

## THE EFFECT OF THE IMPLEMENTATION OF WORKSHEET BASED-PROBLEM SOLVING ON STUDENTS' CRITICAL THINKING SKILLS IN ROTATIONAL DYNAMICS AND ELASTICITY

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### ABSTRACT

*The purpose of the research was to investigate the effect of worksheet based-problem solving on students' critical thinking skills in rotational dynamics and elasticity. The research design used is posttest-only. The study involved two sample classes: the experiment class and the control class. Data collection techniques in the form of written tests with a model of description questions. The assessment is based on indicators of critical thinking skills that can be observed. The results of the study show by applying the same learning model that is the problem-solving learning model, it can be said that both sample classes occurred an increase in the value of critical thinking skills. However, the critical thinking skills of each indicator are higher indicators of analysis, evaluation, and inference in the experiment class compared to the control class, and the average increase in students' grades is seen from final exam scores and the final test scores of the study in the experiment class are higher than the control class. This means that worksheet based-problem solving is instrumental in improving students' critical thinking skills in rotational dynamics and elasticity materials in Grade XI of High School in Kerinci.*

**Keywords :** *Student Worksheet, Problem solving, Critical thinking skills.*



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### I. INTRODUCTION

The 21st century is marked as the century of openness or the century of globalization, which means that human life in the 21st century has undergone fundamental changes, namely the very rapid development of information technology. The advancement of information and communication technology (ICT) requires students to have skills in using technology during the learning process which aims to achieve students' thinking skills. In this 21st century, education is becoming increasingly important to ensure students can learn and innovate, the ability to use technology and information media, and be able to work and survive with life skills[1].

The learning system in the 21st century is a learning system in which the developed curriculum demands schools to change the learning approach. In facing the challenges of the 21st century, education is designed to adapt to the progress and demands of an increasingly competitive era to improve the quality of education.

The quality of education can be pursued by improving the curriculum by the government to realize the national education system. This improvement is following the objectives of the fourth paragraph of Indonesian national education in the 1945 Constitution, namely the intellectual life of the nation. Currently, the government is implementing the 2013 revised 2017 curriculum as an educational curriculum. The developed curriculum demands schools to change the learning approach. Namely, an educator-centered approach to student-centered learning is the hope and goal of 21st-century learning.

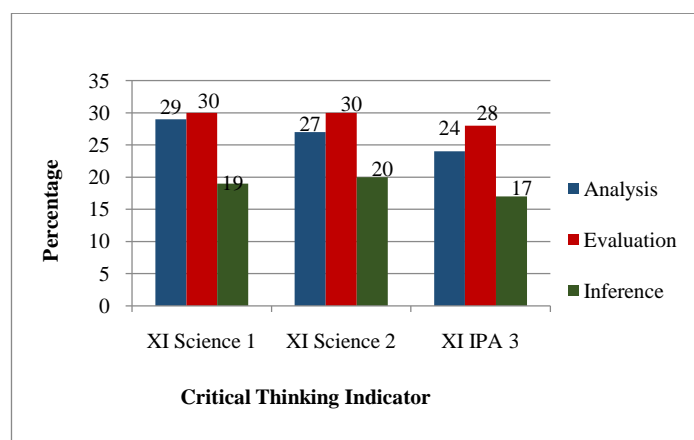
21st-century learning requires students to have 4C skills in learning, one of which is critical thinking skills. Critical thinking skills can be observed with critical thinking indicators, namely analysis, evaluation, and inference. Critical thinking skills can be measured from the answers to student test questions, especially tests in the form of essay questions.

Critical thinking is also known as thinking to regularly investigate the thought process itself. This means not only thinking on purpose but also examining how we and others use existing evidence and logic. So, it can

be concluded that critical thinking is the activity of analyzing an idea or ideas with various aspects of consideration to get a conclusion from scientific findings [1]. So, it can be concluded that critical thinking is the activity of analyzing an idea or ideas with various aspects of consideration to get a conclusion from scientific findings.

Then the learning process is not supported by learning resources that can train students to think critically. One of the learning resources referred to is the students' worksheet. The worksheet is designed to make it easier for students to understand the learning material provided so that student competencies are achieved as expected. Teaching using worksheets in the learning process can make students more active so that students can interact with their environment.

The reality is that there are still some problems in implementing the vision of education in realizing quality learning. The approach to learning is still centered on teachers, not students. Besides, the learning model applied has not been supportive and is not well implemented. This problem can occur because teachers find it difficult to deliver physics subject matter in the limited time available and teachers tend to use the lecture method in the learning process which makes teachers more dominant than students so students find it difficult to be more active and develop critical thinking patterns that lead to critical thinking levels. students are still low. Students' initial critical thinking skills can be seen in Figure 1.



**Fig. 1.** The value of students' initial critical thinking skills

Based on Figure 1, it can be described that the initial critical thinking skills of class XI students of high school in Kerinci are still not optimal. This happens because students still have difficulty solving problems in the form of questions that require higher-order thinking skills, namely HOTS-shaped questions. Students have difficulty working on different questions from the sample questions given by the teacher. Students still have difficulty answering analysis questions (problem-solving) so it can be said that the critical thinking skills of each student are lacking. Based on the criteria for implementing critical thinking skills, the results of the analysis of the final exam answer document are included in the non-critical category [2].

This problem must be resolved because under the demands of the curriculum students must have critical thinking skills. To support physics learning in schools, teachers must have a strategy so that students can learn effectively and efficiently so that learning objectives can be achieved. One of them is by providing good, quality, and easy-to-understand teaching materials that can hone students' skills in the learning process and be able to develop critical thinking skills according to their needs. One of the teaching materials that lead to the above criteria is a student worksheet.

A worksheet is a teaching material that can be developed and used to support student learning activities [3]. The use of worksheets can stimulate students to think critically, try to find solutions from various sources, and help students learn independently[4].

The presentation of this worksheet can be made in various forms, one form of innovation that can be applied is to combine worksheets and problem-solving learning models. Problem-solving is a method that teaches problem-solving by emphasizing the solving of a problem in a rational manner [5]. Whereas this theory states problem-solving is a learning model in solving a problem. Usually, the teacher gives problems based on the topic to be taught to students, then students are asked to solve these problems [6].

From the description above, it can be concluded that the problem-solving learning model is a learning model that teaches students to be able to face problems directly so that students can think about finding the cause

of the problem under the supporting data obtained and continued by formulating hypotheses so that they can formulate conclusions. the end of the problem.

The steps of the problem-solving learning model consist of 5 stages, namely, 1) focus on the problem, 2) explain the relevant concept, 3) compile a problem-solving plan, 4) implement problem solving, 5) evaluate answers [7]. So, from some of the steps in the problem-solving learning model above, it can be concluded that the essence of the steps in the problem-solving learning model is that students focus on the problems given by the teacher and then the teacher gives concepts that are following the learning material then students plan, carry out problem-solving until on evaluation.

This learning model is used in learning that requires answers or problem solving followed by strengthening skills. Because this learning model is given procedures to solve a problem. With this worksheet, it is hoped that it can improve students' critical thinking skills [8].

The difference between problem-solving worksheets and other worksheets is that in problem solving-based worksheets there are steps in problem-solving learning models that can encourage students to be more active and involved in learning besides that it can improve student learning achievement because by using problem solving-based worksheets students are required to complete problems in learning independently that allow students to find solutions to the problems they are looking for so that learning objectives can be achieved.

The facts presented in the field are not under the expected conditions. The problem that occurs is that students' critical thinking skills are still low, this can be seen from the analysis of the final exam answer document, the student worksheets used in schools do not support students' critical thinking skills and the applied learning models do not support the formation of students' critical thinking patterns.

The solution to this problem is the use of worksheets with an appropriate model in the learning process. This worksheet is expected to be able to train students to learn independently so that meaningful learning is created and they can find the correct steps when solving problems with a high level of difficulty. Therefore, the authors are interested in researching with the title "the effect of problem-solving based student worksheets on students' critical thinking skills in the subject of rotation dynamics and elasticity of class XI of high school in Kerinci.

## II. METHOD

The quasi-experimental was conducted in this research. Quasi-experimental research is to determine whether there is a result of something imposed on the research subject [9].

The research design used was posttest-only. In this study design, two groups of samples were randomly selected (R), the first group to be treated (X) was called the experimental group, and the other group that was not treated was called the control group [10]. The treatment given to the experimental class was given the application of problem solving-based worksheets and the control class was given worksheets provided by the school. The research design can be seen in Table 1.

**Table 1.** Posttest-Only Design Research

Class	Treatment	Posttest
Eksperiment	X	T <sub>1</sub>
Control	-	T <sub>2</sub>

Informations:

X : Application of problem solving-based worksheets

- : Application of worksheets provided in schools

T<sub>1</sub> : Posttest experimental class

T<sub>2</sub> : The final test (Posttest) control class

The population was all students of XI science class at high school in Kerinci Semester I in the academic year 2020/2021. The sample consisted of two classes, namely, the experimental and the control class. Sample selection using a purposive sampling technique. The purposive sampling technique is a sample determination technique with certain considerations. This sampling technique is based on a specific objective not based on strata, random, or area [10]. Sampling in this research was based on classes that were taught the same by the same teacher, close study time schedules, and had almost the same final semester examination. After selecting samples, namely XI science class 1 and XI science class 2, then it is analyzed whether the two sample classes have the same initial ability or not by doing the two mean similarity tests. To do the two mean similarity tests, first, the normality test and homogeneity test are carried out. The normality test aims to see whether the experimental class sample and the control class come from a normally distributed population or not and the

homogeneity test aims to see whether the two samples, the experimental class, and the control class, come from a population that has homogeneous variance or not [11].

**Table 2.** Initial Data Normality Test Results for Sample Class

Class	N	A	$L_0$	$L_t$	Information
XI science 1	23	0.05	0.1209	0.190	Normal
XI science 2	23		0.1528	0.190	Normal

Based on Table 2, it can be seen that  $L_0 < L_t$  for the two sample classes with  $\alpha = 0.05$  means that both sample classes come from normally distributed populations.

**Table 3.** Initial Data Homogeneity Test Results for Sample Class

Class	N	$\bar{x}$	S	S2	Fh	Ft	Information
XI science 1	23	56.17	8.57	73.42	1.42	2.07	homogeneous
XI science 2	23	50.52	10.21	104.26			

Based on Table 3, it can be seen that  $F_h < F_t$  is  $1.42 < 2.07$ . This means that the two sample classes have homogeneous variances.

**Table 4.** Similarity Test Results of Two Initial Data Mean of Sample Class

Class	N	$\bar{x}$	S	S2	th	tt	Information
XI science 1	23	56.17	8.57	73.42	2,03	2.02	Has the same initial ability
XI science 2	23	10.21	10.21	104.26			

Based on table 4, it can be seen that the value is in the reception area  $H_0$ . This means that the experimental class and the control class have the same initial ability. From the two sample classes that have been tested, the experimental class and the control class can be determined, namely the cluster random sampling technique. You do this with currency techniques. In this study, it was found that the experimental class was class XI science 1 using problem solving-based student worksheets and the control class was class XI science 2 using worksheets available at school.

This study has 3 main variables, namely the independent variable (treatment given to the two sample classes, namely the application of problem solving-based student worksheets and student worksheets that already exist in schools), the dependent variable (the achievement of critical thinking skills after the action is given to the two-sample classes) and the control variable. (the material provided in both sample classes is the same and the teachers who teach are the same).

The data used in this research are primary data and secondary data. Primary data were collected directly by the researcher. The results of the research for the achievement of students' critical thinking skills were collected through the final test from the two classes obtained after being given treatment, namely using problem solving-based student worksheets and student worksheets available at school which was reviewed from the analysis of students' abilities in answering critical thinking questions. Meanwhile, secondary data were obtained from the results of the document analysis of the results of the final semester examinations and the average score of the final exams before the research which were obtained from the teacher.

Data collection techniques through the final exam. Researchers conducted a final test in the form of an essay test to obtain the results of students' critical thinking skills through indicators of critical thinking skills in the form of analysis, evaluation, and inference. The instrument used in this study was a test of students' critical thinking skills. For this instrument to be good, the questions used previously have been tested for validity, reliability test, level of difficulty, and different power. So that the questions used in this study have been categorized as suitable for use in this study.

### III. RESULTS AND DISCUSSION

#### A. Result

##### 1. Description of Data

The data obtained in this study were the students' critical thinking skills. The research data were obtained from student answer sheets on knowledge competencies after being given a written test in the form of essay questions at the end of the lesson. The data was obtained by giving scores on the student answer sheets with scoring rubric guidelines that were following the critical thinking skill indicators. Table 5 shows the average critical thinking skill value of the two sample classes.

**Table 5.** Mean Value, Standard Deviation and Sample Class Variance

Class	N	$\bar{X}$	$S^2$	S
XI science 1	23	78.83	42.51	6.52
XI science 2	23	74.39	50.70	77.12

Table 5 shows that the average value of critical thinking skills in the experimental class is higher than the average value for the control class and the variance for the experimental class is better than the control class.

##### a. Initial Value of Student's Critical Thinking Skill of Sample Class

The initial value was obtained from the analysis of the UAS answer document. After calculating, the results of students' Critical Thinking Skills for the sample class can be seen in Table 6.

**Table 6.** Students' Critical Thinking Skills

Indicator	Experiment Class	Control Class
Analysis	29	27
Evaluation	30	30
Inference	19	20

Based on the data in Table 6, it is known that the initial value of critical thinking skill on each indicator in the experimental class and control class before being given treatment is still low. It can be said that the achievement of students' critical thinking skills is still in the non-critical category.

##### b. Critical Thinking Skill Value of Students of both Sample Classes during the Learning Process

**Table 7.** Students' Critical Thinking Skills During the Learning Process

Meeting	Critical Thinking Skill Indicator					
	Analysis		Evaluation		Inference	
	Experiment	Control	Experiment	Control	Experiment	Control
1	32	29	32	30	19	20
2	54	47	58	54	48	35
3	68	50	67	58	57	44
4	70	65	78	66	64	51
5	75	68	80	70	65	57
6	78	73	81	76	67	61

Based on Table 7, it is known that the value of students' critical thinking skills on indicators of analysis, evaluation and inference for each meeting using teaching materials in the form of problem solving-based student worksheets and student worksheets in schools on the achievement of students' critical thinking skills on the material of rotation dynamics and elasticity has increased.

##### c. Final Test Score Critical Thinking Skill of Second Class Students in the Sample

The final test scores of the students were obtained from the analysis of the answers to the final exam questions in the two sample classes. The results of the students' Critical Thinking Skills for the sample class can be seen in Table 8.

**Table 8.** Final Value of Critical Thinking Skill of Both Sample Classes

Indicator	Experiment Class	Control Class
Analysis	81	76

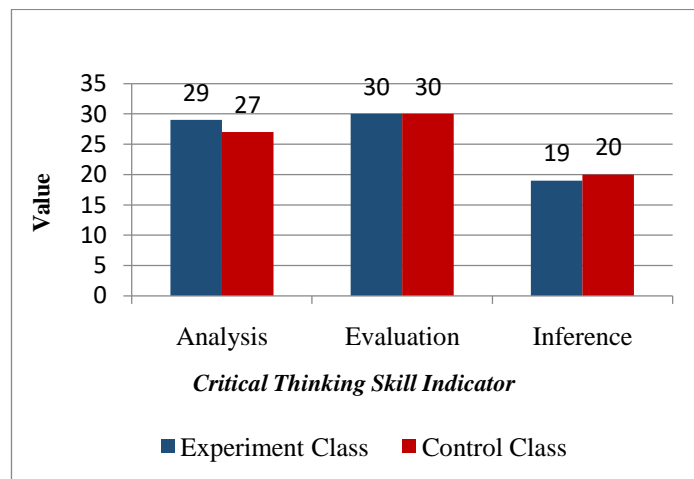
Evaluation	82	78
Inference	70	66

Based on the data in Table 8, it is known that the critical thinking skill final test score on each indicator in the experimental class and control class after being given treatment has increased. It can be said that the achievement of students' critical thinking skills has reached a critical level.

## 2. Data Analysis

### a. Initial Value of Student's Critical Thinking Skill of Sample Class

The initial value was obtained from the analysis of the final exam answer document obtained from the teacher before the study. After calculating, the results of the students' Critical Thinking Skill of the sample class can be seen in Figure 2 below:



**Fig. 2.** Initial Value of Critical Thinking Skill of the sample class students

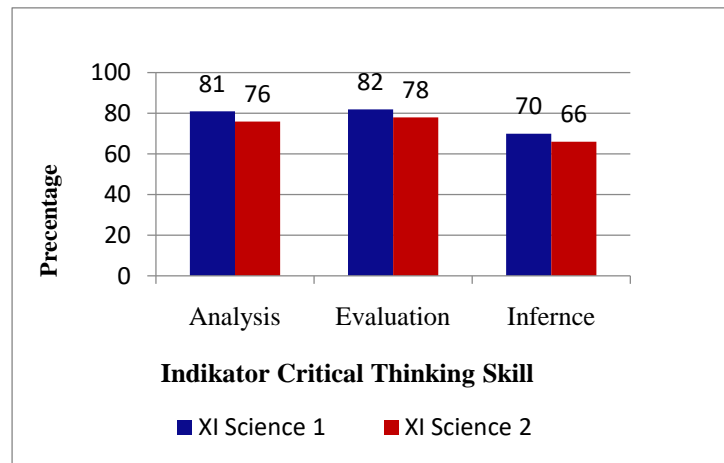
Based on Figure 2, It can be described that the initial value of students' critical thinking skills can be observed in three indicators, namely analysis, evaluation and infrastructure. The average value of students' critical thinking skills in the experimental class is class XI SCIENCE 1 with an analysis indicator of 29, an evaluation indicator of 30 and an inferential indicator 19. The initial critical thinking skill of the experimental class students is in the uncritical category. Whereas in the control class, namely class XI SCIENCE 2 with analysis indicators of 27, evaluation indicators of 30 and inference indicators of 20 with non-critical categories.

### b. Critical Thinking Skill Value of Students of both Sample Classes during the Learning Process

Based on the table in the data description, there is an increase in critical thinking skills on each indicator. In the learning process, the two sample classes were applied the same learning model with different worksheets. During the learning process, an assessment of the students' critical thinking skills was carried out through the student worksheets which were carried out by the students in the questions section for material on rotational dynamics and elasticity. At the first meeting the value of each student indicator was not much different from the student's initial indicator value as seen from the FINAL EXAM answer analysis. This happens because students are still confused about the worksheets and learning models applied in learning. At the next meeting, the students' critical thinking skills had started to increase, this happened because students were able to adjust and were already familiar with the worksheets and models applied by the teacher.

### c. Final Examination Value on Critical Thinking Skill of Second Class Student Samples

The final test score is obtained from the analysis of the answers to the final test questions in the two sample classes. After the calculation is carried out, the value of the students' Critical Thinking Skills for the sample class can be seen in Figure 3.



**Fig. 3.** Students' Critical Thinking Skill Final Test Score

The average score of Critical Thinking Skill in the final examination of experimental class students from each observed indicator was 78.83, including the critical category. Meanwhile, the average score of the students' critical thinking skill in the experimental class from each indicator observed was 74.39, including the critical category.

From the results of the final exams for the two sample classes, there is an increase in critical thinking skills. By applying the problem solving model, both classes have reached the critical thinking skill level in the critical category. By using different worksheets, the level of critical thinking skills of students in the experimental class is higher than the control class.

Before drawing conclusions in this study, data analysis was carried out through statistical hypothesis testing, namely the two-mean equation test. The requirement for using this test is that the data is normally distributed and has a homogeneous variant, for this reason, the normality and homogeneity test is carried out first.

*d. Normality Test*

**Table 9.** Normality Test Results for Experiment Class and Control Class

Class	N	A	L0	Lt	Information
XI science 1	23	0.05	0.0844	0.190	Normal
XI science 2	23		0.0988	0.190	Normal

Based on the table above, it is found that  $L_0 = 0.0844$  in the experimental class and  $L_0 = 0.0988$  in the control class, with  $N = 23$  with a significant level of 5%, then  $L_t = 0.190$ . From the calculation results obtained  $L_0 < L_t$ . it means that the two sample classes in this study are normally distributed.

*e. Homogeneity Test*

**Table 10.** Homogeneity Test Results of The Two Sample Classes

Class	N	$\bar{X}$	S	S2	Fh	Ft	Information
XI science 1	23	78.83	6.52	42.51	1.19	2.07	Homogeneous
XI science 2	23	74.39	7.12	50.70			

Based on the table above, it is found that  $F_h = 1.19$  and  $F_t$  with a real level of 5%,  $dk 22: 22$  which is 2.07. From the results of the calculation of  $F_{count} < F_{table}$  with  $1.19 < 2.07$ , this means that the two classes have homogeneous variances.

*f. Two-Mean Similarity Test*

**Table 11.** Results of t-Test for The Experimental Class and Control Class

Class	N	$\bar{X}$	S2	Sgab	th	tt	Information
XI science 1	23	78.83	42.51	6.83	2.20	2.02	Has the same initial ability
XI science 2	23	74.39	50.70				

After doing the normality test and homogeneity test, it was found that the two sample classes came from populations that were normally distributed and had homogeneous variances. Furthermore, to see the students' initial ability in the two sample classes, parametric statistics were used, namely the t-test.

At the real level  $\alpha = 0.05$  with degrees of freedom  $dk = n_1 + n_2 - 2 = 44$ , the t value in the t distribution table is:

$$t_{(1-\frac{1}{2}\alpha)} = t_{0.975} = 2.02$$

Acceptance criteria  $H_0$  if  $\frac{1}{2}\alpha < t < t_{1-\frac{1}{2}\alpha}$ , because  $t_h = 2.20$  is in the rejection area  $H_0$ . So that  $H_1$ 's working hypothesis is accepted. The acceptance of  $H_1$  shows that each sample class has different critical thinking skills even though the two classes have reached the critical thinking level in the critical category because the same learning model is applied with different worksheets. This difference is caused by the influence of the application of problem solving-based worksheets given to the experimental class, namely class XI science 1.

### B. Discussion

Based on the ability of students 'knowledge aspects, it appears that the application of problem solving-based worksheets on the dynamics of rotation and elasticity affects the achievement of students' critical thinking skills. This can be seen from the increase in the value of students' critical thinking skills. However, for the aspects of attitudes and skills, there is no significant effect.

Before being given treatment to the two sample classes, the value of students' critical thinking skills was still low. Based on the criteria for applying critical thinking skills according to theory, this value is included in the non-critical category [2].

After being given treatment, namely the problem-solving learning model using worksheets, it turned out to be able to support the achievement of the critical level of students. This is in line with what was conveyed by learning experts, that using problem-based worksheets can develop students' critical thinking skills in investigating problems jointly or independently [15].

In general, the experimental class students showed enthusiasm at the time of learning. Students are more willing to express opinions under their respective opinions. As a result, during the learning process, there is good interaction between students and other students and between students and teachers who can make students' critical thinking skills more trained. This is under the opinion of experts in learning that the use of problem solving-based worksheets can occur activities to form students' critical thinking skills. The problem-solving process will give birth to the concepts, principles, and laws of physics [13]. In line with other expert opinions, the teaching and learning process through problem-solving can familiarize students with facing and solving problems skillfully and being able to draw conclusions that are following the facts [12]. The increase in critical thinking skills in the experimental class, namely class XI science 1 by applying problem solving-based student worksheets is higher than that of the control class, namely class XI science 2 which uses the worksheet provided in the school. This is because in problem solving-based worksheets there are syntaxes that can train students to solve problems independently and students will think to find the causes of the problems so that students can be said to be more dominant than teachers who are only facilitators. By the opinion in the theoretical study, the existence of problem solving-based worksheets with the learning syntax, namely focuses on problems, exposure to relevant concepts, problem-solving planning, implementation of problem-solving and student evaluation can solve the problems presented. Furthermore, the formulation process is carried out to solve the problem. Then, students are trained to work on the questions in the worksheets to support students ' problem-solving abilities, which in the end will improve students' critical thinking skills and students can solve problems in the form of questions given by the teacher so that there is an increase in student critical thinking skills [14].

By applying the same learning model to the two sample classes, namely the problem-solving model, it can be said that the two sample classes have an increase in the value of critical thinking skills. However, the increase in the value of critical thinking skills in the rotational dynamics and elasticity of the experimental class was higher than the control class. This means that the application of problem solving-based student worksheets in learning is superior to the existing worksheets in schools. By the opinion in the study of the advantages of the problem-solving learning model, the problem-solving model can stimulate the development of student's critical thinking skills as a whole, because during the learning process students are trained to think using logic [16].

Based on the data analysis, the student's critical thinking skills in the experimental class were higher than in the control class. but the critical thinking skill value of each indicator of analysis, evaluation, and inference in the experimental class is higher than the control class. Furthermore, the t-test was carried out at the



5% real level which showed that there was a difference in the increase in students' critical thinking skills by applying problem solving-based student worksheets and applying worksheets provided by the school. Thus it can be concluded that there is an effect of the application of problem solving-based worksheets on the achievement of students' critical thinking skills in the material of rotation dynamics and elasticity of class XI high school in Kerinci.

#### IV. CONCLUSION

After analyzing and discussing the problems in this study, it can be concluded that there is a significant effect on problem solving-based worksheets when viewed from an increase in critical thinking skills. By applying the same learning model to the two sample classes, it can be said that the two sample classes have increased critical thinking skills. The average score of students' Critical Thinking Skill in the final exam was 78.83 in the experimental class and 74.39 in the control class, including the critical category. However, in the experimental class, the value of critical thinking skills is higher than in the control class in terms of rotational dynamics and elasticity. After being analyzed, it was found that the value of  $t > t_t$ , this means that there is a significant difference. This difference is caused by the effect of implementing problem-solving-based worksheets. Thus, there is an effect of the application of problem solving-based worksheets on students' critical thinking skills in the matter of rotational dynamics and elasticity of class XI of high school in Kerinci.

#### REFERENCES

- [1] Z. Arifin, Mengembangkan Instrumen Pengukur Critical Thinking Skills Siswa Pada Pembelajaran Abad 21. *The Original Research of Mathematics*, 1, 92-100, 2017
- [2] S. Arikunto, *Prosedur Penelitian Suatu Pendekatan Praktik*. Jakarta: Rineka Cipta, 2011.
- [3] R.R. Anugra, "Pengaruh Lembar Kerja Siswa Berbasis PQ4R Terhadap Hasil Belajar SCIENCE Fisika Kelas VIII SMPN 1 Linggo Sari Baganti.," *Pillar Of Physics Education*, vol. 2, pp. 113-120, 2013.
- [4] Depdiknas, *Panduan Pengembangan Bahan Ajar*. Jakarta: Direktorat Jenderal Manajemen Pendidikan Dasar dan Menengah, 2008.
- [5] W. Gulo, *Strategi Belajar Mengajar*. Jakarta: Grasindo, 2002.
- [6] D. Afriyenti, Y. Darvina, and W.S. Dewi, "Uji validitas LKS berbasis problem solving dalam meningkatkan keterampilan berfikir kritis pada materi fluida statis dan fluida dinamis kelas XI SMA/MA," *Pillar Of Physics Education*, vol. 2, pp. 625-632, 2019.
- [7] Abdullah S, Ridwan. (2013). *Inovasi Pembelajaran*. Jakarta: Bumi Aksara.
- [8] A.J. Ikhwanuddin, "Problem solving dalam pembelajaran fisika untuk meningkatkan kemampuan mahasiswa berpikir analitis," *Jurnal Pendidikan*. Vol.9, pp. 215-230, 2010.
- [9] S. Arikunto, *Manajemen Penelitian*. Jakarta: RinekaCipta, 2005
- [10] Sugiyono, *Metode Penelitian Kuantitatif, Kualitatif dan R&D*. Bandung: Alfabeta, 2012.
- [11] Sudjana, *Metode Statistia*. Bandung: Tarsit, 2011.
- [12] B.K. Pelita, "Implementasi model pembelajaran problem solving dalam meningkatkan hasil belajar siswa mata pelajaran ips pokok bahasan globalisasi klas vi sd negeri 047175 deas simacem bekerab tahun pelajaran an 2017/2018," *Jurnal Curere*, vol. 2, pp. 122-132, 2018.
- [13] J. Djamas, Z. Kamus, and Murtiani, "Analisis situasi aktivitas pembelajaran fisika kelas x sman kota padang dalam rangka pengembangan keterampilan dan karakter berpikir kritis siswa," *Jurnal Eksakta*, vol. 2 (25), 2013.
- [14] A. Hidayat, and I. Irawan, "Pengembangan lks berbasis rme dengan pendekatan problem solving untuk memfasilitasi kemampuan pemecahan masalah matematis siswa. *Jurnal Pendidikan Matematika*," vol. 1(2), pp. 51-63, 2017.
- [15] A.A. Zuhendra, A. Fauzi, and Ratnawulan, "Pengaruh lembar kerja siswa (lks) terintegrasi energi panas bumi terhadap pencapaian kompetensi fisika dalam pembelajaran ideal problem solving pad materi uasah, energi, momentm dan impuls di kelas xi sman 10 padang," *Pillar Of Physics Education*, vol. 7, pp. 113-120, 2016.
- [16] B.S. Djamarah, B.S. and A. Zain, *Guru dan Anak Didik dalam Interaksi Edukatif.*, Rineka Cipta. Jakarta, 2000.