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Effect of Problem Based Learning on Student's Metacognitive Ability and Science Process Skills

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ABSTRACT
This study aimed to investigate the effect of problem-learning on student's metacognitive abilities and science process skills. Quasi-experimental with the posttest only design was used in this study. There were two classes namely experimental and control class. Experimental class applied problem-based learning, while the control class applied a scientific approach. The sample consisted of 62 students grade XI which was determined by simple random sampling. Data collection techniques in this study were posttest and observation. The instrument used in this study was a metacognitive ability posttest and a science process skills observation sheet. Data analysis used the Manova test by looking at the Hotteling's Trace value. The results showed that there is a difference in metacognitive ability and science process skills between the experimental and control class. The difference of student's metacognitive ability and science process skills on acid-base topic for the experimental class was higher than the control class. This study suggests that problem-based learning should be always applied to school in order to improve the student's metacognitive ability and science process skills.

Keywords: *Acid-Base, Problem Based Learning, Metacognitive Ability, Science process skills*

1. INTRODUCTION

The nature of abstraction which is characteristic of chemistry, makes students still think that chemistry is difficult, this happens because students feel that chemistry requires abstract reasoning and the number of contextual concepts that must be connected with existing phenomena [1]. Besides, the concept of chemistry is not only macroscopic (observable) but also microscopic (unobserved), symbolic images, such as symbols, formulas, reactions equations and graphics also require to have the ability think, not only understand but also analyze and have the skills to be able to solve problems with various solutions [2]. Seeing these problems, a teacher must make an effort to overcome the difficulties of students by providing treatment to instil valuable learning by construction knowledge of students so that they can develop skills in solving problems as well as being skilled and creative in an effort so that students can understand chemistry learning and have skills to improve learning performance in the chemistry learning [3,4,5,6,7,8].

In this case, these abilities are metacognitive abilities and scientific process skills. So, teachers as facilitators are required to carry out higher-quality teaching and learning activities, by choosing the right strategies, approaches, methods, and learning models have the ability to manage to learn in the classroom and the laboratory, as well as master the material and understand the character of the participants. With this various mastery, it will produce fun learning, so that student's learning interest and motivation are created which have an impact on mastery of the material and the completeness of learning outcomes [9,10].

The application of learning strategies in the form of approaches, methods, models capable of learning media that can develop metacognitive abilities is expected to overcome the difficulties of students in understanding concepts and developing problem-solving skills. This ability helps students to retain the information obtained, apply information to the specified problem. While science process skills are central to science this is useful in solving problems [11]. Therefore, an effort that can be made is applying problem-based learning models to affect student's metacognitive abilities and science process skills.

The problem-based learning model is a model that is based on the aim of reflection on the experience of building and constructing the knowledge possessed by students which aim to facilitate students independent learning by providing problems to develop problem-solving skills and stimulate students to learn. The results of solving problems through the application of problem-based learning models are improving thinking skills and being able to evaluate sources of information obtained effectively in small groups [12]. Also, the problem-solving skills, critical thinking and teamwork, and provides problem content related to complex real-world [13]. Problem-based learning models include asking questions or problems, focusing on interdisciplinary linkages, investigation, authenticity, collaboration, demonstrations that begin with presenting problems to spark students; curiosity, in small or collaborative groups consisting of 6 or 8 students with guidance a tutor and given a complex problem to help students make connections between theory and application in the real world, to help develop metacognitive abilities and science process skills of students in solving complex problems and integrating learning received in school with daily life-day [14, 15,16].

In line with these problems, in this study, chemistry learning invoices were carried out on students of class XI MIPA in one of the high schools in Yogyakarta in implementing a problem-based learning model that could lead students to a more enjoyable learning process, by involving the active participation of students and it is also expected to be able to affect metacognitive abilities and science process skills so that students can learn independently by looking for their sources of information, making their observations and analyzing the results of their observations.

This innovation was carried out based on the results of observations before the study and the results of interviews with teachers at school, that in teaching and learning activities in the chemistry learning process, students still had difficulty understanding chemistry material. One of the reasons is because the teacher has not implemented an effective learning model to help students understand and love chemistry learning, which has an impact on the lack of development of metacognitive abilities and science process skills of students so that the innovations expected to be a solution to influence metacognitive and skills, the scientific process which is a variable that is consistent with the problem-based learning model. This research aimed to investigate the effect of problem-based learning model on student’s metacognitive abilities and science process skills.

2. RESEARCH METHOD

2.1. Research Design and Sample

The type of research used in this study was quasi-experimental post-test only design. The population of this study were students of class XI MIPA on of high school in Yogyakarta and the sample was 62 students who were selected by simple random sampling techniques. The experimental class consist of 31 students, while the control class consists of 31 students.

2.2. Data Collection

Metacognitive ability data collection was carried out once by conducting a post-test after the students were given treatment. Meanwhile, science process skills are acquired through meetings held in the laboratory. The learning process is carried out by following each syntax contained in the problem-based learning model about the acid-base topic. The data collection techniques used in this study were tests and non-test. The form of the test used in this study is a post-test of metacognitive abilities which contains 10 essay items, while the non-test form is an unstructured interview and an observation sheet. The data collection instrument in this study consisted of learning tools and assessment instruments.

The instrument in the form of learning device in this study included a learning implementation plan (RPP), student worksheet (LKPD), while the assessment instrument consists of metacognitive ability test questions and observation sheets of scientific process descriptions. Metacognitive ability test questions were used to measure the metacognitive abilities of students in the form of essay questions as many as 10 questions for the acid-base topic.

The metacognitive ability instrument consists of 3 aspects, namely planning skills, monitoring skills and evaluation skills. In these 3 aspects, there are 5 indicators, namely extracting information, determining information, remembering important information to solve problems, applying concepts to problem correctly ana assessing the strengths and weaknesses that have been done. Science process skills in this study were measured using an observation sheet containing indicators of science process skills as a result of the learning process with 6 aspects of assessment, namely making observations, taking measurements, compiling data tables, concluding conclusions, designing investigations or experiments and communication [17].

2.3. Data Analysis

The research data obtained were analyzed using the Manova technique. Manova is a variant difference test with more than one dependent variable. This study has two dependent variables, namely metacognitive abilities and scientific processing skills so that the data can be analyzed using Manova. The hypothesis in this study is to find out that there are differences in metacognitive abilities and science process skills simultaneously and respect between students who take chemistry learning models, as well as the effective contribution of based learning models problem with metacognitive abilities and science process skills simultaneously and respectively.

Nine assumption tests that must be fulfilled before the Manova test is carried out namely, there are two dependent variables, there are two independent variables, the research was carried out independently, the number of samples used is adequate, namely 62 students, there are no multivariate and univariate outliers, normally distributed data, data comes from a population that has the same covariance matrix (homogeneous), there is a linear relationship between each pair of dependent variables with each independent variable and there is no multicollinearity.

Manova analysis can be carried out if the prerequisite test is praised. The Manova test was carried out to determine the difference between the experimental class and the control class according to the research that had been applied simultaneously and respectively. The conclusion criteria are used if the significance value is > 0.05. The test statistic used in this study is Hotelling's Trace.

3. RESULT AND DISSCUSION

In this study, before the sample was given treatment, the sample was subjected to a different test on the students' initial ability to prove the equivalence of the average ability of the two classes before Manova test. This ability difference test is a normality and homogeneity test using the Kolmogorov-Smirnov test. If the significance values are less than 0.05, it indicates that the research sample from both classes is not normal and not homogeneous. The normality test of metacognitive abilities and science process skills can be seen in Table 1.

Table 1. Normality test of dependent variable

Groups	Statistic	Significance
Experimental	.116	.200
Control	.174	.081

Table 1 shows the Kolmogorov-Smirnov test has a significant score greater than 0.05 where the experimental class is 0.200 and the control class is 0.081, these data indicated that the metacognitive abilities and science process skills of both groups come from a normal population. Furthermore, the data was tested with the Levene test using the help of the SPSS 20 application to prove that the two classes were homogeneous or had the same ability. The test results showed that the significance value obtained was 0.538. This means that the significance values are greater than 0.05, so it can be concluded that the two classed come from the same population with the same diversity

The next stage after testing the 9 prerequisite assumptions is met, then the Manova test can be performed. Based on the analysis with the help of the SPSS program, the following results were obtained. The Manova test result can be seen in Table 2.

Table 2. Results of Manova test analysis on the students' metacognitive ability and science process skills

Manova test					
	Value	F	df.	Sig.	Partial eta squared
Hotelling's Trace	0.988	3.7504[a]	2.000	0.000	0.999

Based on the manova test results table, it shows the significant value in Hotelling's Trace showing a value of 0.000. Thus, because the significance values are smaller than 0.05, it can be concluded that there are differences in metacognitive abilities and science process skills simultaneously between students with a scientific approach and students with problem-based learning models, so it can also be said there is an influence on the application of problem-based learning models on student's metacognitive abilities and science process skills.

The percentage of the effective contribution of the problem-based learning model can be seen from the partial eta squared value in the Manova test result table, then this value is multiplied by 100%. Based on Table 2, it can be seen that the partial eta squared value is 0.999, so it is known that the problem-based learning model contributes 99.9% to the metacognitive abilities and science process skills of students.

Table 3. Test of Between-Subject Effects

Manova test			
Dependent Variable	df.	Sig.	Partial eta squared
Science Process Skills	1	0.000	0.988
Metacognitive Ability	1	0.000	0.055

Table 3 shows the significance value for science process skills 0.000 < 0,05, meaning that there are differences in metacognitive abilities and science process skills between students who take with a scientific approach and participants who take with problem-based learning models. The percentage of the effective contribution of problem-based learning to metacognitive abilities and science process skills by looking at the partial eta squared value in the table, then multiplied by 100%. The result of the percentage of effective contribution of problem-based learning to science process skills was 98.9%, while the percentage of the contribution of problem-based learning to metacognitive abilities was 5.5%.

3.1. Differences in Metacognitive Ability in Control Class and Experiment Class

This study shows that there are differences in the learning outcomes of students metacognitive abilities. The success of applying problem-based learning models to students' metacognitive abilities, because in this learning process it implements teaching and learning conditions that require students to be more active to discover their knowledge and obtain learning outcomes, directly based on self-designed experiments and direct observations results. So, students can explore their ability to understand concepts, solve problems, retain information and apply it to problems that students have. This then also trains students to think creatively and critically, so that it not only affects learning outcomes but it also able to help develop students' metacognitive abilities. The results of the research show the application of problem-based learning models results in better student learning achievement than with a class that does not apply a problem-based learning model, besides this, it is also able to help develop students' metacognitive abilities [18,19,20].

3.2. Differences in Science Process Skills Control and Experiment Class

Based on the acquisition of the average value of science process skills from the two classes, it can be assumed that the application of problem-based learning models can affect students' science process skills. This happens because, in the treatment of problem-based learning models, students are required to investigate themselves relevant knowledge from various sources. With this, students find out their information and fell directly involved in mastering the laboratory. Students who feel they have a responsibility will feel more confident in their abilities, this is also shown in the results of research, that the application of problem-based learning is also able to improve students' ability to solve problems, so that it affects the science process skills of student [21].

Overall, the application of the problem-based learning model affects the metacognitive abilities and science process skills of students. The application of the problem-based learning model in this study applies 5 syntaxes, namely the orientation of students on the problem, conducting student organizations to learn, guiding students to carry out investigations, develop and present problem- solving results, and analyze and evaluate [22]. Thus, this study informs that the selection of learning activities in applying problem-based learning models affects students' metacognitive abilities and science process skills.

Therefore, the role of teachers in the 2013 curriculum as facilitators must be carried out optimally to guide students to develop metacognitive abilities and science process skills that have not yet emerged. Metacognitive abilities and science process skills are very important for students to master to dig up information, determine the information obtained and the concepts they have to solve different problems and be able to evaluate their learning process. The more advanced and developing the world, metacognitive abilities and science process skills must be possessed so that students are not only able to make decisions in solving a problem, but also be able to evaluate them and these metacognitive abilities and science process skills can be developed in the learning process. With the application of problem-based learning models also directly develop collaborative skills of students, so that is trained to be able to work together. Based on the results of the analysis of research, it can be said that the problem-based learning model must be implemented in the teaching and learning process.

4. CONCLUSION

Based on the results of the research in the discussion, it can be concluded that there are differences in the metacognitive abilities and science process skills of students simultaneously and respectively. The percentage of effective contribution of problem-based learning to metacognitive abilities and science process skills was 99.9%. The percentage of the effective contribution of the problem-based learning model to the metacognitive abilities of students was 5.5% and the percentage of the effective contribution of the problem-based learning model to the science process skills of students was 98.9%.

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