerep II/480 Surabaya, students' learning outcomes in science are still low. Teachers revealed that many students experienced a decline in their science scores in the topic of Earth's atmospheric layers, due to the abstract nature of the material. The abstract concepts make it difficult for students to observe them directly, resulting in challenges in understanding. To grasp this topic, students need clear visualizations to comprehend the phenomena involved. Students' difficulties in understanding abstract concepts can be addressed using visual novel games as learning media.

A visual novel game is a genre that integrates narrative storytelling with visual elements (Ali Mukti et al., 2024). Cavallaro (2010) defines visual novel games as interactive fiction that present story-like static images, usually drawn in an anime or Japanese cartoon style. Visual novel games structure the storyline through in-game dialogues, allowing players to directly experience the challenges within the game as if they were the main character (Anggraini & Fu, 2021). The development of visual novel games can serve as an alternative medium that makes learning more enjoyable. The material is presented through engaging narrative stories accompanied by audio that follows the storyline (Putra et al., 2021). The visual novel game media elements can enhance students' motivation and engagement in learning.

Several relevant studies have been conducted. According to Sukma & Kholiq (2021), visual novel game-based learning media improves students' higher-order thinking skills. Another study by (Galindra et al., 2023) found that visual novel game media creates an interactive learning environment and helps students understand the subject matter. Furthermore, research by (Pangestu et al., 2025) concluded that visual novel game media is suitable for use as a learning tool based on validity and practicality tests. These findings collectively strengthen the use of visual novel games as a medium to enhance learning outcomes and increase student engagement in the learning process.

Based on previous research, the researcher chose to conduct further studies on visual novel game media. This study offers several innovations compared to previous research. The innovation lies in integrating Earth's atmospheric layers with real-world environmental issues students face, specifically global warming. This topic was selected for several key reasons, including its abstract nature and the importance of understanding it in daily life. Another difference is in the character illustrations, which do not follow the Japanese anime style but instead depict elementary school students. Additional features such as audio and interactive gameplay have been included to accommodate students with diverse learning styles (visual, auditory, and kinesthetic).

This study focuses on developing the visual novel game learning media Bima's Adventure on Earth's atmospheric layers, based on real-world learning challenges. The development of this media is expected to address learning problems encountered in the field and improve student learning outcomes in the cognitive domain to foster higher-order thinking skills. 21st-century education encourages students to develop higher-order thinking skills (Mustafid et al., 2024). These skills are essential as they enable students to express their ideas logically and confidently, whether in writing, speaking, or actions (Hendriawan & Usmaedi, 2019). The study's focus was on the Earth's atmospheric layers due to its abstract concepts, which require a medium to facilitate understanding. This research aims to determine the feasibility of the visual novel game *Bima's Adventure* as a learning medium to improve the

learning outcomes of fifth-grade elementary school students on the topic of Earth's atmospheric layers.

METHODS

This research adopts the Research and Development (R&D) approach. The development model used is ADDIE, which consists of five stages: Analyze, Design, Development, Implementation, and Evaluation.

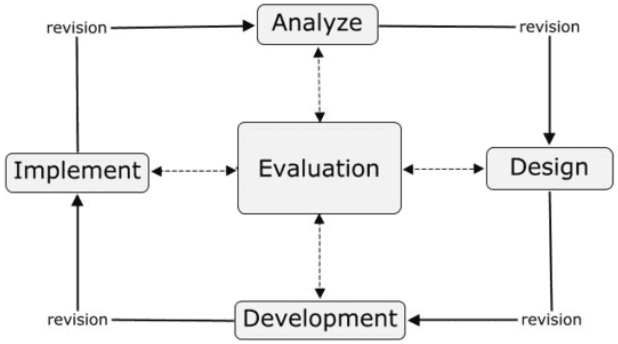


Figure 1. ADDIE Development Model

This research was conducted from October to February 2024-2025 on fifth-grade students at SDN Sambikerep II/480 in Jalan Jelidro, Sambikerep, Surabaya. The research experimental design used was a pretest-posttest control group design. This design involved an experimental class using a developed visual novel game as a learning media and a control class using instructional videos.

The data collection techniques in this research involved observation, tests (pretest and posttest), and questionnaires. The research instrument components included: (1) observation, which was conducted to obtain data on students' learning needs; (2) a test sheet consisting of 10 questions to assess the effectiveness of the developed learning media; and (3) validation and response questionnaires to evaluate the feasibility of the media in terms of validity and practicality. Media and subject matter experts assessed the validity test, while teachers and students conducted the practicality test as the users of the learning media. The validity criteria assessed by media experts include display design, functionality, operability, language, and media presentation. In contrast, the validity criteria assessed by subject matter experts cover the alignment of the material with learning objectives, content quality, language, and evaluation aspects. The practicality test was conducted with teachers and students as users of the learning media. The practicality criteria include display design, concept, usability, and media interactivity during learning.

The validation results and teacher response questionnaires were analysed using a Likert scale developed by Sugiyono (2013). Meanwhile, student response questionnaires were presented using a Guttman scale. To identify the improvement in pretest and posttest scores, the researcher calculated the N-Gain. Since the research subjects were fewer than 100, the Shapiro-Wilk test assessed normality. Subsequently, a homogeneity test was conducted. An Independent Sample T-Test was performed to determine if the data were normal and homogeneous. Conversely, if the data were not normal or not homogeneous, a non-parametric statistical test was conducted using the Mann-Whitney U-Test.

RESULTS AND DISCUSSION

The initial stage of this research was analysis to identify problems and needs in the science learning process. Through preliminary observations, it was found that there was a problem with low science learning outcomes. Low learning outcomes tend to occur in abstract material. Students struggle to visualise abstract concepts because they cannot be directly

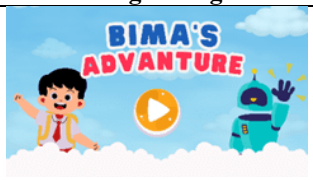
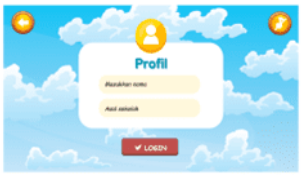
perceived or observed (Fatimah & Bramastia, 2022). Teachers use textbooks and student worksheets (LKPD) in the learning process. However, using technology-based learning media has not been maximised in teaching and learning activities. The lack of technology use in education has made learning activities increasingly tedious and unengaging (Yusa & Sukmana, 2022). Therefore, the integration of technology into the learning process is a solution that should be prioritized (Yusa & Sukmana, 2022).

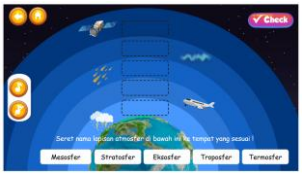
In the interview, the classroom teacher also revealed that students have different learning styles (auditory, visual, kinesthetic). The diversity of learning styles requires an instructional approach that can accommodate all students' preferences to enhance learning effectiveness. Regarding Earth's atmospheric layers, which are abstract, visual learners tend to grasp concepts more easily through images, illustrations, or animations. In contrast, auditory learners benefit more from verbal explanations or narrated audio, while kinesthetic learners require interactive activities to engage physically or simulate experiences during the learning process. Consequently, the researcher conducted a needs analysis and developed a visual novel-based educational game titled "Bima's Adventure" to support learning on Earth's atmospheric layers.

The second stage is designing the visual novel game "Bima's Adventure". This stage includes material design, media design, research instrument design, and evaluation. The instructional content delivered through the media is connected to concepts that are familiar in students' everyday lives, thereby facilitating deeper and more meaningful understanding (Yolanda et al., 2024). The media design focuses on creating a storyboard as an initial framework for developing the learning media. The research instrument design includes expert validation sheets and response questionnaires. The instrument design is based on the previously established indicators.

The third stage is media development. The preparation of instruments is based on previously established indicators. At this stage, the researcher implements the storyboard of the visual novel game that was previously designed. This stage includes media development, expert validation, and small-scale trials. The visual novel game was developed using several software programs, including Canva, Articulate Storyline, and Itch.io. Canva as a source for images and illustrations, Articulate Storyline for creating interactive pathways, and the Itch.io website for turning the project into an online link. The first step was collecting images, illustrations, and audio. Next, the images were arranged according to the storyboard in Canva. The development continued by adding audio, music, and interactive game elements using Articulate Storyline. After that, the project was exported in HTML format and converted into a link using Itch.io, allowing it to be accessed online. Table 1 shows the results of media development.

Table 1. Media Development Results

Page	Design Image	Information
Cover		There is a media title, story characters, Bima and Nova, and a play button to proceed to the next page.
Login Page		To access the media menu, students must fill in their name and school origin on this page.

Page	Design Image	Information
Menu Page		It consists of several main menu buttons (in purple), the developer profile, media information, and text balloons displaying personalised messages with the player's name and school.
Media Information		The media information includes a brief description of the media and the learning objectives for the material being studied.
Learning Objectives		The learning objectives to be achieved are presented.
The Story		The adventure story of Bima and Nova exploring the Earth's atmospheric layers is shown. Illustrations of the story characters, dialogue/narration, and audio accompany this page.
Drag and Drop Games		Students are asked to match the names of the atmospheric layers with the correct locations based on the clues in the image.
Mission		HOTS questions are presented, and students work on them through group discussions and write their answers on the student worksheet (LKPD).

After the media is completed, the validation process is carried out. Media experts and subject matter experts conduct the validation stage. The validation process aims to assess the validity of the media and the research instruments. The media and subject matter experts are faculty members from the Elementary School Teacher Education Department at Universitas Negeri Surabaya. The media expert's role is to evaluate the media programming to ensure it is engaging and interactive, as well as to assess the teacher and student response questionnaires used to gather the practicality data of the media. The subject matter expert's role is to evaluate the material presented in the media, teaching modules, student worksheets (LKPD), and pretest-posttest questions. The validation results serve as the basis for refining the media and research instruments before implementation in the field. Table 2 presents the validation results.

Table 2. The Validation Results

Instrument	Score Obtained	Ideal Score	Percentage	Criteria
Media Validator	87	100	87%	Very Valid
Content Validator	79	85	93%	Very Valid
Questionnaire	39	45	86,7%	Very Valid
Teaching Module	61	65	93,8%	Very Valid
LKPD	63	70	90%	Very Valid

Instrument	Score Obtained	Ideal Score	Percentage	Criteria
Pretest- Posttest	85	90	94,5%	Very Valid

Table 2 presents the validation results of the media and research instruments. The percentage score obtained in the 81%-100% range indicates that the media and instruments received a "very valid" rating. The validators also provided suggestions and feedback to improve the quality of the media. Based on all the suggestions and feedback from the validators, revisions or improvements were made to ensure that the media and instruments met the students' needs.

After the validation process, media development can be strengthened through a small-scale trial before full implementation. The small-scale trial involved 24 students as subjects. This trial was conducted to obtain direct feedback from users, namely teachers and students, regarding the effectiveness and efficiency of the media. Through this small-scale trial, shortcomings in the media that were not identified during the validation process could be detected and corrected. The trial was carried out smoothly without any obstacles, and all features in the media functioned properly.

The fourth stage is implementation. This research used two classes for the large-scale trial: an experimental class and a control class, each with 30 students. Before the implementation, a pretest was conducted to measure the students' initial understanding. The average pretest score for the experimental class was 50.34, while the control class had an average score of 50.67. After completing the pretest, the learning implementation was carried out in each class, with the experimental class using the visual novel game media and the control class using instructional videos.

The implementation activity used the Problem-Based Learning (PBL) model. The Problem-Based Learning model is appropriate for use in learning with the visual novel game "Bima's Adventure" because it encourages students to solve problems within the story. The Problem-Based Learning model requires students to work in teams to solve real-world problems (Afifah et al., 2022). In this learning model, the media presents contextual problems that students must solve through story exploration and group discussions. The stages or syntax of Problem-Based Learning (PBL) include: 1) Orientation to the problem, 2) Organizing students for learning, 3) Guiding group investigations, 4) Developing and producing work, and 5) Analyzing and evaluating the problem-solving process (Arends, 2008).

The initial part of the media, which presents the problems experienced by the characters Bima and Nova, represents the first syntax, namely orientation to the problem. The adventure storyline that takes students on a journey through the layers of the atmosphere from the troposphere to the exosphere reflects the second syntax, which is organizing students to learn. Meanwhile, the mission page supports the third to fifth syntaxes, as it contains practice questions that encourage students to engage in group discussions to solve problems.

The first syntax is an orientation to the problem. Students are given a prompting question related to the material to be studied. The prompting question is used to direct students to start the discussion in the learning process (Setiawan et al., 2022). Next, students observe the adventure story of Bima and Nova in the visual novel game media. The problem the characters face is linked to the concept of heat temperature, which students can relate to in their daily lives.

The second syntax is organising students for learning. Students independently operate the visual novel game "Bima's Adventure" using a PC or computer. In this stage, students explore the storyline, study the material presented in the media, and identify emerging problems. After completing the storyline, students can attempt an interactive challenge in the form of a drag-and-drop game. In this game, students match the names of Earth's atmospheric layers with their correct locations. This activity aims to reinforce students' understanding interactively and engagingly.

The third syntax is guiding group investigation. Students are divided into groups of five members to discuss the problems presented in Bima and Nova's adventure story. They discuss the relationship between heat temperature and global warming, which affects daily life. Students also complete mission questions to enhance their higher-order thinking skills during the investigation process. Students are encouraged to engage in discussions with their group members at this stage, making learning more active, collaborative, and problem-solving-oriented. Group discussion methods are effective in learning, especially in training students' critical thinking skills to solve problems (Sholihah & Amaliyah, 2022).

The fourth syntax is developing and presenting the final product. In this stage, students and their groups present the results of their discussions. Each group takes turns presenting their discussion outcomes related to the problems addressed in the visual novel game "Bima's Adventure," including the mission questions. This presentation activity allows students to share their understanding, practice confidence, and enhance their communication skills.

The fifth syntax is analysing and evaluating the problem. The teacher and students provide feedback on the results of the student discussions. Assessment at this stage is based on students' participation in groups and the outcomes of their discussions. The teacher guides students in appreciating the presenting groups to foster mutual respect and boost learning motivation. As part of the evaluation, the teacher asks students about their experiences using the "Bima's Adventure" visual novel game media, including the challenges they faced, the knowledge they gained, and the enjoyable aspects of the learning activities. Figure 2 illustrates the implementation of the "Bima's Adventure" visual novel game as a learning media.

Figure 2. Media Implementation Activities

Integrating the "Bima's Adventure" media with the Problem-Based Learning (PBL) model makes learning more interactive and meaningful. Students experience direct involvement in the story and situations relevant to their daily lives, making their understanding more contextual and applicable. Contextual learning helps students grasp science concepts more effectively and relate them to real-life situations, ultimately improving learning outcomes (Putri et al., 2023).

The learning activities in the experimental class, which used the "Bima's Adventure" visual novel game, were more interactive than those in the control class, which used instructional videos. Interactive learning media can enhance student participation, as students are encouraged to engage in learning actively (Auliya et al., 2023). Instead of being passive recipients of information, students become actively involved in problem-solving, which fosters deep understanding and improves learning outcomes.

After the learning activities, a response questionnaire and post-test were distributed. The response questionnaire for the "Bima's Adventure" media was given to teachers and students in the experimental class to assess the practicality of the media. Table 3 presents the results of the teacher and student response questionnaires.

Table 3. The Results of The Teacher and Student Response Questionnaires.

Feasibility Aspect	Score Obtained	Ideal Score	Percentage	Criteria
Teacher Questionnaire	63	65	96,9%	Very Practical
Students Questionnaire	418	450	92,89%	Very Practical

Based on the results of the teacher response questionnaire, the media received a "Highly Practical" rating with a percentage of 96.9%. Teachers found the "Bima's Adventure" media engaging and creative because it integrates subject matter with technology. Through the development of this media, teachers also gained ideas for implementing innovative learning media in the teaching process. The student response questionnaire received a percentage of 92.89%, also classified as "Highly Practical". The highest score was obtained from the question, "Does using this media make the learning process more enjoyable?" with a 100% positive response from all 30 students. This score indicates that the developed media successfully creates an engaging student learning experience. Interactive and technology-based learning media can enhance the enjoyment and meaningfulness of the learning process (Rukmana et al., 2024).

The effectiveness of the "Bima's Adventure" media was determined by calculating pre-test and post-test results. First, the learning completeness of the students was calculated. The pre-test results showed that 2 students achieved mastery in the experimental and control classes, with a percentage of 6.67%. After the treatment using the visual novel game media "Bima's Adventure" and instructional videos, there was an improvement in learning mastery. The post-test results in the experimental class showed that 26 students achieved mastery, with a percentage of 86.67%. In the control class, 8 students achieved mastery, with a percentage of 26.57%. The average post-test score in the experimental class was 85, while in the control class, it was 65. An N-Gain test was then conducted to measure the improvement in learning outcomes in both classes. Figure 3 presents the average N-Gain graph.

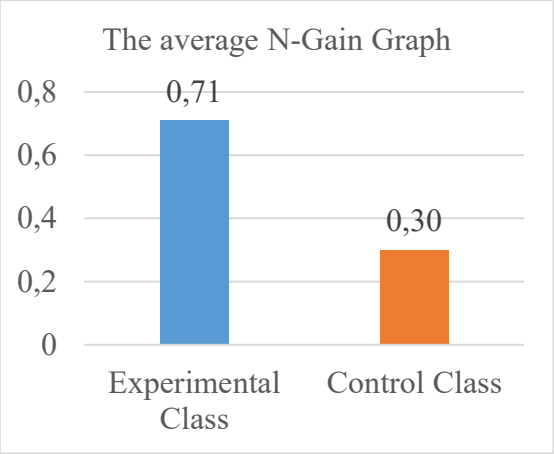


Figure 3. The Average N-Gain Graph

The graph above shows that the average N-Gain in the experimental class is 0.71, which falls into the high category, while in the control class, it is 0.30, which falls into the moderate category. The graph indicates that the improvement in learning outcomes in the experimental class is significantly higher than in the control class. Next, prerequisite tests were conducted, including the normality and homogeneity tests. The normality test for this research used the Shapiro-Wilk test because the sample size was less than 50. The data distribution is considered normal if sig. > 0.05 (5%), in which case the data is declared to be normally distributed. Table 4 shows the results of the normality test for N-Gain.

Table 4. The Results of The Normality Test for N-Gain

	Kolmogorov-Smirnov[a]			Shapiro Wilk		
	Statistic	**df**	**Sig.**	**Statistic**	**df**	**Sig.**
Experimental	,142	30	,125	,947	30	,140
Control	,177	30	,017	,892	30	,005

Based on the normality test results, the N-Gain results in the experimental class showed a significance of 0.140, while in the control class, the significance was 0.005. Since the significance value for the control class is less than 0.05, it can be concluded that the data in that

group does not follow a normal distribution. Table 5 shows the results of the homogeneity test for N-Gain.

Table 5. N-Gain The Results of The Normality Test for N-Gain

		Levene Statistics	df 1	df 2	Sig.
Results	Based on Mean	,348	1	58	,557
	Based on Median	,121	1	58	,729
	Based on the Median and with adjusted df	,121	1	57,777	,729
	Based on trimmed mean	,321	1	58	,573

The significance value of the N-Gain data homogeneity test results in the experimental and control classes is 0.557. This shows that the N-Gain data of the experimental and control classes have a sig.>0.05, so they have homogeneous variance. However, because the normality assumption is unmet, data analysis cannot use parametric tests (Independent Samples t-test). Therefore, the Mann-Whitney U Test is used to determine whether there is a significant difference in the improvement of learning outcomes in the experimental and control classes. The following are the results of the Mann-Whitney U-Test. Table 6 shows the results of the Mann-Whitney U-Test.

Table 6. The Results of The Mann-Whitney U Test

Test Statistics	
	Results
Mann-Whitney U	27,000
Wilcoxon W	492,000
Z	-6,283
Asymp. Sig. (2-tailed)	,000

The results of the Mann-Whitney U Test concluded that there is a significant difference between the learning outcomes of the experimental class using the visual novel game media "Bima's Adventure" and the control class using learning videos. So, the visual novel game media "Bima's Adventure" is stated to be effective in learning. The final stage of this study is evaluation. Based on the student response questionnaire results, it is known that some students still have difficulty recognising character designs in the media. This can be used as evaluation material to improve visual clarity and character details so that they are easier to recognise and so that the learning experience through the media becomes more optimal.

The visual novel game "Bima's Adventure" offers opportunities to integrate the cognitive process dimension (based on Bloom's Revised Taxonomy) into learning objectives as engaging and contextual learning activities. At the cognitive level of "identifying" (C1: remembering), students are guided through an adventure narrative about the layers of the atmosphere. Students are invited to observe and recognize each atmospheric layer's characteristics, sequence, and functions within the storyline. Subsequently, students continue the activity by playing a drag-and-drop game that requires them to match the names of the atmospheric layers to their correct locations. Visualization and drag-and-drop games can enhance engagement and understanding through enjoyable practice. Educational games have increased student engagement, learning motivation, and understanding of the subject matter (Nurhayati et al., 2025).

Next, the ability to "predict" (C4: analyzing) is implemented through the mission feature. In this section, students answer essay questions related to human activities, such as using motor vehicles, forest burning, or industrial emissions. Students are asked to estimate these activities' impact on the condition of the atmospheric layers. This activity is designed to train students to analyze cause-and-effect relationships and draw logical conclusions based on their acquired knowledge. The outcome of this activity is that students can analytically explain how human actions can affect the atmosphere. By formulating logical predictions based on conceptual

understanding, students are trained to think critically. Critical thinking skills not only involve analytical processes but also require deep evaluation (Kusuma et al., 2024).

Third, the ability to "reflect" (C5: evaluating) is implemented through the mission feature in the learning media. In this section, students are presented with essay questions encouraging them to assess specific situations. For example, students are asked to evaluate whether excessive use of air conditioning in a household is appropriate and to consider the potential environmental impacts of such behavior. The outcome of this activity is that students can evaluate the appropriate actions to take and articulate their reasoning. The evaluation level in Bloom's Revised Taxonomy requires learners to make judgments based on criteria and standards through logical reasoning and argumentation. This type of activity trains students to consider the consequences of actions, compare alternatives, and rationally make responsible, value-based decisions (Anderson & Krathwohl, 2001).

The final stage of this study involved an evaluation through a student response questionnaire, which revealed that some students still had difficulty recognizing the character visuals in the media. Clear visual elements can make learning more engaging, stimulate curiosity, and enhance student motivation (Muthi et al., 2023). This finding serves as a point of evaluation for improving visual clarity to optimize the learning experience through educational media.

CONCLUSION

Based on the research results, the final stage is that the visual novel game media "Bima's Adventure" is feasible for learning based on its validity, practicality, and effectiveness tests. The "Bima's Adventure" media was deemed highly valid based on the validation results (media expert validation of 93% and material expert validation of 87%). Furthermore, the media was deemed highly practical based on the teacher and student response questionnaires (teacher response questionnaire result of 96.9% and student response questionnaire result of 92.89%). The "Bima's Adventure" visual novel game media was considered effective based on the student's learning outcomes. The N-Gain score of the experimental class reached a high category, with a value of 0.71, while the control class obtained a moderate category, with a value of 0.30. These N-Gain results demonstrate that the improvement in learning achievement in the experimental class using the "Bima's Adventure" visual novel game media was higher than that of the control class, which used instructional video media. The Mann-Whitney U-Test result with a sig (2-tailed) value of $0.000 < 0.05$ proves that there is a significant difference between the learning outcomes of the experimental class using the "Bima's Adventure" visual novel game media and the control class using instructional videos.

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