



Development of Animalia Bio Board Game Media to Improve Students' Analytical Thinking and Collaboration Skills

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Abstract: This study aims to determine the effectiveness of Bio Board Game (BBG) learning media on Animalia material to improve students' analytical thinking and collaboration skills. This development research was conducted using the ADDIE model. Product effectiveness analysis used MANOVA with a significance level of 0.05. The results of the Bio Board Game (BBG) learning media research have met the validity standards as a learning media reviewed from the aspects of design, learning, media use and visual communication and meet the practicality standards reviewed from the aspects of presentation, language, and visual communication. The results of the N-Gain test on analytical thinking skills were assessed as effective at 73.88 and collaboration skills received a fairly effective category with a value of 58.72, which means that the learning media is significant in improving students' collaboration skills.

Keywords: Bio Board Game; Collaboration; Learning Media

Introduction

One factor influencing the success of learning activities is the presentation model. Fun and engaging presentation of material can be implemented through the use of learning media. Media is a dynamic learning resource that facilitates diverse student learning styles (Dewi et al., 2020). According to the Association of Educational Communication Technology (AECT), learning media aims to support the learning process by stimulating thought, attention, motivation, enthusiasm, and communication between teachers and students (Ariyani et al., 2023).

Over time, entertainment games have evolved into educational games, aiming to motivate students to learn and foster social skills. Game mechanics are adopted to transform existing activities and transform content into games. Playful activities in learning convey the impression that learning is fun (Sultonurohmah, 2023). This learning is essential for a more active learning system. Through the use of learning media, students'

understanding can be increased more effectively than reading books, because the media has an aspect of attracting attention in presenting the material, thus making students interested and making the learning process more effective (Nur'aini, 2015).

Bioboard games are a type of learning media modified from the Monopoly game to create a more enjoyable learning environment, thereby improving learning quality. Bioboard games enable the integration of natural science topics into board game mechanics (Tsai et al., 2021). The presentation of material, packaged in a Monopoly bioboard game, is designed to facilitate explanations to students during the learning process. Educational games have a positive impact on student learning motivation, where motivation is considered a primary determinant of learning. Intrinsic motivation refers to the initiation of intentional behavior, feelings of pleasure, interest, and satisfaction. This helps students strive to achieve their desires, provides them with the freedom to express themselves and collaborate, and discover new things or reinforce existing knowledge.

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Students are given the opportunity to learn to make decisions, determine, create, disassemble, assemble, experiment, restore, express opinions, solve problems, complete tasks, compete, and cooperate, all while experiencing a variety of feelings indirectly through play. The Monopoly bio board game was chosen because Sutraningsi et al. (2021) believes that it has the following advantages: it's engaging and practical, encourages active student participation, provides immediate feedback, allows for the application of concepts in real-world contexts, is flexible, and incorporates classic games commonly played by students, incorporating learning strategies through an active, creative, effective, and enjoyable approach.

Animalia is a 10th-grade topic that encompasses a very complex scope and contains many difficult-to-understand Latin terms. This also takes a considerable amount of time to complete and can lead to student boredom. These obstacles can lead to symptoms of learning difficulties such as drowsiness, lack of enthusiasm, chatter, and inattention during learning.

Research by Wulandari et al. (2023) shows that 32% of students stated that the Latin names of the animalia material were difficult to understand. Another 35% of students reported difficulty understanding the concept of animalia by relating it to everyday phenomena. The interview data was followed up by measuring the level of students' cognitive understanding and the test results at the high cognitive level of 43.46% showed results that were not optimal.

The use of media such as games or similar media has never been implemented in teaching and learning activities. However, the use of games allows for active participation between students and teachers, as well as between students and their peers. This statement aligns with previous research (Pinhati et al., 2019) that shows that difficult concepts with complex technical terms require different teaching strategies to fill gaps left during the learning process. The use of games and simulators is an effective strategy for capturing students' attention and achieving educational goals in the classroom. Based on the literature, interactive activities stimulate creativity, communication, problem-solving, and analytical skills. Learning must consider collaborative skills as an aspect of soft skills. Understanding student collaboration is crucial to improve lifelong learning skills. Collaborative skills are the abilities needed to work effectively together and be tolerant with team members, as well as to practice fluent decision-making to reach mutual agreements. Collaborative skills will function well if several students are actively involved in group work (Redhana, 2019). Collaboration is an essential part of the concept of lifelong learning. Collaboration is the ability of a person

to work together with others to achieve a common goal (Dewi et al., 2020). Collaborative skills emphasize students' ability to adapt, synergize in various responsibilities, and play a role in achieving a shared understanding of problems and their solutions (Azzahra, 2022). Collaborative skills can help individuals correct weaknesses in ideas, thereby facilitating complex problems that are beyond the capabilities of one person (OECD, 2023). In this regard, the Organization for Economic Co-operation and Development (2023) stated that Indonesia's participation in the International Programme for International Student Assessment (PISA) and the Trends in International Mathematics and Science Study (TIMSS) since 2000 shows that the PISA results released by the OECD, Indonesia's ranking in PISA 2022 was 68th out of 81 participating countries. Despite Indonesia's improved ranking, its PISA science score dropped 13 points to 383, placing Indonesia in the bottom 13th out of 81 countries. PISA questions place a high demand on reasoning and problem-solving skills, known as higher-order thinking skills. This can be attributed to a lack of higher-order thinking skills training in the learning process. One way to address this is by streamlining the learning system by training students to think analytically.

Analytical thinking skills are high-level thinking skills strongly influenced by systematic, logical, and rational thinking, which have significant potential for development in game-based learning models (Tipani et al., 2019). Game-based learning is said to have the potential to support higher-level thinking skills, packaged with exercises presented on playing cards (Radityastuti et al., 2023). The exercises presented in games guide students to explore, discover, critique, and solve problems. Strong problem-solving skills can enhance analytical thinking skills (Purnama & Kalkautsar, 2023).

The use of game-based learning media is crucial in today's education system because it can effectively increase student enthusiasm and active participation. Amidst a constantly changing and challenging learning environment, games provide a more engaging, interactive, and challenging learning environment, encouraging students to delve deeper into the material. Furthermore, this learning approach helps hone critical thinking, problem-solving, and collaboration skills. Because it aligns with the characteristics of today's digital generation, this method serves as a bridge between traditional learning methods and the demands of modern learning.

Method

Research design

The learning media development procedure was modified from Sugiyono (2019) opinion, namely the ADDIE method development procedure consists of five stages including Analysis, Design, Development, Implementation, and Evaluation. The ADDIE model is used because it provides a systematic, structured, and flexible approach in designing learning. By following these stages, learning developers can ensure that the material is prepared according to the needs of students, learning objectives are achieved, and the learning process is effective and efficient. In addition, the ADDIE model allows evaluation and improvement at each stage, so that learning outcomes are of higher quality and have a real impact. The field test design used is a pretest-posttest control-group design. This study used one class as a limited trial and two classes in the field trial, namely the control class and the experimental class.

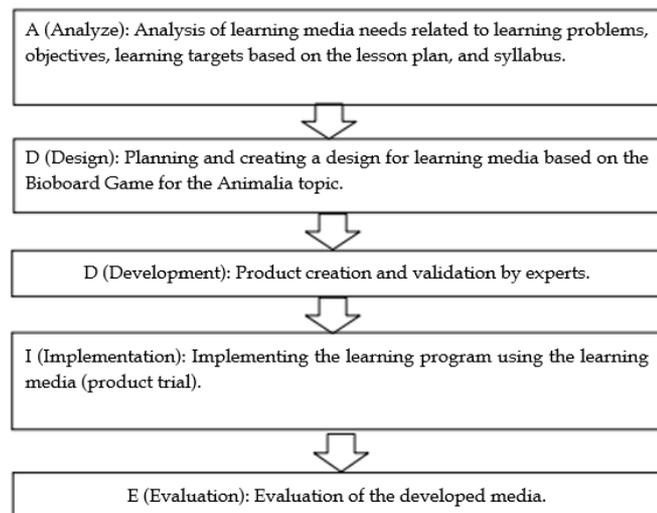


Figure 1. Model Pengembangan ADDIE

Subject and Locations

The experimental class used bio board game (BBG) learning media with game-based learning model and the control class used teams games tournament (TGT) learning model. This research was conducted at SMA Negeri 1 Seyegan, D. I. Yogyakarta. The population in this study were 36 students of SMA Negeri 1 Seyegan from grade XI as a limited trial sample and 2 classes of 10, each consisting of 36 students as a field trial sample. Sampling used cluster random sampling.

Instrument

The evaluation tool used in this research on the development of bio board game (BBG) learning media was a Likert scale assessment instrument, consulted and

validated by expert judgment. Furthermore, the material and validity of the learning media were assessed by media expert lecturers, subject matter experts, biology teachers, colleagues, and students.

Development Design

In this study, the procedure for developing bio board game (BBG) learning media consists of an analysis stage, namely an analysis of learning media needs and learning problems currently faced by the school. Curriculum analysis to determine the depth and breadth of competencies that must be developed and analysis of student characteristics through interviews to determine the difficulties and needs of learning media in learning activities. The design stage consists of two activities: preparing a material framework design and its presentation in learning media and collecting materials needed in developing learning media. The development stage consists of three activities: developing bio board game (BBG) learning media, developing a BBG Book guidebook, and developing research instruments. The implementation stage consists of limited trials and field trials. The evaluation stage looks at the results of learning media characteristics and the effectiveness of learning media on students' analytical thinking and collaboration skills. The data analysis technique used in this development research is to assess the quality of the developed learning media. Assessment of the quality of teaching materials includes:

Descriptive analysis

Qualitative Data Analysis

Qualitative data analysis is in the form of an assessment of the feasibility of the bio board game (BBG) learning media by material experts, media experts, biology teachers, colleagues, and student responses to the learning media.

Table 1. Determination of Product Criteria Intervals (Widyoko, 2017)

Score Range	Value	Criteria
$X > (\bar{X}_l + 1.8Sb_i)$	A	Very Good
$(\bar{X}_l + 0.6Sb_i) < X \leq (\bar{X}_l + 1.8Sb_i)$	B	Good
$(\bar{X}_l - 0.6Sb_i) < X \leq (\bar{X}_l + 0.6Sb_i)$	C	Fair
$(\bar{X}_l - 1.8Sb_i) < X \leq (\bar{X}_l - 0.6Sb_i)$	D	Poor
$X \leq (\bar{X}_l - 1.8Sb_i)$	E	Very Poor

Information:

X = empirical score

\bar{X}_l = ideal average ($1/2(\text{Maximum score} + \text{minimum score})$)

Sb_i = ideal standard deviation ($1/6(\text{maximum score} - \text{minimum score})$)

*Quantitative Data Analysis**Bio board game learning media assessment questionnaire*

The assessment results obtained are then converted into product quality categories with the assessment guidelines in Table 1.

Test Instrument

Data from the students' analytical thinking ability test results were collected in the form of pretest and posttest results in the form of multiple-choice questions at levels C4, C5, and C6. Before conducting the hypothesis test, prerequisite tests were first conducted. These prerequisite tests included a multivariate normality test and a multivariate homogeneity test. The multivariate normality test used the Mahalanobis distance, the multivariate homogeneity test used the Box's M test, and the multivariate hypothesis test used the MANOVA test. Researchers used MANOVA because it allows for testing the average difference of more than one dependent variable so that researchers can obtain a more comprehensive picture of the use of this learning media on variables.

Result and Discussion

In this study, researchers developed a Bioboard Game learning medium, a media usage guidebook, and research instruments. The development method consisted of five stages: analysis, design, development, implementation, and evaluation.

Analysis

At this stage, a preliminary analysis was conducted, including gathering information through interviews with biology teachers at the school. Based on the interview results, the teacher stated that the obstacle faced during the teaching of animalia was the lack of optimal delivery. Furthermore, the teacher stated that the use of media depends on the material being taught. These include PowerPoint, Google Classroom, YouTube videos, textbooks, student worksheets, and student worksheets (LKPD) as learning resources, and the teacher's preferred learning model, namely lecture and discussion methods. This characteristic analysis aimed to determine student characteristics regarding the use of game media in learning activities.

This analysis also examined the desired learning alternatives for students. Based on the results of the student questionnaire, students stated that they were more interested in learning activities when teachers used interactive learning media in the form of games. In line with this, all students require engaging learning materials. The media developed were adapted to the current curriculum, the Independent Curriculum. Based

on the analysis of learning outcomes, the Animalia material could be developed into learning media.

Design

At this stage, the systematic design of the material framework and its presentation in the learning media is developed, followed by the design phase. This design phase encompasses three stages: designing the basic framework for the learning media, including the creation of the bio board game equipment, the game design, and the creation of a storyboard. This aims to facilitate the initial visualization process before producing a product and provide a detailed sequence and overview of the media being developed.

Media development refers to the storyboard, which begins with determining the game's theme and mechanics, sketching the game design, preparing supplementary cards containing questions related to the animalia material, and creating a final product ready for design using graphic design applications. The systematic guidebook for the concise material in the bio board game book, which covers animalia material, consists of vertebrates and invertebrates, tailored to the core competencies to be developed. The storyboard for the bio board game book includes the book cover, game instructions, a foreword, learning outcomes, learning objectives, a description of the material, and a biography of the developer.

Development

At this stage, three steps need to be developed: the development of bioboard game-based learning media in the form of a blueprint, a bioboard game guidebook, and research instruments. The evaluation tool design utilizes several tools, including assessment instruments validated by expert judgment, including lecturers who are media experts and lecturers who are subject matter experts; questionnaires for responses and media assessments by biology teachers, peers, and students; test instruments to measure analytical thinking skills in the form of pre- and post-tests; questionnaires to measure students' collaboration skills; lesson plans (RPPs), and observation sheets for learning implementation. The bioboard game-based learning media was created using several applications, including Canva and Adobe Photoshop CC 80 2018. The components of the bioboard game-based learning media include: cover Mockup; game board; pawns in learning media; point sheet on learning media; and game instructions.

This learning tool comes in a box that houses all the bio board game equipment. The icons can be seen in the Figure 2(a). The background design uses the Adobe Photoshop CC 2018 application. The game board is

printed using hardcover paper with glossy lamination measuring 50×50 cm. On the monopoly game board there are several components including the media title located in the center box and the game squares which have 36 squares. The appearance of the game board can be seen in the Figure 2(b). The game pawns are printed using 3×4 cm acrylic, and the dice are made of 3×3 cm transparent resin. The pawns can be seen in the Figure 2(c). Score sheet makes it easier for players to track their

scores throughout the game. At the end of the game, the score sheet serves as a final-game facility, facilitating quick and accurate calculation and determination of the winner. The score sheet can be seen in the Figure 2(d). The game instructions were designed using Adobe Photoshop CC 2018, and the cards were printed using 260g ivory, matte laminate, A5 size. The instructions can be seen in the Figure 2(e).



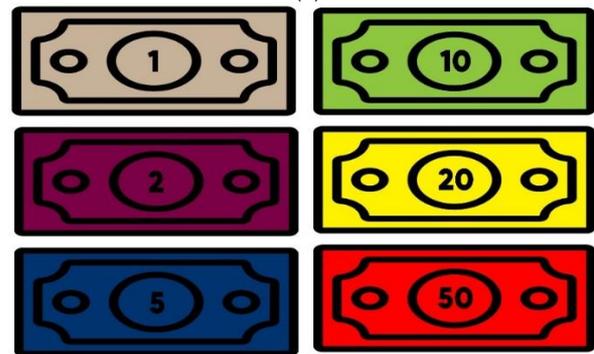
(a)



(b)



(c)



(d)



(e)

Figure 2. Learning media Developed: (a) Cover Mockup; (b) Game Board; (c) Pawns in Learning Media; (d) Point Sheet on Learning Media; and (e) Game Instructions

Playing Cards

The cards in the bio board game learning media consist of step cards, learning cards, challenge cards,

ownership cards, help cards, role cards, picture cards, and glossary cards. These cards aim to master knowledge by answering questions related to the

material presented on the cards. All supplementary cards were designed using Adobe Photoshop CC 2018 software and printed on 260g ivory matte laminate, measuring 12.5x9.5 cm. The game cards can be seen in the Figure 3.



Figure 3. Playing Cards

Step cards are used to start the game and carry out instructions according to the number of steps listed. Learning cards contain information or knowledge related to animalia and ask students to explain it to their peers. Challenge cards are developed with analytical questions related to the material. Ownership cards serve to verify the accuracy of answers to challenge cards. Help cards are useful for requesting assistance from other players. Role cards contain instructions to identify beneficial and detrimental roles based on the images shown. Guess the picture cards contain instructions for analysis and classification. The glossary card contains instructions to explain the Latin terms listed. The appearance of the game cards can be seen in the Figure 3.

Bio Board Game Book Guide

This learning tool includes a game guide for understanding the rules, and the bio board game book also provides information related to a summary of the material on animalia, making it easier for players to remember key concepts and enhance the effectiveness of board game learning. The book's layout can be seen in the Figure 4.

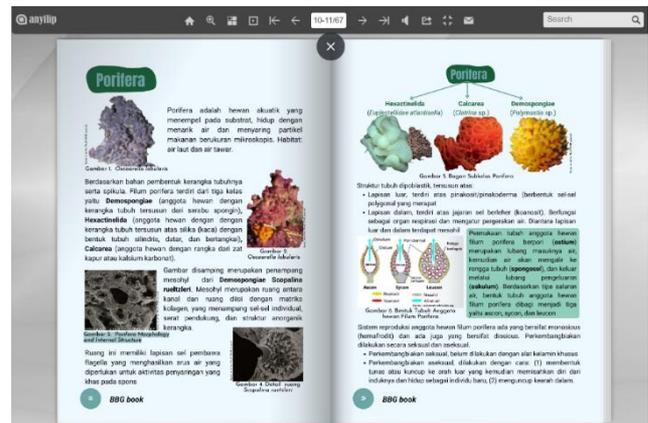


Figure 4. Guidebook on Learning Media

About the Developer

The About Developer page contains information about the learning media developer. The About Developer page can be seen in the Figure 5.



Figure 5. Developer View on Learning Media

Validity of Learning Media Based on Media Expert Assessment

The suitability of learning media based on media expert assessments. Validation results based on media expert assessments of learning media by media experts

are reviewed from four aspects: media design, learning aspects, media use aspects, and visual communication

aspects. Data from media expert assessments can be seen in Table 2.

Table 2. Media Assessment Results by Media Experts

Assessment Aspects	Biology Teacher		Partner	Average	Categories
	1	2	1		
Media Design	36	34	36	35.5	Very Good
Learning	20	19	20	19.7	Very Good
Media Use	9	12	12	11.0	Very Good
Visual Communication	4	4	4	4.0	Very Good
Material Suitability	15	19	20	18.0	Very Good
Material Accuracy	11	11	12	11.3	Very Good
Presentation	6	8	8	7.3	Very Good
Didactics	15	19	18	17.3	Very Good
Construction	30	36	33	33.0	Very Good
Technical	12	15	14	13.7	Very Good

Based on Table 2, the assessment results for all aspects obtained a very good validity category. This indicates that the Bio Board Game-based learning media is suitable for use in biology learning.

assessments by media experts regarding learning media by media experts were reviewed from six aspects: material feasibility, material accuracy, presentation, didactics, construction, and technical aspects. Data from media expert assessments can be seen in Table 3.

Learning Media Validity Based on Assessment by Material Experts

Learning Media Feasibility Based on Assessment by Material Experts. Validation results based on

Table 3. Results of Media Assessment by Material Experts

Assessment Aspects	Assessment Results			
	Amount	Average	Score	Criteria
Media Design Aspects	36	4.0	100	Very Good
Learning Aspects	16	4.0	100	Very Good
Media Usage Aspects	11	3.6	91.6	Very Good
Visual Communication Aspects	4	4.0	100	Very Good

Based on Table 3, the assessment results for all aspects obtained a very good validity category. This indicates that the animalia material in the bio board game-based learning media is suitable for use in biology learning.

previously learned the Animalia material. Students were asked to complete a post-test and then completed a questionnaire to determine their responses to the Animalia learning media used in the learning activities. The results of a limited trial conducted at SMAN 1 Sedayu are as follows:

Implementation

During the implementation phase, the developed and validated product will be piloted. The goal is to determine whether the developed learning media is usable. The implementation of the learning media was carried out through a limited trial in 36 students of class XI IPA 4 and 36 students of class XI IPA 2 at SMAN 1 Sedayu. Field trials were conducted in the control and experimental classes, namely class X9 (36 students) and class X5 (36 students) at SMAN 1 Seyegan.

Small Group Trial Results

The limited trial was conducted with 36 students of class XI IPA 4 and XI IPA 2 at SMAN 1 Sedayu who had

Validity of Learning Media Based on Practitioner Assessments, Student Feedback, and Peer Feedback

The assessments conducted by biology teachers and peers consisted of 10 aspects: media design, instruction, media use, visual communication, material suitability, material accuracy, presentation, didactics, construction, and technical aspects. The following is a summary of the assessments by teachers and peers, who are postgraduate students conducting research on learning media development.

Table 4. Average Assessment Results Media by Practitioners and Peers

Media Assessment Aspects	Assessment Results			
	Amount	Average	Score	Criteria
Eligibility	19	3.8	95	Very good
Accuracy	12	4.0	100	Very good
Presentation	7	3.5	87.5	Very good
Didactic	20	4.0	100	Very good
Construction	39	3.8	97.2	Very good
Technical	16	4.0	100	Very good

Based on Table 4, the assessments conducted by biology teachers and colleagues across the ten assessment aspects resulted in an overall score of "very good." This indicates that the Bio Board Game is suitable for use in the learning process, particularly on the topic of animalia.

Based on the assessments by biology teachers and colleagues, the Bio Board Game (BBG) learning media is suitable for trial with students with several revisions. The learning media assessments conducted by students consisted of four aspects: presentation, language, visual communication, and usability.

Table 5. Average Results of Media Assessments by Students

Assessment Aspects	Average	Categories
Presentation	9.3	Good
Language	10.2	Very Good
Visual Communication	10.3	Very Good
Usefulness	7.1	Very Good

Based on the results in Table 20, the average score for the presentation aspect was 9.3, categorized as good,

Table 6. Results of the Multivariate Normality Test

Variable	Class	Shapiro-Wilk		
		Statistic	df	Sig.
Analytical Thinking Skills	Pre-test Experiment	0.960	36	0.215
	Pre-test Control	0.930	36	0.719
	Post-test Experiment	0.931	36	0.201
	Post-test Control	0.944	36	0.069
Collaboration Skills	Pre-test Experiment	0.976	36	0.612
	Pre-test Control	0.971	36	0.464
	Post-test Experiment	0.989	36	0.969
	Post-test Control	0.962	36	0.243

Based on the results in Table 6, if the sig. value is > 0.05, the data is normally distributed. Overall, the experimental and control classes have a significance value > 0.05, indicating that the data are normally distributed.

and the overall scores for the other three aspects were categorized as very good.

Large Group Trial Results

The implementation phase was a large-scale trial phase implemented by 10th-grade high school students. Implementation was conducted in two classes: an experimental and a control class. The subjects in this study were 36 10th-grade students at SMAN 1 Seyegan. Learning took place in three meetings, each with three lesson plans.

Evaluation

Analytical thinking and collaboration skills were measured by administering a pre-test before the Animalia learning activities in the experimental control class. A post-test was administered to determine students' abilities after engaging in the learning process using the developed learning media.

Multivariate Normality Test

The multivariate normality test aims to determine whether the data from the variables are multivariately normally distributed. The variables measured were students' analytical thinking and collaboration skills. The multivariate normality test used was the Shapiro-Wilk test. Using the Shapiro-Wilk test helps ensure that multivariate data meets the assumptions of a normal distribution before further analysis, thereby increasing the validity of the research results. The results of the multivariate normality test can be seen in the following Table 6.

Multivariate Homogeneity Test

The homogeneity of the variance-covariance matrix was tested using the Box's M Test. The results of the multivariate homogeneity test are shown in the Table 7.

Table 7. Results of the Multivariate Homogeneity Test

Box's M	F	df1	df2	Sig.
1.276	0.412	3	882000.000	0.744

Table 7 shows that the significance value is greater than 0.005, or $0.744 > 0.05$ ($\text{Sig.} > 0.05$), so it can be concluded that the covariance matrix of the dependent variables can be considered equal or homogeneous.

Manowa Test

Table 8. MANOVA Test Results

Model	Value	F	H ₀ df	Error df	Sig.	Noncent Parameter
Hotelling's Trace	2.176	75.078 ^b	2.000	69.000	< 0,001	150.157

Based on Table 8, the Hotelling's Trace has a Sig. (2-tailed) value of less than $0.001 < 0.05$. This means that H₀ is rejected, indicating a significant difference in the average analytical thinking and collaboration skills of 10th-grade students who used Bio Board Game-based learning media compared to students who did not use Bio Board Game-based learning media on the Animalia topic.

N-Gain Test

The N-Gain test was conducted to determine the effectiveness of the Bio Board Game learning media on the Animalia topic in improving students' analytical thinking and collaboration skills.

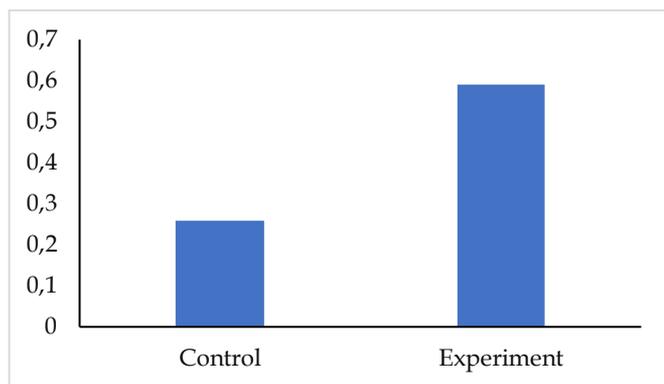


Figure 6. Graph of Analytical Thinking Ability Improvement Based on N-Gain Score Analysis

The average gain score for analytical thinking skills of students in the control class was 0.26, which is considered low. Meanwhile, the average gain score for analytical thinking skills of students in the experimental class was 0.59, which is considered moderate. Therefore, it can be concluded that there is a difference in analytical thinking skills scores between the control and experimental classes.

The calculation of students' collaboration skills in the control and experimental classes can be seen through the normalized gain score calculation.

The MANOVA test was conducted after the prerequisite tests for multivariate normality and multivariate homogeneity were met. The results of the MANOVA test, which examines simultaneous effects, are shown in the Table 8.

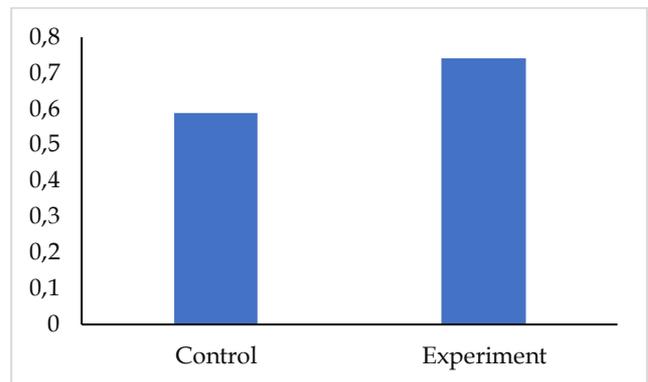


Figure 7. Collaboration Ability Improvement Graph Based on N-Gain Score Analysis

The average gain score for students' collaborative skills in the control class was 0.59, which falls into the moderate category. Meanwhile, the average gain score for students' analytical thinking skills in the experimental class was 0.74, which falls into the high category. Therefore, it can be concluded that there is a difference in analytical thinking skills between the control and experimental classes.

Discussion

The characteristics of the developed learning media are that it utilizes three-dimensional objects due to their unique shape and physical appearance. In its application, the Bio Board Game media for the Animalia topic is inseparable from images. This is essential to support active learning, facilitate explanations and reinforcement of the material on Animalia, and help students better understand and perceive animalia.

The adaptation of the Monopoly game was chosen because the core of the game is quite simple and can be easily learned by new players, despite the variations and additional rules. In this case, the Bio Board Game media contains a competitive element, which is useful for developing students' analytical thinking skills (Borg & Gall, 2007). This aligns with research conducted by Ramadhan et al. (2024) which stated that the developed media was deemed insufficiently engaging due to the lack of a competitive element.

Monopoly is introduced as a fun and interactive way to achieve a number of desired outcomes,

including: increasing student engagement in collaboration. Board games have their own unique characteristics, but Monopoly is even more appealing because the primary goal is to control all the squares on the board. Bioboard games are valuable in honing analytical thinking skills by engaging students in scientific activities, such as using questions that encourage deeper thinking and require complex problem-solving. The questions not only measure memorization but also students' analytical skills, distinguishing between facts and opinions, and connecting previously learned concepts. Organizational skills are an important part of analytical thinking (Sadiman et al., 2010).

Learning with bioboard games trains the brain and stimulates areas responsible for memory formation and complex thinking processes, thereby enhancing cognitive skills such as decision-making, strategic thinking, and problem-solving through playing cards.

The effectiveness of the Bioboard Game learning media is determined by the significant differences and improvements in analytical thinking and collaboration skills between the experimental and control classes. According to Ningtyas (2023), through board games, children not only learn to socialize but also hone their communication skills. Furthermore, board games train children's thinking processes to develop ideas, innovation, and strategies, which in turn foster new soft skills.

Setyanugrah & Setyadi (2017) added that, based on experience, simulation games can be used to stimulate children's motor development and improve comprehension, problem-solving skills, and concentration and memory. Board games offer three aspects: visual (images), audio (discussion and Q&A), and affective (attitude).

Conclusion

Based on the research results, it can be concluded that the Bio Board Game learning media has met the standards of validity, practicality, and effectiveness as a biology learning media. In terms of validity, this media received a very good assessment from media experts and material experts, covering aspects of design, learning, media use, visual communication, content accuracy, and presentation. In terms of effectiveness, there was a significant difference between classes that used the Bio Board Game and those that did not use it in improving analytical thinking and collaboration skills. This was reinforced by the N-Gain analysis which showed an increase of 58.72% in analytical thinking skills and 73.88% in collaboration skills, which according to Hake's classification is included in the fairly effective

category (Hake, 1998). This shows that social interactions, such as playing and discussing in board games, can develop higher-order thinking skills and the ability to work together in groups. Thus, the Bio Board Game is proven to be a valid, practical, and effective learning media in supporting the biology learning process in grade X.

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Author Contributions

This research contributes to game-based learning media that can be used by teachers in high schools. The author was involved in the overall creation of this article. Widyoko contributed to determining the product criteria interval.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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