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ARTICLE

The Effectiveness of the Basic Chemistry Law LKPD Based on Guided Inquiry Learning on Student Learning Outcomes in Phase E of SMA/MA

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ABSTRACT
The basic chemistry law material is one of the abstract and difficult to understand chemistry topics for students. Therefore, instructional materials are needed to enhance understanding and learning outcomes for students using LKPD based on Guided Inquiry Learning. The purpose of this study is to test the effectiveness of using LKPD instructional materials based on Guided Inquiry Learning for the basic chemistry law material on the learning outcomes of Phase E students in class X at SMA N 1 Gunung Talang. This research is a quasi-experiment. The study uses a Non-equivalent Control Group Design. The population in this study is all students in class X at SMA N 1 Gunung Talang in the even semester of the 2023/2024 academic year. The sampling technique was conducted using purposive sampling method. The research instrument consisted of a multiple-choice test that has been validated for validity, reliability, item discrimination, and good difficulty index. The data were analyzed using N-Gain test and hypothesis testing with independent sample t-test. The data analysis results indicate that the experimental group has a higher N-Gain compared to the control group in the moderate category. Additionally, the hypothesis testing results show that the t_{count} value is greater than the t_{table} value, so that, H0 is rejected. From these data analysis results, it can be concluded that the using LKPD based on Guided Inquiry Learning in basic chemistry law material is effective in improving student learning outcomes.

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1. Introduction

The independent curriculum can enhance literacy, understanding, creativity, and communication [1]. Effective curriculum development is essential to achieving educational goals. The independent curriculum has been started in Indonesia as an effort to improve the quality of learning in schools. This policy uses a different curriculum approach that focuses on student empowerment and the development of skills appropriate to the modern world [2][3][4]. The fundamental principles of chemistry are one of the topics studied in the independent curriculum. The material of the basic laws of chemistry is very important because it is a basic concept that students must understand to understand the next material, such as chemical calculations related to the concept of moles. Because students learn abstract, concrete, and mathematical concepts in this material, they find this material difficult. The characteristics of the basic law of chemistry material are not in accordance with the way the teacher lectures, because students only listen, record, and memorize the material.

Based on the results of a questionnaire with students of SMAN 1 Gunung Talang, information was obtained that 83,33% of students considered the basic laws of chemistry as difficult material. Due to uninteresting teaching methods for students, this material can cause them to feel bored, tired, and sleepy. This leads to an inactive learning process [5]. As a result, students often face difficulties, wrong concepts, and their memories of the material will not be well embedded so students must be very involved in learning activities to understand this material [6]. However, students often extrapolate from one basic law of chemistry to another [7]. Teaching materials are a tool to help the learning process and clarify the meaning in the delivery of learning materials [8]. The selection of teaching materials and inappropriate teaching methods can also hinder the achievement of learning objectives, especially in the basic chemistry law material, which results in low student learning outcomes. To effectively and efficiently learn chemistry, supporting teaching aids are necessary [9]. Based on the questionnaire results with students from SMAN 1 Gunung Talang, it was found that 86,6% of students require more engaging teaching materials to prevent monotony in learning. One type of teaching material is the Student Worksheets (LKPD).

The LKPD contains materials, reading summaries, and instructions for completing learning tasks for students based on the basic competencies they must achieve [10]. Supported by the statement of Aini et al (2019), the teaching material that can make learning active and independent is the Student Worksheet (LKPD) [11]. The LKPD aims to enhance and deepen student's understanding of the material provided. This is because there are sections designed to provide motivation or interest through problems related to daily activities [12][13]. This activity sheet contains instructions or steps that must be followed by learners to complete certain tasks based on the basic competencies that must be achieved. As a result, LKPD can help students understand, remember, and use the information they learn [14]. By using LKPD based on a scientific approach,

students are trained to analyze, think critically, and systematically in the learning process. This is an effort to improve student learning outcomes [15][16].

Many studies have shown that LKPD based on the guided inquiry learning model can assist teachers in delivering guided concepts. This is consistent with research by Nur Hamidah et al (2018), which states that guided inquiry learning-based LKPD has been proven effective in improving student learning outcomes [17]. The guided inquiry learning approach allows students to conduct investigations or experiments to discover concepts directly during the learning process and can enhance student engagement [18][19]. This guided inquiry learning approach involves students in the scientific process by investigating phenomena or concepts studied, asking questions, and producing empirical data [20][21][22]. Guided inquiry learning provides an opportunity for students to discover concepts and solve problems independently [23][24].

Based on this description, currently there are LKPD teaching materials based on the guided inquiry learning model on the basic law of chemistry material which is equipped with illustration or image characteristics and there is a barcode that makes it easier to use in the learning process and can help students understand the basic law of chemistry material [25]. Validity and practicality tests have been carried out on this basic law of chemistry LKPD, but effectiveness tests have not been carried out. So that, this LKPD has not been disseminated. Based on the interview results with the chemistry teacher from SMAN 1 Gunung Talang, it was found that the teacher has previously implemented the guided inquiry learning model. However, the teacher still relies on the textbook and has not yet incorporated the use of worksheets based on guided inquiry learning for teaching the fundamentals of chemistry.

Based on the explanation of the issue above, the author needs to conduct research with the title "The Effectiveness of Chemistry Basic Law LKPD Based on Guided Inquiry Learning on Student Learning Outcomes in Phase E of SMA/MA".

2. Research Method

This research was carried out at SMA N 1 Gunung Talang with a type of Quasi Experimental Research. The research design used is Non-equivalent Control Group Design. In the Non-equivalent Control Group Design, the samples in the experimental class and the control class were not randomly selected. In this study, there are two classes, each selected non-randomly, namely the experimental class and the control class. Pretests and posttests are conducted for each group. The sampling method chosen is based on specific considerations and recommendations from experts, thus referred to as purposive sampling technique. Based on the type and design of the research conducted, pretest and posttest were given to both classes. In the control class, learning was carried out as usual, while in the experimental class, learning was carried out using LKPD based on Guided Inquiry Learning [26].

The population in this study is all students of class X Phase E at SMA N 1 Gunung Talang in the even semester of the 2023/2024 school year. The sample in this study was taken using the Purposive Sampling technique so that it was obtained class X E 1 as an experimental class that was treated using LKPD teaching materials based on Guided Inquiry Learning and class X E 2 as a control class that was not treated using LKPD teaching materials based on Guided Inquiry Learning [26].

The variables used in this study are independent variables, bound variables and control. a). Independent/independent variables, namely variables that affect or become because of the change/occurrence of bound variables. In this study, the independent variable is learning using LKPD teaching materials based on Guided Inquiry Learning in the experimental class and learning as usual in the control class. b). Dependent/bound variables, namely variables that are influenced or consequential, because the existence of independent variables. In this study, the bound variable is the learning outcomes of students obtained from the results of the pretest and posstest in the experimental class and the control class. c). Control variables, namely variables that are controlled or made constant so that the influence of independent variables to the bound variable is not affected by external factors that are not studied. In this study the control variables must all be made the same, including the student's initial ability, materials, source books and time allocation, teachers who teach, and the type and number of questions tested [26].

The data used in this study is primary data obtained from student learning outcomes through written tests at the beginning and end of learning. The data sources in this study are students in the experimental class and the control class [26].

The instrument used in this study is a learning outcome test. The learning outcome test is an instrument used to measure the ability or mastery of a measuring object for a series of materials [27]. A learning outcome test is a series of questions or tasks used to assess and evaluate a person's ability to master the material discussed in a learning activity within a certain period of time. The test was carried out on two sample classes.

The type of questions used in this test are multiple-choice questions that have been adjusted. The questions used in this study have been tested for validity, reliability, question discrimination and the level of difficulty of the questions. Research on learning outcomes was carried out by giving a pretest at the first meeting and a posttest at the last meeting using a multiple-choice test with five answer choices. Data analysis was carried out by the N-Gain test. The N-Gain test uses pretest and posttest results that can be analyzed by comparing the first and final test scores in both sample classes. There are 3 categories of interpretation of N-Gain score. First, namely the high category with a score of $g \geq 0,7$. Second, namely the medium category with a value of $0,7 > g > 0,3$. Third, namely the low category with a value of $g \leq 0,3$ [28].

To prove the truth about the alleged value of the parameter (hypothesis), a hypothesis test is carried out. To validate a hypothesis, it is necessary to analyze and utilize the processed data (either from the population or a sample) as a basis for making informed decisions regarding hypothesis validation. Before testing the hypothesis, the data obtained must first be tested for homogeneity

and normality. To test normality, the Lilliefors test was used with a real level of 0.05. If, $L_{count} < L_{table}$, then the data is normally distributed. Whereas if $L_{count} > L_{table}$, then the data is not normally distributed. Then, the homogeneity test was carried out with the F test. The F test was carried out by comparing the F_{count} value with the F_{table} value contained in the F distribution list with a significance level of 5%. If the F_{count} value is smaller than F_{table} (Fc < Ft), it means that the two groups have a homogeneous variance and vice versa [29].

After obtaining data that was typically distributed and has a homogeneous variance, the hypothesis test that was applied was the t-test or independent sample t-test. If $t_{count} > t_{table}$, then H_0 is rejected and vice versa. The steps of this research are shown in the research flowchart below.

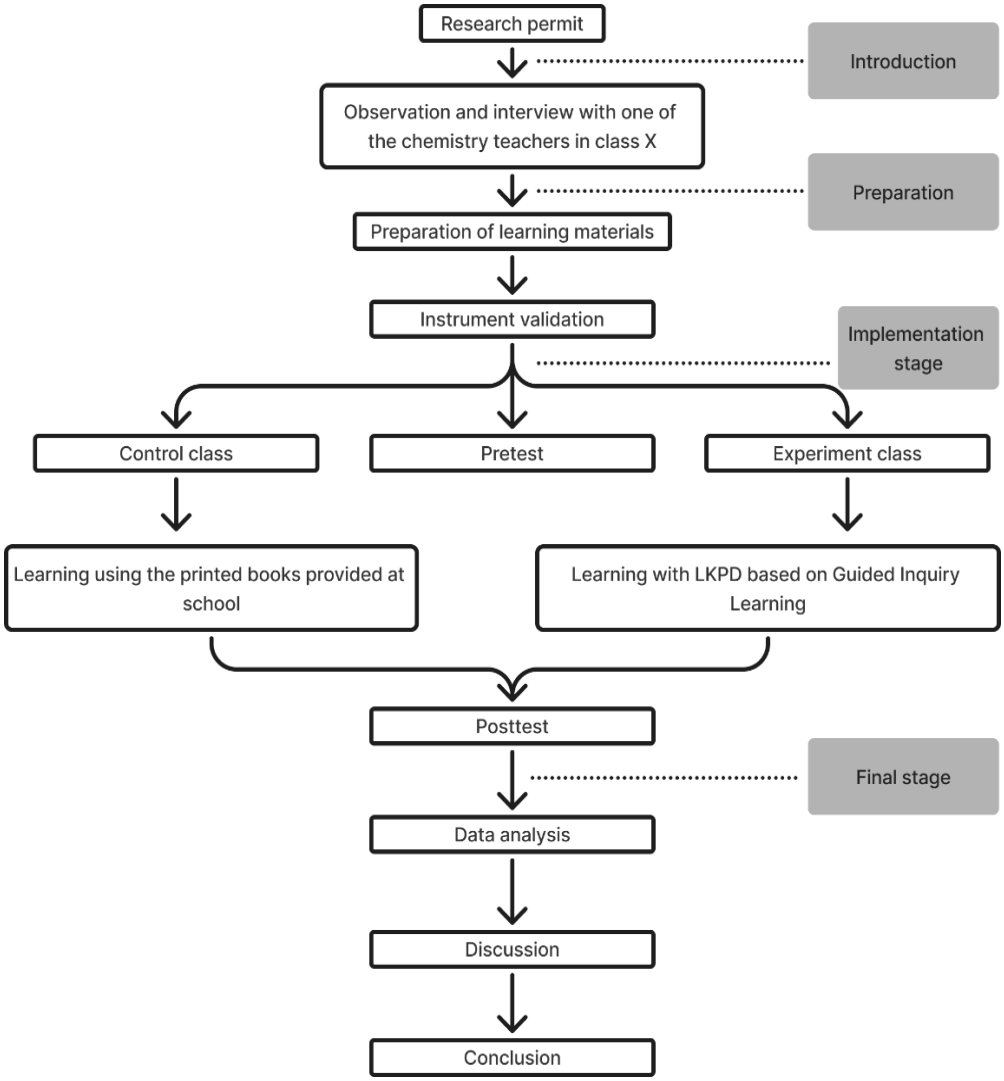

Figure 1. Research flow chart

3. Results and Discussion

3.1 Learning Outcomes

Before conducting the learning using the LKPD based on Guided Inquiry Learning for the topic of basic chemistry laws, the students first take a pretest. During the pretest, the students appear confused as they have not yet understood the material. After completing the pretest, the researcher divides the students into several groups. The grouping process goes smoothly, and the students sit according to their respective groups. Following that, the researcher provides instructions regarding the learning process using the LKPD based on Guided Inquiry Learning for the topic of basic chemistry laws.

The use of instructional media in the learning process can enhance the effectiveness and quality of student learning outcomes. In addition, the use of instructional media can increase student's interest and motivation, encourage their participation in learning activities, and have a psychological effect on students [30]. It is hoped that the Student Activity Sheets (LKPD) will help students understand the lessons. The improvement in student's mastery of material who receive instruction using LKPD media is better than the improvement in students' mastery of material who receive instruction without LKPD media [31].

Based on research that has been conducted at SMA N 1 Gunung Talang, the learning outcomes of students on cognitive competence were obtained. Pretest aims to find out the initial ability of students. In summary, the results of the pretest of students in the experimental class and control class can be seen in Table 1.

Table 1. Average Pretest of Experimental Class and Control Class

Class	Samples Total	Average Pretest
Experiment	34	37.64
Control	34	37.41

After being given a pretest, learning about the Basic Laws of Chemistry material was carried out in the experimental class and control class. The final test (posttest) is given at the end of the learning process which aims to find out the learning outcomes of students after being given treatment. In summary, the average posttest of students in the experimental class and the control class can be seen in Table 2.

Table 2. Average Posttest of Experimental Class and Control Class

Class	Samples Total	Average Posttest
Experiment	34	77.06
Control	34	70.71

3.2 Data Analysis

The data obtained from the pretest and posttest scores were processed and analyzed to draw conclusions. Before conducting data analysis, the pretest results and posttest results from the experimental class and control class were first tested for normality and homogeneity. Furthermore, data analysis techniques were carried out in this study, namely the two-mean similarity test (t-test) to find out the difference in learning outcomes between the experimental and control classes, the N-Gain test to determine the increase in understanding before and after learning and the percentage of learning completeness to find out what percentage of students achieved a score above the minimum completeness criteria.

a. Normality Test

The normality test uses the Liliefors test with the criterion of taking decision when Lc < Lt at a real level of $\alpha = 0,05$. Based on the results of the pretest, the normality test of the experimental class and the control class was obtained as seen in Table 3.

Table 3. Results of the Pretest Normality Test of the Experimental Class and Control Class

Class	α	N	L_{count}	L_{table}	Conclusion
Experiment	0.05	34	0.077	0.151	Data distribute
Control	0.05	34	0.102	0.151	normally

Furthermore, the results of the posttest normality test of the experimental class and control class can be seen in Table 4.

Table 4. Results of Posttest Normality Test for Experimental Class and Control Class

Kelas	A	N	L_{count}	L_{table}	Conclusion
Eksperimen	0.05	34	0.110	0.151	Data distribute
Kontrol	0.05	34	0.123	0.151	normally

b. Homogeneity Test

The homogeneity test was carried out using the F test with the decision-making criteria when $F_{count} < F_{table}$ at the real level of $\alpha = 0,05$. The results of the pretest homogeneity test of both the experimental class and the control class can be seen in Table 5.

Table 5. Results of Homogeneity Test Pretest for Experimental Class and Control Class

Class	S^2	N	F_{count}	F_{table}	Conclusion
Eksperiment	98.053	34	1.05	1.79	Homogeneous
Control	102.674	34			data

Furthermore, the results of the posttest homogeneity test of the experimental class and the control class can be seen in Table 6.

Table 6. Results of Posttest Homogeneity Test for Experimental Class and Control Class

Class	S^2	N	F_{count}	F_{table}	Conclusion
Experiment	112.784	34	1.23	1.79	Homogeneous
Control	91.85	34			data

c. Hypothesis Test (t-Test)

The decision-making criterion is at the real level $\alpha = 0.05$ accept H_0 if $t_{count} < t_{table}$ where t_{table} is obtained from the list of t distributions with dk = (n1 + n2 - 2) and the opportunity (1 - α). Based on the results of data analysis, a hypothesis test was obtained on the student's initial ability (pretest) which can be seen in Table 7.

Table 7. Results of the Pretest Hypothesis Test of the Experimental Class and Control Class

Class	N	X Mean	S^2	T_{count}	T_{table}
Experiment	34	37.64	98.05	0.097	2
Control	34	37.41	102.67		

Furthermore, the hypothesis test on student learning outcomes (posttest) can be seen in Table 8.

Table 8. Results of Posttest Hypothesis Test for Experimental Class and Control Class

Class	N	*X*	S^2	T_{count}	T_{table}
Experiment	34	77.06	112.78	2.59	2
Control	34	70.71	91.85		

d. N-Gain Test

The N-Gain test aims to determine the increase that occurs before and after learning based on the pretest and posttest scores in the experimental class and control class. The average results of the N-Gain test can be seen in Table 9.

Table 9. N-Gain Test Results of Experimental Class and Control Class

Class	N-Gain Average	Criteria
Experiment	0.623	Medium
Control	0.490	Medium

e. Learning Completion Percentage

The difference in student learning outcomes in the experimental class and the control class can also be seen from the percentage of learning completion. The percentage of completeness was used to determine the completeness of student learning outcomes in both sample classes for the use of LKPD based on Guided Inquiry Learning. Based on the KKM score at SMA N 1 Gunung Talang which is 73, so the percentage of learning completeness of the sample class can be seen in Table 10.

Table 10. Percentage of Learning Completeness in Experimental Class and Control Class

Class	Samples Total	Total Students who Completed	Completeness Percentage
Experiment	34	25	73.52%
Control	34	11	32.35%

3.3 Discussions

The learning outcomes of students in the experimental class and the control class before being treated in Table 1 showed the student's initial ability, where the average of the experimental class was 37,64 and the average of the control class was 37,41. The average score of the pretest showed that both sample classes had the same starting ability. The same initial ability is a variable that researchers must control in this study. Posttest is carried out to find out the learning outcomes of students after being given treatment. The posttest scores in each experimental class and control class can be seen in Table 2, where the average posttest score of the experimental class is 77,06 and the control class is 70,71. This is in line with the research by Nur Hamidah et al (2018), which was proven by the increase in average pretest and posttest scores, indicating that the developed LKPD is effective in improving student learning outcomes [17].

This is because in consolidating the concept in the experimental class, students use LKPD teaching materials based on Guided Inquiry Learning so that students participate and are motivated in learning. By using LKPD, students will be fully involved in the learning process. Unlike the control class, to solidify the concept, students do not use LKPD based on Guided Inquiry Learning but only use printed books so that students participate less when given questions. The data obtained from the pretest and posttest scores is processed and analyzed to draw conclusions. Conclusions are drawn using the test of equality of two means (t-test) and the N-Gain test, with the prerequisite of first conducting tests for normality and homogeneity.

Testing for normality aims to determine whether the learning outcomes in the experimental class and the control class are normally distributed or not. Normality testing is conducted using the Liliefors test. Table 3 shows that the value of $L_o < L_t$ at a significance level of $\alpha = 0,05$. This means that the pretest data for the experimental and control groups are normally distributed. Table 4 shows that the value of $L_o < L_t$ at a significant level of $\alpha = 0,05$. This means that the learning outcomes of the experimental group and the control group are normally distributed. Next, a homogeneity test was carried out.

The homogeneity test aims to determine whether the learning outcomes in the experimental class and the control class have homogenous variances or not. The homogeneity test is conducted using the F-test. Table 5 shows that the experimental class and the control class have $F_{count} < F_{table}$ at the real level of 0,05. This means that the data of the pretest results in the experimental class and the control class have homogeneous variances. Table 6 shows that the experimental class and the control class have $F_{count} < F_{tabel}$ at the real level $\alpha = 0,05$. This means that the posttest data in the experimental class and the control class have a homogeneous variance.

Based on the results of the normality test and homogeneity test, it is shown that the learning outcomes data from the experimental class and the control class are normally distributed and have homogeneous variances. Therefore, to test the hypothesis, a t-test for equality of means is conducted. Table 7 shows that the value of $t_{count} < t_{table}$, then H_0 is accepted. This shows that there is no difference in learning outcomes between the experimental class and the control class. Table

8 shows that the $t_{count} > t_{table}$, then H_0 is rejected. This shows that there is a difference in the learning outcomes of the experimental class and the control class, where the learning outcomes of the experimental class are higher than the learning outcomes of the control class. This research is in line with the study conducted by Pramudiyanti et al (2024) which shows that $t_{count} > t_{table}$ indicates that inquiry-based LKPD is proven to effectively improve student learning outcomes [32].

After that, the N-Gain test is conducted The N-Gain test aims to determine the improvement that occurs before and after learning based on pretest and posttest scores in the experimental and control classes. Based on the data in Table 9, the experimental class had an average N-Gain of 0,623 with a medium category compared to the control class which had an average N-Gain of 0,490 with a moderate category. It can be seen that there is a significant difference between the average N-Gain of the two classes. This shows that there is an increase in student's cognitive learning outcomes in the experimental class that uses LKPD based on Guided Inquiry Learning better than the control class. This is in line with the research by Zulfa et al (2024), which found that the N-gain value in the experimental class is higher than that in the control class [33].

After that, the percentage of learning achievement is calculated. The percentage of achievement aims to determine the level of student learning achievement in the experimental class and the control class regarding the use of LKPD based on Guided Inquiry Learning in the topic of basic chemistry laws. Based on the Minimum Achievement Criteria (KKTP) at SMA N 1 Gunung Talang, it is 73. In Table 10, it can be seen that the experimental class has 25 students who complete the posttest so that the percentage of learning completion is 73,52% with the good category, while in the control class the number of students who complete the test is 11 people so that the percentage of learning completion is 32,35% with the poor category.

Based on the presented data, it can be said that the developed teaching materials (LKPD) have been effective in supporting learning. In addition, students claim that using LKPD in the learning process helps alleviate boredom, so it is advisable to use LKPD that has been tested for its effectiveness [34]. Furthermore, the Inquiry-based LKPD, which encourages students to discover concepts on their own based on the material they have learned, aligns with the research by Zulfa et al (2024). This is because in the teaching and learning process, which is often perceived as monotonous and lacking motivation in science education for students, the use of effective LKPD teaching materials becomes crucial [33].

Overall, this research concludes that the use of Student Worksheets (LKPD) based on guided inquiry learning is effective in improving student learning outcomes at SMA N 1 Gunung Talang. This finding contributes significantly to the development of more effective and innovative learning models in education. Based on this research, better learning strategies can be designed for the future, especially to enhance student understanding and achievement. Therefore, the implementation of guided inquiry learning-based LKPD can be considered a suitable and effective step in improving student learning outcomes.

4. Conclusion

Based on the research results, it can be concluded that the use of instructional materials based on Guided Inquiry Learning in the topic of basic chemical laws effectively improves the learning outcomes of students in Class X Phase E at SMA N 1 Gunung Talang. The improvement in learning outcomes for the experimental group using Guided Inquiry Learning-based instructional materials on basic chemical laws is significantly higher than the control group. Additionally, the learning achievement percentage for the experimental group 73,52% is significantly higher than the control group 32,35%, demonstrating the effectiveness of using Guided Inquiry Learning instructional materials.

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