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# THE IMPACT OF INVESTIGATION BASED E-LKPD ON MATHEMATICAL CRITICAL THINKING SKILLS OF FIFTH-GRADE STUDENTS

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***ABSTRACT***
*This study aims to determine the effect of the use of E-LKPD based on an investigation approach on the critical thinking skills of 5th grade students at MI Pembangunan UIN Jakarta in mathematics. The research method used is Pre Experimental Design. The research design used is One Group Pretest-Posttest Design. The research instrument used is 10 essay questions that have been tested for validity and reliability. The data collection technique used is a test in the form of descriptive questions and documentation. The data analysis technique used in this study uses the normality test with the Shapiro Wilk technique. Furthermore, the homogeneity test uses One Way ANOVA. Then the hypothesis test uses the Paired Sample T-test with a significance level of 5%. The average pretest score is 33.24 and the posttest is 41.52. The average N-Gain Score is 49% and is included in the "Medium" category. The results of this study indicate that there is an effect of the use of E-LKPD based on an investigation approach on the critical thinking skills of 5th grade students of MI Pembangunan UIN Jakarta in mathematics. This can be proven by the results of the t-test on the average post-test score, which obtained a $p < 0.05$, meaning that H0 is rejected and Ha is accepted.*
**Keywords**: *e-LKPD, investigation approach, critical thinking skills and elementary school mathematics*

**ABSTRAK**
Penelitian ini bertujuan untuk mengetahui pengaruh penggunaan E-LKPD berbasis pendekatan investigasi terhadap kemampuan berpikir kritis siswa kelas V di MI Pembangunan UIN Jakarta pada mata pelajaran matematika. Metode penelitian yang digunakan adalah Pre-Experimental Design dengan desain penelitian One Group Pretest-Posttest Design. Instrumen penelitian yang digunakan berupa 10 soal esai yang telah diuji validitas dan reliabilitasnya. Teknik pengumpulan data menggunakan tes berupa soal uraian dan dokumentasi. Teknik analisis data dalam penelitian ini menggunakan uji normalitas dengan teknik Shapiro-Wilk. Selanjutnya, uji homogenitas menggunakan One Way ANOVA. Kemudian uji hipotesis menggunakan Paired Sample T-test dengan taraf signifikansi 5%. Nilai rata-rata pretest sebesar 33,24 dan posttest sebesar 41,52. Rata-rata skor N-Gain sebesar 49% dan termasuk dalam kategori "sedang". Hasil penelitian menunjukkan bahwa terdapat pengaruh penggunaan E-LKPD berbasis pendekatan investigasi terhadap kemampuan berpikir kritis siswa kelas V MI Pembangunan UIN Jakarta pada pembelajaran matematika. Hal ini dibuktikan dengan hasil uji t terhadap rata-rata nilai posttest yang memperoleh $p < 0,05$, yang berarti H0 ditolak dan Ha diterima.

**Kata kunci:** *e-LKPD, pendekatan investigasi, kemampuan berpikir kritis, dan matematika sekolah dasar*

## 1. Introduction

The development of science and technology progresses alongside the advancement of the times. Currently, both are developing very rapidly. This development is certainly something that cannot be avoided in our lives. As individuals living in this modern era, it is important to position ourselves so that we can adapt to and keep pace with the development of science and technology. One effort to keep up with these developments is by improving the quality of human resources through education, both in schools and outside of schools. Schools are formal educational institutions that strive to improve the quality of education through curriculum improvement, enhancement of educational facilities and infrastructure, development of learning materials, and training for teachers. In addition, schools also play an important role in shaping students' character through rules and regulations implemented within the school environment.

Twenty-first-century learning emphasizes the development of creativity, critical thinking, collaboration, problem-solving, communication skills, social awareness, and character building. Problem-solving ability reflects an individual's capacity to face and resolve challenges effectively. In the context of the learning process, students who are able to overcome problems demonstrate that they possess critical thinking skills (Mardhiyah et al., 2021). Analytical thinking constitutes a fundamental component of holistic educational innovation, particularly in the context of 21st-century skills development. Within this framework, critical thinking has become a central focus of educational reform, as it is essential for cultivating the competencies required to navigate the complexities of the modern world (Sayangan et al., 2024).

Critical thinking skills are a foundational competency for students in an increasingly complex modern era. Thinking itself is a mental process that involves internal questioning to appropriately connect knowledge. In the thinking process, information is processed, manipulated, and transformed. Key to remember is that the term critical thinking itself encompasses numerous skills. For example, if you ask generative AI to list the skills required to think critically, it will quickly provide a list of 15 individual skills required: analysis, evaluation, interpretation, inference, explanation, problem-solving, creativity, reflection, curiosity, metacognition, active listening, communication, open-mindedness, skepticism and decision-making (Silva et al., 2025). Numerous studies have demonstrated that integrating CT into science instruction improves students' understanding of scientific concepts and supports informed decision-making in real-life situations (Affandy et al., 2024). Critical thinking is defined as reasonable and reflective thinking that focuses on deciding what to believe or what action to take. It involves logical reasoning and a systematic approach to understanding the relationships between ideas or facts (Septiany et al., 2024). Critical thinking encompasses a set of essential skills, such as analyzing information, evaluating arguments, solving complex problems, and making appropriate and rational decisions (Sholeh et al., 2024). According to Rima et al., critical thinking is a reflective thinking process that focuses on determining the validity of facts and data. Critical thinking is characterized by the ability to formulate, analyze, reflect, and evaluate information from various perspectives. Therefore, critical thinking is often referred to as the most responsible form of thinking (Sari et al., 2021). The emphasis on critical thinking skills aligns with the shift in educational paradigms that now prioritize active and participatory learning. A student-centered approach, in which students are directly and

actively involved in the learning process, is considered more effective in developing critical thinking skills compared to traditional learning models that focus on the dominant role of the teacher (Juraidah & Hartoyo, 2022).

According to Sayangan et al., critical thinking can foster independence from an early age and develop students' mental readiness to face various problems, both those that arise in their immediate environment and in the wider community. Therefore, critical thinking becomes a fundamental foundation in every students' learning process (Sayangan et al., 2024). Critical thinking has been found to facilitate the development of increased self-awareness and an open-minded approach among students in both personal and professional contexts (Silva et al., 2025). However, at the elementary school level, critical thinking skills often do not receive sufficient attention. The learning process is still largely dominated by memorization activities and the completion of routine exercises. In fact, training students to think critically from an early age can provide significant advantages in the future, particularly in facing the increasingly complex, dynamic, and demanding challenges of the modern workforce (Rahmaniah et al., 2023).

Student Worksheets (LKPD) function as effective instructional tools for facilitating investigation and analysis, thereby enhancing students' critical thinking skills. The structured procedures embedded in LKPD guide learners through activities, projects, and problem-solving tasks, supporting the development of mathematical competencies (Siswanto et al., 2024). One of the main benefits of using Student Worksheets (LKPD) is their ability to support and facilitate learning activities. Effective communication between teachers and students contributes to the improvement of the overall teaching and learning process (Nafisa et al., 2025). Meanwhile, E-LKPD (Electronic Student Worksheets) are a digital form of LKPD that can be accessed anytime and anywhere through digital devices such as smartphones, laptops, computers, tablets, and others. While conventional LKPD are usually provided in hard-copy form, E-LKPD are designed using digital applications in the form of soft copies, making them easier to distribute to students (Wijayanti et al., 2021). E-LKPD can be supported with images and videos, as well as questions presented in written or oral form, which can be answered directly by students. Therefore, E-LKPD provides a more interactive learning experience (Lioba et al., 2021). According to Hafsah et al., as cited in Khoerunnisa et al., the use of E-LKPD essentially facilitates students in completing learning tasks or exercises. Therefore, teachers as facilitators should be able to create an enjoyable learning atmosphere. In addition, E-LKPD can also serve as a form of engaging learning media for students, as it can be accessed anytime and anywhere. Thus, E-LKPD is flexible in supporting students in completing their learning activities (Khoerunnisa et al., 2023). An alternative that can be used to support the teaching and learning process is the use of electronic student worksheets (E-LKPD). The use of E-LKPD can make learning activities more engaging and encourage students to be more active during the learning process (Prastika & Masniladevi, 2021). The use of E-LKPD can enhance teachers' creativity, enabling them to design learning materials that are interactive, enjoyable, and capable of increasing students' interest in learning (Made et al., 2022).

The implementation of E-LKPD constitutes a technology-integrated instructional strategy to enhance students' mastery of subject matter. Through the use of E-LKPD, students are trained to solve problems related to the material they have learned, thereby strengthening their understanding and critical thinking skills (Herlina et al., 2023). This serves as one approach to encourage students to think critically when determining solutions to a problem. In line with the rapid advancement of technology, MI Pembangunan UIN

Jakarta has adopted the use of digital devices in its learning process, one of which is the implementation of E-LKPD. The use of E-LKPD is expected to assist students in understanding the learning material and to encourage them to solve the given problems through critical thinking. However, the current condition in Grade 5 at MI Pembangunan UIN Jakarta has not yet reached the expected level. Some students still experience difficulties and require assistance from the teacher when asked to solve mathematics word problems. In addition, several students have not yet mastered basic arithmetic skills, particularly multiplication and division. This situation may be caused by the E-LKPD design being less interactive and engaging, the learning approach used being less appropriate, or the lack of practice exercises or assignments that incorporate Higher Order Thinking Skills (HOTS).

One of the solutions that has been implemented by the mathematics teacher is strengthening students' basic arithmetic skills by providing practice exercises that encourage students to think critically. In addition, the teacher also uses real-life situations as concrete examples presented in the form of word problems to stimulate students' critical thinking in solving the problems given. However, these efforts have not yet shown significant results and further improvements are still needed as known as each result of research below.

According to research conducted by Puspita and Dewi, the use of an investigative approach in learning provides students with the opportunity to analyze a topic in depth and to connect various forms of conceptual representation. This approach is rich in mathematical content and strongly supports both teachers and students in applying a variety of problem-solving strategies. An optimal effort by a teacher in mathematics learning is to encourage students to seek solutions independently, use reasoning, and conduct investigations as the basis for proving a problem. Thus, the mathematical investigative approach provides space for students to solve problems in their own ways, thereby fostering their critical thinking skills in responding to the problems presented by the teacher (Puspita & Dewi, 2021).

## 2. Metodology

This study employs a quantitative approach. The research method used is the pre-experimental design. In addition, the sample selection in this design is not conducted randomly (non-random), which increases the potential for bias. The research design applied in this study is the one-group pretest–posttest design, which involves only one group, namely the experimental group. In this design, students are given an initial test in the form of a pretest before receiving the treatment, and at the end of the learning process they are given a final test in the form of a posttest.

This design assesses students' critical thinking abilities before and after the intervention. The treatment provided to the students is the use of E-LKPD based on an investigative approach. The research design is illustrated in the table below:

Table 1. Research Design

| Pretest | Treatment | Posttest |
|---|---|---|
| $O_1$ | X | $O_2$ |

Information:
$O_1$ = initial test before the treatment (pretest)

X = treatment administered to the experimental group using an E-LKPD based on an investigative approach
$O_2$ = final test after the treatment (posttest)

This study was conducted at MI Pembangunan UIN Jakarta from April 23 to May 14, 2025. The population comprised all fifth-grade students at MI Pembangunan UIN Jakarta in the 2024/2025 academic year. A sample of 25 students from class 5G was selected through purposive sampling, based on accessibility and its representativeness of the population. Data were collected using tests and documentation. The research instrument consisted of a critical thinking test in the form of 10 essay questions, based on six aspects of critical thinking according to Ennis, namely: focus, reason, inference, situation, clarity, and overview (Aini et al., 2024). The content of the test to be administered is aligned with the competencies and core material relevant to the current curriculum. This test was given to class 5G students both before and after the implementation of the treatment, which consisted of using an E-LKPD based on an investigative approach. Documentation in this study was conducted to collect data in the form of photographs of each activity related to the learning process, including teaching modules, E-LKPD, student worksheets (LKPD), student scores, and learning media used throughout the lessons. This also serves as evidence that the researcher carried out the study and allows observation of students' activities during the learning process.

## 3. Result and Discussion

### 3.1 Results

Two sets of data were obtained from the students' critical thinking skills essay tests: the pretest and the posttest. The test was administered during the pretest to assess the students' critical thinking abilities in responding to questions on the specified material. Following this, learning activities were conducted over three sessions using an E-LKPD based on an investigative approach. Subsequently, a posttest was administered to determine the extent of the students' critical thinking skills after receiving the treatment. The results of the pretest and posttest are as follows:

Table 2. Pretest dan posttest Score Description

| **Description** | ***Pretest*** | ***Posttest*** |
|---|---|---|
| Lowest Score | 30 | 34 |
| Highest Score | 37 | 46 |
| Mean | 33,24 | 41,52 |
| Standard Deviation | 1,877 | 3,111 |
| Sample Size | 25 | 25 |

Based on Table 2, the lowest score in the pretest was 30, and the highest score was 37, with a mean score of 33.24. In the posttest, the lowest score was 34, and the highest score was 46, with a mean score of 41.52. These results indicate an increase in the average scores from the pretest to the posttest. To determine the extent of this improvement, an N-gain test was conducted. The results of the N-gain test are as follows:

Table 3. N-gain Test Result

| N | Posttest Mean | Pretest Mean | N-gain Score | Category |
|---|---|---|---|---|
| 25 | 41,52 | 33,24 | 0,5 | Moderate |

To determine the category of the N-Gain score improvement, the criteria in the table below can be used (Sukarelawa et al., 2024):

Table 4. N-gain Criteria

| ***N-gain* Score** | **Interpretation** |
|---|---|
| $0{,}70 \leq g \leq 100$ | High |
| $0{,}30 \leq g < 0{,}70$ | Moderate |
| $0{,}00 < g < 0{,}30$ | Low |
| $g = 0{,}00$ | No Improvement |
| $-1{,}00 \leq g < 0{,}00$ | Decrease |

Based on the results and criteria presented in the table above, the N-gain score was 0.5, which falls into the moderate category. This indicates that the treatment using an E-LKPD based on an investigative approach had a positive effect on students' critical thinking skills, from the pretest to the posttest.

Before conducting the paired sample t-test, two prerequisite tests must be performed: the normality test and the homogeneity test. The normality test is conducted to determine whether the research population is normally distributed, as the use of parametric statistics for hypothesis testing requires the variable data to be normally distributed. Once the research data are confirmed to be normally distributed, the next step is to perform the homogeneity test. The homogeneity test is conducted to determine whether the variances of each dataset come from a homogeneous group of students. The results of the normality and homogeneity tests for the pretest and posttest data are as follows:

Table 5. Normality Test Result

| | ***Statistic*** | ***df*** | ***Sig.*** |
|---|---|---|---|
| ***Pretest*** | 0,963 | 25 | 0,474 |
| ***Posttest*** | 0,937 | 25 | 0,127 |

Based on Table 3, the results of the calculations for both the pretest and posttest indicate a normal distribution, as the significance values for both tests are greater than $\alpha = 0.05$. The Shapiro-Wilk significance value for the pretest was 0.474, and for the posttest, it was 0.127, thus both values are greater than 0.05.

Table 6. Homogeneity Test Result

| | ***Levene Statistic*** | ***df1*** | ***df2*** | ***Sig.*** |
|---|---|---|---|---|
| ***Based on Mean*** | 3,568 | 1 | 48 | 0,065 |

Based on Table 6, it can be concluded that the significance value for **Based on Mean** is greater than 0.05, specifically 0.065 and indicating that the data can be considered homogeneous. Once the data are confirmed to be normal and homogeneous, the paired sample t-test can be conducted. The results of the paired sample t-test are presented in the table below:

Table 7. Paired Sample Test Result

| | t | df | Sig. (2-tailed) |
|---|---|---|---|
| **Pretest-posttest** | -11,808 | 24 | 0,000 |

Based on Table 7, it can be concluded that the results of the paired sample t-test show a significance level of 5%. The guideline for hypothesis testing is as follows: if the two-tailed significance value is less than 0.05, $H_0$ is rejected and $H_a$ is accepted. The table shows that the two-tailed significance value is 0.000, which is less than 0.05. Therefore, $H_0$ is rejected and $H_a$ is accepted. Thus, it can be concluded that the use of an E-LKPD based on an investigative approach has a significant effect on students' critical thinking skills, as evidenced by the significant difference between the pretest and posttest results.

3.2 Discussion

The learning process in the experimental class was conducted over five sessions, with three sessions using the E-LKPD based on an investigative approach and the remaining two sessions dedicated to administering the pretest and posttest. The implementation of the E-LKPD based on an investigative approach in the experimental class followed several steps: first, students were guided to observe existing phenomena, identify problems, collect data, design steps to solve the problems, carry out problem-solving with calculations, draw conclusions, verify the results, and present their findings. These steps are consistent with Ulfa's perspective, which states that the investigative approach supports students in solving problems through several stages, namely: 1) understanding the problem, 2) developing a problem-solving plan, 3) implementing the problem-solving plan, and 4) reviewing the results (Elvira, 2022). This view is also in line with the statement by Apriliani, cited in Safirah et al., which asserts that critical thinking skills encompass the ability to identify problems, solve them, and analyze issues in depth. These skills are a key component of the learning process, requiring students to actively think, evaluate information, and make rational decisions. (Safirah et al., 2024). According to Ennis, there are six indicators of critical thinking skills that should be considered: 1) Focus, the ability of students to determine the key points in the presented problem; 2) Reason, the students' skill in providing appropriate justification for their answers; 3) Inference, the ability of students to anticipate conclusions based on the answers obtained; 4) Situation, the capacity of students to assert their perception of more complex problems; 5) Clarity, the ability of students to provide examples of problems in their own words; and 6) Overview, the ability of students to verify the correctness of the answers they have obtained. (Aini et al., 2024).

The findings suggest that the use of an investigative approach–based E-LKPD may contribute to improvements in students' critical thinking skills. The results obtained from before and after the treatment in class 5G show a pretest mean score of 33.24 and a posttest mean score of 41.52, with a difference of 8.28. This indicates an improvement in students'

critical thinking skills from before to after the use of the E-LKPD based on an investigative approach.

Critical thinking is one of the essential skills that students must possess. In the study by Rosmania et al., citing Patel, sixteen characteristics of critical thinkers were identified, including keen observation, curiosity, objectivity, introspection, analytical ability, reasoning skills, empathy and decisiveness, humility, openness to new ideas, awareness of faulty thinking, creativity in thinking, effectiveness in oral communication, and active listening. (Rima et al., 2024). According to Novianti (2020), students who possess critical thinking skills are more adept at providing simple explanations, developing foundational skills, drawing conclusions, and constructing logical explanations. Furthermore, these skills also support their ability to interact effectively in academic activities at school, both with teachers and peers (Novianti, 2020).

According to a study conducted by Hayati and Setiawan (2022), students' critical thinking skills are influenced by two factors: internal and external. Internal factors include students' characteristics, reading ability, learning motivation, writing ability, and habits. External factors include the implementation of learning by the teacher and the routines or practices that teachers instill in students (Siti Rofi'ah and Rokhmaniyah, 2024). Therefore, the use of an E-LKPD based on an investigative approach represents one effort to positively influence students' critical thinking skills (Siti Rofi'ah & Rokhmaniyah, 2024). Therefore, the use of an E-LKPD based on an investigative approach represents one effort to positively influence students' critical thinking skills.

During the three learning sessions, the experimental class studied the topic of area measurement. In the classroom learning process, in addition to using the E-LKPD based on an investigative approach, the researcher frequently posed supporting questions to stimulate students' critical thinking skills. The teacher also provided opportunities for students to ask questions related to the facts presented in the problems. According to Aror and Listiani, at this stage, students do not merely recall information but are able to independently discover a set of facts through the learning process. The question-and-answer activities during learning promote student engagement, as students act as the primary subjects of learning rather than merely recipients of information (Aror & Listiani, 2024). The following are the results from the E-LKPD based on an investigative approach using LiveWorksheet, which students completed on the topic of time unit measurement:

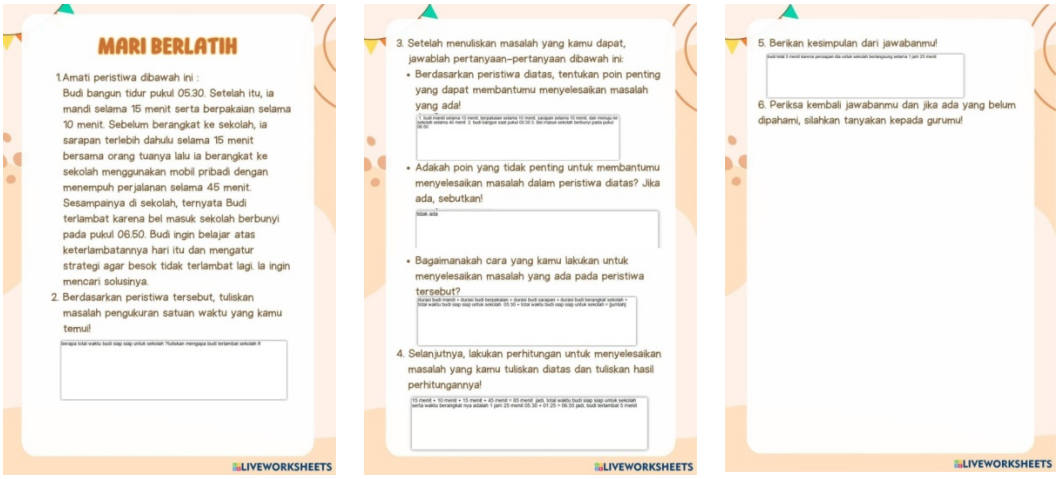


Figure 1. E-LKPD based on an investigative approach using LiveWorksheet

The implementation of the E-LKPD based on an investigative approach, students are allowed to find their own ways to identify problems, determine solutions, solve the problems, and draw their own conclusions. Carrying out these activities requires critical

thinking. Students who possess strong critical thinking skills are able to solve and overcome problems they encounter in their daily lives. Learners who are accustomed to thinking critically are more likely to recognize and pay attention to knowledge and processes in achieving learning objectives. This, in turn, enables students to better understand the material being studied (Fatimah Millenia Fauziah, 2022). Critical thinking is essential for students in various aspects of life, as it enables them to understand the world, act decisively, and develop self-confidence, ultimately preparing them to face future challenges in both personal and professional domains (Alifteria et al., 2023).

The limitation of this study was the restricted research time, which was due to the school's busy schedule and issues with the school's Wi-Fi network during the learning sessions. These network disruptions affected students' ability to scan the barcode containing the E-LKPD using their learning devices, such as tablets.

## 4. Conclution

Based on the results and discussion, the findings suggest that the use of an investigative approach–based E-LKPD may contribute to improvements in students' critical thinking skills. This is indicated by an increase in the mean scores from the pretest (33.24) to the posttest (41.52). The results of the paired-samples t-test show a significance value ($p < 0.05$), indicating a statistically significant difference between pretest and posttest scores. In addition, the mean N-gain score of 49% falls within the moderate category, suggesting a moderate level of improvement in students' critical thinking skills following the intervention. Overall, these findings indicate that the implementation of an investigative approach–based E-LKPD is associated with improvements in the critical thinking skills of fifth-grade students at MI Pembangunan UIN Jakarta, although the results should be interpreted with caution given the research design.

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