

REDUCTION OF STUDENT MISCONCEPTIONS: APPLICATION OF TTW-PBL LEARNING WITH CHEMICAL REPRESENTATION ON BUFFER SOLUTION MATERIALS

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ABSTRACT

The research was conducted on the chemical representation of buffer solution learning through multi-model TTW-PBL learning to determine the understanding of chemical representation and reduce students' misconceptions. The method used is a quasi-experimental design with a non-equivalent control group. The samples of this study were students of class XI MIPA 1 as the experimental class and XI MIPA 3 as the control class at SMAN 11 Banjarmasin. The independent variables are the TTW-PBL learning model in chemical representation and the PBL model in chemical representation. In contrast, the dependent variable is the understanding of chemical representations and misconceptions. The data analysis technique used descriptive and inferential analysis techniques. Descriptive analysis was used to find out the differences in students' misconceptions. The inferential analysis uses a t-test to analyze differences in understanding of chemical representations. The results showed significant differences in the understanding of chemical representation in the class using the multi-model TTW-PBL and PBL model with a value of $t_{count} > t_{table} = 2.15 > 1.99$ and the percentage of misconceptions of 16.57% and 23.24%, respectively. Finally, TTW-PBL learning with Chemical Representation can reduce students misconception.

Keywords: TTW-PBL learning, chemical representation, buffer solution

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Introduction

Chemistry, in science content, is part of nature that examines and identifies matter and its changes (Faizi, 2013). Chemical concepts include macroscopic, microscopic, and symbolic representations (Shui-Te, Kusuma, Wardani, & Harjito, 2018). The multicomplex characteristics of chemistry must be studied by memorizing the names of compounds or symbols of chemical elements and by understanding the characteristics and chemistry of the concrete itself (Keith, 2013). Students' difficulty in understanding chemistry is marked by the inability of students to understand chemical concepts correctly (Amarlita & Sarfan, 2014). Chemical materials containing many complex concepts are buffered materials (Purwati & Budhi, 2018).

Based on initial observations at SMAN 11 Banjarmasin, when the teacher carried out the teaching and learning process on the buffer solution material, the teacher focused more on the calculation aspect than the conceptual in explaining the material. Students had difficulty learning chemistry correctly. This difficulty causes students to have a varied understanding of chemical concepts so that it can foster misconceptions. The misconception is a misunderstanding of concepts that are not following experts in chemistry (Suparno, 2013).

The buffer solution based on the characteristics of the material is conceptual, so to understand this material, students must understand the concept well and know the relationship between concepts and apply the concept in solving calculation problems (Nurhujaimah, Kartika, & Nurjaydi, 2016). Chozim, Qurbaniah, & Harida (2018) showed that there were misconceptions experienced by 76% of students in determining the components to make a buffer solution.

The use of the Problem Based Learning (PBL) learning model, a 2013 curriculum-based learning model implemented in the school, has not been implemented as it should. It impacts learning that is still not effective, so teachers need to design a creative and innovative learning strategy. Teachers can use varied models by adjusting the learning situation to achieve a multi-model learning goal (Arends, 2007).

If students have become doubtful about the truth of their ideas, then it will make it easier for teachers to direct students' understanding in constructing their knowledge (Sadia, 2008). One of them is by using multi-learning models to stimulate the social interaction of students and the

formation of a good understanding of concepts. The multi-learning model in question is collaborating the Cooperative Think-Talk-Write (TTW) model with the Problem Based Learning (PBL) model in chemical representation.

The collaboration of this learning model is carried out based on compatibility with the indicators to be achieved in the learning process. TTW-PBL learning is carried out by giving students problems related to buffer solution material in the student worksheet. The Student worksheet contains an overview of the chemical representation of the buffer solution material, analytical concepts that can stimulate students' cognition, and questions that describe chemical representations. The TTW-PBL learning in chemical representation can make it easier for students to understand the buffer solution material. Therefore, collaborating TTW-PBL learning with a chemical representation approach will minimize students' misperceptions. Based on this phenomenon, the researcher wants to research chemical representation through multi-learning models to reduce students' misconceptions in class XI MIPA SMAN 11 Banjarmasin.

Research Methods

The type of research used is experimental with a quasi-experimental research design with a non-equivalent control group design. Both classes were given the same treatment, a pretest to determine the students' understanding of chemical representations and initial misconceptions. Post-test aims to find out how much students understand the chemical representation and misconceptions after being given treatment.

This research was conducted at SMAN 11 Banjarmasin. The population in this study were all students of class XI MIPA SMAN 11 Banjarmasin. Then, sampling was carried out using the purposive sampling technique considering the proximity of the learning time of the buffer solution material and the results of understanding representations and misconceptions that were normally distributed and had homogeneous variants in both classes. Samples were taken from class XI MIPA 1 as an experimental class using TTW-PBL learning with chemical representation and class XI MIPA 3 as a control class using a PBL learning model with chemical representation.

The test technique was carried out to determine the understanding of students' representations and misconceptions. The questions

Reduction of Student Misconceptions

used are three-tier multiple-choice diagnostic test instruments. Students' misconceptions can be identified by using formula 1.

$$P = \frac{f}{N} \times 100\% \dots (1)$$

Information:

P = percentage of misconceptions

f = frequency of misconceptions

N = number of students studied

The category of misconceptions based on the pattern of students' answers can be seen in table 1.

Table 1 Categories of misconceptions

Answer Combination			Classification of student answers
Level 1	Level 2	Level 3	
True	True	Sure	Understand the concept
True	False	Sure	Misconception (+)
False	True	Sure	Misconception (-)
False	False	Sure	Misconception
True	True	Not Sure	Lucky
True	False	Not Sure	Less Understand
False	True	Not Sure	Less Understand
False	False	Not Sure	Lack understand

(Mubarak, Susilaningsih, & Cahyono, 2016)

The effectiveness of the model used in reducing misconceptions can be calculated by formula 2.

$$\% \text{Efektifitas} = \frac{\text{akhir-awal}}{\text{mula-mula}} \times 100\% \dots 2$$

The effectiveness criteria can be seen in table 2.

Table 2 Effectiveness Criteria

Effectiveness (%)	Criteria
< 30	Less Effectiveness
30 – 70	Low Effectiveness
> 70	High Effectiveness

(Siregar, 2015).

Result and Discussion

The result of this research is the influence of TTW-PBL learning in chemical representation. The influence can be seen from developing the pattern of student answers in each case related to the material being taught. This sub-material

discusses how to distinguish the concepts of fully and partially ionized acid-base in a buffer solution and analyze which is a buffer solution and not a buffer solution. TTW learning has three stages, namely think (think), talk (speak), and write (write). The level of understanding of students' chemical representations can be seen in think and writing.

At the thinking stage, students are given time to think or analyze problems individually, which are then solved based on their respective prior knowledge. It is in line with Agey, Harini, and Hadi (2015) that thinking affects learning outcomes and makes students active. The pattern of students' answers in formulating problems is still incomplete, so the answers written are only basic answers. The first and second answers show that students do not fully understand the meaning of the problem. Another thing that can be seen is that their initial knowledge of the microscopic picture of the buffer solution seen in Figure 2 is still not fully understood. Most of the students have not been able to solve the problem.

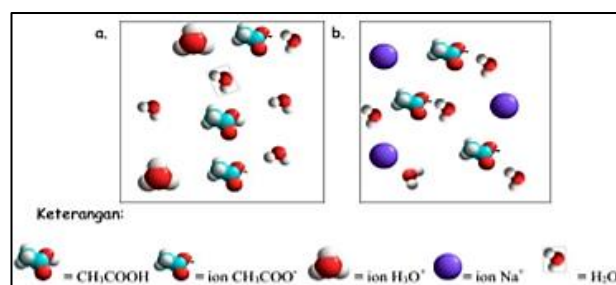


Figure 1. Microscopic case of buffer solution

The next stage is talk, where students are divided into groups to solve problems together. There is an exchange of opinions or information they have to solve the problems given. In the discussion, they became more active in speaking and asked the teacher how to understand the problem to minimize the occurrence of misconceptions. In addition, this stage can contribute to understanding in formulating problems and the final answers they get.

The last stage is writing, and they write their final answers in the final note column. Students construct their initial answers with what they discussed in groups in their respective languages. These results showed that they could understand the buffer solution system not only at the macroscopic and symbolic levels but also at the microscopic level.

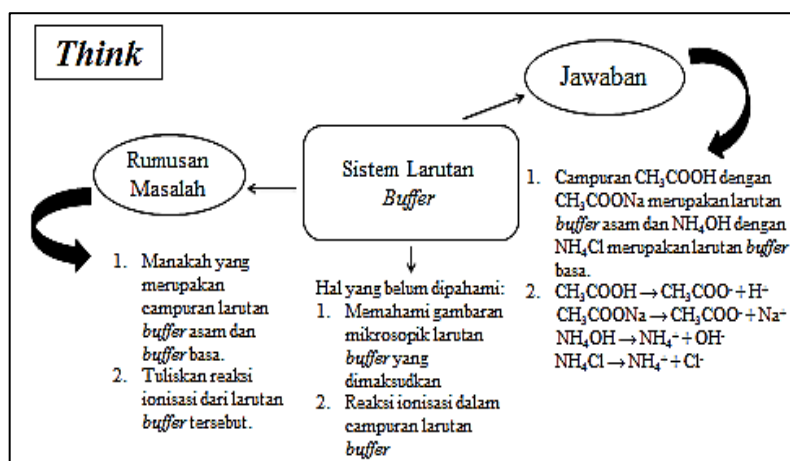


Figure 2. Think Stage

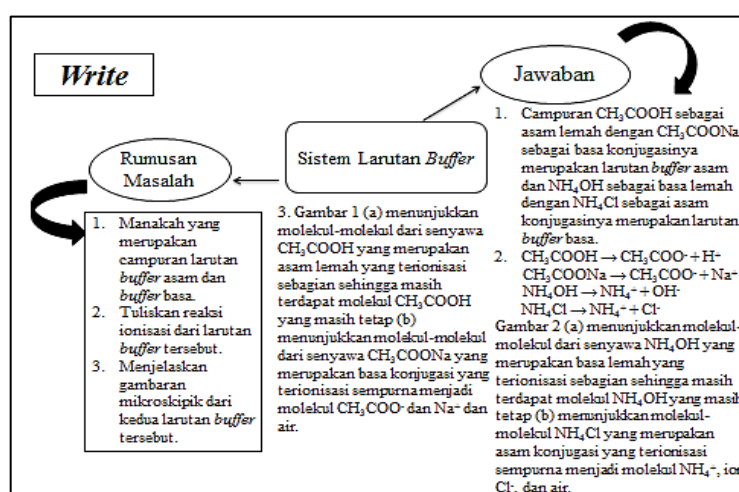


Figure 3. Write Stage

The sub-material of composition and pH of buffer solution is a mastery of concepts and mathematics that discusses the composition of acid buffer solution and alkaline buffer solution. Then, calculate the pH of the given buffer solution in the form of story problems. Setyawan and Simbolon (2018) say that solving mathematical problems requires good concentration, patience, and thoroughness so that students can complete calculations correctly.

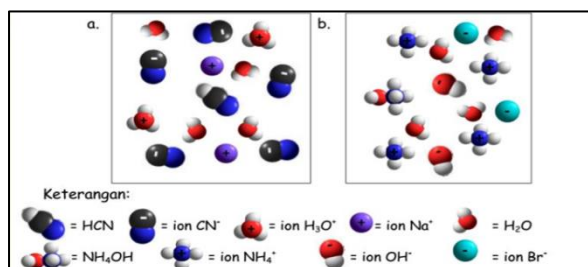


Figure 4. The case of the composition of the buffer solution

At the initial stage, namely think, students are asked to think about and then write

down the results of their thoughts into the column provided in the student worksheet. Some students still do not understand the meaning of the problem. One of them still thinks that the mixture of NaOH and HCl is a mixture of buffer solution, but some have already answered correctly. It is a misunderstanding of students who still do not fully understand the composition of the buffer solution.

Then, they entered the talking stage, where they discussed and looked for information in groups to solve the problem. At this stage, it provides an essential role in solving the problems given because students can exchange information, references, and opinions, which are different to find the exact solution and minimize misunderstanding of concepts among students. Conceptual understanding is formed because of a meaningful relationship between the new information they get from discussions conducted on existing knowledge (Kusasi, 2010). The solution they got was then written down in their final answer, namely at the writing stage.

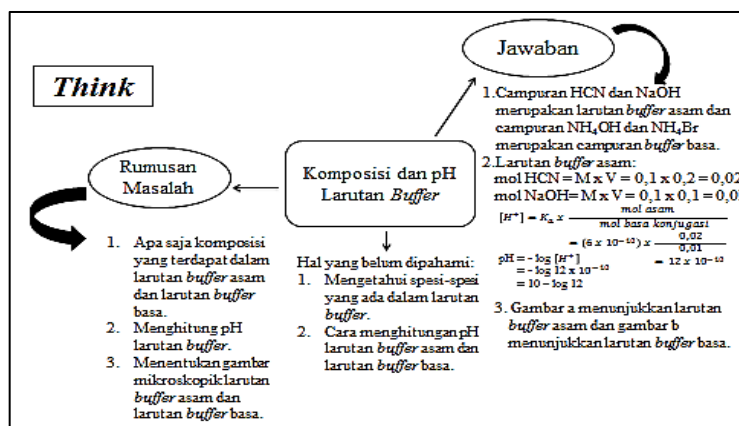


Figure 5. Think stage

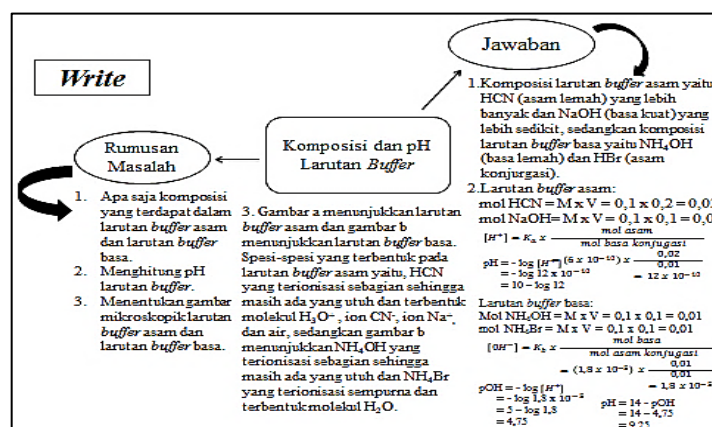


Figure 6. Write stage

Students' understanding of concepts has begun to develop at the writing stage and is more precise than their initial answers. Mathematical material such as calculating the pH of a buffer solution, students seem to understand better, making it easier to work.

The sub-material of the working principle of a buffer solution is material about the working principle of a buffer solution. The model used is the PBL learning model. The difference in the pattern of students' answers appears to be due to several learning factors which may also be different. This sub-material begins with giving problems in the student worksheet, which students in groups must complete.

Different learning models in the experimental class are used to achieve a learning goal by considering the time and indicators of the material being studied. In this case, the sub-materials studied are mastery of concepts and mathematics. The working principle of a buffer solution can be more easily understood with a practicum so that students can prove directly how the principle of the buffer solution itself is.

In this sub-material, it can be seen that students are more enthusiastic about learning because learning is carried out in the laboratory rather than in the regular class. The interest of students is even more increased than usual. Interest in learning caused by environmental factors will also impact student learning outcomes (Slameto, 2010).

At the stage of making a hypothesis, students still think that acidic orange juice will change the body's pH if it is drunk. However, after doing the practicum and looking for various further information, they can solve the problem correctly after doing the practicum at the stage of analyzing the data. They can explain the working principle of buffer solutions through experiments and mainly through the microscopic picture shown in Figure 8.

The use of buffer solutions in everyday life is the last sub-material. This sub-material begins by giving problems related to the use of buffer solutions in the body. Problems are given in the form of story questions to analyze what problems students have to solve in groups. The learning model used is the PBL learning model in chemical representation.

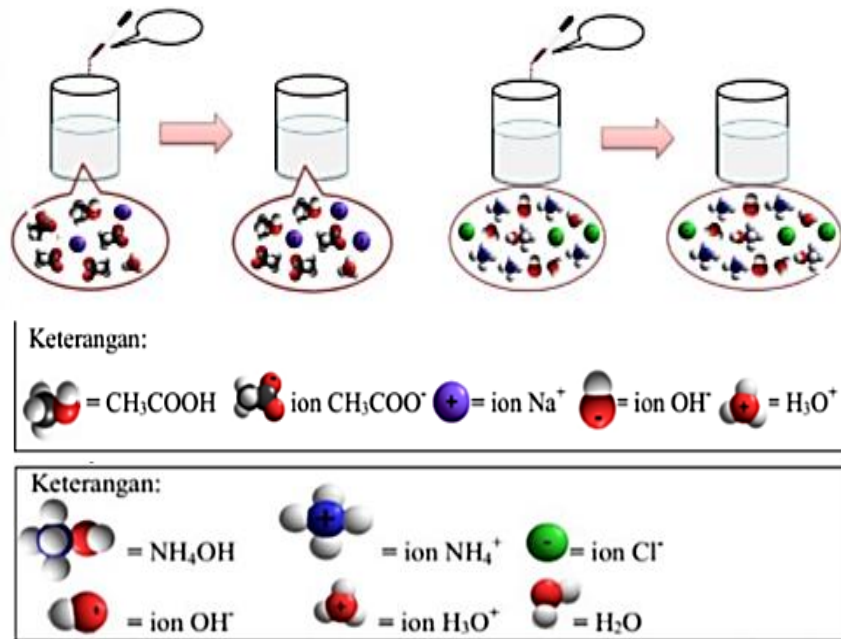


Figure 7. Working principle of buffer solution

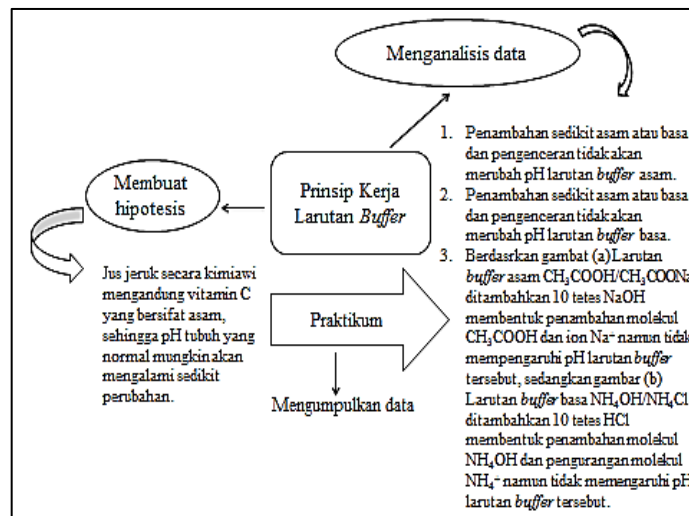


Figure 8. Creating hypotheses and analyzing data

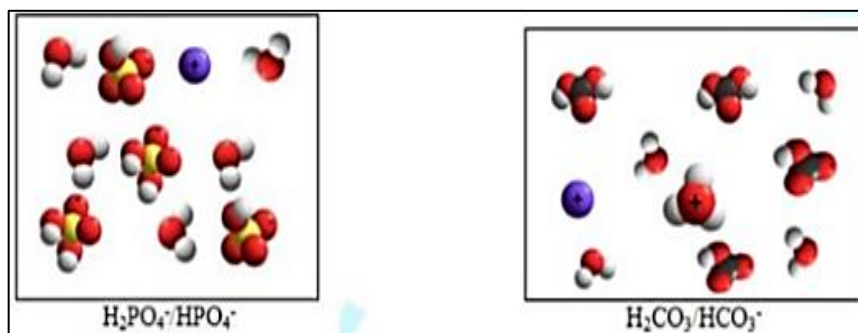


Figure 9. buffer solution in the body

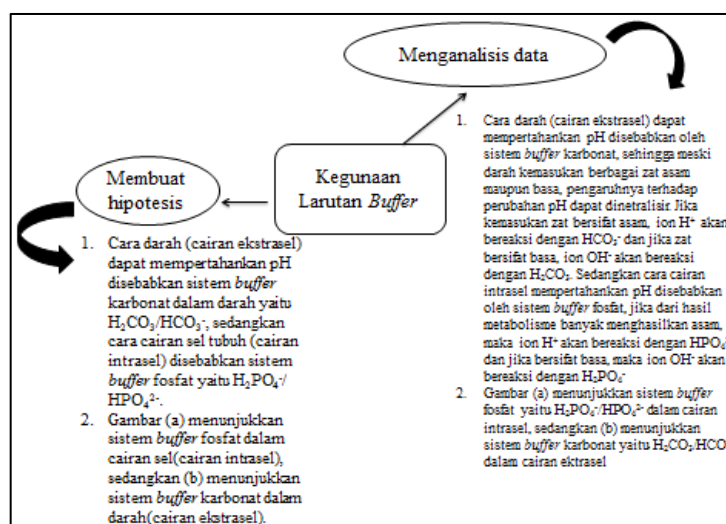


Figure 10. Creating hypotheses and analyzing data

Table 3. Results of t-test understanding of chemical representation

	Class	db	\bar{x}	SD^2	T_{count}	$T_{\text{table}} (\alpha=0,05)$	Conclusion
Pre-test	Experiment	67	18,57	183,19	0,439	1,99	Not significantly different
	Control		20,00	181,82			
Post-test	Experiment	67	81,43	183,19	2,15	1,99	Significantly different

Table 4. Value of n-gain understanding of chemical representation

Class	$\langle g \rangle$	Category
Experiment	0,77	High
Control	0,68	Moderate
Average	0,73	High

In the first stage, students hypothesize that the body has extracellular and intracellular buffer systems without explaining how the buffer system works. Understanding the concept of students begins to develop at the stage of analyzing the data they get from the stage of collecting from the internet and books. In addition to writing down how buffer solutions work in the body correctly, students can also distinguish microscopic images of compounds that play a role in maintaining pH in extracellular and intracellular fluids. The pattern of student answers can be seen in Figure 10.

The use of multi-models in learning carried out in this study is based on the material being taught to achieve a learning goal by considering the time and strategy that a teacher wants to do (Arends, 2007). TTW-PBL learning

with chemical representation has a better impact on student learning outcomes, which can be seen from the post-test results. Learning in chemical representation provides more meaningful learning for students because students learn from the context of chemistry itself, thereby minimizing the occurrence of misconceptions.

Hasil pemahaman representasi kimia terhadap pembelajaran yang menggunakan multi-model pembelajaran TTW-PBL dengan model PBL. Adapun uji-t dan *n-gain* yang dapat dilihat pada tabel berikut.

Learning progress ($n\text{-gain} = 0.77$) is a visualization of the success of the treatment carried out. It is in line with the research of Hardiyanto and Santoso (2018) that learning with the PBL approach to the TTW setting is effective in terms

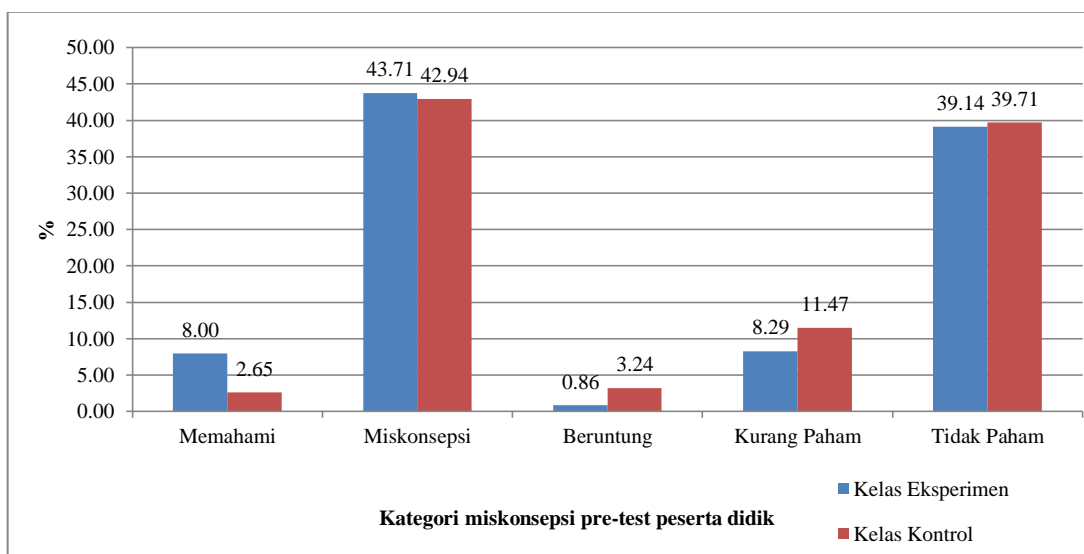
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of student achievement. The research of Yanuarta, Gofur also supports, and Indriwati (2017) that learning with the TTW model combined with PBL has more significant potential in improving students' cognitive learning outcomes on motion system material and the human circulation system on biology material.

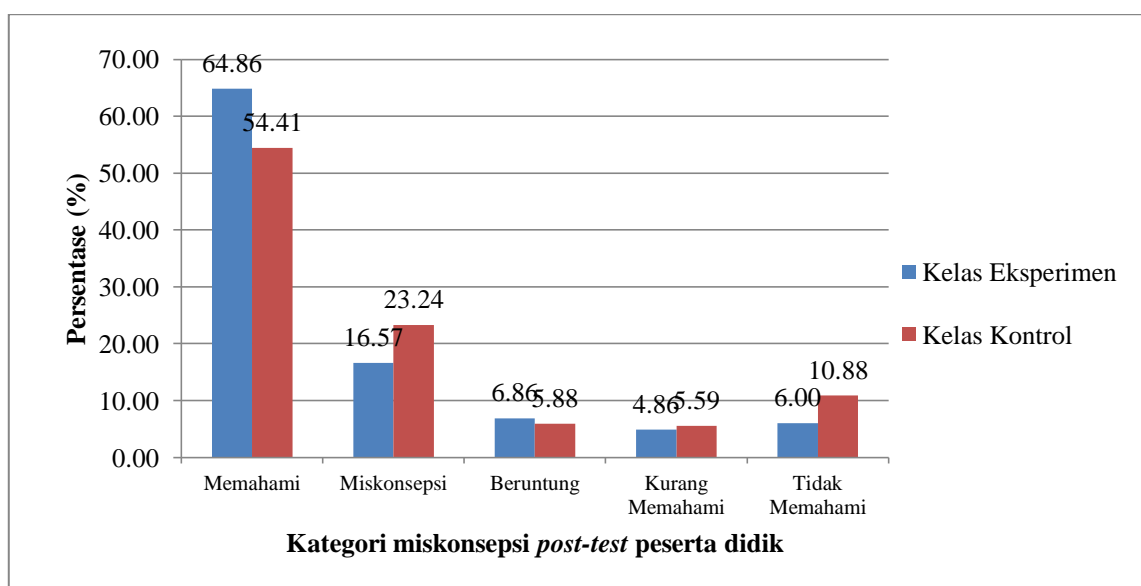
Purwati and Budhi (2018) research revealed that the TTW learning model could influence student learning achievement. PBL learning can also make students do a series of problems to find their concepts to become more meaningful and improve student learning outcomes (Arif, Istiyadji, & Syahmani, 2018).

The PBL learning model also impacts if it is adapted to the material to be taught. PBL learning can allow students to develop all their competencies and potentials actively and creatively, which Amiluddin and Sugiman (2018) show that the PBL approach has a positive effect on student achievement in mathematics education. However, in this case, the researcher provides a new strategy, namely by using TTW-PBL learning in chemical representation, which positively impacts student learning outcomes.

Increased understanding of student representation also impacts the percentage of students' misconceptions previously in the medium category to below.



Gambar 11. Perbandingan persentase miskonsepsi awal



Gambar 12. Perbandingan persentase miskonsepsi akhir

The percentage of understanding the class that uses TTW-PBL as a whole is higher at 64.86%, with a misconception percentage of 16.57%. Based on the percentage of effectiveness, TTW-PBL learning with a chemical representation of 62.10% can reduce students' misconceptions. It is due to the multi-learning models used and chemical representational learning that provides a complete understanding so that understanding of chemical representations increases and misconceptions decreases. Talanquer (2011) says that representation competence is essential for meaningful understanding (Syahmani, Suyono, & Imam-Supardi, 2017).

Conclusion

It can be concluded that there are differences in understanding of chemical representations and misconceptions between learning that applies TTW-PBL and the PBL model. The researchers' suggestions are (1) Chemistry subject teachers can consider the application of multi-model TTW-PBL learning in chemical representation as an alternative to reduce students' misconceptions. (2) For teachers or other parties who will apply the multi-model TTW-PBL learning in chemical representation so that they can pay attention and manage time well. (3) For teachers or other parties who will apply the multi-model TTW-PBL learning by chemical representation in learning activities, with the help of media to support learning objectives.

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