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The Effectiveness of Kahoot Media and E-LKPD in the Implementation of the Discovery Learning Model for Teaching Acid-Base in Improving Student Learning Outcomes

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ABSTRACT

This study aims to determine the effectiveness of using Kahoot media and e-LKPD based on the Discovery Learning model in improving student learning outcomes in acid-base solution material at SMA Negeri 10 Medan. The research method used is a quasi-experimental design with a Pretest-Posttest Non-Equivalent Control Group Design. The subjects of the study consisted of four classes: F1, F2, F3, and F5, with each class consisting of 35 students. Class F1 used Kahoot media, F2 used e-LKPD, F3 used a combination of both, and F5 served as the control class. The instrument used was an objective test in the form of 20 multiple-choice questions. The results showed that the average improvement in student learning outcomes was higher in the experimental classes than in the control class. The Independent z-test revealed a significant difference between the experimental and control classes. Thus, the use of Kahoot media and e-LKPD based on discovery learning has proven effective in improving student learning outcomes in acid-base material.

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INTRODUCTION

Learning in the 21st century is grounded in principles that prioritize student-centered learning, where the role of the teacher is to act as a facilitator. 21st-century education emphasizes the importance of students' skills in formulating problems and gathering information from various learning sources. The objective is for students to think analytically, collaborate, and work together to solve problems, thereby developing collaborative skills and higher-order thinking abilities [1].

Chemistry education often presents challenges for students due to its inclusion of many abstract concepts that require deep understanding and high-level thinking skills [2]. One such complex topic is acid-base chemistry. Students are required not only to understand theoretical concepts but also to connect them to real-life phenomena and solve chemistry problems involving calculations [3], [4].

Observations at SMA Negeri 10 Medan reveal that the learning process remains conventional, characterized by a dominance of lecture methods and minimal use of interactive

learning media. This condition has contributed to a low level of student interest and achievement in chemistry [5], [6].

This issue calls for educational innovations that encourage active participation and critical thinking among students. The Discovery Learning model offers an alternative that can engage students in the process of independently discovering key concepts through exploration and observation [7]. The effectiveness of this model can be enhanced by integrating media that support interactive and independent learning.

Media such as Kahoot and e-LKPD have the potential to increase student engagement and motivation. Kahoot is a game-based quiz platform that fosters a competitive spirit and direct student involvement [8], [9]. Meanwhile, e-LKPD provides a structured space for independent exploration, allowing students to better understand the learning material [10], [11]. The integration of these two media in the Discovery Learning model can create a learning environment that is both enjoyable and effective. This study aims to assess the effectiveness of using Kahoot media and e-LKPD in the application of the Discovery Learning model to improve student learning outcomes in acid-base chemistry. The focus of this research is on enhancing conceptual understanding and achieving better learning outcomes through the use of media tailored to the characteristics of the students and the subject matter.

METHODOLOGY

This research is a quasi-experimental study with a Pretest-Posttest Non-Equivalent Control Group Design conducted at SMA Negeri 10 Medan during the second semester of the 2024/2025 academic year. The research sample consists of four tenth-grade classes, namely F1, F2, F3, and F5, with each class comprising 35 students. Class F1 used Kahoot media, class F2 used e-LKPD media, class F3 used a combination of both, and class F5 served as the control group using conventional learning methods. The scope of the research includes the application of the Discovery Learning model supported by interactive media on the topic of acid and base solutions. The main tools and materials in this study include laptops, projectors, Google Forms, pretest and posttest multiple-choice questions (20 items) that have been validated, as well as the learning media Kahoot and e-LKPD. Data collection was carried out through a pretest and a posttest to measure student learning outcomes.

The data obtained were analyzed using SPSS version 25. Before performing hypothesis testing, prerequisite tests were conducted, including the normality test using the Shapiro-Wilk test and the homogeneity test using Levene's test to ensure that the data were normally distributed and had homogeneous variances. Once these assumptions were met, an Independent Z-test was performed to determine the differences in learning outcomes between the experimental and control groups. The variables in this study consist of the independent variable, which is the learning media (Kahoot and e-LKPD based on Discovery Learning), the dependent variable, which is the students' learning outcomes, and control variables such as the material and time. The operational definition of learning outcomes in this study is the scores obtained by students from the pretest and posttest, which are analyzed to measure the improvement in students' understanding of the acid and base solution material. Data in this study were collected through several methods, as follows:

1. Test (Pretest and Posttest): The pretest and posttest were used to measure student learning outcomes before and after the learning process. The test items were developed based on the achievement indicators (IPK) of the Acid and Base material by the requirements of the Merdeka Curriculum. This test covers cognitive aspects such as knowledge, understanding, and application of acid-base concepts.
2. Student Response Questionnaire: The questionnaire given to students after the learning process aims to explore their perceptions of the media used. Student responses to this

questionnaire will reflect how much they feel that Kahoot and e-LKPD media helped them in understanding the acid-base solution material, as well as how they evaluate these media in enhancing their motivation and interest in learning. The questionnaire will identify whether students feel more engaged, more motivated, or more active in learning due to the use of these media.

3. Documentation: Documentation in the form of photos and videos was used to record class dynamics and student activities during the learning process. This documentation provides visual evidence of student interactions with the Kahoot and e-LKPD media, as well as the classroom atmosphere, which helps assess the level of student participation and involvement in the learning process.

By using this combination of methods, the collected data will provide a more comprehensive picture of students' learning outcomes and learning interests. The questionnaire covers aspects such as ease of use, difficulty level, and the effectiveness of the media in supporting student understanding.

RESULTS AND DISCUSSION

This study aims to evaluate the effectiveness of using Kahoot media and e-LKPD based on the Discovery Learning model in enhancing student learning outcomes on the topic of acid and base solutions at SMA Negeri 10 Medan. The research employs a quasi-experimental design with a Pretest-Posttest Non-Equivalent Control Group Design, involving four classes: F1, F2, F3, and F5. In this study, class F1 was exposed to Kahoot media within the Discovery Learning model, while class F2 used e-LKPD media with the same approach, and class F3 utilized a combination of both Kahoot and e-LKPD media. Class F5 served as the control group, receiving conventional instruction without the use of interactive media.

The research instrument consisted of a multiple-choice test, initially comprising 40 items. The test was administered in two phases: a pretest to assess the students' baseline abilities and a posttest to measure improvements in learning outcomes following the treatment. However, before utilizing the instrument for evaluating learning outcomes, a feasibility test was conducted by a faculty member from the Chemistry Department. The results of the feasibility test revealed that out of the 40 items, only 35 were deemed suitable for use as valid evaluation tools. Subsequently, 20 items were selected to form the test instrument. From the 35 valid items, 20 were chosen for the posttest, taking into consideration the limited testing time, alignment with learning indicators, and a balanced distribution of difficulty levels and discriminative power. This selection was made to ensure that the questions could accurately reflect the achievement of competencies within an efficient time frame.

A total of 140 students participated in the study, with each class consisting of 35 students. The study was conducted over two weeks, with each class receiving two treatment sessions.
The Discovery Learning model was applied in the experimental groups to encourage students to explore the concepts of acid and base solutions through discussions and active engagement with the learning media provided. Data analysis will focus on comparing pretest and posttest results between the experimental and control groups. By comparing scores before and after the intervention, the study seeks to determine whether there was a significant improvement in learning outcomes for students who used Kahoot and e-LKPD media, both separately and in combination, compared to the conventional method. Descriptive statistical methods, such as the calculation of mean values, standard deviations, and score distributions, will be employed to support the interpretation of the findings.

Additionally, an advanced analysis of the test instrument was conducted to ensure the quality of the questions used. This analysis measured aspects such as validity, reliability, difficulty

level, and discriminative power. The results of this analysis informed the refinement of the instrument, ensuring that only the most suitable questions were selected, specifically the 40 items. These data will serve as the foundation for discussing the effectiveness of the learning media in improving student learning outcomes. Based on the data and analysis of the research conducted at SMA Negeri 10 Medan, the results of both the pretest and posttest for the experimental and control classes are summarized in Table 1 below.

Table 1. Description of Data for the Experimental and Control Classes at SMA Negeri 10 Medan

	Deskriptive stastistics						
	N	Range	Min	Max	Mean	Std dev.	Variance
Pre-test experiment 1	35	35	15	50	34.86	9.962	99.244
Postest experiment 1	35	30	70	100	84.43	8.204	67.311
Pretest experiment 2	35	45	10	55	33.14	10.784	116.303
Postest experiment 2	35	30	65	95	77.57	8.168	66.723
Pretest experiment 3	35	45	10	55	34.57	11.781	138.782
Postest experiment 3	35	25	70	95	81.71	6.854	46.975
Control pretest	35	35	15	50	34.43	10.057	101.134
Control Postest	35	20	65	95	76.71	8.220	67.563

Based on the data in Table 1, the average pretest and posttest scores in both the experimental and control classes indicate an improvement in learning outcomes. In Experimental Class 1, the average pretest score was 34.86, which increased to 84.43 in the posttest. Experimental Class 2 had an average pretest score of 33.14, which improved to 77.57 in the posttest. Meanwhile, Experimental Class 3 showed an increase from 34.57 in the pretest to 81.71 in the posttest. In the control class, the average pretest score was 34.43, which rose to 76.71 in the posttest. The higher improvement in learning outcomes in the experimental classes compared to the control class suggests that the teaching methods implemented in the experimental classes were more effective in enhancing students' understanding.

In this study, data normality was tested using the Shapiro-Wilk Test, as the sample size for each group consisted of 35 students. The Shapiro-Wilk test is recommended for samples of size ≤ 50, as it is more sensitive than the Kolmogorov-Smirnov test in detecting deviations from normal distribution in small sample sizes.

The decision criteria for the Shapiro-Wilk test are as follows:

- If the Sig. value (p-value) > 0.05, the data is normally distributed.
- If the Sig. value (p-value) ≤ 0.05, the data is not normally distributed [12].

The results of the normality test for the experimental and control classes in this study can be seen in the table below.

Table 2. Results of the Normality Test for the Experimental and Control Classes.

	Test of normality					
	Kolmogorov Df	Statistic	Sminorva.Sig	Sminorvstastitic	Shapiro-Wilk Df	Shapiro-Wilk Sig
Pretest eksperimen 1	35	.116	.200*	.948	35	.102
Pre-test experiment 1	35	.134	.115*	.950	35	.113
Postest experiment 1	35	.165	.016*	.952	35	.135
Pretest experiment 2	35	.131	.134*	.947	35	.090
Postest experiment 2	35	.143	.067*	.951	35	.120
Pretest experiment 3	35	.154	.035*	.940	35	.056
Postest experiment 3	35	.139	.084*	.944	35	.072
Control pretest	35	.154	.035*	.940	35	.056

Based on the results of the Shapiro-Wilk test, the significance values for each group were as follows:

- Pretest F1 (Experimental 1): Sig. = 0.102 → Normally distributed
- Posttest F1 (Experimental 1): Sig. = 0.113 → Normally distributed
- Pretest F2 (Experimental 2): Sig. = 0.135 → Normally distributed
- Posttest F2 (Experimental 2): Sig. = 0.090 → Normally distributed
- Pretest F3 (Experimental 3): Sig. = 0.120 → Normally distributed
- Posttest F3 (Experimental 3): Sig. = 0.056 → Normally distributed
- Pretest F5 (Control): Sig. = 0.072 → Normally distributed
- Posttest F5 (Control): Sig. = 0.056 → Normally distributed

Since all Sig. values are > 0.05, it can be concluded that the data in this study follow a normal distribution, allowing for the continuation to the parametric statistical analysis stage using the Independent Z-Test.

After confirming that the data are normally distributed, the next step is to test whether the variances between groups are homogeneous. Homogeneity of variance is an essential assumption for the Independent Z-test, as this method assumes that the variances of the two groups being compared are not significantly different. If the variances are not homogeneous, the statistical test results may be biased and lead to incorrect conclusions. In this study, Levene's Test of Homogeneity of Variance was used to test for homogeneity. Levene's Test is used to determine whether the variances between groups are significantly different.

The decision criteria for the Levene's test are as follows:

- If the Sig. value (p-value) > 0.05, the variances between groups are considered homogeneous.
- If the Sig. value (p-value) ≤ 0.05, the variances between groups are considered not homogeneous.

Based on the results of Levene's Test, the significance values were as follows:

- Based on Mean = 0.055
- Based on Median = 0.072
- Based on Median with adjusted df = 0.073

Since all Sig. values are > 0.05, it can be concluded that the variances in this study are homogeneous, satisfying the assumption of homogeneity. Therefore, the analysis can proceed using the Independent Z-Test without the need for adjustments to account for differences in group variances.

Next, the Independent Z-Test was conducted to compare the students' learning outcomes based on posttest scores between the experimental classes (F1, F2, F3) and the control class (F5). The primary goal of this test was to assess whether the use of different learning media had a significant impact on improving student learning outcomes in acid-base instruction. Below is a more detailed analysis based on the statistical test results for each class comparison. The decision rule is based on significance:

- If Sig. (2-tailed) ‹ 0.005 (difference between the mean scores of the two groups)
- If Sig. (2-tailed) › 0.005 (no difference between the mean scores of the two groups)

The results of the Independent Z-Test are as follows:

Table 3. Results of the Independent Z-Test.

Variances	*Levene's Test for Equality of Variances*	*P-value*
Results of posttest F1 (experiment 1) with posttest F5 (control)	3.930	‹ 0.001
Results of posttest F2 (experiment 1) with posttest F5 (control)	0.438	0.663
Results of posttest F3 (experiment 1) with posttest F5 (control)	2.880	0.005

1. **Comparison of Posttest Results Between Experimental Class 1 (F1) and Control Class (F5)**

   The results of the Independent Z-Test show a T value of 3.930 with a p-value ‹ 0.001. This indicates that there is a significant difference between the posttest scores of the two classes. The mean difference between the two groups is 7.714, with a confidence interval of 3.797 – 11.631, suggesting that students in class F1 achieved better learning outcomes compared to students in class F5. The use of Kahoot in learning has a significant positive impact on students' understanding. This media enhances student engagement and motivation, which then contributes to improved learning outcomes. Pedagogically, these results can be explained through constructivist theory, where interactive, game-based learning like Kahoot allows students to actively participate, test their understanding in real-time, and receive instant feedback. This contrasts with conventional methods, which tend to be passive and less engaging for students. Therefore, the use of Kahoot can be recommended as an effective learning media for improving student learning outcomes, especially in subjects that require strong conceptual understanding, such as acid-base solutions. However, its effectiveness also depends on other factors, such as the teacher's readiness in designing appropriate questions and the students' ability to adapt to technology-based learning.

2. **Comparison of Posttest Results Between Experimental Class 2 (F2) and Control Class (F5)**

   The results of the Independent Z-Test show a T value of 0.438 with a p-value of 0.663. Since the p-value is greater than 0.05, it can be concluded that there is no significant difference in the learning outcomes between students in class F2 and class F5. In other words, the use of e-LKPD in learning did not provide better results compared to conventional methods. This result may be attributed to several factors. First, while e-LKPD based on discovery learning can help students understand acid-base concepts more independently, its use may not yet be optimal in directly enhancing student engagement. Second, it is possible that students are not accustomed to using e-LKPD as a learning medium, causing them to still rely on conventional learning methods.

   From this result, it can be concluded that although e-LKPD has potential as a learning media, its effectiveness depends on how it is implemented and the students' readiness to use

it. Therefore, additional strategies, such as more intensive guidance from teachers or integration with more interactive learning methods, may be necessary for e-LKPD to be more effective.

3. **Comparison of Posttest Results Between Experimental Class 3 (F3) and Control Class (F5)**

The learning strategy implemented in class F3 provided a deeper learning experience compared to the conventional method used in class F5. Although the results show the effectiveness of the learning model in class F3, there are some challenges that need to be considered. For example, this model requires more time in the learning process and demands active participation from students, so its effectiveness also depends on the readiness of both teachers and students to implement it.

In this study, an N-Gain test was used to measure the effectiveness of learning by observing the improvement in student learning outcomes from pretest to posttest. The N-Gain score test was conducted using SPSS version 25. Based on the analysis results, each class showed different levels of learning effectiveness. Below is a detailed explanation for each class. In class F1, the average N-Gain score was 0.7764, with a standard deviation of 0.11629. This score falls into the high category ($g > 0.7$), indicating that the improvement in student learning outcomes in this class was quite significant after the applied teaching method. This shows that students were able to understand the material better than before the treatment was implemented. The analysis results can be seen in the table below.

Table 4. N-Gain Analysis for F1-F5.

Kelas	N	Ngaint_score	Gain percent	Max	Mean	Std. Deviation
F1 (eksperimen 1)	35	.60	60.00	100	.7764	.11629
F2 (eksperimen 2)	35	.45	45.45	87	.6546	.12574
F3 (eksperimen 3)	35	.57	53.85	100	.7421	.11587
F5 (kelas kontrol)	35	.30	30.00	94	.6309	.13036

In terms of percentage, the N-Gain in Class F1 ranges from 60.00% to 100.00%, with an average of 77%. Based on the effectiveness interpretation, this percentage falls within the "effective" category (76%–100%). This indicates that the teaching method applied in Class F1 was highly successful in improving students' understanding of the material taught. These results suggest that the use of learning media in Class F1 played a significant role in enhancing student comprehension. The high improvement could be attributed to the effectiveness of the Discovery Learning model employed, where students were more active in discovering concepts on their own through interactive media. Additionally, the use of Kahoot as an evaluation tool likely provided a more engaging learning experience and motivated students to understand the material more deeply. The difference in scores before and after the learning process also indicates that students in this class were quite enthusiastic and engaged in the learning process. The relatively small standard deviation suggests that the improvement in understanding occurred fairly consistently across students.

Class F2 obtained an average N-Gain score of 0.6546, with a standard deviation of 0.12574. Based on the N-Gain category, this score falls within the "moderate" range ($0.3 \leq g \leq 0.7$), indicating that the learning method applied was still fairly effective in improving students' learning outcomes, though not as high as in Class F1. The N-Gain percentage in Class F2 ranged from 30.00% to 93.75%, with an average of 63%. Based on the effectiveness interpretation, this result falls within the "fairly effective" category (56%–75%). This suggests that most students experienced an improvement in learning outcomes, but with greater variation compared to Class F1.

Although the improvement was fairly good, the lower scores compared to Class F1 could be due to several factors, such as differences in learning media. While Class F1 used Kahoot, Class F2 employed e-LKPD, which may have provided a different learning experience. This media might be more suitable for students who prefer independent learning but may be less engaging for those who require higher levels of interactive stimulation. The higher standard deviation also indicates variability in understanding among students. Some students may have benefited greatly from this method, while others experienced less significant improvement. Other factors, such as students' readiness for self-directed learning or the way the teacher guided the use of e-LKPD, could also influence the effectiveness of the learning in this class.

Class F3 had an average N-Gain score of 0.7421, with a standard deviation of 0.11587. Based on the N-Gain category, this score falls into the "high" category ($g > 0.7$), meaning that the teaching method applied in this class significantly improved students' understanding. The N-Gain percentage in this class ranged from 53% to 100.00%, with an average of 74.21%. Based on the effectiveness interpretation, this result falls within the "fairly effective" category (56%–75%), but is close to being considered "effective". The learning effectiveness in this class is approaching the results achieved in Class F1. This could indicate that the method used in Class F3 was similar to the one used in Class F1 or that students in this class had a more homogeneous level of understanding compared to other classes. With a relatively low standard deviation, it can be concluded that the improvement in students' understanding occurred fairly evenly across students. Factors such as student engagement, teaching strategies applied, and how the teacher managed the class may have contributed to the success of learning in this class.

Class F5 had an average N-Gain score of 0.63, with a standard deviation of 0.13036. Based on the N-Gain category, this score falls within the "moderate" range ($0.3 \leq g \leq 0.7$), indicating that the improvement in student learning outcomes was still fairly good, but not as optimal as in Classes F1 or F3. The N-Gain percentage in this class ranged from 45.45% to 86.67%, with an average of 65.46%. Based on the effectiveness interpretation, this result falls within the "fairly effective" category. As the control class, these results serve as a benchmark for evaluating the effectiveness of the Discovery Learning model with Kahoot and e-LKPD media applied in the experimental classes. With lower scores compared to Classes F1 and F3, it can be concluded that the conventional teaching method used in Class F5 was less effective in improving student learning outcomes. The slightly higher standard deviation suggests variability in understanding among students in this class. Some students may have experienced significant improvement, while others showed less progress. This could be due to the teaching method being less engaging or a lack of active interaction in the learning process.

In this study, a student response survey was conducted to assess the effectiveness of using media in Discovery Learning-based instruction on the topic of acid-base solutions. Student responses play a crucial role in evaluating the extent to which the media used can enhance their interest, understanding, and engagement in the learning process. Therefore, the validated student response questionnaire was used as an instrument to collect data on students' acceptance of the learning media applied in each experimental class. The following table presents the student response data.

Table 5. Student Response Percentage.

Kelas	Presentase respon (%)
F1	91.37 %
F2	88.23 %
F3	89.5%

This study was conducted in three experimental classes, namely F1, F2, and F3, each using technology-based learning media. Each class was given a different treatment to examine variations in student responses to the type of media used. The questionnaire provided covered several key indicators, such as:

1. Interest in the learning media
2. Ease of understanding the material using the media
3. Interactivity of the media in increasing student engagement
4. Motivation to learn is influenced by the use of the media
5. Effectiveness of the media in helping students complete tasks

Based on the survey results, Class F1 received the highest response percentage at 91.37%, followed by Class F3 with 89.5%, and Class F2 with 88.23%. These percentages indicate that, in general, all three experimental classes had a high level of acceptance of the use of learning media. The highest response rate obtained by Class F1 suggests that the media used in this class was more effective in capturing attention and improving student understanding. While the response rates in Classes F3 and F2 were slightly lower compared to F1, the percentages remained high, above 88%. This suggests that the media used in both of these classes was still quite effective in enhancing student engagement and understanding, although several potential factors may have influenced the differences in response levels, such as:

1. Student preferences regarding the type of media used
2. The ease of access and use of the media for students
3. Differences in the methods of material presentation in each experimental class

CONCLUSION

Based on the research findings, Kahoot learning media proved to be more effective in improving student learning outcomes in acid-base instruction compared to e-LKPD media and conventional methods. The average posttest scores of the classes using Kahoot (F1: 82.71, F2: 84.43) were higher than those of the control class (F5: 76.71), with the Z-Test indicating a significant difference ($p < 0.01$). Meanwhile, e-LKPD did not show a significant difference in learning outcomes (F3: 77.57 vs. F5: 76.71; $p = 0.663$), making it more suitable as a supplementary media. In conclusion, Kahoot is more effective in enhancing student engagement and learning outcomes compared to e-LKPD.

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