

THE EFFECT OF STUDENT WORKSHEETS BASED ON PROBLEM SOLVING ON STUDENTS' CRITICAL THINKING ABILITY

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ABSTRACT

Teachers must prepare teaching materials in order to achieve educational goals in the twenty-first century. A worksheet is one of the teaching materials that teachers can use in the learning process. Worksheets that contain learning models with 21st century skill indicators, such as critical thinking, communication, collaboration, and innovation, can help students develop 21st century skills. Based on preliminary observations made at SMAN 12 Padang in Natural Sciences class XI, the data obtained for daily test scores on dynamic fluid materials, particularly critical abilities, are quite low, owing to students' inability to fully solve the problems presented related to daily review of the material. The solution is to use a problem-solving model worksheet on dynamic fluid material on critical thinking skills in SMAN 12 Padang's class XI Natural Sciences. This is a quasi-experimental study with a quantitative approach. The participants in this study were from SMAN 12 Padang's class XI Natural Sciences. The experimental class (XI Science 1) with module teaching materials sourced from the teacher and the control class (XI Science 2) in the form of problem-solving worksheets are the subjects of this study. Normality, homogeneity, and hypothesis testing were performed on the research data at a significance level of 0.05. Based on data analysis, it is concluded that the value of critical thinking in class XI Natural Sciences 2 is greater than in class XI Natural Sciences 1, and that the effect of using problem solving worksheets is greater in learning.

Keywords : Worksheets for problem solving models, module, and critical thinking skills



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I. INTRODUCTION

Building a nation that is more advanced than previous generations require education. As time goes on, education will also continue to change. In the twenty-first century, science and technology (IPTEK) are developing very swiftly. This is demonstrated by how science and technology are used in every aspect of life. One of the requirements for success in the twenty-first century is the mastery of various abilities, one of which is the 4C skills (communication, collaboration, critical thinking, creativity).

For students to succeed in the twenty-first century, they need the 4C abilities. The four C skills are communication (communication), collaboration (collaboration), creativity and innovation (creativity and innovation), and critical thinking skills (critical thinking talents) (Creative thinking and innovation). The mastering of 4C skills is crucial for students. By learning the 4C skills, students' mindsets will be prepared to handle challenging situations. Soft abilities like 4C talents are much more useful in daily life than learning hard skills.

In order to achieve 4C competencies, the government has now adopted the 2013 revised 2017 curriculum as the education curriculum in Indonesia. The 2013 revised 2017 curriculum defines student-centered learning. The revised 2017 curriculum aims to teach students the 4Cs (communication, collaboration, critical thinking, and creativity), as well as HOTS (Higher Order Thinking Skill) [1].

The HOTS and 4C Skills are intertwined. Problem solving, critical thinking abilities, creative thinking skills, and decision-making skills are among the HOTS accomplishment markers. We can observe the relationship between this HOTS accomplishment indicator and 4C competencies, which both require pupils to have critical thinking skills. As a result, students' HOTS will have a direct impact on 4C skills, particularly critical thinking skills.

Indicators of critical thinking ability can be used to assess a student's critical thinking abilities. Analysis, assessment, and inference are all indicators of critical thinking. Students' responses to test questions, particularly those in the form of essay questions, can be used to assess their critical thinking ability.

The problem was obtained as a real condition in the field based on observations made at SMAN 12 Padang with the permission of the Education Office. Observations were made in two ways: first, through the analysis of answer documents for the Daily Examination for Dynamic Fluids in 2020; and second, regarding the importance of critical thinking skills. Second, through interviews with physics subject teachers about the use of Student Worksheets or other common teaching materials, such as modules and learning models in schools.

The first fact is that, according to the results of the analysis of the answer documents for the daily test of dynamic fluid material in 2020, the indicator value of students' critical thinking abilities is not optimal, as shown in Figure 1:

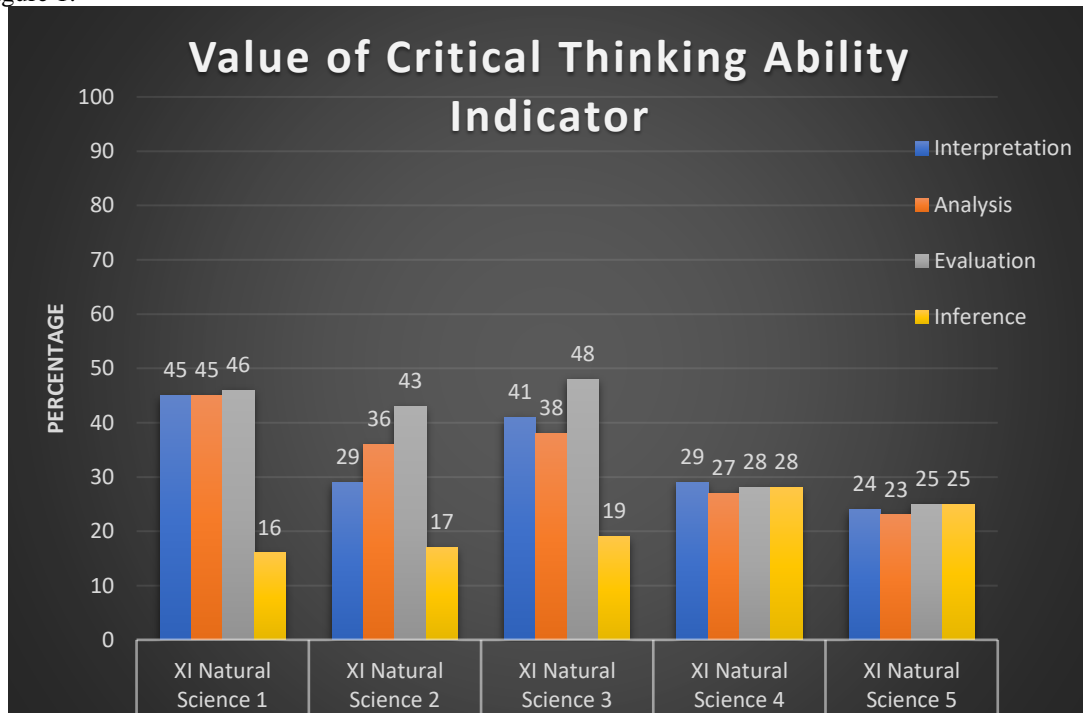


Fig 1. Early Critical Thinking Ability Indicators of Science Students in Class XI at SMAN 12 Padang

The pupils' critical thinking skills above fall into the uncritical group based on the criteria for adopting critical thinking skills [2].

This issue must be resolved because, in order to meet the curriculum's requirements, pupils must be able to think critically. Several attempts must be taken to increase critical thinking skills, including the use of educational resources in the form of Student Worksheets, which are a source of learning for students. The Student Worksheet is designed to help teachers deliver and direct physics instruction. Students require Student Worksheets as a guide to the competencies that must be achieved as well as an assessment tool to determine the extent to which students have mastered the concepts in the learning process. The Student Worksheet saves time for teachers, assists them in their position as facilitators, promotes effective and interactive learning, and steers the learning process. Both teachers use learning models to help pupils improve their critical thinking skills. There are numerous learning models that can be used in accordance with the 2013 curriculum, including discovery learning models, inquiry models, issue based learning models, project based learning models, and problem solving models.

However, the second evidence came from a chat with a Physics instructor at SMAN 12 Padang. Teachers employ traditional modules as teaching resources and still use the lecture technique to limit student engagement during the learning process. Students are less prepared to think critically and creatively as a result of this. Teachers are supposed to use learning models that can help students develop critical thinking abilities in this setting.

The Student Worksheet is based on the steps of the learning model and was created as a result of various investigations. Using a paradigm of teaching materials based on guided inquiry physics students' critical thinking capacity, this was accomplished [3]. Then, according to studies, using Student Worksheets with problem-solving models can help boost critical thinking skills [4]. According to the findings of the two research, using the Student Worksheet based on the learning model can help students develop their thinking skills. Furthermore, in the usage of modules, especially employing modules that are regularly used by educators or teachers themselves, so that differences in each application of the two teaching materials may be evaluated and how they effect students' critical

thinking skills. Modules are learning tools or means that incorporate materials, techniques, boundaries of learning materials, directions for learning activities, exercises, and ways of evaluation that are methodically and amusingly intended to accomplish the necessary competences and can be used independently [5]. The improvement in student test results between before and after the research can be used to demonstrate this.

Researchers were motivated to use instructional materials, specifically the Student Worksheet of the problem solving paradigm, as a result of the two experiments mentioned above. Teaching using a problem-solving approach places a strong emphasis on students' ability to articulate goals, assess empirical facts, present arguments, and make judgments [6]. The self-prepared issue solving model worksheet is based on the range of the available indicators and the problem solution-based In order to help students develop their critical thinking skills, the Learner Worksheet offers problem-solving techniques using a variety of methodologies. On materials made of dynamic fluids, the student worksheet for the problem solving model is applied. then a traditional module with the same content, namely a dynamic fluid obtained directly from the instructor as opposed to a comparison when the two teaching resources were used. The purpose of this study is to determine the impact of using problem-solving-based student worksheets on students' ability to use critical thinking when studying dynamic fluid materials in Class XI SMAN 12 Padang.

II. METHOD

Pseudo-experimental research is the kind that is done. The study's methodology will be a randomized Posttest-Only Control Group Design. In this study, the class XI natural sciences SMAN 12 Padang constitutes the affordable population. A random sampling method is employed for sample division. The simple random sampling technique involves selecting population members at random without taking into account the strata that make up that population [7]. As a result, the technique's division of the population's samples into two samples, sample 1 for the control class (XI Natural Sciences 1) using traditional modules and sample 2 for the experimental class (XI Natural Sciences 2) using the Problem-Solving Model Student Worksheet, results in the division of the population's samples into two samples. A final test (posttest) on student competences, particularly the capacity to think critically about elements of knowledge, was the instrument utilized in this study. The assessment was given as a written essay test with two sets of questions. then the response data an improvement in the capacity to use critical thinking criteria serves as the study's final exam (posttest).

The criteria for measuring critical thinking skills are as follows: 0–40% are considered uncritical, 41–55% are considered less critical, 56–65% are considered highly critical, 66–80% are considered critical, and 81–100% are considered critical once. Interpretation, analysis, assessment, and inference are the observed indications of critical thinking skills based on these claims [8].

The analysis of the data obtained follows the collection of the study data. The steps of data analysis in this study were as follows: normality tests with real levels > 0.05 , homogeneity tests with real levels > 0.05 , and hypothesis testing with real levels 0.05 [9]. With the aid of the most recent SPSS application version, such data were analyzed [10].

III. RESULTS AND DISCUSSION

a. Comparison of the Average Critical Thinking Ability of Students in the Two Groups

The difference between the results before and after treatment. Prior to and after the investigation, the importance of students' critical thinking has increased. Table 2 shows a comparison of the increase in value over time :

Table 2. Improving the Critical Thinking Skills of Second-Year Students

		Control Class			Experiment Class		
		Before	After	Enhancement	Before	After	Enhancement
Indicator of Critical Thinking Ability	Interpretation	45 %	50 %	5 %	29 %	81 %	52 %
	Analysis	45%	57%	12%	36%	86%	50%
	Evaluation	46 %	68 %	22 %	43 %	81 %	38 %
	Inference	16 %	46 %	30 %	17 %	81 %	64 %

Critical Thinking Ability Indicator Average Score	38%	55%	17%	31%	82%	51%
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Table 2 shows that when students are assigned to problem-solving-based Student Worksheets, their critical thinking skills improve more than when they are assigned to traditional-based modules.

In other words, according to the research data, the improvement in students' critical thinking skills for each indicator in the experimental class is greater than the improvement in students' critical thinking skills for each indicator in the control class for the subject matter studied in each sample class, namely dynamic fluids. This is due to the fact that using problem-solving-based worksheets has a number of advantages than using conventional-based modules. Because students solve their own issues by thinking and applying their skills, if it is coupled with comments made based on the findings of previous studies regarding the benefits of worksheets, it is to make students more involved in learning activities [11].

Additionally, for the benefits of problem-solving models, namely, in other researchers' eyes. Challenge students' abilities while also giving them choices about how to learn new information, improve student learning activities, aid students in developing their new knowledge, and encourage students to take ownership of their learning. Additionally, solving problems might promote self-evaluation of both the outcomes and the learning process [12].

A problem-solving-based worksheet is offered as a solution to the issue that has been raised if you examine the flashbacks of the two statements and it has also been demonstrated in the field that students are easier to understand the material that has been packaged succinctly coupled with using various approaches (learning models) that are compiled to train students in solving various problems (problem solving) both in completing tasks and in carrying out various practicums.

b. Analytical Descriptive

Table 3. Descriptive Analysis of Student Posttest Results

Sample	Number of Samples	Variable	Minimum Value	Maximum Value	Average value	Standard Deviation	Variance
1. Control Class (XI Natural Sciences 1)	40	<i>Posttest</i>	44	66	55.35	5.357	28,695
2. Experiment Class (XI Natural Sciences 2)	40		76	93	82.37	3.119	9,728

The average posttest result of the two sample classes was 55 for the control class and 82 for the experimental class. This demonstrates that using problem-solving-based Student Worksheets for the experimental class results in the development of students' critical thinking skills when compared to using traditional modules for the control class, because success in fostering students to achieve desired learning goals or competencies cannot be separated from the role of the teacher or the teacher himself.

c. Test for normalcy

When utilizing the SPSS 26.0 program, the Kolmogorov-Smirnov formula is used. If sig > 0.05, the data is normal; else, it is abnormal. The following are the calculations' outcomes :

Table 4. Student Posttest Normality Test Results

Sample	Number of Samples	Variable	Testing using	Test result (Asym. Sig (2-tailed))	Conclusion
1. Control Class (XI Natural Sciences 1)	40	<i>Posttest</i>	<i>One-Sample Kolmogorov-Smirnov Test</i>	0.200	Distribution of the Normal
2. Experiment Class (XI Natural Sciences 2)	40				

Natural Sciences 2)					
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Based on the results of the table above, it can be concluded that the study data is normally distributed because the significant value (Sig.) for all excellent data on the Kolmogorov-Smirnov test was $0.200 > 0.05$.

d. Test for homogeneity

The homogeneity test was used to see if the variance of the experimental class's posttest data (XI Natural Sciences 2) and the control class's posttest data (XI Natural Sciences 1) was homogeneous or not. The Levene's Test technique was used to demonstrate homogeneity by comparing the sig value > 0.05 . The following are the findings of the calculations, which can be seen in Table 5:

Table 5. Experiment and Control Class Homogeneity Test Results

Sample	Number of Samples	Variable	F value count	Test result (Sig.)	Conclusion
1. Control Class (XI Natural Sciences 1)	40	<i>Posttest</i>	0.060	0.808	Homogeneous
2. Experiment Class (XI Natural Sciences 2)	40				

Because the significant value (Sig.) of the experimental and control class posttest data is $0.808 > 0.05$, it may be assumed that the variance of the experimental and control class posttest data is the same or homogeneous. As a result, at the time of the posttest, the control and experimental classes have a homogeneous population, or in other words, both classes have the same ability.

e. Testing hypotheses

With parametric statistics, hypothesis testing is done using the t-test, and the formula or formula employed is the independent sample t-test. The SPSS 26.0 software for Windows was used to perform the calculations. If the p value was less than 0.05, the study's conclusion was judged significant. The following table 6 summarizes the results of the students' posttest t-test using problem-solving-based Student Worksheets and traditional-based Modules :

Table 6. Experiment and Control Class Test Results of Independent Sample T-Test

Sample	Number of Samples	Variable	The t test	Test result (Sig.)	Conclusion
1. Control Class (XI Natural Sciences 1)	40	<i>Posttest</i>	-24.203	0, 000	H_0 rejected and H_1 accepted
2. Experiment Class (XI Natural Sciences 2)	40				

Based on the table above and the Sig. (2-tailed) value of $0.000 < 0.05$, it can be concluded that there is a difference in the average post-test results of students between the experimental class (problem solving-based Student Worksheet program) and the control class (conventional-based module).

The results of statistical testing for descriptive tests (b), normality tests (c), homogeneity tests (d), and hypothesis tests (e) show very satisfactory data results from testing posttest questions on students in both sample classes, and each of the data displayed in these tables displays statistical data results that are in compliance with

the restrictions of the data limit that is declared valid in each square. The fact that this outcome complies with the requirements of the predetermined number provisions will lead to its declaration as normal and homogenous. When it comes to hypothesis testing, the cutoff point is 0.05, therefore if the result is little from the cutoff point, the study hypothesis is approved. Therefore, it can be said that students who use Student Worksheets that are problem-based are often better at critical thinking than those who use modules that are conventional in nature. This indicates that the work hypothesis (H1) is accepted or that the use of problem-solving-based student worksheets has an impact on the students' capacity for critical thought with regard to dynamic fluid materials.

This concurs with other research' assertions that learning's advantages center on the development of critical thinking skills, namely the following: Learn more effectively so that what is learned and how it is taught lasts a long time in students' thoughts. In addition, it tends to boost pupils' excitement for learning. Through critical thinking, it is intended that students will develop a scientific mindset and the problem-solving skills necessary for both the classroom teaching and learning process and real-world problems that they will face in the future [13]. Learning success is also inextricably linked to the learning models, methods, and media employed. These aspects include learning models, self-motivation, learning styles, learning facilities, and others. The use of worksheet media affects how successfully students learn; if the worksheet is effective, the learning objectives will also be successful [14].

The Use of Problem-Solving Learning Models equipped with the Use of Worksheets to Improve Critical Thinking Ability and Student Learning Achievement on Solubility Material and Solubility Times Results of Class XI SMA Muhammadiyah 1 Karanganyar Academic Year 2014/2015 is one application by other studies that obtained data results that are consistent with related research. The achievement of students' critical thinking ability increased between cycles, with cycle I students being classified as high by 58 percent and cycle II students being classified as high by 68 percent, demonstrating the results that there was an increase in students' critical thinking ability [15].

IV. CONCLUSION

The usage of problem-solving-based worksheets has a major impact on pupils' critical thinking abilities. This indicates that pupils who use worksheets centered on problem solving have better critical thinking skills than those who use standard modules. The typical outcomes of students' critical thinking abilities on posttest testing demonstrate this. According to these findings, teaching materials, particularly worksheets that use the problem-solving model, play an important part in the learning process because they make it simpler for students to comprehend a variety of learning materials and help them develop a critical mindset. By developing a critical mindset, students can more easily deal with problems that will arise in the future. The preceding study compared the effects of problem-solving worksheets and guided inquiry on the critical and creative thinking of pupils. Additionally, it has been demonstrated that the application of teaching materials, particularly worksheets with problem-solving models, has been successful in enhancing students' critical thinking abilities. In fact, the value of students' critical thinking in its application is significantly more dominant than the value of students' creativity.

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