Analysis of High Order Thinking Skills (HOTS) of High School Students Learned Using the Problem Based Learning (PBL)

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Abstract. This research is quantitative research with the research method is Pretest Posttest Control Group Design. This study aims to determine the improvement of students' High Order Thinking Skills (HOTS) chemistry by using the Problem Based Learning (PBL) learning model. This research was conducted at SMA BTB Balige in class XI IPA for the academic year 2021/2022. In this study, the aspects of HOTS studied were problem solving skills, critical thinking skills and argumentation skills. Prerequisite analysis test in the form of normality test with Kolmogorov-Smirnovv test and homogeneity test with Anova Lavene test found that the data obtained were homogeneous but not normally distributed. Hypothesis testing using non-parametric test, namely by using the Wilcoxon Signed Rank Test. From the results of the analysis of hypothesis testing using the Wilcoxon Signed Rank Test, it was found that Z count was 4.957 and Z table was 1.645 with a sample of 32 students. Thus, it can be stated that Z count > Z table, meaning that H1 is accepted, that is, there is an increase in students' HOTS chemistry ability by using the PBL learning model. The results of the pretest posttest showed that students experienced a significant increase in HOTS abilities, especially in the aspects of critical thinking skills and problem-solving skills.

Keywords: Chemistry; Problem Based; Thinking Skills

1 Introduction

Education is the main benchmark for a nation so that it can be said as a nation that has high welfare, because education has a very important role in improving human resources (Cindiana, 2020). Education aims to develop the potential of students to become human beings who believe, have noble character, are healthy, knowledgeable, capable, creative, independent and become democratic and responsible citizens (Shidiq, 2015). Quality education will produce quality human resources, as well as being able to face the challenges of life and being able to actively adapt to changing times.

Nowadays, the younger generation must be creative, flexible, think critically, make the right decisions and be ready to solve problems (Sani, 2019). These abilities are part of High Order Thinking Skills (HOTS). In Bloom's taxonomy, HOTS involves the cognitive domains at the highest level, namely: C4 (analyze), C5 (evaluate) and C6 (creativity). The development of Science and Technology (IPTEK) is currently a challenge in the development of HOTS. But the increasing development of science and technology today does not have an impact on increasing

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the ranking of Indonesian students in PISA. According to the Kompas daily report, at PISA 2018 the ability of students from Indonesia in the field of science was number 70 out of 78 participating countries. These low results have resulted in Indonesia having to prepare itself to face the rapid development of science and technology and equip students with HOTS (Setiawati, 2018 dan Saraswati, 2020).

The progress of education is highly expected by Indonesia as prestige in the eyes of the international community. Chemistry learning is one of the means to develop scientific literacy for students in achieving educational achievements (Malau, 2019). Chemistry lessons involve material in the form of theory and calculations and have the aim of increasing students' logical, analytical, systematic, critical, and creative thinking skills. This causes chemistry to be a difficult subject matter. The failure of students in learning is caused by: (1) students often learn by rote, (2) students cannot understand the essence of the material being taught, (3) teachers are less successful in conveying the essence of learning so that what students get is not optimal (Julia, 2020).

Based on the results of the researcher's observations, it was found that the evaluation questions used during the daily test and the grade-up exam did not meet the HOTS criteria because they tested more for memory skills and low-level thinking aspects. Especially now that we are faced with online learning, where the impact is that the learning process is not optimal. From the results of these observations, it can be concluded that the teacher does not know the HOTS ability of each student. Through the results of Fitriani's study (2019), it was found that the determination of the learning model in the application of HOTS had a major influence which in turn would determine the quality of students.

According to Putri (2018), students' HOTS abilities can be improved by utilizing the Guided Inquiry learning model. The Guided Inquiry learning model used is a problem-solving-based learning model. Problem Based Learning learning model is a learning model used by the authors in this study to improve students' HOTS abilities. The PBL learning model can be defined as a process of learning activities that prioritize the process of solving problems faced scientifically (Lismaya, 2019). This learning model can be used for learning chemistry with hydrocarbon material. Hydrocarbons are materials that require understanding concepts, not just memorizing. Hydrocarbon material has a lot to do with our daily lives, so students are required to understand the concept of hydrocarbon material related to HOTS.

Students are required to have HOTS abilities so that they can solve problems that occur in everyday life which often require HOTS abilities. HOTS in its application cannot be taught directly to students. Students are first trained and given an understanding of HOTS then apply student-centered learning (Zhafirah, 2021). To practice HOTS skills, students must be familiarized with solving HOTS-based questions. In order for students' HOTS to develop for the better, students must be familiarized with HOTS-based things, otherwise the potential for HOTS in students will not increase.

2 Materials and Methods

In this research, the type of approach used is a quantitative approach, namely experimental research using a pretest–posttest control group design.

Table 1. Research Design

Class	*Pretest*	Treatment	*Posttest*
Experiment	Q1	X_1	Q2
Control	Q1	X_0	Q_2

This research was conducted at SMA BTB Balige in Tobasa Regency with the time of the research being carried out on July 12 – July 24, 2021. The population in this study were all students of class XI at SMA BTB Balige, totaling 128 students in the academic year 2021/2022 which were divided into in 6 classes. The sampling method in this study is to use a non-probability sampling technique with purposive sampling method. The sample consisted of 32 students for the experimental class and 32 students for the control class. The technique used in data collection is a test instrument. The test instruments used include pretest and posttest instruments. The test instruments were arranged based on indicators for learning the hydrocarbon material.

Before the instrument is used, the instrument is first validated constructively by an expert validator. The expert validator in this research is Dr. Sumiyati Gultom, M.Pd. He is a lecturer in the Chemistry Education Study Program. After the researcher got the pretest data as the initial data and the posttest as the final data, the researcher conducted a prerequisite analysis test with normality test and homogeneity test. The analysis prerequisite test was in the form of a normality test with the Kolmogorov-Smirnovv test and homogeneity with the Anova Lavene test. The data analysis technique in this research is to determine the hypothesis test. The hypothesis test in this study, namely the Wilcoxon Signed Rank Test, was then tested using a gain test to see how much of an increase in the sample was.

3 Result and Discussion

The results of construct validation showed that the instrument with a total of 10 essay questions was valid and feasible to be used in measuring students' HOTS chemistry abilities. The results of the normality test based on the pretest data in the control class and in the experimental class are shown in table 2.

Table 2. Test of Normality

Result		Kolmogorov-Smirnov[a]		
	Class	Statistic	df	Sig.
	Pretest-control	.174	32	.015
	Pretest-experiment	.231	32	.000

The normality test uses the Kolmogorov-Smirnov test using SPPS 25 with the condition that if Sign > 0.05 then the class is normally distributed. Meanwhile, if Sign < 0.05 then the class is said to be not normally distributed. From Table 3, the results of the normality test of the control class and the experimental class for the pretest and posttest values of the control class have data that are not normally distributed. The results obtained in the homogeneity test of the pretest data in the control class and experimental class are shown in table 3.

Table 3. Homogeneity of Variances

Hasil Pretest			
Levene Statistic	df1	df2	Sig.
.525	1	62	.472

Homogeneity test was carried out using the Anova Levene Test. Levene's test uses SPSS 25 where the data significance level is > 0.05, it can be said that the variance is homogeneous, whereas if the significance level is < 0.05, it can be said that the variance is not homogeneous. Based on the data in table 4, the homogeneity significance value is 0.47, so it can be concluded that the variance in this study is homogeneous.

After conducting the analysis prerequisite test in the form of normality and homogeneity tests, it was found that the data obtained were homogeneous but not normally distributed. So the researchers tested the hypothesis using a non-parametric test, namely by using the Wilcoxon Signed Rank Test.

Table 4. Test of Wilcoxon

	postest-control - pretest-control	postets-experiment - pretest-experiment
Z	-4.982[b]	-4.957[b]
Asymp. Sig. (2-tailed)	.000	.000

a. Wilcoxon Signed Ranks Test

The Wilcoxon Signed Rank Test with the help of SPSS 25 used data from the pretest and posttest results in the control class and the experimental class. Based on table 4.6 the results of the Wilcoxon test obtained a calculated Z value of 4.957 and Z table of 1.645, so it can be concluded from this study that there was an increase in the HOTS of chemistry students who were taught using the PBL learning model. The results of the calculation of the gain score can be seen the increase in students' HOTS abilities. The following is the average gain score in the experimental class and in the control class in table 5.

Table 5. Result of N-Gain Test

Class	Result of *N-Gain Test*	Interpretasi
Control	0,368	Medium
Experiment	0,458	Medium

Based on table 5, it can be seen that there was an increase in the HOTS ability of students in the control class and experimental class with gain values of 0.368 and 0.458. The interpretation of the data from the gain test in the control class and the experimental class is categorized as moderate. The results of the gain test for the control class and the experimental class can be concluded that the use of the PBL learning model has an effect on students' HOTS chemistry abilities.

The researcher gave treatment to the control class and the experimental class based on the lesson plans that had previously been prepared by the researcher and approved by the supervisor before conducting the research. The lesson plan made by the researcher must be in accordance with the class to be studied. In the control class, the lesson plan used was a lecture learning model, while the lesson plan used in the experimental class was treated using a problem-based learning model.

Before giving treatment, the researcher conducted a pretest with an instrument of 5 essay type questions, this was done to obtain initial data on students' HOTS abilities. After giving the treatment, the researcher gave a posttest, which was given the same as the questions when given the treatment to get the final data on the students' HOTS abilities. Based on the test results, it can be concluded that the hypothesis test H1 is accepted. Furthermore, a test using a gain test was carried out to see how much improvement in the control class and experimental class, the

test results in the control class and experimental class. If it is adjusted to the gain score criteria, it can be categorized as a control class and an experimental class classified as moderate.

In theory, the learning process using the Problem Based Learning model should be able to improve students' HOTS chemistry abilities, but in reality, the HOTS abilities in both classes are in the medium category. It can be explained that the HOTS ability can increase or develop if learning is carried out properly and with stages that are in accordance with the learning model used. Humans have the potential to develop their respective HOTS abilities, because every human being has the ability to think at a higher level. The key lies in how she; her family and the environment contribute to developing these abilities (Putri, 2018).

4 Conclusions

High Order Thinking Skills (HOTS) ability of students who are taught chemistry using the Problem Based Learning (PBL) learning model has increased. The improvement of the students' HOTS chemistry ability in the experimental class and control class after the N-gain test was carried out was in the medium category interpretation.

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