UNESA Journal of Chemical Education *ISSN: 2252-9454*
Vol.12,No.3, pp.237–243, September 2023

THE EFFECT OF PROBLEM BASED LEARNING MODEL ON STUDENTS METACOGNITIVE KNOWLEDGE ON ACID BASE MATERIAL

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Abstract

The aim of this research is to know the influence of learning model problem solving on metacognitive knowledge in class XI IPA at one of state senior high school 10 Makassar on acid base material. Research methods that have been used are quasi-experimental with a quantitative approach and using post-test control group design. The research population is the entire XI IPA class with a total of two classes. Research samples are class XI IPA 6 as an experimental group and class XIIPA 5 as a control group. Data gathering techniques use expression tests to obtain metacognitive knowledge data. Data analysis is done using descriptive and inferential statistics. The results of the statistical analysis obtained the average metacognitive knowledge test of the experimental group 71.2 higher than the control group 58.2. The results of inferential statistical analysis of the metacognitive knowledge test results of the students showed that the data of the experimental and control groups came from homogeneous but not normally distributed populations, so the hypothetical test used was the Mann-Whitney test. From the data the results of the analysis show Zhitung (4.51) > Ztable. (1.64). Based on the results of the analysis, it can be concluded that there is an influence of the learning model Problem Solving on the metacognitive knowledge of students of grade XI High School State 10 Makassar on the acid base material.

Key words: knowledge metacognitive, problem solving model, acid base material

INTRODUCTION

The new curriculum had been start to apply for education in Indonesia mainly independen curriculum. However, there was important things in the previous curriculum such as the 2013 curriculum. The independen curriculum is a curriculum with diverse intracellular learning. Where learning content will be more optimal for learners to have enough time to conceptualize and strengthen competence. The learning process builds educational ecosystems that enable growth and development of reason, character, innovation, self-reliance, comfort, and student skills. Freedom of study can thus create superior or qualified resources to complete the educational opportunities of the industrial age 4.0 and is expected to increase the metacognitive knowledge available to learners.

Metacognition is a form of consciousness associated with a person's cognitive abilities about what is known and what is unknown based on knowledge already possessed, cognitivo experience, and monitoring in which he is involved in his own cognitiva activities [1]. Metacognition is the awareness or knowledge of a person's thinking processes and outcomes, as well as their ability to control and evaluate those cognitive processes [2]. Metacognition is defined as the theory that integrates a person's cognitive knowledge and regulation. Metacognitive theory is a relatively systematic knowledge structure that can be used to explain and predict various cognitive phenomena [3].

Metacognitive knowledge is the knowledge of how a person learns and processes information [4]. Metacognitive knowledge, according to Kuntjojo in [5], consists of three components, namely: (1) declarative knowledge, which is knowledge of oneself as a learner as well as skills strategies and the learning resources it needs for learning purposes; (2) procedural knowledge, which is the knowledge of how to use knowledge that has been known in knowledge about oneself for its learning activity; and (3) conditional knowledge, which is the knowledge about how to apply a procedure, skills, and strategies.

Implementation of learning at SMAN 10 Makassar, according to class XI chemistry teachers at the school, has already used models and approaches based on the 2013 revised edition curriculum. Chemistry teachers at the school said the model used in chemistry learning was a guided inquiry model. However, in its implementation in class, chemistry teachers tend to be more active in providing material explanation (teacher center), meaning the guided inquiry model has not been implemented in class. This results in students becoming passive and less trained in finding a concept, and they tend to get tired faster following the learning process. Chemistry teachers sometimes use group discussion methods in the classroom. Teachers of chemistry have not yet applied learning that trains metacognitive knowledge, so they do not reach the graduate competence standards expected from Permendikbud No. 37 in 2018.

Chemistry is one of the natural science subjects studied in high school. One of the main subjects of chemistry is the base acid studied in class XI, second semester. Results of research showed learning difficulties in understanding substantial base acid sub-matter in class XI IPA 2 SMAN 1 Wolowa with an average percentage of 47% and the most difficult percentages of learning on the material calculation pH solution base acid of 88% [6]. While other research results said that students in the 12th grade state high school in Sragen experienced misconceptions on base acid material, with an average misconception on each subconcept of 49% [7].

Teachers, as facilitators of learning, who want to train metacognitive knowledge in their pupils, require a structured plan and preparation. Like a learning model with a scientific approach that can sharpen the thinking power of the student in solving a problem. Educators can also implement interactive and convenient learning so that the activity of all students in the classroom can be expected to increase. The importance of applying a model of learning based on problem solving is that learning is centered on the student.

Problem solving is an attempt to find a way out of a difficulty in order to reach a goal that cannot be reached so quickly. Polya continues that there are four stages when using the ability to solve problems: understanding the problem, devising a plan, carrying out the plan, and looking back [8].

In problem-based learning, teachers can act as metacognitive trainers who help students define problems, define information, analyze and synthesize problems, and be able to choose the right solution process. Metacognition has three components in problem-solving in learning, namely: (a) metacognitive knowledge, (b) meta-cognitive skills, and (c) metakognitive beliefs [9].

Research revealed that the application of problem-solving learning models has a positive impact on improving student chemistry learning outcomes and metacognitive knowledge [10]. This is supported by research that says there is a relationship between metacognitive knowledge and problem-solving abilities. The association is seen in each metacognitive knowledge indicator: declarative knowledge, which reaches a percentage of 84.93% (very good), procedural knowledge, which achieves a percent of 91.18% (highly good), and conditional knowledge, which reaches a percentage of 84.12% (highly good) [11].

Based on the background, research is carried out to find out whether there is an effect of learning model problem solving on metacognitive knowledge of acid-base students in class XI IPA SMAN 10 Makassar.

METHOD

This study was conducted in the full semester of the academic year 2022–2023. The location of the research is in SMAN 10 Makassar, Manggala Prefecture, Makassar City, South Sulawesi Province.

This type of research is an experimental study. (Quasi Experiment). This study aims to understand the influence of problem-solving learning models on the metacognitive knowledge of students on base-acid material.

The research design used in this study is a post-test-only control group design. The population in this study is the entire student class of XI IPA SMAN 10 Makassar. The study involved two randomly selected classes: the experimental group and the control group. The group of experiments is class XI IPA 6, which is given treatment for learning using a problem-solving learning model, while the control group is Class XI IPA 5, which is provided treatment without using a problem-solving model. The design can be seen in Table 1 below.

Table 1. Post-test Only Control Design

Groups	Treatment	Posttest
Experiment →	X →	O
Control →	→	O

The research instruments used in this study are: (1) a metacognitive knowledge-based test (post-test); this test has a total of as many as ten questions with an assessment based on the analytical rubric made; and (2) an observation sheet of learning performance, which is compiled using an observation sheet with 18 observation items of the learning activity at the time of the learning activity.

There are two statistical analyses used in this study: descriptive analysis and inferential analysis. Descriptive analysis is used to provide a general overview of metacognitive knowledge that includes declarative knowledge, procedural knowledge, and conditional knowledge through problem-solving learning models as well as the implementation of problem-solving learning models.

Before conducting inferential statistics, a pre-conditional test is carried out, namely a normality test and a homogenity test. As for inferential statistics used in this study, the Mann-Whitney test (a non-parametric test) aims to test the hypothesis. Non-parametric testing is carried out by obtaining non-normally distributed and homogeneous group data.

RESULTS

1. Descriptive Statistical Analysis

The data results of the metacognitive knowledge of students in classes XI IPA 5 and XI IPA 6 at State 10 Makassar High School were obtained through post-testing that was carried out after giving treatment to both the experimental group and the control group. Post-test scores in the experimental group showed that the highest scores obtained by the students in the experimental group were 83.33 and the lowest score was 43.33, with an average score of 71.2. The control group obtained the highest score of 80 and the lowest rating of 30, with an average score of 57. The results of the metacognitive knowledge test of students based on the results of descriptive statistical analysis can be seen in Table 2 below.

Table 2. Descriptive statistical analysis of metacognitive knowledge

No	Statistics	Groups	
		Eksperiment	Control
1.	∑ student	30	30
2.	Highest value	83.33	80
3.	Lowest value	43.33	30
4.	Average value	71.2	57.1
5.	Medially (Me)	73.33	59.27
6.	Modus (Mo)	79.37	61.27
7.	Standard Deviation	10.33	11.26

Metacognitive knowledge consists of declarative knowledge, procedural knowledge, and conditional knowledge. Declarative knowledge is factual information known to a person. Procedural knowledge is the knowledge of how a person performs in executing steps in a process. Conditional knowledge is the awareness of conditions that influence learning and the knowledge of why to use a particular strategy.

Description: The test instruments used for declarative knowledge include items 1(b), 3(b), and 4(b). As for the percentage of students on each score in the declarative knowledge category, you can see it in Table 3 below.

Table 3. Percentage of declarative knowledge

Issue no.	Groups			
	Eksperiment		Control	
	∑	%	∑	%

	Total score (90)	Achieved	Total score (90)	Achieved
1(b)	65	72.22	52	57.78
3(b)	73	81.11	33	36.67
4(b)	47	52.22	51	56.67
x̄	61.67	68.52	45.33	50.37

Question number 1(b) has an indicator with which the student can determine the species of base acid of a Lewis base acid. Issue number 3(b) has an indicator with which the student can determine the properties of acid and base solutions using indicators. Issue number 4(b) has an indicator where the student can determine the strength of the acid and base of a solution that has a known pH value.

As for the comparison of the average performance of the students in the declarative knowledge category in the experimental group, it was 68.52%, and the control group was 50.37%. That is, the declarative knowledge of the learners in the experimental group is in a better category than the declarative knowledge of students in the control group, which is in a lower category.

In the descriptive test instruments used, procedural knowledge includes questions 3(a), 4(a), 5(a), and 6. The percentage of students on each score in the procedural knowledge category can be seen in Table 4 below.

Table 4. Percentage of procedural knowledge

Issue no.	Groups			
	Eksperiment		Control	
	Σ Total score (90)	% Achieved	Σ Total score (90)	% Achieved
3(a)	80	88.89	53	58.89
4(a)	79	87.78	76	84.44
5(a)	62	68.89	68	75.56
6	81	90	38	42.22
x̄	75,5	83.89	58.75	65.28

Issue number 3(a) has an indicator where the student can write and use the steps in predicting the pH value using the indicator. Issue number 4(a) has an indicator where the student can write and use steps in calculating the pH value of a strong base acid solution. Issue number 5(a) has an indicator where students can write and use steps in calculating the pH value of a weak base acid solution and the degree of ionization. Issue number 6 has an indicator where students can write and use steps in calculating the value of the acid ionization setting (Ka) of a weak acid solution.

As for the comparison of the average scores of students in the procedural knowledge category in the experimental group, they were 83.89 and 65.28, respectively. That is, the procedural knowledge of the learners in the experimental group belongs in a very good category compared to that of the students in the control group, which belongs in a sufficient category.

The test instruments used for conditional knowledge include questions 1(a), 2, and 5.(b). The percentage of participants on each score can be seen in Table 5.

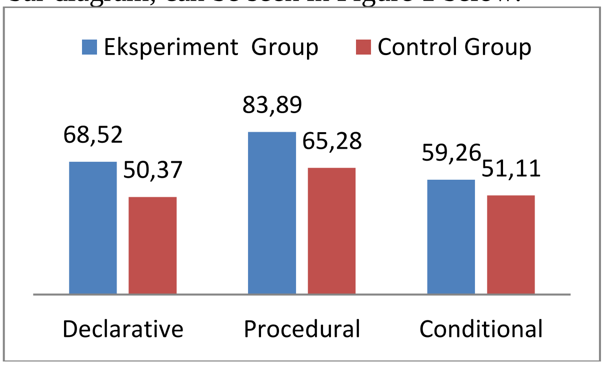
Table 5. Percentage of conditional knowledge

Issue no.	Kelompok			
	Eksperimen		Kontrol	
	Σ Total score (90)	% Achieved	Σ Total score (90)	% Achieved
1(a)	57	63.33	49	54.4
2	41	45.56	37	41.11
5(b)	62	68.89	52	57.78
Rata	53.33	59.26	46	51.11

On question number 1(a), there is an indicator where the student can explain why the reaction of ammonia and Boron Trifluoride includes Lewis base acid. On question number 2, there is an indicator where the student can explain why the reactions include Arrhenius and Bronsted-Lowry base acids. Issue number 5(b) has an indicator in which the student can write reasons for problems in the application of acid-base in everyday life.

As for the comparison of the average scores of the students in the conditional knowledge category in the experimental group, they were 59.26 and 51.11, respectively. That is to say, the conditional knowledge of the student in the experimental group includes a category greater than that of the learner in the control group, which includes a category less..

The three metacognitive knowledge categories that include declarative knowledge, procedural knowledge, and conditional knowledge, if presented in a bar diagram, can be seen in Figure 1 below.



Picture 1. The Metacognitive Knowledge

Another thing that supports the results of the metacognition knowledge description test in the experimental group is the use of a problem-solving learning model compared to the control group, which does not use a problem-solving model. Based on the observation results of the implementation of the learning model of problem solving in the group of experiments that are categorized as active, see table 6 below.

Table 6. Percentage of Implementation of Learning Models

Group	Meeting	Implementation
Eksperiment	1	88.46%
	2	85.42%
	3	90.91%
Average		88.26%
Keterangan		Active

2. Results of statistical analysis

Statistical inferential analysis is used to test the research hypothesis of the influence of the learning model Problem Solving on the metacognitive knowledge of students of XI grade High School State 10 Makassar on the acid-base material. Before the test of the hypothesis, a pre-conditional test is carried out, namely the normality test and the homogenity test, on the results of the metacognitive knowledge test for the experimental group and the control group.

a. Preliminary Test

1) Test of Normality

The normality test uses the statistics of the chi-square test, where the data is categorized as normal when $\chi^2_{\text{count}} < \chi^2_{\text{table}}$ has a level of significance (α) = 0,05 and a degree of freedom (dk) = 3. Test results can be seen in Table 7.

Table 7. Results of the Metacognitive Knowledge Test

Group	χ^2_{count}	χ^2_{table} **(α) = 0.05**	**Conclusion**
Eksperiment	9.81	7.81	Not a normal distributionl
Control	12.65	7.81	Not a normal distribution

2) Test of Homogeneity

According to the homogeneity test criterion, if F-calculation < Ftable is at a level of significance of 0.05, then the variance of the experimental group is homogenous with the control group variance. The homogenity test results can be seen in Table 8.

Table 8. Test of Metacognitive Knowledge of Students

Group	F_{count}	F_{table} **(α) = 0.05**	**Conclus ion**
Eksperiment	1.19	1.86	Homoge neous
Control			

a. Testing the hypothesis

Based on the results of the prerequisite test, it is known that the data from the experimental group and the control group have homogeneous variance, but the experimental groups and control groups are not normally distributed, so the testing of the hypothesis cannot be done using parametric statistics (test-t), but the test of the hypotheses is done using non-parametrical statistics. (uji Mann-Whitney).

This hypothesis is tested with two-party testing with the following statistical hypotheses:

$$H0: \varphi_1 \leq \varphi_2$$
$$H1: \varphi_1 > \varphi_2$$

The results of calculating the rankings of metacognitive knowledge of students using the Mann-Whitney test can be seen in Table 9 below.

Table 9. Test the results of the Metacognitive Knowledge Test.

Group	Z_{count}	Z_{table} = 0.05	Conclusion
Eksperimen	4.44	1.64	H_0 rejected dan H_1 accepted
Kontrol			

3. Discussion

This research was carried out with the aim of knowing whether or not the influence of learning model problem solving on metacognitive knowledge of students in class XI IPA High School State 10 Makassar on the material of acid base a learning model for problem solving is one that requires students to play an active role and be able to think. This model requires students to analyze the material, starting with the search for data to draw conclusions. This model makes the problems of everyday life the focus of learning. The impact of this learning model is to enable students to strengthen their intellectual capacity by formulating new ways, strategies, or techniques to solve their problems while learning basic acids. Learning results are metacognitive knowledge consisting of questions about what (declarative), how (procedural), and why (conditional) is trained and developed throughout the learning process.

The research used two different models: the experimental group used the problem-solving learning model according to Polya, with four stages: understanding the problem, making a solution plan, implementing a solution scheme, and reviewing the results. The control group uses the conventional hands-on learning model in the classroom with three stages: demonstration of knowledge and skills, training guidance, and understanding testing and feedback.

During the learning process of the two groups, use the support student worksheet gives to each student participant that is integrated according to the learning model of each group. Learning in the experimental group tends to be more active as learning is based on the problems of the student's daily life. The problems revealed in the student worksheet stimulate the learners to figure out what, how, and why they are solving problems using the problem-solving model by Polya.

In the control group, students generally tend to be passive and perform other activities. Students feel saturated with a monotonous learning model; they feel burdened with tasks and exercises to be solved but do not get good guidance; there is no time to discuss with friends and teachers because the time is very limited and students use a lot of time to complete the training or answer the questions given. The basic difference between metacognitive abilities in both classes is the phase of the model of learning in which the teacher functions in the learning process. In the experiment group, the teacher acts as a facilitator. In the control group, the teacher acts as a content transmitter or a transmitter of science.

The results of the descriptive statistical analysis in Table 2 showed that the experimental group obtained an average metacognitive knowledge score of 71.2 with good categories, while the control group obtained 57.1 with sufficient categories. The differences in metacognitive knowledge values are influenced by the learning process in the classroom, where the experimental group uses a problem-solving learning model that makes the student active in learning. It is different with the control group, where the learning process uses a direct spending model that makes the student tend to be passive because learning is centered on the teacher.

Table 3 shows that declarative knowledge in the experimental group had a percentage accuracy of 68.52 with good categories. Declarative knowledge in the control group had a percentage of accuracy of 51.17 with a category less. The achievement of declarative knowledge values by the experimental group is not beyond the learning model of problem solving at the step of understanding the problem.

Following this step, the learners understand the problem through the phenomena that exist within the LKPD. Participants can also ask questions about the phenomenon. Related questions about what is often written by learners so that concepts can be easily understood differently from the control group, where the explanation of the concept of acid-base material is still the source of teachers frustration, many students have difficulty understanding the concepts of material or asking questions about what.

Table 4 shows that procedural knowledge in the experimental group had a percentage of accuracy of 83.89 percent with a very good category, while procedural know-how in the control group had an accuracy of 65.28 percent with a good category. The high value of procedural knowledge in the experimental group is influenced by the learning model of problem-solving in the steps of devising a plan and carrying it out.

In both of these steps, the student uses his knowledge of the steps or ways to work to solve a problem. The plan of solution that has been prepared is then implemented based on how to achieve the goal of learning. On the other hand, learners who are actively seeking themselves through various sources related to the steps to solve a problem are more dominant than students who are in the control group where the teacher teaches the steps to solving problems so that the learners are not trained in the use of such steps.

Table 5 shows that conditional knowledge in the experimental group had a percentage accuracy of 59.26 with sufficient categories. Conditional knowledge in the control group had a percentage of accuracy of 51.11 with category less. The experimental group obtained sufficient value because some of the students are less accustomed to answering questions related to why.

On the learning model of problem solving through a step-by-step look back at the results, few of the learners are able to respond well to the reason why such a phenomenon occurs. In the control group, students tend to be passive when receiving any information from teachers. They were more focused on what they heard from teachers but less on understanding the reasons for something related to base-acid material.

Based on Table 6, the implementation of the learning model for problem solving is seen based on the activity of students during learning. In this study, there were three meetings during the learning process. The first meeting had an implementation percentage of 88.46 with active statements. The second meeting had an implementation percentage of 85.42 with active statements. The third meeting had a performance percentage of 90.91. The average rate of execution was 88.26%. If you see the second meeting, there is a decrease in effectiveness compared to the first meeting. However, in the third meeting, there was a significant improvement.

The learning process in the experimental group using the learning model of problem solving and the learning process in the control group without using the learning model of problem solving have different impacts and results on the metacognitive knowledge of the student.

The results of the test of the hypothesis in Table 4.8 of the metacognitive knowledge test results obtained a value of Zcount > Ztable, which means the hypothetical proposal is accepted. Thus, it can be concluded that there is an influence of the learning model of problem Solving on the metacognitive knowledge of students of Grade XI High School State 10 Makassar on the acid-base material. The test results of the hypothesis showed the zcount value was 4.44 and the ztable value at the confidence level of 0.05 was 1.64. From this data, it is seen that zcounting (4,44) > ztable (1,64). This shows that H0 is rejected and H1 is accepted, and it is concluded that there is an influence of the Learning Model Problem Solving on the metacognitive knowledge of students of Class XI High School State 10 Makassar on base acid material.

Similar research found that the learning model of problem solving influenced the metacognitive knowledge of students in the study of chemistry. Students who are taught with a problem-solving learning model have higher metacognitive knowledge compared to students studying with a direct learning model [12].

CONCLUSION

Based on the results of data analysis and discussion, the average results of the metacognitive knowledge test of the experimental group 71.2 with a good category and the control group 57.1 with a sufficient category, as well as the Z_{count} (4.44) > Z_{table} (1.64), can be concluded that H0 is rejected and H1 is accepted, which means there is an influence of learning model problem solving on the metacognitive knowledge of students of class XI State High School 10 Makassssar on the acid base material.

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