



# The Effect of Using Dartboard Media on Critical Thinking Skills and Student Learning Outcomes in the Digestive System Topic

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**Abstract:** The development of critical thinking skills and improved learning outcomes are central goals of effective biology instruction. However, conventional learning media often fail to sufficiently stimulate higher-order thinking processes. This study examined the effect of dartboard-based learning media on students' critical thinking skills and learning outcomes in the topic of the digestive system. A quantitative quasi-experimental design with a pretest-posttest control group structure was employed, involving two grade XI classes at SMA Negeri 8 Gowa assigned as experimental and control groups. Data were collected through validated critical thinking and achievement tests and analyzed using inferential statistics. The results indicated that students taught using dartboard learning media demonstrated significantly higher critical thinking skills and learning outcomes compared to those receiving conventional instruction ( $p < 0.05$ ). These findings suggest that dartboard-based media effectively promotes active engagement, facilitates higher-order cognitive processes, and enhances academic performance in biology learning contexts.

**Keywords:** Critical thinking skills; Dartboard; Learning outcomes

## Introduction

The development of 21st-century skills, such as critical thinking, creativity, collaboration, and digital literacy, is an urgent need in education to meet the demands of the ever-changing world of work (Ridwan & Edward, 2024). Education that encourages active student engagement plays a crucial role in developing these skills, as interactive and challenging learning encourages students to analyze, solve problems, and make decisions independently (Purbayanti et al., 2022; Wasila et al., 2024). Students who are active in the learning process tend to have better critical thinking skills and learning outcomes than passive learners (Held & Mejeh, 2024; Li et al., 2024; Narca & Caballes, 2021).

Critical thinking is a form of reflective thinking that underlies rational decision-making and problem-solving. This skill encompasses the ability to analyze arguments, draw conclusions, conduct reasoning, and evaluate and make decisions based on mature cognitive processes (Jamaluddin et al., 2023). Research in biology

education has demonstrated that critical thinking skills can be effectively developed through contextual and problem-based learning approaches, particularly in complex biological topics such as the digestive system (Aisy & Trisnowati, 2024). Therefore, education needs to focus on developing critical thinking through challenging learning experiences, such as problem-based learning (Jaffar, 2025), as high-level critical thinking ability contributes significantly to improved learning outcomes.

Learning outcomes are an important indicator of learning success at the high school level, encompassing cognitive, affective, and psychomotor aspects, and reflecting students' mastery of the material, critical thinking skills, and active engagement (Yasin et al., 2023). Research shows that learning outcomes are greatly influenced by the use of appropriate, interactive, and contextual learning media (Rasnawati et al., 2023). Therefore, educational media that involve cognitive and physical activities, such as dart boards, have the

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potential to increase student engagement and improve learning outcomes in a comprehensive manner.

However, the results of observations and interviews with the Grade XI Biology teacher at SMAN 8 Gowa show that students still experience difficulties in understanding the digestive system material because it is considered abstract and complex. Learning tends to be dominated by lecture-based methods with minimal variation in activities and instructional media, causing students to feel bored, passive, and less engaged. These findings are in line with the study by Safitri et al. (2025), which reported low learning completeness as well as a high level of misconceptions regarding the digestive system material. Monotonous and one-way instructional approaches also have a negative impact on students' motivation, creativity, critical thinking skills, and learning outcomes (Susanti et al., 2024; Masniladevi, 2017).

The condition is exacerbated by the use of learning media that do not accommodate the diverse learning styles of students. In fact, the low cognitive achievement in Biology—particularly in the abilities to understand, apply, and analyze—is influenced by inadequate and less varied teaching methods, as well as minimal supporting media (Marwah & Wally, 2024; Siburian & Hutabarat, 2025). Therefore, appropriate learning media are needed to present the material in an interesting, contextual, and interactive way so that students can understand the relationship between the digestive process of food and the nutrients produced. This is important because balanced nutrition plays a crucial role in supporting optimal body function (Almatsier, 2011).

One alternative that can be utilized is game-based educational learning media, such as dartboards. The development of interactive learning media in biology has been proven to enhance students' critical thinking skills through engaging and meaningful learning experiences (Noris et al., 2023). This media has the potential to increase student interest, motivation, concentration, and active engagement because it integrates cognitive, affective, and psychomotor aspects in learning (Faridah et al., 2019; Nuridha & Haryanti, 2022; Hidayat & Asyhar, 2021). Along with the development of education, dartboard media has modified become an interactive media that combines game with questions and materials lessons, so that give experience learn more concrete and meaningful (Sutraningsi et al., 2021; Arsyad, 2021). Research by Ameliyah et al. (2024) and Muliana & Basri (2024) shows that that the dartboard media is capable increase engagement and quality learning.

Various studies have also demonstrated the effectiveness of dartboard media in improving learning outcomes, learning activities, and students' critical thinking skills on the topic of the digestive system

(Ramadani et al., 2025; Sutraningsi et al., 2021; Maradhy et al., 2023; Rachmasari & Setiawan, 2024). However, most previous studies have focused on only one aspect of learning outcomes and have not comprehensively examined the influence of dartboard media on learning activities, critical thinking skills, and learning outcomes simultaneously.

In addition, the integration of nutritional aspects into dartboard media has not been widely developed, even though nutrition is an essential component directly related to the digestive system and students' daily lives.

## Method

This study employed a quasi-experimental method with a nonequivalent control group pretest-posttest design. The population consisted of all Grade XI students of SMAN 8 Gowa. The sample included 60 students from two classes, namely Grade XI-3 as the experimental class and Grade XI-6 as the control class. The sampling technique used was purposive sampling. This study focused on systematic data collection and analysis to determine the effect of using dartboard media on students' critical thinking skills and learning outcomes in the digestive system topic.

The instrument used to assess critical thinking skills was based on Ennis (1996) indicators, which include focus, reason, inference, situation, clarity, and overview. Learning outcomes were measured using a multiple-choice test. The test indicators referred to the cognitive domain of the Revised Bloom's Taxonomy (Anderson & Krathwohl, 2010), including remembering, understanding, applying, analyzing, evaluating, and creating. The instruments were modified and adjusted according to the learning objectives, media, and instructional materials used in this study. Critical thinking skills were categorized into five levels: very poor, poor, sufficient, good, and very good. Similarly, learning outcomes were classified into the same five categories. To ensure validity and clarity, the media and research instruments were evaluated by two academic experts who provided feedback and suggestions for improvement. The results of the media and instrument validity are presented in Table 1.

**Table 1.** Validity of dartboard media

Research Aspects	Assessment score	Category
Format	3.90	Very valid
Design/appearance	3.75	Very valid
Language	3.67	Very valid
Average	3.77	Very valid

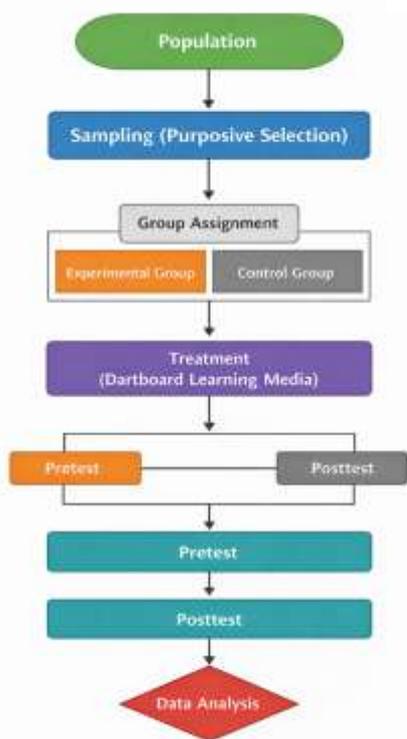


Figure 1. Research design

Table 2. Validity of critical thinking skills

Research aspects	Assessment score	Category
Format	4.00	Very valid
Content/critical thinking aspects	3.90	Very valid
Language	4.00	Very valid
Average	3.97	Very valid

Table 3. Validity of learning outcomes

Research Aspects	Assessment score	Category
format	4.00	Very valid
Content/learning test aspects	3.90	Very valid
Language	4.00	Very valid
Average	3.97	Very valid

The inferential statistical test used to examine the hypothesis was the independent samples t-test to analyze the effect of dartboard media on students' critical thinking skills and learning outcomes. Prior to hypothesis testing, preliminary analyses were conducted to determine the normality and homogeneity of the research data.

The results of the normality test showed that the p-values ranged from 0.140 to 0.200 for critical thinking skills and from 0.089 to 0.124 for learning outcomes, indicating that all data were normally distributed (see Tables 2 and 3 for more detailed results).

Meanwhile, the homogeneity test results showed a significance value of 0.077 for critical thinking skills and

0.111 for learning outcomes. Since all significance values were greater than 0.05, it can be concluded that the data were homogeneous across all groups (see Tables 4 and 6 for detailed results).

## Result and Discussion

### Dartboard Media Implementation

Learning begins with the delivery of learning objectives and providing motivation to students. The learning process in both classes is carried out using the Student Teams Achievement Division (STAD) model supported by Student Worksheets (LKPD). The experimental class uses dartboard learning media, namely a dartboard containing questions and material on the digestive system used in discussion activities and group work. Meanwhile, the control class uses torso anatomy media as a learning aid. LKPD is used in both classes to help students understand the material, discuss, and complete assignments according to the stages of the STAD model.

This learning media was implemented in just one experimental class. Afterward, students were divided into groups to complete worksheets and present their results. The researchers presented the learning material in a modified game board format with content on the digestive system, including macro and micronutrients, digestive organs and mechanisms, digestive glands, and digestive system disorders. Each section of the dartboard corresponded to a question or challenge that students had to answer based on the subtopic covered.

Meanwhile, the control class received conventional instruction conducted directly in the classroom. At each meeting, the teacher used a torso anatomy model as a teaching aid to explain the digestive system material, which included macronutrients and micronutrients, digestive organs and their mechanisms, digestive glands, as well as disorders of the digestive system.

The use of the torso anatomy model aimed to help students visually observe the structure of the digestive organs and understand the relationship between each organ and its respective function. During the learning process, students were also provided with student worksheets to identify and record information obtained from the teacher's explanation and the torso anatomy media.

The results of the descriptive analysis show that the average critical thinking skills and learning outcomes in the dartboard class were categorized as very good based on the predetermined interval criteria. Meanwhile, in the torso class, the average scores were categorized as good. These findings indicate a significant difference in the influence between the two groups (more detailed results can be seen in Table 4).

**Table 4.** Normality test of critical thinking skills

		Kolmogorof-smirnov normality test			Description
Class		Statistic	df	p	
Dartboard	Pretest	.113	30	.200	Normal Distributed
Torso anatomy		.207	30	.200	Normal Distributed
Dartboard	Posttest	.129	30	.156	Normal Distributed
Torso Anatomy		.137	30	.155	Normal Distributed

**Table 5.** Normality test of learning outcomes

		Kolmogorof-smirnov normality test			Description
Class		Statistic	df	p	
Dartboard	Pretest	.139	30	.146	Normal Distributed
Torso anatomy		.139	30	.146	Normal Distributed
Dartboard	Posttest	.149	30	.089	Normal Distributed
Torso Anatomy		.142	30	.124	Normal Distributed

**Table 6.** Homogeneity test of critical thinking skills and learning outcomes

Variable	Sig.	Description
Critical thinking skills	0.77	Homogenic
Learning outcomes	0.111	homogenic

**Table 7.** Category of critical thinking skills

Interval	Category	Dartboard				Torso Anatomy			
		Initial		Final		Initial		Final	
		N	(%)	N	(%)	N	(%)	N	(%)
81.26-100	Very Good	0	0.00	20	66.66	0	0.00	10	33.33
71.51-81.25	Good	0	0.00	10	33.33	0	0.00	16	53.33
62.51-71.50	Fair	0	0.00	0	0.00	0	0.00	4	13.33
43.76-62.50	Poor	9	30.00	0	0.00	12	40.00	0	0.00
0-43.7	Very Poor	21	70.00	0	0.00	18	60.00	0	0.00
Total		30	100.00	30	100.00	30	100.00	30	100.00

**Table 8.** Category of learning outcomes

Interval	Category	Dartboard				Torso Anatomy			
		Initial		Final		Initial		Final	
		N	(%)	N	(%)	N	(%)	N	(%)
85-100	Very Good	0	0.00	18	60.00	0	0.00	11	36.66
75-80	Good	0	0.00	12	40.00	0	0.00	18	60.00
65-60	Fair	0	0.00	0	0.00	6	0.00	1	3.33
≤ 54	Poor	5	16.66	0	0.00	12	40.00	0	0.00
0-20	Very Poor	25	83.33	0	0.00	18	60.00	0	0.00
Total		30	100.00	30	100.00	30	100.00	30	100.00

*The Effect of Dartboard Media on Critical Thinking Skills*

Based on The t-test results in Table 5 are available significant difference in skills think critical between participant students who are taught using Dartboard and Torso Anatomy media. The significance value obtained is at the level < 0.05, so can concluded that use of Dartboard media influential in a way significant to skills think critical participant educate compared to with Torso Anatomy media.

Dartboard media can improve critical thinking skills because it actively engages students through game

activities that require analysis, evaluation, and decision-making. This finding is consistent with previous research demonstrating that interactive biology learning media significantly enhances students' critical thinking abilities by providing contextual and engaging learning experiences (Aisy & Trisnowati, 2024; Noris et al., 2023). This activity stimulates multiple senses, helps process information more meaningfully, and encourages students to connect concepts and organize ideas systematically.

**Table 9.** Independent sample t test of critical thinking skills

t-test for equality of means					
	F	Sig.	t	df	Sign (2 tails)
Same variance assumed	.705	.401	-4.188	58	.000
Equal variance is not assumed			-4.188	56.776	.000

On the other hand, Anatomical Torso media also contributes positively to students' critical thinking skills through the presentation of concrete and visual three-dimensional anatomical objects. The use of physical anatomical models helps students achieve a deeper conceptual understanding and encourages analysis and evaluation of information within cooperative learning environments. Consequently, 3D anatomical media can enhance students' engagement and conceptual comprehension, as well as support the development of analytical and evaluative skills in science learning, although it is less interactive than game-based media (Kinanti & Kusuma, 2025; Lee et al., 2025).

Game-based media such as Dartboard present information in a more representative and engaging manner, thereby facilitating students' understanding of learning materials. Students are stimulated to form assumptions, draw inductive conclusions, and make decisions in the process of problem solving (Sarwinda et al., 2020). Learning activities that incorporate visualization, simulation, and dynamic elements also contribute to the development of abstract thinking skills, symbolic competence, and language skills, which play an essential role in critical thinking and decision-making processes (Sudarmin, 2009; Rahayu et al., 2019; Kurniawan et al., 2021; Sianturi, 2021).

*The Effect of Dartboard Media on Learning Outcomes*

Based on the results of the independent samples t-test presented in Table 6, there is a significant difference in learning outcomes between students taught using

dartboard media and those taught using anatomical torso media. The obtained significance value ( $p < 0.05$ ) indicates that the use of dartboard media has a statistically significant effect on students' learning outcomes compared to anatomical torso media.

Dartboard media is effective in improving learning outcomes because it integrates game elements, interaction, and active student engagement. Board game-based learning encourages knowledge exploration, discussion, and problem solving, thereby enhancing conceptual understanding and content retention (Mayer, 2020; Aryuni et al., 2022; Saylendra et al., 2021; Putri et al., 2023). Students who learn using game-based Dartboard media also tend to achieve higher learning outcomes than those taught using conventional methods, as improved conceptual understanding is facilitated through interaction and collaboration (Marinda et al., 2025; González-Pérez & Ramírez-Montoya, 2022).

Although anatomical torso media positively affects students' learning outcomes through the concrete visualization of organ structures, dartboard learning media demonstrates a greater impact on both critical thinking skills and learning outcomes. Direct interaction with anatomical models enables students to understand the structure and function of organs more realistically, thereby enhancing motivation, engagement, and cognitive abilities in comprehending and retaining biological concepts (Karim & Asrijal, 2022). The use of this media facilitates observation and discussion, which contributes to improved conceptual understanding.

**Table 10.** Independent sample t test of learning outcomes

	t-test for equality of means				
	F	Sig.	t	df	Sign (2tailed)
Same variance assumed	.037	.801	-4.523	58	.000
Equal variance is not assumed			-4.523	57.811	.000

However, based on the statistical analysis, the improvement in learning outcomes among students who used dartboard media showed a more significant difference compared to those who used anatomical torso media. Dartboard media not only presents learning materials visually but also actively engages students in game-based activities that require analysis, evaluation, and decision-making. This active involvement promotes deeper cognitive processing, leading to a stronger impact on learning outcomes.

Therefore, although anatomical torso media is effective in facilitating conceptual understanding, dartboard media demonstrates a greater influence on enhancing students' learning outcomes. This can be attributed to its integration of game elements, interaction, and cognitive challenges, which create more engaging and meaningful learning experiences and

significantly contribute to students' academic achievement.

**Conclusion**

The use of dartboard and anatomical torso learning media significantly influences the learning activities, critical thinking skills, and learning outcomes of Grade XI students at SMAN 8 Gowa, particularly in the digestive system topic. The findings indicate that dartboard media provides a more substantial effect than anatomical torso media in enhancing students' active engagement, critical thinking skills, and learning outcomes. These results provide important implications for educators in selecting innovative and interactive instructional media to foster meaningful Biology learning. Teachers are encouraged to design and

implement learning media that actively involve students and support the development of higher-order thinking skills to improve overall academic performance.

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#### Author Contributions

Conceptualization, methodology, formal analysis, investigation, resources, writing—preparation of original draft, N., M.T., and H.; writing—reviewing and editing, visualization, supervision, project administration, F.D. and A.A. All authors have read and approved the published version of the manuscript.

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#### Conflicts of Interest

The authors declare no conflict of interest.

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