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Effectiveness of LKPD Based on Chemical Representation Using the Discovery Learning Model in Improving Science Process Skills On Chemical Equilibrium Material

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Abstract: Effectiveness of LKPD Based on Chemical Representation Using the Discovery Learning Model in Improving Science Process Skills in Chemical Equilibrium Material . This research aims to describe the effectiveness of chemical representation-based LKPD with discovery learning models in improving KPS in chemical equilibrium material. The population in this research is all students in class XI Science at SMAN 14 Bandarlampung for the 2022/2023 academic year. The sample was selected using purposive sampling technique. The sample in this research was class XI IPA 6 as the experimental class and XI IPA 5 as the control class. The design in this research is The Matching-Only Pretests-Posttest Control Group Design. The data analysis techniques used are n-gain and independent samples t-test. The research results show that the average KPS n-gain is in the high category in the experimental class and medium in the control class. The results showed that the average KPS n-gain was in the high category in the experimental class and medium in the control class; There was a significant difference in the average KPS n-gain between the experimental class which applied LKPD based on chemical representation with the discovery learning model and the control class which used LKPD which was not based on chemical representation with the discovery learning model. Based on the research results, it can be concluded that the LKPD based on chemical representation with the discovery learning model is effective in increasing students' KPS in chemical equilibrium material.

Keywords: LKPD based on chemical representation, *discovery learning model*, chemical equilibrium, science process skills

Abstrak : Efektivitas LKPD Berbasis Representasi Kimia Dengan Model Discovery Learning Dalam Meningkatkan Keterampilan Proses Sains Pada Materi Kesetimbangan Kima. *Penelitian ini bertujuan untuk mendeskripsikan efektivitas LKPD berbasis representasi kimia dengan model discovery learning dalam meningkatkan KPS pada materi kesetimbangan kimia. Populasi dalam pe-nelitian ini adalah seluruh siswa kelas XI IPA di SMAN 14 Bandarlampung Tahun Pelajaran 2022/2023. Sampel dipilih dengan menggunakan teknik purposive sampling. Sampel dalam penelitian ini adalah kelas XI IPA 6 sebagai kelas eksperimen dan XI IPA 5 sebagai kelas kontrol. Desain dalam penelitian ini adalah The Matching-Only Pretests-Postest Control Group Design. Teknik analisis data yang digunakan adalah n-gain dan independent samples t-test. Hasil penelitian menunjukkan bahwa rata-rata n-gain KPS berkategori tinggi di kelas eksperimen dan berkategori sedang di kelas kontrol; terdapat perbedaan rata-rata n-gain KPS yang signifikan antara kelas eksperimen yang diterapkan LKPD berbasis repre-sentasi kimia dengan model discovery learning dan kelas kontrol yang menggunakan LKPD tidak berbasis representasi kimia dengan model discovery learning. Berdasarkan hasil penelitian maka dapat disimpulkan bahwa LKPD berbasis representasi kimia dengan model discovery learning efektif dalam meningkatkan KPS peserta didik pada materi kesetimbangan kimia.*

Kata kunci: *LKPD berbasis representasi kimia, model discovery learning, kesetimbangan kimia, keterampilan proses sains*

• INTRODUCTION

Natural Sciences is a science that deals with finding out answers to the questions what, why, and how of natural phenomena related to the composition, structure and properties, changes and dynamics of nature (Widiadnyana et al., 2014)), so that Science is not only defined as a collection of knowledge in the form of facts, concepts or principles, but also a process of discovery to solve everyday life problems (Yusuf et al., 2016). Chemistry, part of science, can be a tool for students in studying oneself and the natural surroundings, as well as prospects for further development and implementing it in everyday life (Miftianah, 2017). Chemistry lessons have many important concepts that students must master in order to achieve the expected competencies. The expected competency is the ability to work on questions, understand theory and apply chemical concepts in everyday life (Atminiati & Binadja, 2017). To make it easier to apply and implement chemical concepts in learning, teaching materials are needed.

Teaching materials are external factors for students that can increase students' learning motivation. This is reinforced by the opinion of Djamarah (2005) that basic teaching materials accompanied by supporting learning materials will help motivate students in learning. Apart from that, teaching materials are expected to help students learn independently (Hernawan et al, 2010). Student Worksheets (LKPD) are teaching materials that can help learning activities to form effective interactions between students and educators, so that they can increase student learning activities and student learning motivation (Muslimah, 2019).

Chemistry has abstract concepts (Mutia, 2021). Chemical equilibrium material is one of the abstract chemical concepts, this material is difficult for students to understand (Haryani, 2014). This difficulty is caused by a lack of ability to connect the three levels of representation during learning activities (Farida, 2013). According to Johnstone in Chitleborough (2004) chemical representation is divided into three levels, namely macroscopic, submicroscopic and symbolic levels. Based on this, to help students understand the concept of chemistry learning, appropriate teaching materials are needed as a source of knowledge and reference material for students to learn chemistry (Marks, 1985; Hernawan et al, 2010). Chemistry learning activities can be included based on representation in LKPD. The representation contained in this LKPD can connect abstract things with concrete things, so that chemistry learning will be easier for students to understand conceptually.

Chemical equilibrium material is contained in the Basic Competency (KD) of the 2013 curriculum for class factors that influence the shift in the direction of equilibrium. To achieve KD above, students must go through steps such as designing, carrying out and concluding. In studying this material, students experience learning skills directly, develop a scientific attitude and other skills such as using tools, discovering concepts and solving problems. These skills are known as Science Process Skills (KPS) (Rustaman *et al* ., 2005).

KPS is a skill that focuses on the learning process to develop students' skills in understanding knowledge or concepts, discovering themselves, and developing desired facts and values (Kane *et al* ., 2016). This KPS can be used to improve students' thinking abilities so that they can help discover material concepts and connect new information with old information to create meaningful relationships between facts (Minasari *et al* .,

2020; Suryaningsih, 2017). Therefore, KPS is one aspect of skills that needs to be developed for students.

However, KPS in Indonesia is still not ideal and is relatively low, this is based on studies regarding the cognitive abilities of students, namely according to TIMSS (Trends in Mathematics and science study) held by the IEA (International Association for the Evaluation of Educational Achievement), in In 2015, Indonesia received a score of 397 at rank 44 out of 47 participating countries (Martin et al ., 2016). Study report from the Program for international student assessment (PISA) organized by the Organization for economic cooperation and development (OECD) stated that in 2018 Indonesia was ranked 71st out of 79 countries (OECD, 2019). The facts found were based on the results of interviews with chemistry teachers at SMA Negeri 14 Bandarlampung. The learning method used by the teacher, namely the teacher center, did not carry out practical activities in chemistry learning, and also did not apply questions that required observing, classifying, and predicting skills. , measure, conclude, and communicate.

Based on the explanation above, a learning model is needed that can increase students' KPS. The learning model that is thought to be able to create student activity by discovering for themselves so that they can develop science process skills is the discovery learning model . The discovery learning model is a learning model that emphasizes Self Directed Learning , with the aim of creating an active learning atmosphere by directing students to discover concepts, information, and be able to solve the problems they face which includes strategic steps such as stimulation, problem identification , collecting data, processing data, proving and drawing conclusions (Hosnan, 2014). This series of steps in learning activities in this model allows students to face a problem and systematically find a solution to the problem using the scientific process (Bruner, 1977). According to Balim (2009), the steps in the discovery learning model can increase the success of students and KPS. The steps for this discovery learning model are included in the LKPD.

Several relevant studies regarding learning using the discovery learning model , research conducted by Rijal (2018) states that the discovery learning model has a significant effect on students' KPS. Apart from that, according to Irmita et al (2014) learning using the discovery learning model is effective in improving students' evaluation skills on chemical equilibrium material.

In this article, we will describe the effectiveness of chemical representation based LKPD with discovery learning models in improving science process skills on chemical equilibrium material.

- **METHOD**

The method used in this research is quasi-experimental with the research design The Matching Only Pretest-Posttest Control Group Design (Fraenkel et al, 2012). The population in this study were all students in class XI Science at SMA 14 Bandarlampung for the 2022/2023 academic year.

Sampling was carried out using a purposive sampling technique. The samples in this research were class XI IPA 6 as an experimental class with learning using LKPD based on chemical representations with a discovery learning model and

The variable in this research, namely the independent variable, is the LKPD used, namely the use of LKPD based on chemical representations in the experimental class and learning using LKPD not based on chemical representations in the control class. The

dependent variable is students' KPS. The control variables are discovery learning learning material and material on factors that influence the direction of chemical equilibrium.

The instruments in the research were test questions in the form of pretests and posttests to measure students' KPS, LKPD based on chemical representations in the experimental class and LKPD not based on chemical representations, scientific attitude observation sheets. The validity of the instrument is carried out by means of judgment.

The data analysis carried out in this research is quantitative data which includes calculating student grades and n-gain calculations. According to Hake (1998), the n-gain classification is e" 0.7; 0.3 d" < 0.7; g < 0.3 corresponds to high, medium, and low.

Calculation of student n-gain using the formula according to Hake (1999) as follows:

$$< g > = \frac{\text{postest value} - \text{pretest value}}{\text{ideal value} - \text{pretest value}}$$

Hypothesis testing in this research uses a difference test between two means. Before testing the difference between two means, a normality test and homogeneity test are carried out first. Data testing in this study used the SPSS 25.0 program. With the following hypothesis

Hypothesis 1.

H_0 : both samples come from a normally distributed population.

H_1 : both samples come from populations that are not normally distributed

Hypothesis 2.

H_0 : both research samples have a homogeneous population.

H_1 : both research samples have populations that are not homogeneous.

Hypothesis 3.

H_0 : The average KPS pretest score of students in the experimental class is the same as the average KPS pretest score of students in the control class on factors that influence the direction of equilibrium.

H_1 : The average KPS pretest score of students in the experimental class is not the same as the average KPS pretest score of students in the control class on factors that influence the direction of equilibrium.

Hypothesis 4.

H_0 : The average KPS n-gain value of students in the experimental class is lower or the same as the average KPS n-gain value of students in the control class.

H_1 : The average KPS n-gain value of students in the experimental class is higher than the average KPS n-gain value of students in the control class.

Student activities observed in the learning process were answering questions, asking the teacher, collaborating or discussing with groups, and responding to presentations from other groups which were analyzed using descriptive analysis.

• RESULTS AND DISCUSSION

Based on the research that has been carried out, data was obtained in the form of pretest and posttest KPS scores of students in the experimental class and control class which are presented in Figure 1

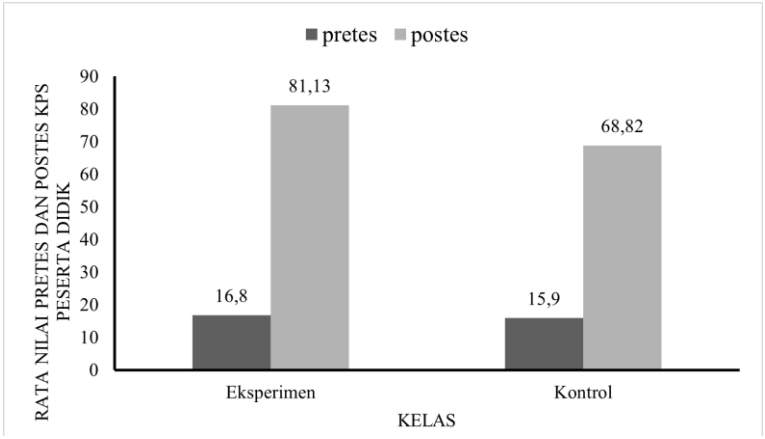

Figure 1. Average KPS pretest and posttest scores of students in the experimental class and control class.

Based on Figure 1, the average post-test score of students in the experimental class was greater than the control class, this shows that in the experimental class and control class there was an increase after being given treatment. To determine that the initial KPS for the two classes is the same, a similarity test of the two averages is carried out using the *independent sample t-test.* Before testing the equality of two means, a normality test was carried out with the following results:

Table 1. Normality test results of students KPS pretest scores

Class	Sig.	Test Criteria	Information
Control	0.192	Accept H_0 if sig. > 0.05	Accept H_0
Experiment	0.200		Accept H_0

In Table 1 it can be seen that the value is significant in the control class and experimental class is greater than 0.05. Based on the test criteria, it can be concluded that H_0 is accepted, meaning that both research samples come from a normally distributed population. that significance is greater than 0.05. The results of the homogeneity test obtained a significant value of 0.251, where significance was greater than 0.05. Based on the test criteria, it can be concluded that accepting H_0 means that the control class and experimental class have homogeneous variances.

After carrying out normality and homogeneity tests, it was found that the data were normally distributed and homogeneous, then the statistical test used to test the similarity of two averages was the Independent Samples t-Test. A significant value was obtained of 0.752, where the significance was greater than 0.05. Based on the test criteria, it can be concluded that accepting H_0 means that the average KPS pretest score of students in the experimental class is significantly the same as the average KPS pretest score of students in the control class.

The average n-gain KPS of students in the experimental class and control class is presented in Figure 2.

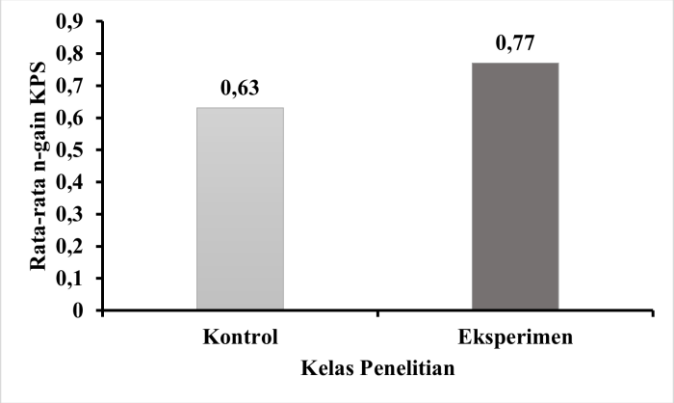

Figure 1. Average n-gain KPS of students in the experimental class and control class

The normality test on the average n-gain KPS of students in the experimental class was carried out with SPSS 25.0, with the acceptance test criterion H_0 if sig. > 0.05, a significant value is obtained for KPS students in the experimental class is presented in Table 2.

Table 2. Normality test results for students' average n-gain KPS

Class	Sig.	Test Criteria	Information
Control	0.200	Accept H_0 if	Accept H_0
Experiment	0.200	sig. > 0.05	Accept H_0

In Table 2, it can be seen that the significant KPS value obtained by students in the experimental class and in the control class was greater than 0.05. Based on the test criteria, the test results accept H_0, which means the average n-gain of the two classes comes from a normally distributed population. The homogeneity test is used to determine whether the two classes have homogeneous variances. The data from the homogeneity test results for the average KPS n-gain obtained an n-gain value of 0.162. Based on the results of homogeneity test calculations on the average KPS n-gain, a significant value was obtained greater than 0.05. Based on the test criteria, it can be concluded that accepting H_0 means that the average n-gain of the control class and experimental class has a homogeneous variance.

The results of the normality test and homogeneity test showed that the two research classes came from populations that were normally distributed and had homogeneous variances, so a difference test of two means was carried out using the parametric Independent Samples t- Test . This test has an acceptance test criterion of H_0 if sig. > 0.05. Data from calculating the difference between the two average n-gains of students shows a value of 0.000, which is smaller than 0.05. Based on the test criteria, it can be seen that the average n-gain in both classes rejects H_0 and accepts H_1, meaning that the average n-gain KPS of students in the experimental class is significantly different from the average n-gain in the control class. Based on data analysis, it shows that LKPD based on chemical representation with a discovery learning model is effective in increasing students' KPS.

Student activity data

The percentage of student activity in the experimental class and the percentage of aspects of their activity data can be seen in Figure 3 and Figure 4.

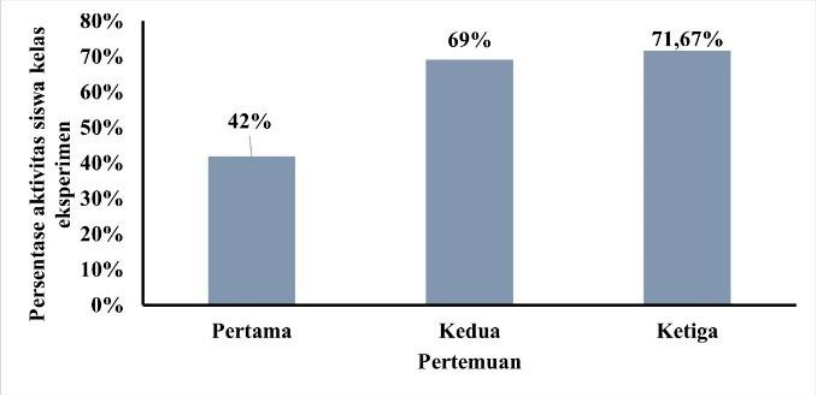

Figure 3. Percentage of student activity in all meetings in the experimental class

In Figure 3, it can be seen that the percentage of students' activity scores in the experimental class at the first meeting was in the poor category, the second meeting was in the good category and the third meeting was in the medium category. Based on this data, it shows that the percentage of student activity was highest at the third meeting.

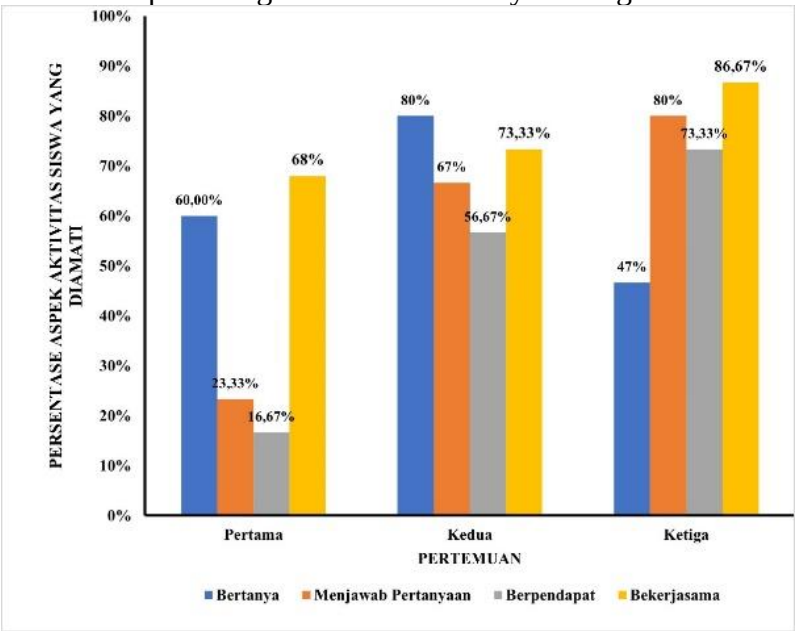

Figure 4. Aspects of student activities at each meeting in the experimental class

Stage 1 stimulation

The first stage in the discovery learning model is stimulation, the teacher raises discourse regarding material factors that influence shifts in the direction of chemical equilibrium. This is done to raise problems and foster students' curiosity and interest in being involved in problem solving. At this stage, the KPS students are trained in is observing. This results in students being able to observe the information provided.

Stage 2: problem statement

In the next stage, namely problem statement, students write down the problems found in the discourse. After finding a problem, students learn to formulate questions. At this stage the teacher can practice how to formulate questions correctly based on discourse. At this stage, the KPS students are trained in is preparing hypotheses.

Stage 3 data collection

The next stage is data collection, students collect data through experiments and/or search for information relevant to the problem formulation through books and the internet then write the data on the LKPD. Most of the stages of collecting data in this learning are carried out by conducting experiments in the laboratory or by analyzing the submicroscopic images or animations provided, so that students can train students to be thorough, honest, responsible and work together. The PPP that can be trained at this stage is observing, designing experiments, and measuring.

Stage 4 data processing

The teacher continues learning to the next stage, namely data processing . At this stage the teacher guides students in processing data from the results of experiments that have been carried out. Students discuss in their groups to answer the questions contained in the LKPD, so that answers to problems are found. At this stage KPS that can be trained to students is the skill of interpreting data.

Stage 5 verification

At the verification stage, students carry out careful examinations to prove whether the stated hypothesis is true or not, then connect it with the results of data processing. Students are given the freedom to process all the information they get and relate it to the students' initial knowledge, so that this process leads students to develop skills in using arguments to solve problems. At this stage students can prove that the hypothesis created is correct based on the processed data.

Stage 6 generalization

The next stage is generalization (drawing conclusions). At this stage students are asked to draw conclusions from the knowledge they have gained and have proven, then communicate the results to other students. At this stage students will be trained to draw conclusions or generate skills according to the results of observations and experiments at the learning stages of discovery learning. When drawing conclusions, students practice KPS skills, namely draw conclusions or inferences.

Based on the discussion above and the results of observing student activities, it can be seen that during the process of working on LKPD, students work by collaborating or discussing with their group friends and then providing opinions from the results of the discussion. It was found that at the first meeting the percentage of student activity had medium criteria with a figure of 42%, while at the second and third meetings the high criteria were obtained with figures of 69% and 71.67%. Often students experience problems in working on LKPD and then ask the teacher about things related to LKPD, then the teacher answers and/or asks questions related to the things asked to stimulate students' knowledge. Student activity increases at each meeting, indicating that learning using LKPD based on chemical representations with the discovery learning model is effective in increasing students' KPS. This is also supported by research by Rijal (2018)

which states that the discovery learning model has a significant effect on students' KPS. Apart from that, the results of research conducted by Utari et al (2017) concluded that animated chemical representation media was able to improve the ability to represent material on factors that influence shifts in equilibrium.

Aspects of student activity tend to increase with each meeting. The questioning aspect at the first meeting had a high criterion of 60%. At the second meeting it had increased to a very high criterion of 80%. This is because students find it difficult to observe the submicroscopic level given by the teacher which raises many questions from students. Meanwhile, the questioning aspect at the third meeting decreased to 47% with moderate criteria, this was because students were used to using chemical representation-based LKPD with the discovery learning model. The attitude aspect of answering students' questions at the first meeting was 23.33% with low criteria, at the second meeting it was high criteria with a percentage of 67% and very high criteria at the third meeting with a percentage of 80%. It can be seen that the aspect of answering questions increases at each meeting, which indicates that students have the courage to answer questions from the teacher. Students' communicative attitudes also continued to increase, with the first meeting having very low criteria with a percentage of 16.67% then increasing at the second meeting with a percentage of 56.67% with medium criteria and again increasing at the third meeting 73.44% with high criteria. This means that students have the courage to have deep opinions convey their ideas according to the learning material. Then finally, the cooperative attitude aspect increased at the first second and third meetings with percentages and criteria respectively 68% (high), 73.33% (high), and 86.67% (very high). This means that students have collaborated when conducting discussions and solving problems well.

An increase in every aspect of student activity means that in this learning students feel helped by the existence of a chemical representation level that can visualize submicroscopic conditions, so that students find it easier to understand the material on factors that influence shifts in the direction of chemical equilibrium. Students are also more likely to remember the material because students are not only asked to memorize but students are guided in finding their own concepts which are then reinforced by the teacher.

• CONCLUSION

Based on the research that has been carried out, it is concluded that the LKPD based on chemical representations with a *discovery learning model* is effective in increasing students' KPS in material on factors that influence shifts in the direction of chemical equilibrium This is indicated by the significant difference in average n-gain between the experimental class and the control class.

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