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Development of Discovery Learning-Based E-LKPD to Enhance Students' Learning Motivation and Achieve Critical Thinking Skills in Salt Hydrolysis Material

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Abstract: This study aims to evaluate the viability, practicality, and effectiveness of based on discovery learning (E-LKPD) in raising students' motivation to learn and cultivating their critical thinking abilities (CTS). This study adopts a quantitative methodology by utilizing the research and development (R&D) technique and the Borg and Gall model. Sixty-two students from SMA Negeri 1 Baitussalam's class XI make up the study sample. The average results of the viability test for the E-LKPD, reviewed from the aspects of material completeness, accuracy, currency, and alignment with objectives, obtained a percentage of 91.25% with the criterion of "very feasible." Meanwhile, the practicality of the E-LKPD based on the responses from students and teachers achieved average percentages of 87.38% and 82.5%, respectively, with the criterion of "very practical." The effectiveness assessment of the E-LKPD, based on non-test results of learning motivation with an N-Gain percentage of 0.56 and the students' CTS test results with a completeness percentage of 79.48, falls under the criterion of "quite effective." Therefore, it can be concluded that this discovery learning-based E-LKPD is viability, practicality, and effectiveness in enhancing learning motivation and achieving students' critical thinking skills (CTS).

Keywords: Critical thinking skills (CTS); Discovery learning; E-LKPD; Learning motivation

Introduction

In the 21st century, learners are required to possess skills that enable them to compete not only with their peers but also with other countries (Zhao et al., 2024). These abilities encompass digital literacy, strong communication, critical thinking, and high productivity, all of which are essential for preparing learners to thrive in life (Guo & Wang, 2021; Wijayati et al., 2019; Wardani et al., 2024). Education is the primary choice to prepare learners to compete in the current era (Ghazali et al., 2024). Through education, humans can develop their potentials (Hikmawati et al., 2020). The educational process today involves educating, teaching, and training activities (Puspitasari & Wulandari, 2022).

Educators have a vital role in boosting motivation and improving learning outcomes, for example, by using learning models, methods, strategies, or other facilities (Aldalur & Perez, 2023; Zhou et al., 2024). Teachers as educational professionals are key factors in educational success (Tsai et al., 2023; Rahmawati et al., 2023). As a result, teachers need to develop learning strategies, facilitating, that boost motivation, critical thinking and make the learning experience more enjoyable (Yilmaz et al., 2023; Miftakhurrohmah et al., 2023). One way to increase student engagement and enhance cognitive learning outcomes is by choosing effective models and

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strategies (Gutierrez et al., 2022; Warlinda et al., 2022; Nurilyasari & Sundaygara, 2023).

One teaching approach that can actively involve students in the classroom is the discovery learning model (Bruner, 1961). Discovery learning is a process that encourages learners to draw conclusions based on activities and observations during the learning process (Hammer, 1997). This model provides learners with opportunities to discover concepts, develop ideas, and acquire new knowledge (Nasution et al., 2019).

Critical thinking skills (CTS) involve reflective and logical thinking in problem-solving (Ennis, 2013; Li et al., 2024; Syamsinar et al., 2023). CTS significantly stimulate learners' cognitive reasoning abilities as they assist in decision-making (Changwong, 2018; Pradana et al., 2020; Razak et al., 2021). The ability to think critically is one of the skills that can greatly enhance students' capacity for critical analysis (Seki et al., 2023). The improvement of students' critical analysis is closely related to enhancing their intellectual abilities (Setiawati & Corebima, 2017). One way to enhance students' critical thinking skills is by presenting them with real-world problems, encouraging them to present and question each other's opinions, and making final decisions (Falloon, 2024; Jiang, 2022). However, in reality, the CTS system has not been fully integrated into the learning process, especially in chemistry education.

Based on initial observations conducted at SMA Negeri 1 Baitussalam, it was found that: students were less active in class and did not discover concepts independently during learning activities; there was a lack of motivation among students in learning chemistry; chemistry teachers tended to use lecture methods (only using the blackboard and books); chemistry teachers only used printed LKPD and had not yet utilized discovery learning-based E-LKPD. Therefore, teachers can develop learning tools through innovation to improve the quality of the teaching and learning process. If teachers continuously use printed LKPD, students might become bored over time. According to Nurdyansyah et al. (2016), this does not align with the demands of the 2013 curriculum, which implements innovative learning where innovative learning is more student-centered.

One alternative way to address these issues is by using a learning models that involves student creatively, encourages them to think critically, and actively engages them in the learning process (Guncaga et al., 2024; Rosnidar et al., 2021). One such learning model that can enhance student engagement is the discovery learning model (Panggabean et al., 2021; Nursakinah & Suyanta, 2023). Thus, this research aims to enhance learning motivation, classroom participation, and critical thinking skills by utilizing E-LKPD based on discovery learning.

Method

This study applies the research and development (R&D) technique and takes a quantitative approach. The study adheres to the Borg and Gall paradigm, which comprises the following phases: planning, preliminary research and data collection, development of the initial prototype, product validation, revisions, product testing, additional revisions, usability testing, final revisions, and product implementation (Borg and Gall, 1989).

This study uses an experimental approach with a quasi-experimental design. As stated by Sugiyono (2007), the goal of experimental research is to determine, under carefully monitored circumstances, how one treatment affects another variable. Both the quasi-experimental technique makes use of both a posttest-only control group design and a pretest-posttest control group design. The study consists of two groups: an experimental class and a control class. Treatment for the experimental class is provided using discovery learning-based E-LKPD, while the control class is used for comparison and utilizes conventional LKPD only.

The research population includes all eleventh-grade science students at SMA Negeri 1 Baitussalam, consisting of four classes totaling 124 students. The research sample comprises 62 students. The sample selection method employed is random sampling due to the homogeneity of the population. Data were collected using a learning motivation questionnaire and test questions.

Result and Discussion

Feasibility Test Results

The assessment of E-LKPD based on discovery learning was deemed feasible after going through an expert validation process. Table 1 shows the results of the validity and reliability of E-LKPD calculated using the Aiken Index and Inter-Rater Agreement (IRA).

Table 1. Validity and Reliability Calculation Results

Category	Aiken's index	Validity standard	Inter-rater agreement (IRA)	Reliability standard
E-LKPD	0.89	Valid	0.85	Excellent agreement beyond chance

Table 1 shows that the calculation results of Aiken's Index indicate that the E-LKPD meets the validity standards and that the expert agreement on the E-LKPD using Inter-Rater Agreement (IRA) indicates a level of agreement that is considered quite good, beyond chance.

The next step is to validate the RPP (Lesson Plan) to determine its level of validity. This validation stage involves 2 experts. The validation results obtained will serve as a basis for improvements to enhance the quality of the RPP. Table 2 presents the results of validity and reliability calculations for the RPP using Aiken's Index and Inter-Rater Agreement (IRA).

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Table 2. Validity and Reliability Calculation Results for the RPP

Category	Aiken's index	Validity standard	Inter-rater agreement (IRA)	Reliability standard
RPP	0.85	Valid	0.83	Excellent agreement beyond chance

Practicality Test Results

The teaching materials are considered practical if the practicality assessment results reach the good category according to the established criteria. If the results are not practical, improvements will be made based on feedback from respondents. Table 3 displays the results of the practicality analysis for the E-LKPD.

Table 3. The Practicality of Discovery Learning-Based E-LKPD

Indicator	Number of statements	Average percentage	Level of validity
Student responses			
Student acceptance	2		Highly valid, or usable
Practicality	2	87.38%	without revisions
Student interest and motivation	3		
Teacher responses			
Alignment of E-LKPD with basic competencies	1		Highly valid, or usable
Alignment of E-LKPD with student needs	1	82.5%	without revisions
Usage instructions	1		
Presentation of material	2		
Appearance	2		
Function of E-LKPD	2		
Language	1		

According to the data shown in Table 3, it is indicated that the average practicality percentage for students is 87.38% and the average practicality percentage for chemistry teachers is 81.25%. When combined, both (students and chemistry teachers) have the same validity range, which is highly valid or usable without revisions. This indicates that the developed E-LKPD is effective and practical for both educators and students, and can be used as one of the supports in teaching.

Effectiveness Test Results

Operationally, the efficacy of a discovery learning-based E-LKPD product produces the desired outcomes. Researchers designed the E-LKPD, and the effectiveness data analysis was derived from pretest and posttest outcomes. Testing for effectiveness is done to gauge how well a learning method is working (Putri & Sholikhah, 2020). Based on the pretest results, the assessment of student motivation in the experimental class overall showed a category of "less satisfactory" with a score of 59.07%, and the control class had 57.05% with the same category. Nonetheless, the experimental class's posttest showed that 83.14% of students were motivated, which was classified as "good" (developing), while the control class had 71.72%, categorized as "fair." Further details on the analysis of the increase in student motivation Table 4 provides the details for the experimental and control classes.

Table 4. The Results of the Analysis of Improvement in Learning Motivation

Class	Average score		N-gain	Category
	Pretest	Posttest		
Experimental	59.07	83.14	0.56	Moderate
Control	57.05	71.72	0.30	low

The influence of using E-LKPD (Electronic Learning Media) on salt hydrolysis towards improving students' learning motivation in this study can be seen through the calculation of normalized gain (N-Gain). N-Gain is the comparison of the gain score achieved by students with the highest possible gain score they could attain (Sugiyono, 2015). The pretest and posttest results

on student learning motivation provide the data for this study. An N-Gain score of 0.56 was noted for motivation in the experimental class was classified as moderate based on the results of the pretest and posttest. Within the control group, the pretest-posttest motivation score resulted in an N-Gain of 0.30, categorized as low. If both N-Gain scores are interpreted into percentages to assess effectiveness, it can be concluded that the discovery learning-based E-LKPD on salt hydrolysis is fairly effective in improving students' learning motivation (Ulfah et al., 2021).

Results of Student CTS Analysis

Critical Thinking Skills (CTS) involve an individual's ability to develop concepts, analyze information, synthesize ideas, and evaluate data to arrive at answers or conclusions (Changwong, 2018). Following the data analysis after the treatments were applied Table 5 displays the average posttest results of the students in the experimental and control groups.

Table 5. Comparison of Posttest Average Scores

Descriptions or labels	Experimental class	Control class
Maximum score	92	72
Minimum score	48	40
Mean	79.48	58.83
Median	76	60
Mode	80	60

As can be seen from the above table, the experimental and control classes' posttest results differed; the experimental class averaged 79.48 while the control class averaged 58.83. The normality of the posttest findings for both classes was evaluated using SPSS's Shapiro-Wilk test. If the significance value is more than 0.05, the data is regarded as normally distributed; if not, it is not. Table 6 displays the findings of the posttest scores' normalcy analysis.

Table 6. Results of Normality Test Calculation

Class	Normality Sig. posttest	Category
Experimental	0.205	Data is normally
Control	0.176	distributed

The posttest results for both classes exhibit significance values more than 0.05, as seen in the above table. For the experimental class, the sig value for the posttest is 0.205, while for the control class, it is 0.176. A homogeneity test will next be performed to see whether the differences between the experimental and control groups are equal after determining whether the data are normal. There is no discernible difference in variances between the groups if the significance value is higher than 0.05, which denotes homogeneity of variances. Conversely, if when the significance value is less than 0.05, it indicates that the variances between the experimental and control groups differ significantly, indicating that the variances are not homogeneous. Table 7 displays the homogeneity test findings.

Table 7. Results of the Homogeneity Test Calculation

Levene's test for determining variance equality				Conclusion
	Statistic	Df	Sig	
Posttest scores for experimental class and control class	0.204	60	0.653	Homogene

The posttest results for both classes display a significant value larger than 0.05, precisely 0.653 for both the control and experimental groups, as seen in the above table. Consequently, it may be said that there is homogeneity in the variances between the two classes.

Table 8. Results of Hypothesis Testin

	Sig	Decision
Posttest scores for experimental class and control class	0.000	H_0 rejected

Table 8's results indicate that the experimental and control groups' posttest results for critical thinking skills (CTS) differ significantly, with a significance value of 0.000 (less than 0.05). Consequently, H1 is accepted while H0 is rejected, demonstrating that pupils' capacity for critical thought at SMA Negeri 1 Baitussalam are greatly impacted by the implementation of E-LKPD, which is based on discovery learning.

Discussion of the Outcomes from the Developing an E-LKPD Based on Discovery Learning

Based on the research findings, in comparison to the control class, the experimental class had greater posttest scores for student motivation. This indicates that there was a variation in the motivation of students in the experimental class (which used E-LKPD based on discovery learning) and the control class (which used traditional LKPD). This finding aligns with theoretical concepts indicating that discovery learning models can boost student motivation during the learning process. Consequently, Students actively participate in their learning activities, which is in line with the findings that Bahir et al. (2020).

With the implementation of E-LKPD based on learning, an increase in N-gain was observed in the experimental class, achieving 0.56 categorized as moderate, while the control class achieved 0.30 categorized as low. However, the rise in learning motivation was more pronounced in the experimental class compared to the control class. In line with the

research conducted by Ardana (2019) found that the implementation of discovery learning models can enhance student motivation.

After E-LKPD was implemented, pupils' critical thinking abilities (KBK) increased overall. According to the research findings, E-LKPD developed through discovery learning can serve as an effective tool for educators to actively engage students, boost their motivation, and enhance their critical thinking skills. The research done by Balazinec et al. (2024) supports this, this also highlighted the positive effects of discovery learning on students' motivation and academic achievement. Consequently, by actively participating in the concept's discovery, E-LKPD, which is based on discovery learning, can help students critical thinking, grasp or discover a concept more fully (Yaiche, 2021; Hardeli et al., 2022). As expressed by Normore et al. (2024), students are challenged to play an active role in constructing their knowledge, thereby achieving cognitive learning outcomes and fostering critical thinking.

Learning outcomes show how students' critical thinking skills (KBK) have improved. Through the use of a posttest on salt hydrolysis, these results are assessed. With an average score of 73.68, students in the experimental class which used E-LKPD based on discovery learning performed better than those in the control class, which had an average score of 58.83. Therefore, it can be concluded that discovery learning significantly improves student learning results (Muhayati et al., 2023).

Throughout The process of learning in the experimental classroom, where E-LKPD was implemented, students were observed to be more enthusiastic and active in problem-solving compared to those in the control class. This is due to the fact that the E-LKPD in the experimental class is presented in text format, images, and videos, whereas LKPD in the control class consists only of text without visual aids. This finding is consistent with the discovery made by Kwangmuang et al. (2021) that the use of videos and images as learning resources can enhance skills in communication and collaboration during problem-solving.

Conclusion

The study's conclusions indicate that the creation of discovery learning-based E-LKPD is considered feasible with an average score of 91.25% when reviewed in terms of material completeness, accuracy, currency, and alignment with objectives, which is classified as "highly feasible". The practicality of this E-LKPD, based on feedback from students and teachers, achieved percentages of 87.38% and 82.5%, respectively, falling under the "very practical" category. Its effectiveness in improving students' learning motivation and critical thinking skills is also evident, with an N-Gain of 0.56 for learning motivation based on non-test results and an average completeness percentage of 79.48% for students' critical thinking skills (CTS) test results, which falls under the "quite effective" category.

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