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# THE EFFECT OF PROBLEM-BASED LEARNING MODEL ON MULTIPLE REPRESENTATIONS ABILITY OF XI-GRADE STUDENTS ON ACID-BASED TOPIC

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***Abstract***

It takes the ability to conceive at three different levels of representation, macroscopic, sub microscopic, and symbolic to comprehend acid-base material. Still, most students are unable to make the connection between the three levels of representation. As a result, instruction that helps students connect various representations in acid-base content is required. The PBL model is one appropriate learning paradigm that can be used. The purpose of this study is to determine whether PBL models and conventional models differ in their capacity to support numerous representations. A quantitative experiment using a quasi-experimental study design is the research methodology employed. A post-test-only control group design is used in this study. The samples of this study were XI MIPA 3 as a control group of 34 students and XI MIPA 4 as an experimental group of 33 students. Simple random sampling was used to get the research samples. A post-test consisting of multiple-choice questions was the instrument utilized. With a reliability score of 0,802 across 20 items, the empirical validation results indicate that all instruments are appropriate for use as research measures. methods for gathering data through tests. Data collection techniques in the form of tests. The data analysis technique in this study is descriptive and inferential statistics with hypothesis testing in the form of the Independent Sample t-Test. With a sig value of 0,000 < 0,05, the results demonstrated that there is a difference in the ability of multiple representations between those taught using the PBL model and those taught using the conventional model.

**Key words:** problem-based learning, multiple representations, acid-base

## INTRODUCTION

Students' success in learning chemistry can be shown by their ability to solve problems using three levels of chemical representation [1]. One of the chemical materials that is considered quite difficult and has the characteristics of the three levels of representation is an acid-base topic [2]. Acid-base is one of the chemistry topics taught to students in the SMA/MA science program [3]. Generally, in the learning process, the measurement of the three levels of representation is carried out separately. There are studies that state that students experience more misconceptions at the submicroscopic and symbolic levels. [4]. The lack of students' ability to connect the observed phenomena with the conceptual framework that they must master in solving problems, shows that students' representation skills are not connected with other representation skills [1].

Chemical representation ability can be measured using various methods and measurement instruments. One of them is a framework for categorizing questions into the form of a DAC (Definition, Algorithmic, Conceptual) framework by referring to macroscopic, submicroscopic, symbolic representation levels, cognitive levels, and Bloom's Taxonomy Revised [5]. The use of the DAC framework is considered the most relevant for measuring the ability of three levels of representation because each category in the DAC framework contains the relationship between levels of representation [1].

Students' ability to connect the three levels of representation that are still lacking, needs an improvement in the learning process. As a result, a learning model is used to solve the issue. The PBL learning approach is said to be capable of boosting pupil involvement and enthusiasm for learning [6]. With the support of real-world situations, students can subsequently compile their knowledge, develop higher-level abilities, and become more independent. This is known as the PBL learning model [7].

The PBL learning model has five stages : (1) Introducing problems to students; (2) guiding what they learn; (3) leading both individual and group investigations; (4) creating and presenting work; and (5) analyzing and assessing every step of the problem-solving process. All stages of PBL can improve multiple representation skills starting from the first stage based on providing problems that are contextual and arouse interest, problems that are complex enough to encourage students to gather relevant information and actively cooperate, and problems that can improve representation skills [7]. According to Dewanto's research, the mathematical multiple representation ability of students in PBM programs are more capable than those in conventional classrooms [8]. It may serve as an indication of the problem-based learning model's importance in terms of helping students to have multiple representation skills that have not previously been widely applied to chemical materials.

## METHOD

A quasi-experimental research design with a "posttest only control design" was employed in this study. The learning model is the independent variable in this study, and multiple representation ability is the dependent variable. The research population was the XI MIPA class of SMAN 1 Campurdarat Tulungagung. Simple Random Sampling is the sampling method utilized to choose the samples, namely random sample selection. The results of this Simple Random Sampling resulted in two class samples, namely XI MIPA 3 and XI MIPA 4.

The instrument used in this study was a validated multiple-choice test sheet (post-test). Before the instrument was used, researchers validated one chemistry expert lecturer and one chemistry teacher, as well as empirical testing using SPSS. This 20-item test sheet was used to measure students' multiple representation ability after treatment. Based on the assessment by the validators, a value of 77,41% was derived from the test instrument's feasibility test results, which is included in the feasible category. Then the reliability test was carried out using Cronbach's alpha formula. Based on the test results, Cronbach's alpha value was 0,802. This means that the reliability of the question is included in the high category.

Both descriptive and inferential statistics were employed in data analysis approaches. Descriptive statistical analysis includes the mean, mode, median, and standard deviation. Inferential statistical analysis tested the hypothesis. After the prior precondition test was completed, the data were homogeneous and normally distributed, therefore parametric tests specifically, the T-test were used to analyze the hypothesis. All tests that have been carried out focus on processing sample data so that they can produce decisions or conclusions for the entire population.

## RESULTS AND DISCUSSION

### A. Research Results

#### 1. Descriptive Analysis of Multiple Representation Ability

Table 1 presents the research findings, which show an important difference in the mean post-test score across the experimental and control groups.

Table 1. Results of the Post-test Value of Multiple Representation Ability

| Class | Control | Experimental |
|---|---|---|
| Number of samples | 34 | 33 |
| Highest score | 90 | 95 |
| Lowest score | 75 | 75 |
| Mean | 80,44 | 85,76 |
| Std. deviation | 4,329 | 5,466 |

The results indicate that the experimental group's potential for ability of multiple representations is greater than that of the control group, as seen from the average value and in the hypothesis test described in the inferential statistical analysis.

### 2. Inferential Statistical Analysis

Inferential statistical analysis is used to test the hypothesis, specifically, how the PBL paradigm affects pupils capacity for multiple representation. Before the inferential test is conducted, the prerequisites must be tested first, including normality and homogeneity tests. The prerequisite test results show that the data is normally distributed and homogeneous. The normality test is the condition that is employed to ascertain whether or not the data originates from a population that is regularly distributed. The results of this test are based on SPSS calculations using the Kolmogorof-Smirnov test. Results obtained, consequently both groups are normally distributed. The experimental class got a sig. value of 0,178 > 0,05, and the control class got a sig. value of 0,109 > 0,05. The homogeneity test in this study used the Levene test with the help of SPSS. A homogeneity test is conducted to determine whether the data comes from the same population or not. Both classes are homogeneous or come from populations that have the same variance with a sig value of 0,271 > 0,05. The Independent Sample t-Test parametric test was used to assess the hypothesis based on the outcomes of the prerequisite test. The following hypothesis test results are presented in Table 2.

Table 2. Independent Sample t-Test Results

| Hypothesis | Testing criteria | Test results | Decision |
|---|---|---|---|
| $H_0$ = there is no difference in the ability of multiple representations of students with PBL models and conventional models on acid-base material | sig. < 0,05, then $H_0$ is rejected | 0,000 < 0,05 | $H_0$ rejected |
| | t-count > t-table, then $H_0$ is rejected | 4,420 > 1,669 | $H_0$ rejected |

It can be interpreted that When teaching acid-base concepts, there are differences in students' multiple representation abilities the control class used the conventional approach and the experimental class used the PBL model.

## B. Discussion

Students' multiple representation ability can be measured through post-test questions. Each item of multiple representation questions contains the characteristics of the framework developed by Smith, namely the DAC framework (Definition, Algorithmic, Conceptual).

The difference in students' multiple representation ability measured through the post-test between the control and experimental classes showed significant results. The PBL learning approach was used to instruct the experimental class was found to be superior to the control class without being taught a specific learning model (conventional). Based on the results, the average value of the XI MIPA 4 post-test was higher than the XI MIPA 3 class, which was 85,76 > 80,44. This significant difference in numbers explains the difference between the two classes. The T-test results also show significant results, namely that the t-count value of 4.420 is greater than the t-table value of 1,669. This indicates that students' various representation skills and the PBL learning model that they are taught have a favorable relationship.

This outcome is consistent with other studies, which show that students in the experimental class had an average value of 70,29, whereas those in the control class had an average value of 60,54. The t-count result obtained in the statistical test (t-Test) is 2.36. This number is higher than the 1,678 t-table value. This explains why students who use the PBL assisted LKS learning paradigm have an improvement in their critical thinking abilities [9]. There was a positive and significant correlation between student learning activities and student learning outcomes taught with the PBL learning model, according to the results of previous research data analysis. Additionally, students taught with the PBL learning model had higher learning outcomes (83,75) than students taught with the Direct Instruction learning model (71,94) [10]. Based on the results of several studies, it is confirmed that the PBL model is very effective in learning.

Because it can pique students' attention and curiosity in addressing problems presented in the form of LKPD, the PBL learning model is thought to be appropriate for use in the educational process. There are five stages in the PBL learning model, and each one helps students gain multiple representation abilities. First stage involves assigning pupils to issues based on real-world scenarios, for example, by showing pictures of oranges and soap at the beginning of learning, what substances cause acids and what substances cause bases. The DAC framework of students' multiple representation abilities is seen at this stage to examine a problem that focuses on remembering, understanding, applying, or recognizing definitions. Because of the smooth operation of communication between students and teachers or between students and other students, the experimental class's reaction from the students was superior to that of the control group using the conventional learning model.

In stage two, pupils are arranged both individually and in groups for learning. To tackle the assigned tasks, each group must learn how to collaborate with one another. For example, discussing together the relationship between pictures of oranges and bath soap with Arrhenius acid-base theory. Stage 3 involves assisting with individual or group research; at this phase, students are urged to get data in order to address the issues that have been displayed. For example, the teacher helps students who are struggling by explaining the ionization reaction equation in acids and bases. The DAC framework of students multiple representation abilities seen at this stage focuses on demanding students to use information that has been memorized or obtained to examine, Combine and resolve issues.

Developing and presenting the work's outcomes is stage four. At this point, they should plan and deliver their work either verbally or in writing by summarizing the outcomes of their conversation. Analyzing and assessing learning in relation to the outcomes of the debate is stage five. For example, the teacher makes corrections to student answers that are still wrong and reflects in the form of questions about today's learning experience and feedback to test the level of student understanding. The DAC framework of students' multiple representation abilities seen at this stage is focused on demanding students to do non-algorithmic analysis. In this instance, analyzing and assessing an issue to determine the relationship between the solved problem and the notion of the content that has been grasped. Multiple representation skills can be effectively improved by following the five steps of the PBL learning model. The five stages of the PBL learning model are effective for improving multiple representation skills. This is what underlies the PBL learning model assisted by LKPD, which is effectively used to develop students' multiple representation skills. In Figure 1 below, shows a question that contains multiple representations.

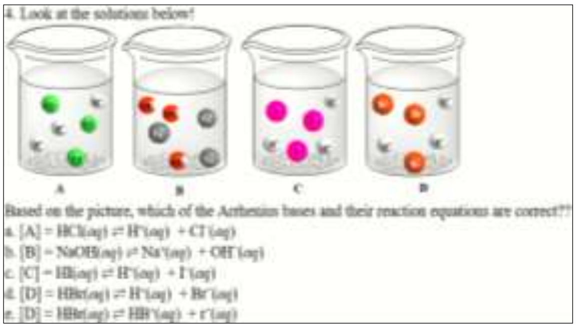


Figure 1. One of the research questions that contains multiple representations

This is one of the problems used to contain the DAC framework, which is pictorial representation analysis (C-P). Since this problem provides pictorial representations of acid-base molecules in water, students are asked to analyze these pictorial representations and recognize that one of the four solutions is basic. In the question, students are asked to observe submicroscopic images in solution and recognize the ions in them that characterize Arrhenius bases.

## CONCLUSION

From the conversation, it can be inferred that the competence of multiple representations students taught using the PBL (Problem Based Learning) learning model differs significantly from the conventional approach. In future research, tests can be added at the beginning before of treatment (pre-test), and for comparison of learning models, we can use learning models that already exist in the 21st century.

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