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Open-Ended Problems Improve High-Level Thinking Skills of Vocational High School Students with CPS Learning

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Higher Order Thinking Skills (HOTS) are abilities that consist of analyzing, discovering, and creating. HOTS is an ability that students must have to solve various problems. However, not all students have high HOTS, so efforts are needed to increase students' HOTS. The purpose of this article is to determine the effect of open problems on increasing students' HOTS in trigonometry material. The subjects of this research were 26 students of class X SMK. The research method used is a mixed method, which combines qualitative and quantitative methods. The research instrument used is the test results, the test used has been tested for validity. Quantitative data analysis used paired t-test, while qualitative data analysis used data reduction, data presentation, data interpretation, and drawing conclusions/leverages. after learning by applying the Creative Problem-Solving (CPS) model, students work on questions in the form of open problems. The results obtained are: (1) there is a significant increase in the value indicated by the value of Sig. 0.00 < 0.05 it also shows that the provision of open-ended problems during CPS learning able to increase students' HOTS. (2) students with high HOTS can apply the HOTS cognitive domain well, while students with moderate and low HOTS have difficulty applying the HOTS cognitive domain. the provision of open problems and appropriate learning models can increase students' HOTS.
Keywords: open-ended problems, HOTS, trigonometry

Abstrak

Keterampilan Berpikir Tingkat Tinggi (HOTS) adalah kemampuan yang terdiri dari menganalisis, ditemukan, dan mencipta. HOTS menjadi kemampuan yang harus dimiliki siswa untuk menyelesaikan berbagai masalah. Namun tidak semua siswa memiliki HOTS yang tergolong tinggi, sehingga diperlukan upaya untuk meningkatkan HOTS siswa. Tujuan artikel ini adalah untuk mengetahui pengaruh masalah terbuka terhadap peningkatan HOTS siswa pada materi trigonometri. Subjek penelitian ini adalah siswa kelas X SMK sebanyak 26 siswa. Metode penelitian yang digunakan adalah *mixed method*, yang menggabungkan metode kualitatif dan kuantitatif. Instrumen penelitian yang digunakan adalah hasil tes, tes yang digunakan telah diuji validitas. Analisis data kuantitatif menggunakan uji-t berpasangan, sedangkan analisis data kualitatif menggunakan reduksi data, penyajian data, interpretasi data, dan penarikan kesimpulan/pengungkit. setelah pembelajaran dengan menerapkan model *Creative Problem-Solving* (CPS), siswa mengerjakan soal-soal berupa masalah terbuka. Hasil yang diperoleh adalah: (1) terdapat peningkatan nilai yang signifikan ditunjukkan nilai Sig. 0,00 < 0,05 hal tersebut juga menunjukkan bahwa pemberian open-ended problems selama pembelajaran CPS mampu meningkatkan HOTS siswa. (2) siswa dengan HOTS yang tergolong tinggi dapat terapkan domain kognitif HOTS dengan baik, sedangkan siswa dengan HOTS yang tergolong sedang dan rendah kesulitan menerapkan domain kognitif HOTS. pemberian masalah terbuka dan model pembelajaran yang tepat dapat meningkatkan HOTS siswa.
Kata kunci: open-ended problems, HOTS, trigonometri

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INTRODUCTION

Education has undergone many developments, this is in line with technological developments and discoveries by researchers in the field of education. One of the findings in the field of education is the concept of bloom taxonomy proposed by Benjamin Bloom in 1956 (Hains et al., 2018; Iljazi & Grncaroska, 2021). Bloom's taxonomy consists of three learning domains, namely cognitive, affective, and psychomotor (Sharunova et al., 2018). However, this article will focus on the cognitive domain.

Bloom's taxonomy describes students' cognitive domains into six abilities, namely knowledge, understanding, applying, analyzing, synthesizing, and evaluating (Abosalem, 2016; Iljazi & Grncaroska, 2021). Anderson and Kratwohl revised the bloom taxonomy in 2001 (Ariyanto et al., 2020).

These domains are then divided into two skill levels, namely: 1) Lower-Order Thinking Skills (LOTS) consisting of remembering (C1), understanding (C2), and applying (C3) domains. 2) Higher-Order Thinking Skills (HOTS) which consists of analyzing (C4), evaluating (C5), and creating (C6). Each cognitive level in the HOTS is redefined into several indicators, including (C4) analyzing consists of distinguishing, organizing, and attributing; (C5) evaluating consists of examining and criticizing; and (C6) creating consists of formulating, planning, and producing (Ariyanto et al., 2020; Saraswati & Agustika, 2020).

HOTS becomes a very important and useful ability for students (Lu et al., 2021). This can be seen in many countries that have implemented teaching to improve student HOTS. Indonesia is one of the countries that has combined HOTS in the education system, the merger can be seen in the 2013 Curriculum (Ichsan et al., 2019). The 2013 curriculum refers to the Bloom taxonomy revised by Anderson and Kratwohl (Verdina et al., 2018). The incorporation of bloom's taxonomy in the 2013 Curriculum is not without reason, because HOTS can improve student achievement, reduce weaknesses in using formulas, control information, and ideas, and be useful for daily activities (Kwangmuang et al., 2021).

Being able to solve problems is one of the benefits of HOTS for students, problem solving activities are activities that involve a variety of knowledge and experience (Abdullah et al., 2017). Problems are classified into closed and open problems based on alternative problem-solving. Problems are categorized as closed-ended problems if they can be solved in one way, while problems are categorized as open problems if they can be solved in unlimited ways (Agustianingsih & Mahmudi, 2019; Gracin, 2018). The term open-ended problems are known as open-ended problems. Open-ended problems have two forms, namely problems that have not only one way of solving and problems that do not only have one correct answer (Suyitno et al., 2017). If a problem has not only one solution, it is called an open-ended problem with fluency characteristics, while a problem that does not only have one correct answer is called an open-ended problem with flexibility characteristics (Pujiastuti et al., 2021). Open-ended problems are considered capable of providing a learning experience for students in solving problems (Laah-on et al., 2021). In addition, open-ended problems allow and provide opportunities for students to find solutions in several ways so that students will be able to develop their abilities and not depend on the teacher (Munahefi et al., 2021).

The learning model used is the Creative Problem Solving (CPS) learning model. The Creative Problem Solving (CPS) learning model is learning that focuses on students to find out problems, how to solve them and utilize students' knowledge (Lertyosbordin, C. et al., 2018). The steps of the CPS learning model are clarification, idea, development, and implementation (Fauziah et al., 2019; Huang et al., 2019). Through CPS students are allowed to understand concepts by solving a problem, students

will be more active during the learning process, and can improve their thinking skills and problem-solving skills (Agoestanto & Masitoh, 2021).

The importance of HOTS for students is not in line with the reality, there are still students with low HOTS, and students are not able to show indicators of abilities that exist in each HOTS cognitive domain (Hasyim & Andreina, 2019; Kurniati et al., 2016; Purbaningrum, 2017). Students with low HOTS are less capable and even unable to be completed properly by students (Megawati et al., 2020). Meanwhile, the results of other studies show that students with moderate HOTS have difficulty in the C6 domain (creating) (Saraswati & Agustika, 2020). It was also found in previous research that of the three HOTS cognitive domains students' achievement in the creating domain was the lowest compared to the analyzing and evaluating domains (Prasetyani et al., 2016).

According to the findings of previous researchers, many students experience difficulties in the C6 indicator (creating). The indicator of creating is one of the important indicators for students to solve math problems, especially non-routine questions. The CPS model is used to overcome the student's HOTS problem but there are still sufficient achievement results with details of indicators C4 sufficient, C5 lacking, and C5 lacking (Agustina et al., 2018). Based on this background, the purpose of this study was to determine the effect of using open-ended problems during CPS learning to improve students' higher thinking skills (HOTS). It is hoped that by combining open-ended problems in CPS learning, it is able to increase students' HOTS.

METHODS

The research method used is a mixed-method concurrent embedded strategy model. Concurrent embedded strategy is a method that combines the use of qualitative and quantitative methods, with different weighting methods (Creswell, 2021; Sugiyono, 2020). Researchers used qualitative data as primary data to describe the increase in students' HOTS during the provision of open-ended problems in CPS learning. The research was conducted at SMK Dharma Lestari Salatiga. The subjects of this research were 26 students of class X-A Tataboga SMK Dharma Lestari Salatiga. The research activity begins with giving pre-test questions to determine students' HOTS before learning is carried out using the CPS model and ends with giving post-tests to determine the effect of giving open-ended problems during the learning process.

Quantitative data is used to see student learning outcomes before and after learning as well as to group students' HOTS. The quantitative data analysis technique used is the pairet t-test. The pre-test and post-test data were processed using SPSS 22 software, and the SPSS calculation results were interpreted descriptively. Quantitative research begins with the examination and assessment of student answer sheets, the scoring system used does not only refer to the final results of students' correct answers but the answer process presented by students on the answer sheets, student answer sheets that present HOTS indicators will have different scores from students which does not present a HOTS indicator. After the assessment process and data processing with SPSS 22 then the results are interpreted

descriptively. Followed by grouping students, students are grouped by paying attention to the results obtained by students in the pre-test and posttest. The groups were divided into three groups, namely low, medium, and high HOTS groups. Grouping based on the mean ($\bar{x}$) and standard deviation (σ) of the students' pretest and posttest (Hasyim & Andreina, 2019). Students are grouped into three, namely students with low, medium, and high HOTS. The grouping formula is presented in Table 1.

Table 1. Student HOTS Category

Value	Criteria	Code
$N < (\bar{x} - \sigma)$	Low	A1
$(\bar{x} - \sigma) \leq N < (\bar{x} + \sigma)$	Medium	A2
$N \geq (\bar{x} + \sigma)$	High	A3

Qualitative data as primary data is used to describe the increase in students' HOTS before and after learning. The increase is viewed from whether or not the HOTS indicators are met. The qualitative data analysis technique used in the study consisted of data reduction, data presentation, data interpretation, and drawing conclusions/verification (Suyitno et al., 2017). The research begins by analyzing student answer sheets, both pre-test and post-test answer sheets, whether they have met the HOTS indicators, followed by selecting students to be reviewed in this article regarding the increase in HOTS that students have achieved after learning CPS by using open-ended problems. Qualitative research ends with drawing conclusions and strengthening conclusions using previously analyzed quantitative data.

RESULTS AND DISCUSSION

The research was only carried out by researchers involving only one class as the research subject, this was because researchers had limited time during research. The research process begins with giving pre-test questions with a processing time of 10 minutes, ending with giving a posttest in the form of open-ended problems with a processing time of 30 minutes. The questions given have been tested for validity using SPSS 22 before being used as research instruments. The results of the validity test of the pre-test showed that the questions were valid, it was shown from the value of r_count>r_Table with details: (1) the first question was 0.618 > 0.478; (2) second question 0.607 > 0.478. While the posttest questions show that the questions used are valid, with details: (1) the first question is 0.654 > 0.478; (2) second question 0.575 > 0.478; (3) third question 0.656 > 0.478; (4) fourth question 0.881 > 0.478; (3) fifth question 0.748 > 0.478. The student answer sheets collected were then graded. The results of the assessment are then processed using the SPSS application. The results of the pre-test and post-test scores are presented in table 3 to table 5 below.

Table 3. Paired Samples Statistic

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	60.88	26	11.122	2.181
	Posttest	75.65	26	11.872	2.328

Tabel 4. Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	Pretest & Posttest	26	.911	.000

Table 5. Paired Samples Test

		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference		T	df	Sig. (2-tailed)
					Lower	Upper			
Pair 1	Pretest – Posttest	-14.769	4.910	.963	-16.752	-12.786	-15.339	25	.000

Based on Table 3, it can be seen that the average score of students increased in the post-test. The average increased by 14.77 from the pre-test score of 60.88 to 75.65 in the post-test score. And in Table 5 the results of Sig. (2-tailed) 0.00 < 0.05 so it can be concluded that there is a significant difference in student scores before and after giving open-ended learning during Creative Problem Solving (CPS) learning. With the increase in student learning outcomes, it shows that there is also an increase in student HOTS. After testing and calculating the results of the pre-test and post-test the students were grouped into 3 groups, namely students with low HOTS (A1), medium (A2), and high (A1).

Table 6. Student Grouping

Value	Category	Results *Pre-test*		Results *Posttest*	
		Total students	Percentage	Total students	Percentage
. N > ($\bar{x} + \sigma$)	Tinggi	1	4%	6	23%
($\bar{x} - \sigma$) N < ($\bar{x} + \sigma$)	Sedang	13	50%	17	65%
T < ($\bar{x} - \sigma$)	Rendah	12	46%	3	12%

Based on Table 6, it can be seen that there was an increase in the percentage in the high and low HOTS groups, based on the results of the pre-test students were dominated by moderate abilities but there were still many students who were in low rank. While the posttest experienced a reduction in the number of students in the low group and an increase in the high group. HOTS in the dominant group was also found by previous researchers (Kurniati et al., 2016). And there are still a few students who have high HOTS (Purbaningrum, 2017). In order to describe the increase in HOTS after giving open-ended problems to the CPS class, an analysis of the pre-test and post-test student answer sheets was carried out with HOTS indicators.

Table 7. The description of HOTS Ability

Cognitive Domain	Indicator	Definition	Total Students	
			Pre-test	Posttest
Analyze (C4)	Differentiate	Able to select relevant and irrelevant information.	20	26
	Organize	Able to identify information into an organized structure.	18	26

	Attribute	Able to determine the relationship pattern of each information structure.	13	26
Total Meets All Indicators			13	26
Evaluate (C5)	Check	Able to check and determine the wrong part.	14	23
	Criticize	Able to accept or reject information based on predetermined criteria.	14	23
Total Meets All Indicators			14	23
Create (C6)	Formulate	Able to provide a perspective on a problem.	1	6
	Plan	Able to design ways to solve problems.	1	6
	Produce	Able to make solutions or conclusions from a problem.	8	17
Total Meets All Indicators			1	6

Based on the groupings carried out in Table 6, three students from each group of students' HOTS abilities were selected to describe the increase in HOTS before and after being given open-ended problems during CPS learning. The number of students in the creative domain has increased by 5 students, initially only 1 student who has been able to fulfill all the indicators of creating at the end of the lesson to 6 students. Meanwhile, in the evaluating domain, it also increased from 14 students to 23 students. In the domain of analyzing at the end of learning students have been able to all indicators. One low HOTS student (A), one moderate HOTS student (AA), and one high HOTS student (AAA). The following are the results of the analysis carried out on the students' pre-test and posttest worksheets.

Problem Solving High Order Thinking Ability (HOTS) Low (A)

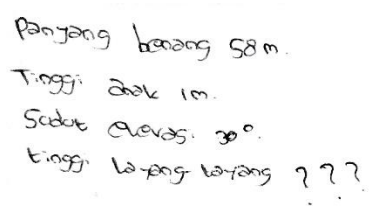


Figure 1. Student (A) Pretets Answer

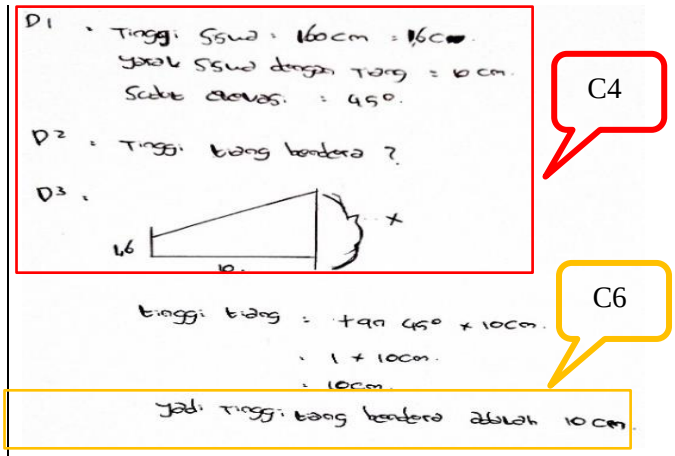


Figure 2. Student (A) Posttest Answer

Figure 1 shows that students have low HOTS on the pre-test answer sheet. Students have difficulty in distinguishing relevant information from story problems, organizing, and attributing. While in the realm of "evaluating" and "creating" students have not been able to show it on the answer sheet. Figure 2 shows that students have low HOTS. In the domain of "analyze" students can meet the following indicators: 1) differentiate, with students being able to select relevant information on story questions; 2) organize, with students being able to make the structure of the information known and asked; 3) attribution, with students being able to describe what is known in the form of pictures, but

student A1 has an error when describing the length of *x*. The analysis domain was not fulfilled properly by students wherein the attribution section the students were less precise in drawing which should be *x* length not the entire length of the pole. Students do not fulfill the “evaluate” and “create” domains. The domain of "evaluate" students is not able to meet the indicators of checking and criticizing, this can be seen from the answers of students who are still wrong. The domain of "create" students is not able to meet the indicators of formulating and planning, this can be seen from the way students are still wrong. While on the producing indicator students can make conclusions but the conclusions given are not true, so students do not meet the producing indicators (Hasyim & Andreina, 2019; Situmorang et al., 2020). Based on Figure 2 and Figure 3, it can be concluded that students in the low group experienced an increase in the HOTS indicator which was successfully fulfilled, although the posttest results were still in the low group because students had difficulty in fulfilling the "evaluating" domain and all indicators "making". So it can be concluded that the provision of open-ended questions in CPS learning is able to increase HOTS.

Problem Solving High Order Thinking Ability (HOTS) Medium (AA)

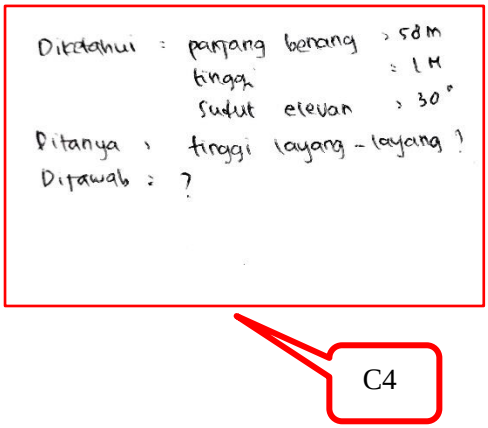


Figure 3. Student (AA) Pretets Answer

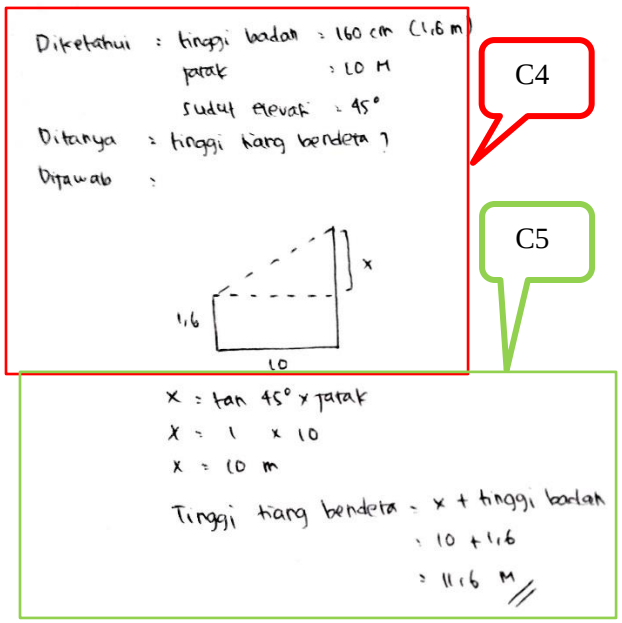


Figure 4. Student (AA) Posttest Answer

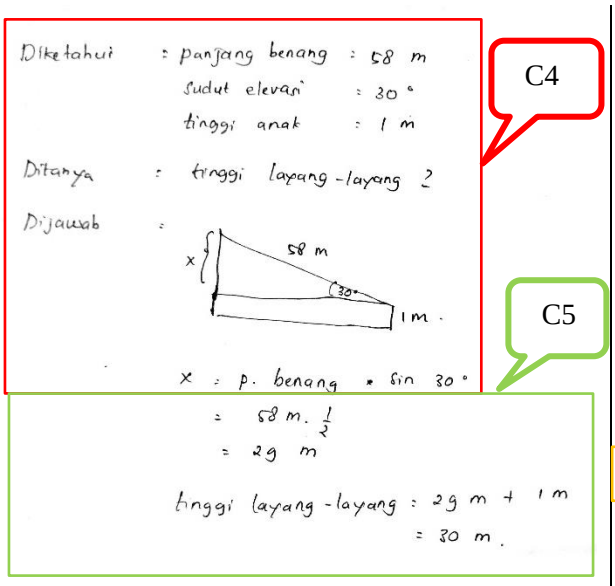
Based on Figure 3, the students in the pre-test grouping results were in the low group. Students have difficulty analyzing (C4), the indicators of analyzing cannot be fulfilled entirely by students. while for indicators evaluating and creating students have not been able to show it on the answer sheet.

Figure 4, students can be categorized as having moderate HOTS. This can be seen from students being able to fulfill the realm of "analyzing" which is indicated by students being able to fulfill the indicators of distinguishing, organizing, and attributing appropriately. In the realm of "evaluating" students can meet the indicators of checking and criticizing, this is shown by students from the results

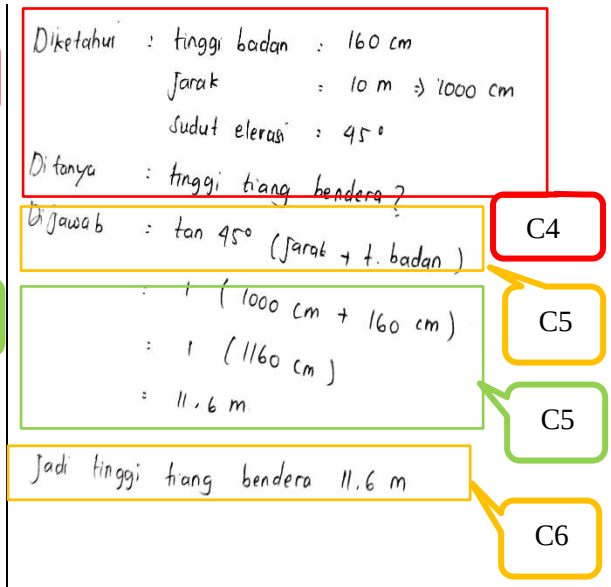
of the correct answers. While the dominance of "create" on the indicators of students formulating and planning is only limited to formulating and planning solutions according to the examples given, not in the way. The production indicators have not been fulfilled by students, because students have not been able to make a way of completing and writing conclusion sentences (Hasyim & Andreina, 2019).

Based on Figure 4 and Figure 5, it can be seen that students experienced an increase in the fulfillment of the HOTS indicators, where students at the end of the lesson had been able to fulfill the indicators of analyzing and evaluating. However, the indicators of creating have not been able to be shown by students. Students still tend to answer questions according to the examples given by the teacher and have not been able to make their own conclusions.

Problem Solving High-Order Thinking Ability (HOTS) High (AAA)



Gambar 5. Lembar Jawab *pre-test* siswa AAA



Gambar 6. Lembar Jawab *posttest* siswa AA

Based on Figure 6, it shows that students do not have difficulty in analyzing story questions and students have been able to evaluate, this is shown from the students' correct answers but in the realm of creating students have not been able to fulfill it, it is shown by students who have not been able to make conclusions or do the problem in their own way.

Based on student answers A3, it can be categorized as students having high HOTS. it can be seen that students fulfill the "analyzing" domain, where students can meet the indicators of distinguishing, organizing, and attributing. Although the students did not describe the relationship of information in pictures, the information relations were arranged at $\tan 45^{\circ}$ $(distance + t.body)$. The "evaluating" domain is fulfilled with students being able to answer the questions correctly. The "creating" domain is also filled by students, where students can present their way to solve problems and make appropriate conclusions on questions.

Based on Figure 6 and Figure 7 it can be concluded that students have increased HOTS abilities, from students who have not been able to fulfill the realm of creating at the end of the lesson, they have

been able to fulfill the realm of creating. In other words, providing open-ended problems in CPS learning can be a solution in improving HOTS abilities. With open-ended problems, students will be able to develop creative thinking patterns (Wulandari & Sulandra, 2021). So that open-ended problems can be given to students in order to grow the cognitive realm of creation.

Given the limited time that the researcher has, the results of the study can only describe the increase in student HOTS in one class. So that it will be input for other researchers if they want to research the topic of open-ended problems with CPS learning by examining the effect of returning to CPS learning with open-ended problems or without open-ended problems.

CONCLUSION

There is an increase in student learning outcomes shown from Sig. 0.00 < 0.05, based on the pre-test results, students were dominant in the medium group, but there was an increase in the percentage in the high group and a decrease in the low group. The high group which was initially only 4% increased to 23%, while the medium group experienced an increase from 50% to 65%, the low group experienced a decrease from 46% to 12%. This shows that the open-ended problems given during learning using the Creative Problem Solving (CPS) learning model can increase students' HOTS. The results of the analysis of student answer sheets also showed an increase. Student (A) experienced an increase in the indicator of creating although not all indicators were fully met by students. Students (AA) have increased in the realm of evaluating but have not been able to present indicators of creating. Meanwhile, students (AAA) experienced an increase in the realm of creating. Students with low HOTS abilities and are having difficulty in the realm of evaluating and creating. It was also found that it was difficult to analyze the story sola. Giving open-ended problems can be one solution to improve students' HOTS, giving challenging questions for students to solve in their own way will be able to increase student creativity.

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