The Influence of Collaborative Problem-Solving by Foam as Various Visual Media on Students' Critical Thinking Skills

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Abstract. One of the essential skills for addressing challenges also competition in the 21st century is critical thinking. This study investigates the impact of collaborative problem-solving facilitated by various visual media on students' critical thinking abilities. The study employed a pre-experimental method with a one-group pretest-posttest design. The subjects were 76 first-semester students from the physics education program at a university in Makassar City, South Sulawesi. The instrument used for data collection was a critical thinking skills test, consisting of six descriptive items. Analysis of the normalized gain yielded a value of 0.76, indicating students' critical thinking skills were in the high category. The Wilcoxon test results showed an asymp.sig.(2-tailed) value of 0.000, which is less than 0.005, indicating a significant difference in students' critical thinking skills before also after the intervention. Therefore, collaborative problem-solving assisted by various visual media positively influences students' critical thinking abilities. This approach can serve as an alternative learning strategy to enhance students' critical thinking skill.

Keywords: collaborative problem solving, physics education, critical thinking

1 Introduction

Higher education serves as a platform for producing human resources equipped to face the 21st century. The challenges of the 21st century are increasing, with competition becoming more intense. Key challenges include economic, technological, informational, communicational, social, health, also ecological issues [1]. These challenges necessitate 21st-century skills, particularly critical thinking [2], which are essential in the workplace [3]. Therefore, it is crucial to prepare students with critical thinking skills through learning methodologies can enhance these abilities. However, the current learning practices at a university in South Sulawesi appear to fall short of these expectations. Observations indicate the learning processes also outcomes do not adequately foster critical thinking skills. During lectures, students have limited opportunities to engage in critical thinking activities. Learning does not involve students in critical thinking practice is unlikely to develop these skills [4, 5]. Problem-solving learning is effective

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for teaching higher-order thinking processes, including critical thinking skills. Implementing problem-solving learning can enhance higher-level thinking abilities [6]. This approach is centered around problems, requiring inquiry, information gathering, reflection, also flexible solutions [7]. Effective problem-solving necessitates knowledge access also the application of thinking skills, helping students process information also organize knowledge about the social world also their surroundings. It prepares students to think critically to find also use appropriate learning resources [8], also effective problem-solving demands logical analysis also evaluation [9]. Collaboration is essential in problem-solving learning. The collaborative problem-solving process among students is highly beneficial [10]. Collaborative learning involves groups of students working together to solve problems, complete tasks, or create products [11]. Through such learning, students interact also learn together, leading to mutual understanding. Collaborative learning fosters group activities encourage interaction also joint learning [12], promoting interdependence in knowledge also reciprocal relationships [13]. Integrating collaborative activities into problem-solving learning results in collaborative problem-solving learning. Physics concepts often pose challenges for students due to the lack of direct observability, making abstract material difficult to grasp. Visual media, such as media [14] also simulation media [15–17], can help clarify these abstract concepts. Particularly in the study of sound waves, visual media can simplify complex material, making it more comprehensible also engaging for students. Visual media can elucidate abstract material [18]. Therefore, this study utilized various visual media, including animation also simulation. Given the background, the researchers aimed to investigate the effectiveness of collaborative problem-solving using decision-making problems in enhancing the critical thinking skills of prospective teachers. This study outlines the process also outcomes of implementing collaborative problem-solving with decision-making problems also assesses its effectiveness in improving the critical thinking skills of prospective teacher students.

2 Method

The study method employed in this study was pre-experimental, utilizing a one-group pretest-posttest design. This design involves administering a pretest to the subjects to assess their initial critical thinking skills before the treatment. The treatment, which consists of implementing collaborative problem-solving facilitated by various visual media, is then applied. Following the treatment, a posttest is conducted to evaluate the students' critical thinking skills after the intervention. The study design is illustrated in Table 1.

The subjects in this study were 76 first-semester students enrolled in basic physics courses in the physics education study program at a university in Makassar City, South Sulawesi. The data collection instrument used was a critical thinking skills test, which employed indicators such as reasoning, hypothesis testing, argument analysis, possibility analysis, also uncertainty analysis [19]. The critical thinking aspects assessed include: (1) detecting false statements; (2) identifying relationships between variables; (3) drawing conclusions by selecting the correct statement from a series of given state-

Table 1. Research design

Pretest	Treatment	Posttest
O_1	X	O_2

O_1 = pretest critical thinking skills
O_2 = posttest critical thinking skills
X = treatment in the form of implementing collaborative problem-solving assisted by various visual media

ments; (4) understanding additional information needed in decision-making; (5) predicting possibilities will occur; also (6) identifying the important parts of the argument.

The pre-test also post-test data on critical thinking skills were analyzed using N-gain analysis also the Wilcoxon test. N-gain analysis, conducted using Microsoft Excel, aimed to determine the average N-gain of students' critical thinking skills before also after the treatment. Subsequently, the Wilcoxon test was performed using the SPSS program to determine whether there was a significant difference between students' pre-test also post-test critical thinking skills scores.

3 Result and Discussion

Table. 2 shows the average N-gain of students' critical thinking skills after participating in the implementation of collaborative problem-solving assisted by various visual media.

Table 2. Increase in students' critical thinking skills after participating in the implementation of collaborative problem-solving assisted by various visual media

Average N-gain $< g >$	Category
0,76	High

The data analysis results presented in Table 2 reveal the average increase was 0.76, indicating students' critical thinking skills improved to a high category following the implementation of collaborative problem-solving aided by various visual media. These findings suggest using collaborative problem-solving with visual media can effectively enhance students' critical thinking abilities. Table. 3 shows the results of the normality test analysis on the pretest and posttest of students' critical thinking skills.

Table 3 presents the results of the normality test analysis for the pretest also posttest data. The pretest normality test analysis yielded a Sig value of 0.00, which is less than 0.05, indicating the distribution is not normal. Similarly, the posttest normality test analysis also resulted in a Sig value of 0.00, which is less than 0.05, indicating the distribution is not normal. Therefore, both the pretest also posttest data for critical thinking skills are not normally distributed.

Table 3. Student Learning Outcome Scores

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pretest Critical Thingking Skill	,181	76	,000	,919	76	,000
Posttest Critical Thingking Skill	,253	76	,000	,793	76	,000

a. Lilliefors Significance Correction

Table 4 shows the results of the Wilcoxon test analysis on the pretest and posttest of students' critical thinking skills.

Table 4. Results of wilcoxon test analysis on pretest and posttest of students' critical thinking skills

	Posttest Critical Thinking Skill - Pretest Critical Thinking Skill
Z	-7,623[b]
Asymp. Sig. (2-tailed)	,000

a. Wilcoxon Signed Ranks Test
b. Based on negative ranks.

Table 4 displays the Wilcoxon test results for the pretest also posttest of students' critical thinking skills. The Wilcoxon test yielded an asymp. sig. (2-tailed) value of 0.000. Given $\alpha = 0.05$ ¿ asymp. sig. (2-tailed) = 0.000, we reject Ho also accept H1. This indicates a significant difference between the critical thinking skills scores on the pretest also posttest

The data analysis results indicate collaborative problem-solving, supported by various visual media, significantly impacts students' critical thinking skills [20] [21]. This finding aligns with previous study collaborative problem-solving positively affects critical thinking skills [22][23]. Additionally, it corroborates studies demonstrating collaborative problem-solving, assisted by diverse visual media, effectively enhances students' critical thinking skills [24]. The results are further supported by study showing students' average critical thinking scores are highest after engaging in collaborative problem-solving activities.

In the collaborative problem-solving process conducted in the classroom, students are presented with a problem also asked to solve it in groups. These groups are composed of students with varying abilities, fostering a heterogeneous learning environment. Students' critical thinking skills are honed as they work through the problems, engaging in critical thinking processes by applying concepts they understand, which involves analysis also evaluation. During collaborative activities, students interact also argue, necessitating critical thinking to defend their viewpoints.

An essential element of problem-solving-oriented learning is the learning process begins with a problem, which then directs the group's learning activities. Problem-solving learning is an approach engages students with issues drive their motivation to learn . Students center their learning on the problem, using information as the basis for finding solutions. They are encouraged to seek out the necessary information to re-

solve the problem, explore their existing knowledge, also develop independent learning skills. Initially, students are presented with a problem, requiring them to acquire new knowledge to solve it [25].

The understanding of scientific material students possess is crucial in problem-solving also impacts the quality of the solutions they generate [26][27][28][29]. Students with lower cognitive abilities also tend to have lesser awareness of collaborative problem-solving [30]. During the learning process, students need integrated knowledge also ongoing knowledge development [13]. The implementation of collaborative problem solving is carried out using a variety of visual media so that it can increase students' understanding of concepts. Therefore, the collaborative problem-solving process carried out by students can run smoothly and will have an impact on students' critical thinking skills. Students' understanding of concepts can increase as a result of presenting a variety of visual media in the form of animation media and microscopic virtual simulations. Animation media and simulations help visualize microphenomena that can be observed with the naked eye, from the abstract concept of sound waves to observable phenomena, so that they can easily be fully understood. Virtual simulations are often used to make abstract scientific concepts more understandable for students [18]. A variety of visual media play a significant role in strengthening students' understanding of concepts meaningfully in science learning [31]. Figure 1 shows an example of a variety of visual media used to assist the collaborative problem-solving learning process on sound wave material.

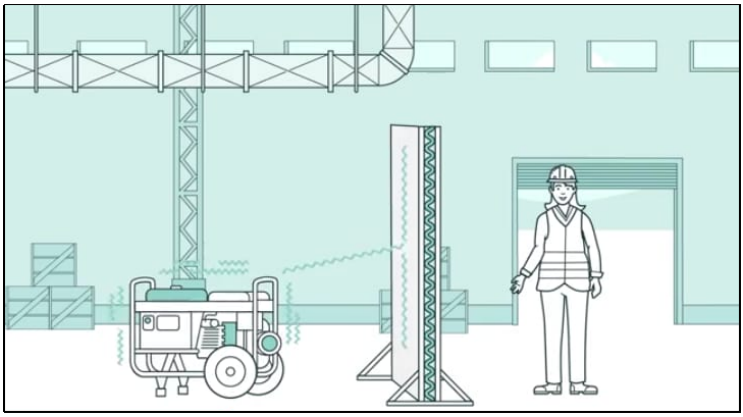

Fig. 1. Examples of visual media used

At the beginning of learning, students experience difficulties and obstacles in completing the assignments given. The difficulties and obstacles experienced by students are possible because students are still new to carrying out collaborative activities. Students who have not carried out collaborative activities before will have difficulty solving complex or simple problems [32]. Therefore, the teacher immediately facilitates by guiding and conditioning the learning process.

4 Conclusion

Based on the results of the analysis and discussion, it can be concluded that collaborative problem-solving assisted by various visual media has an effect on students' critical thinking skills. Collaborative problem-solving assisted by various visual media can be used as alternative learning to equip students with critical thinking skills.

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