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The Effect of Using Student Worksheets on Student Learning Outcomes in Cross-Interest Chemistry Subjects

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Abstract: The Effect of Using Student Worksheets on Student Learning Outcomes in Cross-Interest Chemistry Subjects. This research aims to find out whether there is a significant influence from the use of Student Worksheets on student learning outcomes in cross-interest chemistry subjects in class X of SMA Negeri 2 Indralaya Utara. In this study, it was divided into two classes into an experimental group (with Lavoisier LKPD with KPS) and control (normal LKPD). The data collection technique used consists of two main methods, namely the learning outcome test and the observation sheet. It was concluded that the use of Student Worksheets based on the Law of Lavoisier oriented Science Process Skills had a significant effect on student learning outcomes in cross-interest Chemistry subjects in class X of SMA Negeri 2 Indralaya Utara. This was proven through the results of the Independent Samples T-Test which showed a significance value of 0.002 (< 0.05). These findings indicate that KPS-oriented LKPD is effective in increasing student active involvement, conceptual understanding, and achieving more optimal learning outcomes in accordance with the learning objectives of the Independent Curriculum.

Keywords: Effect LKPD, Cross-Interest Chemistry, and Student Worksheets (LKPD).

Abstrak: Pengaruh Penggunaan Lembar Kerja Peserta Didik Terhadap Hasil Belajar Siswa pada Mata Pelajaran Kimia Lintas Minat. *Penelitian ini bertujuan untuk mengetahui apakah terdapat pengaruh yang signifikan dari penggunaan Lembar Kerja Peserta Didik terhadap hasil belajar siswa pada mata pelajaran kimia lintas minat di kelas X SMA Negeri 2 Indralaya Utara. Dalam penelitian ini, dibagi dua kelas menjadi kelompok eksperimen (dengan LKPD Lavoisier dengan KPS) dan kontrol (LKPD biasa). Teknik pengumpulan data yang digunakan terdiri dari dua metode utama, yaitu tes hasil belajar dan lembar observasi. Disimpulkan bahwa penggunaan Lembar Kerja Peserta Didik berbasis Hukum Lavoisier berorientasi Keterampilan Proses Sains berpengaruh signifikan terhadap hasil belajar siswa pada mata pelajaran Kimia lintas minat di kelas X SMA Negeri 2 Indralaya Utara. Hal ini dibuktikan melalui hasil uji Independent Samples T-Test yang menunjukkan nilai signifikansi sebesar 0,002 (< 0,05). Temuan ini mengindikasikan bahwa LKPD berorientasi KPS efektif dalam meningkatkan keterlibatan aktif siswa, pemahaman konseptual, serta pencapaian hasil belajar yang lebih optimal sesuai dengan tujuan pembelajaran pada Kurikulum Merdeka.*

Kata kunci: *Pengaruh LKPD, Kimia Lintas Minat, dan Lembar Kerja Peserta Didik (LKPD).*

INTRODUCTION

One important indicator for assessing the success of education is student learning outcomes. Learning outcomes are changes in knowledge, attitudes, and skills that occur after going through the learning process (Sudjana, 2017). However, learning outcomes in science, particularly chemistry, still face various challenges at both the global and national levels. Chemistry, as a branch of science, requires a deep conceptual understanding and the ability to relate abstract concepts to real phenomena. This complexity often poses an obstacle for students, especially in the subject of Chemistry for Non-Science Students (Majid, 2018).

Interdisciplinary Chemistry is an elective subject for non-science students who are still interested in studying chemistry to support other fields of study. However, most interdisciplinary students do not have a strong background in science, making it difficult for them to understand concepts, perform analyses, and solve science-based problems (Prastowo, 2022). In addition to impacting academic achievement, this also hinders the development of critical thinking skills and students' readiness for the world of work and technology-based higher education (National Research Council, 2020).

This situation illustrates a research and practice gap, namely, between the ideal of active, science-based learning and actual practice in the field, which remains conventional and teacher-centered. Therefore, innovation in learning strategies and media is needed to increase student engagement and strengthen conceptual understanding, especially in the Cross-Interest Chemistry subject.

Therefore, innovation in learning strategies and media is needed to increase student engagement and strengthen conceptual understanding, especially in Cross-Interest Chemistry. One potential alternative is the use of Student Worksheets (LKPD) based on scientific activities. LWPs designed with a scientific approach can guide students to think analytically and systematically through exploration, inquiry, and problem-solving activities (Widodo & Jasmadi, 2020). Furthermore, according to the Ministry of Education, Culture, Research, and Technology (Kemdikbudristek, 2021), student worksheets (LKPD) developed based on scientific activities can increase learning motivation, deepen conceptual mastery, and foster higher-order thinking skills, which are essential for chemistry learning in the modern era.

Considering the urgency of low chemistry learning outcomes, limited active student involvement in learning, and the pedagogical potential of scientific activity-based LKPD in line with the Merdeka Curriculum, this research is necessary. This research is expected to make a concrete contribution to improving the quality of chemistry learning, supporting the implementation of a competency-based curriculum and 21st-century skills, and strengthening research-based learning practices in the Indonesian educational environment. Based on the background and problem identification, this study aims to determine whether there is a significant effect of the use of Student Worksheets (LKPD) on student learning outcomes in chemistry across interests in class X at SMA Negeri 2 Indralaya Utara.

▪ METHOD

This study uses a quantitative design with a quasi-experimental approach, which aims to test the relationship between the use of Student Worksheets (LKPD) and student learning outcomes in the Cross-Interest Chemistry subject with a Pretest-Posttest Control Group Design research design. The implementation of Student Worksheets (LKPD) is expected to address the problems frequently faced by students in chemistry, namely a lack of active involvement in the learning process and difficulty understanding abstract concepts (Yuliani & Hartono, 2020). This study will examine whether there is a significant relationship between the cause and effect of the two variables, namely the independent variable (X), which in this case is the use of LKPD, and the dependent variable (Y), which is student learning outcomes in chemistry.

The population of this study was all Grade X Science students at Indralaya State Senior High School 2 in the 2024/2025 academic year, consisting of 90 students divided evenly into three classes, namely Grade X Science 1, Grade X Science 2, and Grade X Science 3. This population was selected because all students studied Chemistry as a cross-interest subject. Sampling was conducted using cluster sampling technique, because the research subjects were naturally formed classes, not individual students. From the three available classes, two classes were randomly selected as research samples, namely one group as the experimental class (using KPS-based Lavoisier's Law LKPD) and one group as the control class (using conventional LKPD).

In this study, the data collection techniques used consisted of two main methods: learning outcome tests and observation sheets. Learning outcome tests are used to measure students' cognitive achievements after participating in the learning process using student worksheets. These tests aim to measure various cognitive aspects, from factual knowledge and conceptual understanding to application and analytical skills (Ananiadou, K & Claro, 2021). Meanwhile, an observation sheet contains notes related to the object being observed or investigated, arranged systematically, logically, objectively, and rationally. Observation sheets serve to obtain information on relevant variables with the goal of achieving the highest possible validity and reliability (Saavedra, A.R & Opfer, 2020).

Data Collection Techniques

The data collection techniques used consisted of two main methods, namely learning outcome tests and observation sheets. Both were systematically designed to support the analysis of the effect of using Student Worksheets (LKPD) on student learning outcomes in chemistry across different interests.

In this study, achievement tests were used to measure students' achievement levels after participating in Chemistry lessons using LKPD. These tests were designed in the form of 16 multiple-choice questions, with one correct answer from four options provided.

The observation sheet is one of the instruments used to collect data during observation or direct observation in the field. The results of this test were used to identify the effect of using LKPD on student learning outcomes. The test scores were then correlated with data from the questionnaire to analyse the relationship between the frequency and quality of LKPD use and student academic achievement in interdisciplinary chemistry.

Data Analysis Techniques

The data analysis technique in this study used a quantitative approach with the help of the latest version of the Statistical Package for the Social Sciences (SPSS) software. The analysis was carried out systematically to answer the research questions and test the hypotheses that had been set. The research sample consisted of 30 students, 15 students in the experimental group who used Student Worksheets (LKPD) based on Lavoisier's law, and 15 students in the control group who followed conventional learning. Data analysis in this study comprised four main stages. Normality testing was the initial stage in testing the prerequisites for parametric statistical analysis to ensure that the analysis procedures used, particularly parametric tests such as the t-test, could be applied validly. In this study, normality testing was conducted using the Shapiro-Wilk Test through SPSS software. This is because the sample size is less than 50. The implementation begins by entering the pretest and posttest data into SPSS, then selecting the Analyze → Descriptive Statistics → Explore menu. Next, the student learning outcome variable is entered into the Dependent List box, and the Normality plots with tests option is checked before the test is run. The test results will be displayed in the SPSS output, specifically in the significance value (Asymp. Sig. 2 tailed). The decision-making criteria are based on this value, where if the p-value is > 0.05, the data is considered to be normally distributed (H_0 is accepted), whereas if the p-value is ≤ 0.05, the data is not normally distributed (H_0 is rejected).

Variance homogeneity is one of the important prerequisites in applying the independenttwo-sample t-test. In this study, the homogeneity test was performed using Levene's Test for Equality of Variances, which can be accessed through the Analyze → Compare Means → Independent-Samples T Test menu in SPSS. After entering the learning outcome data as the Test Variable and the group variable as the Grouping Variable, the next step is to define the groups (for example, 1 for the experiment and 2 for the control), then run the analysis. The results of Levene's Test are displayed in the output, and interpretation is based on the significance value (Sig.). If the Sig. value is > 0.05, it is concluded that the variances between groups are homogeneous (H_0 is accepted). Conversely, if the Sig. value is ≤ 0.05, the variances are considered non-homogeneous (H_0 is rejected), which may affect the type of follow-up statistical test used. Mathematically, Levene's Test calculates the F value based on the absolute deviation from the median of each group, using the following formula. Homogeneity Test Formula (Levene's Test).

$$F = ((k-1)/(N-k)) \times [\Sigma_{i=1}^{k} \Sigma_{j=1}^{n_i} (Z_{ij} - Z_{i.})^2] / [\Sigma_{i=1}^{k} n_i (Z_{i.} - Z_{..})^2]$$

Explanation:

F: Levene's statistic k:

Number of groups

N: Total number of samples

Z_{ij}: Absolute value of the deviation from the median of group i for observation j

$Z_{i.}$: Mean deviation within group i

$Z_{..}$: Overall mean deviation

Where $Zij = |Yij - Yi\sim|$, which is the absolute difference between the jth value in the ith group and the median of that group. The value of Zi. is the average absolute deviation in the ith group, while Z.. is the overall average of all groups. This formula basically measures the extent to which the data spread from the median in each group differs from one another. If the variation between groups is relatively small compared to the variation within groups, the F calculation result will be low and indicate that the variance between groups is homogeneous.

Bivariate analysis in this study was conducted to determine whether there were significant differences between the two groups. This test was performed using SPSS by selecting the Analyze menu, then Compare Means, and selecting Independent-Samples T Test. The learning outcome variable was entered as the Test Variable, and the group was entered as the Grouping Variable, which was then defined with the appropriate code.

The analysis results will be displayed in the Sig. (2-tailed) section of the SPSS output. The results are interpreted with reference to this significance value. If Sig. (2-tailed) is < 0.05, then the null hypothesis (H_0) is rejected, which means that there is a significant difference in learning outcomes between students who use LKPD and those who do not. However, if the value is ≥ 0.05, then H_0 is accepted, indicating that the difference is not statistically significant. The type of test used is the independent samples t-test. The testing steps include:

a) Calculating the combined variance:

$$S^2 = [(n_1 - 1)S_1^2 + (n_2 - 1)S_2^2] / (n_1 + n_2 - 2)$$

b) Calculate the t- value:

$$t = (\bar{x}_1 - \bar{x}_2) / [S \times \sqrt{(1/n_1 + 1/n_2)}]$$

Explanation:
$\bar{x}_1$ = average learning outcome of the experimental class
$\bar{x}_2$ = average learning outcome of the control class
S = combined standard deviation
n_1 = number of students in the experimental class
n_2 = number of students in the control class
Decision criteria: Reject H_0 if t calculated > t table at a significance level of $\alpha = 0.05$, with degrees of freedom $df = n_1 + n_2 - 2$.

The statistical hypothesis in the null hypothesis (H_0) is that there is no significant effect between the use of Lavoisier's Law LKPD oriented towards science process skills and students' chemistry learning outcomes.

$$H_0: \mu_1 = \mu_2$$

(The average learning outcomes of students who use KPS-based LKPD are the same as the average of students who do not use KPS-based LKPD). Meanwhile, the alternative hypothesis (H_1) states that there is a significant effect between the use of Lavoisier's Law LKPD oriented towards science process skills and students' chemistry learning outcomes.

$$H_1: \mu_1 \neq \mu_2$$

(The average learning outcomes of students who use KPS-based LKPD are different from the average of students who do not use it).

▪ RESULT AND DISCUSSION

This study used a quasi-experimental design with a pre-test post-test control group design. Both groups were given a pre-test to determine their initial abilities, then the experimental group received an intervention in the form of KPS-oriented worksheets, while the control group used conventional worksheets. Subsequently, both groups were given a post-test to see the difference in learning outcomes.

The normality test was conducted using the Shapiro-Wilk Test because the sample size was < 50. The normality test results are presented in the following table:

Table 1. Normality Test Results

Data	Sig.	Conclusion
Pre-test Control	0.200	Normal (p > 0.05)
Post-test Control	0.176	Normal (p > 0.05)
Experimental Pre-test	0.124	Normal (p > 0.05)
Experimental post-test	0.086	Normal (p > 0.05)

Based on the results in Table 1, all pre-test and post-test data are normally distributed because the significance value is > 0.05.

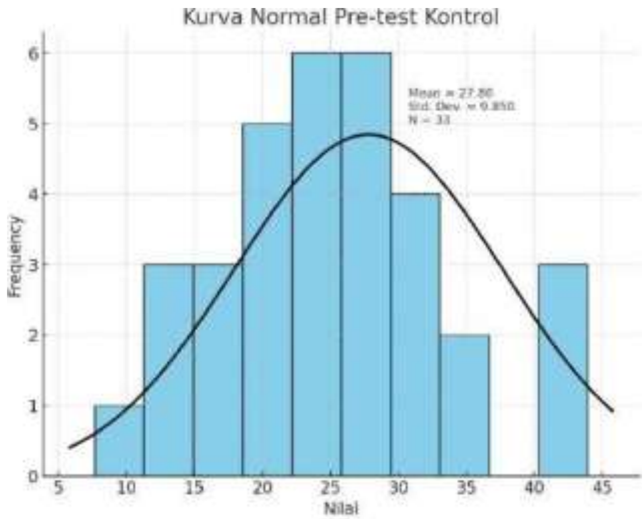

Figure 1. Normal Curve of the Control Class *Pre-Test*

Figure 1 shows the distribution of control class pre-test data in the form of a histogram overlaid with a theoretical normal curve. The histogram shows that student scores tend to be distributed according to a normal distribution pattern. The normality test results show a significance value of 0.200 (p > 0.05), so it can be concluded that the data is normally distributed. The data has a mean of 27.80, a standard deviation (Std. Dev.) of 9.850, with a sample size (N) of 33 students.

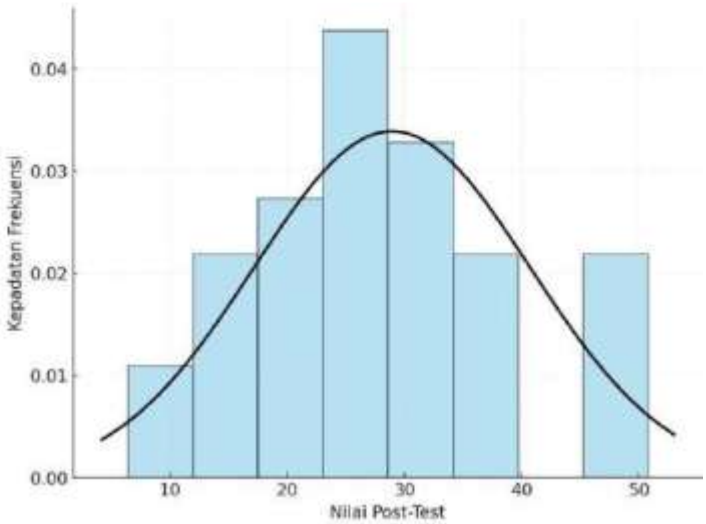

Figure 2. Normal Curve of the Control Class *Post-Test*

Figure 2 shows the distribution of the control class post-test data in the form of a histogram overlaid with a theoretical normal curve. The histogram shows that the student score data tends to be distributed close to a normal distribution pattern, with a mean of 27.80, a standard deviation (Std. Dev.) of 9.850, and a sample size (N) of 33 students. The normality test results show a significance value of 0.176 (p > 0.05), so it can be concluded that the control class post-test data is normally distributed.

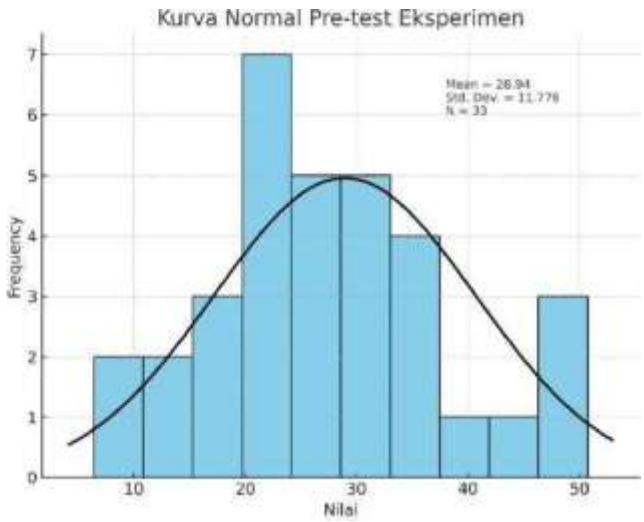

Figure 3. Normal Curve of *the Pre-Test for* the Experimental Class

Figure 3 shows the distribution of control class pre-test data in the form of a histogram overlaid with a theoretical normal curve. The histogram shows that the students' scores tend to be distributed close to a normal distribution pattern, with a mean of 28.94, a standard deviation of 11.776, and a sample size (N) of 33 students. The normality test results show a significance value of 0.124 ($p > 0.05$), so it can be concluded that the pre-test data for the experimental class is normally distributed.

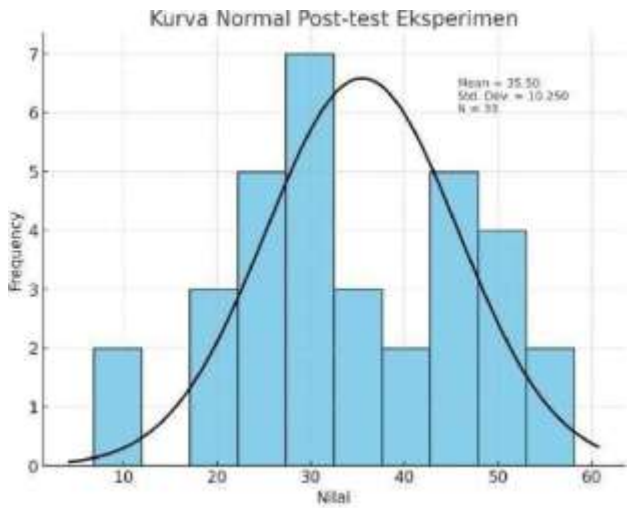

Figure 4. Normal Curve of the Experimental Class *Post-Test*

Figure 4 shows the distribution of the post-test data for the experimental class in the form of a histogram overlaid with a theoretical normal curve. The histogram shows that the student score data is distributed close to a normal distribution pattern, with a mean of 35.50, a standard deviation (Std. Dev.) of 10.250, and a sample size (N) of 33 students. The normality test results show a significance value of 0.086 ($p > 0.05$), so it can be concluded that the post-test data for the experimental class is normally distributed. Homogeneity testing was performed using Levene's Test to determine whether the two groups had the same variance.

Table 2. Homogeneity Test Results

Learning Outcome Data	Sig .	Conclusion
Mean	0,614	Homogeneous (p > 0,05)

Based on the results in Table 2, the significance value (Sig.) of 0.614 > 0.05 means that the variance between the experimental class and the control class is not significantly different. Thus, it can be concluded that the learning outcome data of the two groups is homogeneous or has a relatively similar level of diversity. This condition indicates that both groups have equivalent initial characteristics in terms of learning outcome variance, thus fulfilling the basic assumption for conducting a parametric statistical test, namely the Independent Samples T-Test. This homogeneity also strengthens the validity of the comparison analysis results, because the differences that arise can be more reliably attributed to the treatment (use of KPS-based LKPD) and not to differences in initial characteristics between groups.

To reinforce the findings, the following presents the average learning outcomes of students in both classes:

Table 3. Average Student Learning Outcomes

Class	Pre-test Average	Post-test Average	fferen ce
Experimental (LKPD KPS)	58,4	82,6	+24,2
Control (Regular LKPD)	59,1	71,3	+12,2

The results in Table 3 show that the initial scores (pre-test) of both classes were relatively the same, indicating that the students' initial abilities were at a comparable level. However, after the treatment was administered, the experimental class that used the Lavoisier's Law-based LKPD oriented towards Science Process Skills (KPS) experienced an average increase in learning outcomes of 24.2 points, which was much higher than the control class, which only increased by 12.2 points. These results were confirmed by an Independent Sample T-Test with a significance value of 0.002 (< 0.05), which proved that there was a significant difference between the two groups. Thus, it can be concluded that the application of KPS-based LKPD had a significant effect on improving student learning outcomes in cross-interest chemistry learning.

Theoretically, these findings are consistent with constructivism theory, which states that knowledge cannot be passively transferred from teacher to student, but is actively constructed through experience and interaction with the learning environment (Piaget, 1976; Fosnot & Perry, 2005). KPS-based LKPD encourages student involvement in the scientific process, from observing, formulating hypotheses, designing experiments, analysing data, to drawing conclusions. This active involvement makes learning more meaningful, contextual, and long-lasting in long-term memory. Understanding Lavoisier's Law is not merely memorisation, but is obtained through reflective and applicable learning experiences.

Furthermore, these results are in line with previous studies showing that the application of Science Process Skills (SPS) can improve students' critical thinking, problem-solving, creativity, and learning achievement (Ariyani et al., 2021; Nurmayani et al., 2020; Yulianti et al., 2022). Research by Setiawan and Susanti (2023) also confirmed that the use of science process-based LKPD can reduce misconceptions of chemistry concepts because students directly prove scientific principles through experimental activities. Thus, KPS-based learning can transform the learning process from *teacher-centred* to *student-centred learning,* where students become active subjects in constructing their knowledge.

From a curriculum perspective, the implementation of KPS-based LKPD is in line with the spirit of the Merdeka Curriculum, which emphasises experience-based learning, competency strengthening, and the development of students' scientific character (Kemdikbud, 2022). Through this approach, students not only understand theory but are also skilled in applying scientific methods, thinking analytically, and relating concepts to real life. Additionally, this approach also supports the development of 21st-century skills such as *critical thinking, collaboration, communication,* and *creativity (*Oktaviani S, 2024). In practical terms, this has important implications for chemistry teachers to utilise KPS-based LKPD as an effective pedagogical innovation in improving student learning outcomes and science literacy, which are crucial competencies in facing learning challenges in the era of the Industrial Revolution 4.0 (Abungu et al., 2021; Gultepe, 2016; Wati et al., 2021).

To determine the difference in learning outcomes between the experimental and control classes, an Independent Sample T-Test was conducted**.**

Table 4. Hypothesis Test Results (Independent Sample T-Test)

Data	Sig (2-tailed)	Conclusion
Post-test Experiment vs Control	0,002	H_0 is rejected; there is a significan

Table 4 shows that Sig. (2-tailed) = 0.002 < 0.05, so H_0 is rejected and H_1 is accepted. This means that there is a significant difference between the learning outcomes of students who use KPS-oriented LKPD based on Lavoisier's Law and students who use regular LKPD.

The results of this hypothesis test are also consistent with previous research findings that confirm that the application of the KPS approach in science education is able to improve student learning outcomes, critical thinking, and problem-solving skills (Ariyani et al., 2021; Yulianti et al., 2022; Setiawan & Susanti, 2023). This approach allows students to act as young scientists who actively construct knowledge through exploratory and reflective activities, making learning more meaningful. Thus, the results of this study not only support constructivist theory (Piaget, 1976; Fosnot & Perry, 2005), but also reinforce the relevance of KPS-based LKPD as a learning strategy in line with the principles of the Merdeka Curriculum (Kemdikbud, 2022) in shaping students who are critical, collaborative, and scientific in character.

CONCLUSION

The use of Student Worksheets (LKPD) based on Lavoisier's Law oriented towards Science Process Skills (KPS) had a significant effect on student learning outcomes in chemistry across interests in class X at Indralaya Utara State Senior High School 2. This was proven through the results of the Independent Samples T-Test, which showed a significance value of 0.002 (< 0.05), indicating a significant difference in learning outcomes between the experimental class and the control class. The experimental class that used KPS-based LKPD showed higher learning outcomes than the control class. These findings indicate that KPS-oriented LKPD is effective in increasing student active engagement, conceptual understanding, and achieving more optimal learning outcomes in accordance with the learning objectives of the Merdeka Curriculum.

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