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The Role of Problem-Based Worksheets in Enhancing Students' Critical Thinking Skills

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ABSTRACT

Research has been conducted to determine the effect of Problem-Based Learning (PBL) based worksheets on the critical thinking skills of students in class XI IPA. The subjects of this study were 30 students from class XI IPA. This research was conducted by applying a conventional learning model in the control class, using worksheets, while the experimental class applied a PBL-based worksheet over three meetings. The t-test results revealed a sig. 2-tailed value of 0.007 (before treatment) ≤ 0.05, which leads to the acceptance of H1 and rejection of H0. After treatment, the value was 0.160 (≥ 0.05), so H0 is accepted, and H1 is rejected. This indicates that worksheets based on problem-based learning (PBL) do not significantly affect the critical thinking skills of students in class XI IPA. However, the N-gain Score Test results show that the experimental class had an average N-gain score of 12.73, higher than the control class, which had a score of 8.73. Therefore, it can be concluded that the use of PBL-based worksheets affects the experimental class, improving critical thinking skills by 12.73, compared to the control class, which only improved by 8.73 after the learning process.

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INTRODUCTION

Chemistry is always present in daily life, making chemistry education very important. This is because chemistry learning requires an understanding of concepts and their application in solving problems or chemistry questions scientifically. However, some students still consider chemistry to be difficult. This is because chemistry is highly abstract, both in terms of actual states and the theories and approaches used to solve problems.

Problem-solving is a complex activity and an important component of an individual's thinking process [1][2]. Reasoning is used in problem-solving as the basis for combining ideas and guiding students to a solution. To effectively use this reasoning, students need strong critical thinking skills. However, in reality, the measurement of students' critical thinking skills in solving problems remains inadequate. It is essential to assess students' critical thinking skills to determine how well they can analyze opinions, draw conclusions based on reasoning, evaluate,

and make decisions [3][4]. Two factors affect students' ability to think critically: internal factors (the students themselves) and external factors, such as a lack of parental attention.

Interviews with chemistry teachers at SMAN Sasitamean revealed that teachers still face challenges in selecting accurate teaching models to help improve students' critical thinking skills in solving real-world problems. Learning both inside and outside the classroom showed that only a small number of students actively participated, as current teaching methods tend to rely on lecturing. Underperforming students only engage passively in learning, leading to poor exam results. Students still face difficulties understanding and completing material from some of the topics taught. One of the topics that remains challenging is acid-base titration. This is due to the complexity of the material, the lack of critical thinking skills among students, and their lack of interest in learning new concepts. The exam results on the acid-base titration topic indicated that students in grade XI at SMAN Sasitamean did not meet the Minimum Completion Criteria (KKM) of › 75, with exam scores not reaching 50%. Currently, students have an average score of 50.0. Therefore, a major change is needed in chemistry education, particularly in the innovation of learning media used. This is necessary with the aim of improving students' critical thinking skills. One media that can stimulate students' interest and enhance their critical thinking abilities is problem-based learning worksheets, which can be applied as a solution to the challenges faced in chemistry education at schools.

Problem-based learning (PBL) offers several advantages compared to other teaching models, such as: 1) students are engaged in solving authentic problems, 2) students have the opportunity to build their understanding, 3) learning remains focused on specific issues and is not fragmented, 4) students improve teamwork skills while participating in scientific activities, 5) access to various media, students learn to seek sources that contribute to their knowledge, 6) students can evaluate their progress in learning, 7) students develop skills in discussion, presentation, and scientific communication, and 8) collaborative group work allows students to assist each other, thereby reducing potential learning challenges [5][6][7].

Problem-based learning enables students to directly participate in solving problems provided by the teacher. In contrast, the expository learning approach emphasizes memorization. PBL provides students with greater opportunities to solve problems collaboratively. By implementing this model, students are directly encouraged to engage actively in problem-solving, which fosters habits of independent learning, active literature searching, and problem-solving skills.

In the learning process, students have the opportunity to solve problems collaboratively, unlike traditional teacher-centered learning that emphasizes memorization. In the implementation of the problem-based learning model, students are required to be actively involved in solving problems, thus forming habits of independent learning, active literature searching, and practicing problem-solving.

According to previous literature, as reported by Edy et al. (2024) [8], out of thirteen articles, the role of applying the problem-based learning model on students' critical thinking skills shows a significant and strong effect overall. Furthermore, Niswa et al. (2022) [9] stated that the application of problem-based learning can develop students' critical thinking abilities. Then, Wahyuningtyas et al. (2023) [10] reported that the critical thinking skills of fifth-grade students in science subjects related to the water cycle were more effective with the implementation of the problem-based learning model supported by the Ponorogo Ethnoscience Student Worksheet. Meanwhile, Darmawati and Mustadi (2023) [11] also reported that students' critical thinking skills were significantly different between the group taught using problem-based learning and the group taught using expository learning. According to this research, it can be concluded that

problem-based learning allows students to address real-world problems and allows them to use their critical thinking skills to solve those problems.

For effective learning, learning resources are crucial as they relate to student engagement in the learning process [12][13]. Student Worksheets are an alternative online learning tool that allows teachers to create systematic learning activities for students, enabling them to understand the subject matter more effectively. According to Hartati et al. (2024) [14], it was reported that students' problem-solving skills are influenced by the problem-based learning model assisted by WORKSHEETS. Therefore, research on the role of problem-based worksheets in enhancing students' critical thinking skills at SMAN Sasitamean is important to conduct. In this study, students use the Merdeka Curriculum with offline learning, which differentiates it from previous studies.

RESEARCH METHODOLOGY

This quasi-experiment involves a sample of class XI IPA students at SMAN Sasitamean in Malaka Regency, East Nusa Tenggara Province. The research sample consists of two classes, divided into two groups: one will use the experimental model assisted by problem-based WORKSHEETS (experimental group), and the other will use the conventional worksheets model (control group).

The pretest results will be used to determine the experimental and control class groups. The pretest results showed that students in class IPA-1 had better critical thinking skills compared to students in class IPA-2, with average scores of 33.29 and 23.44, respectively. The research instrument used to measure students' critical thinking skills was an essay-type test integrated with chemistry material. A trial test was conducted before use to ensure the validity and reliability of the questions. The collected data were analyzed using SPSS 25 software.

RESULTS AND DISCUSSION

Pre-treatment t-test

The data analysis was performed using an independent t-test with SPSS 25 software. The results of the t-test recapitulation for the experimental and control groups are presented in Table 1.

Table 1. Results of the t-test recapitulation before treatment

Pretest	N	Mean	std.Deviation	Std. Error Mean
Class IPA1	14	33.29	10.69	2.86
Class IPA2	16	23.44	7.83	8.96

Independent Sample Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	T	Df	Sig.(2-tailed)
Assumption of equal variances in post-test	.684	.415	2.904	28	.007
Unequal variances are not assumed.			2.844	2.375	.009

According to Table 1, the significance value obtained is 0.007, which is smaller than (α = 0.05), meaning that the initial critical thinking skills of the students in IPA-1 differ from those of the students in IPA-2. The mean critical thinking skills of IPA-1 students is 33.29, while the mean critical thinking skills of IPA-2 students is 23.44. Therefore, the IPA-2 class is designated as the experimental group and the IPA-1 class as the control group.

Post-Treatment t-test

After the treatment, the critical thinking skills of the students were tested using an essay question instrument integrated with chemistry material. Table 2 shows the results of the t-test recapitulation for the experimental and control groups.

Table 2. Results of the t-test recapitulation after treatment

Statistics Group

Posttest	N	Mean	Std. Deviation	Std. Error Mean
Kelas Pembanding	14	56.14	6.57	1.76
Kelas Ekaperimen	16	60.12	8.30	2.08

Independent Sample Test

	Levene's Test for Equality of Variances		t-test for Equality of Means		
	F	Sig.	T	Df	Sig.(2-tailed)
Assumption of equal variances in post-test	1.582	.219	-1.443	28	.160
Unequal variances are not assumed.			-1.466	2.775	.154

Table 2 above shows that the significance level (α = 0.05), which is 0.160, is higher than 0.05. Therefore, there is no significant difference in critical thinking skills between the experimental group and the control group. However, the critical thinking skills of the experimental group are better compared to the control group. Table 3 presents the results of the N-Gain test for the experimental and control groups.

Discussion

This study compares two learning models. The experimental group, with low initial critical thinking skills, was assigned to the problem-based worksheets group, while the control group was assigned to the conventional worksheets created by the teacher. Problem-based worksheets was used in the experimental group, while conventional worksheets was used in the control group. The lessons were conducted in three meetings. A post-test was given to both the experimental and control groups in the fourth meeting or at the end of the lesson. The statistical test results showed no significant difference between the experimental and control groups after the post-test. However, the average N-gain score of the experimental group was higher, at 12.73, compared to the control group's 8.74.

The non-significant statistical test results may be because only three meetings were held, but the N-gain score significantly increased in the experimental group. If the learning process were extended over a longer period, the results might differ significantly, as the development of critical thinking skills is different from changing cognitive learning. Developing critical thinking skills requires a considerable amount of time. This is supported by research from Persky et al. (2019) [15], which states that developing critical thinking skills is a deliberate and ongoing process that requires a supportive educational environment, explicit teaching strategies, and motivational tools. Despite being challenging, with proper intervention and focus, students can significantly improve their critical thinking skills over time. In this study, only three meetings were conducted in a short period, which indicates that the application of problem-based worksheets in teaching, if conducted over a longer period, could lead to significant improvements in students' critical thinking skills.

Efforts to improve students' critical thinking skills can be made by applying problem-based worksheets, as students will actively engage in group discussions, seek answers within

their groups, and express their own opinions about what they are doing. The problem-based worksheets learning medium allows students to improve their critical thinking skills due to its characteristics, as it enables students to think according to the steps outlined in the teaching process. Students can work in teams, learn to communicate both orally and in writing effectively, and demonstrate better mastery of the material.

Problem-based worksheets learning also provides all students the opportunity to express opinions, share ideas, and talk with their peers while working on group tasks. As shown by Della (2021) [16], problem-based learning (PBL) worksheets helps students improve their creative and critical thinking abilities. Since critical thinking skills are related to the learning process, the success of students' critical thinking is influenced by the teaching model used during learning activities. On the other hand, students in the control group showed lower critical thinking skills, likely because the lecture-based teaching model, which was teacher-centered, did not allow them to communicate orally and in writing, nor did it demonstrate a strong mastery of the material.

This is in line with previous research by Istni et al. (2022) [17], where the researchers found that the application of the PBL model supported by worksheets had a positive impact on the critical thinking skills of students in class XI IPS at MA Bilingual Batu in Geography lessons. The advantages of the PBL model supported by worksheets and critical thinking indicators show that worksheets designed with critical thinking indicators can help students develop specific skills. The selection of appropriate material is also crucial for the application of the PBL model. With this model, students' critical thinking skills are improved because it encourages them to participate more actively in conversations and arguments. Furthermore, the PBL model supported by worksheets is well-suited for learning during the pandemic. In addition, Afridiani et al. (2020) [18] demonstrated that the ability to understand mathematical concepts is influenced by teaching using the PBL model supported by worksheets. Previous research by Hidayati and Purwaningsih (2023) [19] showed that the implementation of the problem-based learning model affects students' critical thinking skills, with an improvement in skills after its application in the taught subjects. Furthermore, Adnyani and Suniasih (2023) [20] found that the implementation of the problem-based learning model had a significant impact on students' critical thinking skills in science lessons.

CONCLUSION

Based on the research objectives and the discussion presented, the statistical calculations did not show a significant difference in critical thinking skills between students taught using problem-based WORKSHEETS and those taught using conventional worksheets. However, based on the N-gain score, problem-based worksheets was able to improve students' critical thinking skills by 12.73 compared to conventional worksheets.

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