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Original Research Article

Enhancing critical thinking skill by implementing electronic student worksheets based on guided inquiry in natural science subject for elementary school

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ABSTRACT

Students' critical thinking skills currently fall short of the requirements for effective learning in the 21st century, highlighting a need for innovative educational models to help cultivate these skills. This study investigates the enhancement of critical thinking skills among sixth-grade elementary students by using an E-LKPD (electronic student worksheets) grounded in guided inquiry. The study utilized a pretest and posttest non-equivalent control group design, encompassing the full student cohort as the sample. Information regarding students' critical thinking abilities was obtained via a descriptive assessment that satisfied recognized validity and reliability standards. The study results, analyzed with an independent t-test on the N-gain score, show an overall improvement rate of 76.16%, exceeding the 70% threshold for high effectiveness. When analyzed by group, the control group achieved an N-gain of 68.11%, falling in the moderate category, while the experimental group reached an N-gain of 84.21%, showing a huge level of effectiveness. Those results conclude that the guided inquiry-based E-LKPD significantly increased critical thinking skills.

Introduction

Critical thinking is a sophisticated cognitive talent vital for efficient learning (Lestari et al., 2023). This skill enhances students' understanding of natural science (IPA) concepts and enhances their capacity to utilize this knowledge in daily life (Ginting et al., 2022). Students do not naturally develop critical thinking skills on their own. Instead, a structured learning approach, including effective methods and resources, is essential to help foster and enhance these skills in students.

The thinking process stage of primary school learners is focussed on actual events that learners can observe. Critical thinking is different from control skills and basic learner skills. Critical thinking is related to logic, as it prepares learners for the formation of conclusions, the creation of unified ideas and the acceptance of reasonable decisions. As long as the problem is real, learners can perform quite complex problem solving (Morozova et al., 2022).

Shavkatovna & Qizi (2021) states that one of the factors of critical thinking is that students can appreciate the thinking process. Learning science at the elementary level plays a very important role, because science provides basic knowledge to students in dealing with life in the surrounding environment. Learning science at the elementary level aims to enhance students' critical thinking abilities (Irsan, 2021). Effective science learning involves developing critical thinking skills, enabling students to approach problems with logical and sound reasoning. Deehan (2022) suggests that elementary school science education equips students to apply scientific understanding to address real-life challenges. Science learning is fundamentally an inquiry-based process, fostering knowledge-building through well-designed experiments, data collection, and clear, rational communication of findings (Fahlevi et al., 2022; Milanto et al., 2023). Scientific products and processes that occur have an important position in science learning in elementary schools.

To effectively teach science in primary schools, an active learning environment is essential, allowing for the integration of students' cognitive, emotional, and physical development. Cognitive aspects are related to building understanding and critical reasoning (Jegstad, 2023). However, the current science learning process only focuses on memorising theories, principles and laws in science learning. Learners can gather new information through a series of thinking processes that include cultivating abilities for autonomous and collaborative problem-solving (Alarcon et al., 2023).

One way to enhance this skill is by using a guided inquiry-based learning model. This method promotes active student engagement, allowing them to investigate, uncover facts, and grasp concepts and principles through firsthand experiences (Strat et al., 2023).

Initial observations with elementary school teachers revealed the following: although a scientific approach is used in classroom teaching, it has not yet fully enhanced students' critical thinking skills; students show limited interest in learning activities, largely because the worksheets consist only of questions that the teacher assigns without guiding students on how to reach the answers; worksheets circulating in schools are less in line with the achievement indicators in the syllabus and only explore low-level thinking skills, such as choosing answers and remembering subject matter; and the worksheets utilized up to this point have not been created by teachers but are instead sourced from publishers. As a result, the students' understanding of the material and their critical thinking abilities have not been adequately cultivated. This aligns with findings from Tressyalina et al. (2023) which indicate that existing worksheets fail to cultivate students' skills and critical thinking abilities. This shortcoming stems from teachers' limited proficiency with digital tools, despite schools being equipped with resources like internet access, learning accounts, and computers.

Current science education must use learning strategies that emphasise more on students' understanding through scientific processes and investigations using ideas (Muskita et al., 2020). Employing worksheets as instructional tools can significantly enhance students' skills during their educational journey (Yusro et al., 2023). Thus, the existence of E-LKPD utilizing guided inquiry as instructional resources for kids can provide creative innovation in the learning process. Combining guided inquiry with E-LKPD aims to enhance students' comprehension and their critical thinking skills regarding various problems, subjects, and challenges (Zhai, 2021). E-LKPDs can enhance the learning experience by fostering interactivity and illustrating each phase of the scientific method. One innovative approach to bridge the learning gap caused by reliance solely on textbooks or printed resources is the use of student worksheets (Asma et al., 2020; JK & Yuliani, 2021).

Students who possess critical thinking skills are more likely to select the most effective course of action or solution. They can evaluate and analyze a given idea, issue, or situation to make informed decisions (Ariani, 2020; Ilhamdi et al., 2020). The grounded inquiry model promotes scientific reasoning, encourages critical thinking, and fosters idea generation among learners. Kılıç & Sahin (2022) note that guided inquiry significantly enhances conceptual understanding during educational activities. Additionally, Korkman & Metin (2021) highlight that guided inquiry can enhance collaborative skills among students, leading to a more meaningful learning experience and improved academic outcomes.

In light of the identified issues and prior research, it is imperative to investigate the enhancement of critical thinking skills among sixth-grade elementary students through the implementation of E-LKPD grounded in guided inquiry, assessing both pre- and post-application, while also identifying factors that affect the efficacy of its application.

Materials and Methods

This research used a quasi-experimental methodology using a non-equivalent control group design. It focuses on all sixth-grade students at SD Swasta Nurul Hasanah located in the Percut Sei Tuan District of Deli Serdang Regency for the academic year 2023/2024. The employed sampling method was total sampling, indicating that the complete population of interest was encompassed in the sample. Data regarding the students' critical thinking skills were gathered via a descriptive assessment that adhered to recognized validity and reliability criteria.

Table 1. N-gain criteria

N-gain Score	Normalized Gain
$0.70 < \text{N-gain}$	High
$0.30 \leq \text{N-gain} \leq 0.70$	Moderate
$\text{N-gain} < 0.30$	Low

The results were analyzed using an independent t-test to ascertain if a statistically significant difference existed between the performance of the control and experimental groups. This statistical method yielded insights into the intervention's efficacy in enhancing critical thinking skills. Additionally, the computation of normalized gain (N-gain) based on Hake's formula (1999) was conducted to measure the relative improvement of students' critical thinking abilities before and after the intervention. The N-gain results offered a quantifiable indicator of learning progress, enabling comparisons across groups. These results were then categorized into low, medium, and high criteria, as outlined in Table 1, to facilitate a clearer interpretation of the extent of learning improvement achieved through the utilize of the guided inquiry-based E-LKPD.

Results and Discussion

The evaluation of students' critical thinking abilities was conducted by analyzing their responses to descriptive questions. This analysis employed an independent t-test, which compares two separate groups using quantitative data. The focus of this assessment was on the change in scores between the pre-test and post-test. The rise in scores, regarded as the dependent variable, was determined by subtracting the pre-test results from the post-test findings. Thus, the study concludes that a considerable disparity exists in score improvement between the experimental group and the control group.

This research evaluates various components of critical thinking abilities (1) The ability of students to provide simple explanations based on the phenomenon of the movement of the earth and the moon; (2) The ability of students to build basic knowledge by observing the movement of the earth and the moon; (3) The ability to conclude by making decisions based on observations of the movement of the earth and the moon; (4) The ability to make further explanations by identifying terms and assumptions related to the movement of the earth and the Moon; and (5) The ability of strategies and tactics when providing explanations and presenting hypothesis results on the movement of the earth and the moon.

Based on the initial evaluation results obtained through pretest, as presented in Fig-1, the average critical thinking skills of students varied across different indicators. For the indicators of elementary clarification score was 77.5. The basic support indicator showed an improvement with an average score of 119.5, while the inference indicator yielded a higher average score of 163. Furthermore, the advance clarification indicator demonstrated even better results, with an average score 195. Lastly, the indicator of strategy and tactics for explaining the movement of the Earth and the Moon achieved the highest average score at 216. These findings indicate variability in the level of critical thinking proficiency across the measured indicators.

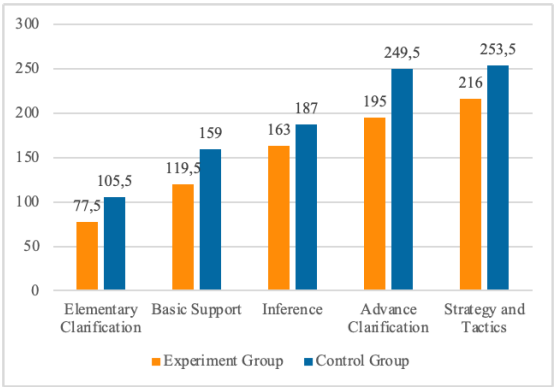

Fig-1. Average initial critical thinking ability

The assessment conducted through the posttest showed a significant increase in the critical thinking ability of students related to the explanation of the movement of the earth and the moon after being given guided inquiry-based E-LKPD. Stated by Fig-2, the average score obtained by students has increased in all indicators. In the indicator elementary clarification the average score increased to 110.5. A higher increase was seen in the indicator basic support with the average score reaching 227.5. The indicator inference recorded a significant increase with an average score of 311. Meanwhile, the indicator advance clarification obtained the highest average score of 397.5. In the last indicator, namely strategy and tactics for explaining the movement of the earth and moon the average score reached 389.

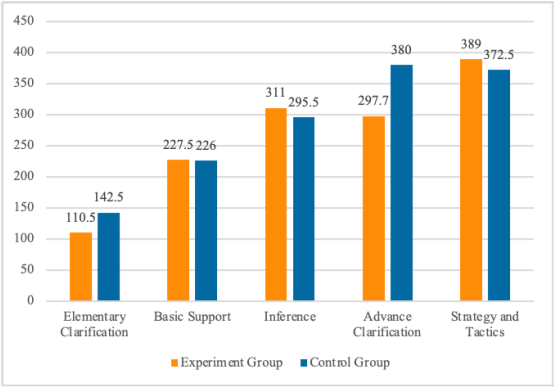

Fig-2. Average final critical thinking ability

The results demonstrate the efficacy of employing guided inquiry-based E-LKPD in enhancing students' critical thinking abilities. A comprehensive analysis of the data obtained from the N-gain tests for both the experimental and control groups is presented in Table 2.

Tabel 2. Independent sampel t test

	t	df	Mean	Std. Error
Gain	4.171	62	-15.156	3.52

Tabel 3. Improvement in students' critical thinking skills

Groups	N-Gain	Category	Learning Effectiveness
Control	68.11	Moderate	Moderately effective
Experiment	84.21	High	Effective

The results in Table 2 indicate an average improvement difference of -15.156 between the two groups, accompanied by a 95% confidence range of 3.52. The calculated t-value is 4.171, resulting in a p-value of 0.001, which is below 0.05. Thus, we reject the null hypothesis (H0), signifying that the disparity in mean improvement between the two groups is statistically significant at the 95% confidence level. The overall N-gain for the group stands at 76.16%, which meets or exceeds the 70% threshold, placing it within the high effectiveness range for learning, as it is equal to or surpasses 76%. When analyzing the groups separately, the control group has an N-gain of 68.11%, categorizing it as medium and indicating a moderate level of learning effectiveness as shown in Tabel 3. In contrast, the experimental group achieved an N-gain of 84.21%, positioning it in the high category and demonstrating strong learning effectiveness.

Utilizing E-LKPD developed through guided inquiry at each phase significantly enhances students' critical thinking abilities, making the learning experience more meaningful and of higher quality. The stages of learning rooted in the guided inquiry approach facilitate an environment where students can delve into their own thoughts and ideas. This exploration is crucial for understanding concepts, enabling students to grasp essential elements of their learning effectively (Aditomo & Klieme, 2020; Ahaddin et al., 2020).

The findings aligns with the findings of Maknun (2020) which indicated that students engaged in science lessons utilizing E-LKPD based on guided inquiry demonstrated better performance than those taught through a scientific approach. As shown in Table 4, the experimental group exhibited an average improvement in critical thinking skills of 84.21%, classified as high, while the control group showed a lower average increase of 68.11%. The comparison of average N-gain scores between the two classes indicates that E-LKPD based on guided inquiry is more effective in improving students' critical thinking skills than conventional scientific approaches. Furthermore, the inclusion of Google Sites featuring captivating images and videos can enhance students' motivation to learn (Damayanti & Ratnasari, 2021).

According to the findings by Minarni and Barus (2023) electronic worksheets are effective in enhancing students' critical thinking abilities. Facilitated inquiry-driven E-LKPD functions as an interactive instructional tool for students. This method promotes a favorable disposition towards learning by motivating pupils to interact actively and think innovatively when confronted with problems. Consequently, this method helps to develop their critical thinking skills across various educational activities (Anjarwani et al., 2020).

The guided inquiry strategy focuses on finding solutions, ideas and concepts to build new knowledge to develop critical thinking skills. Learners use their scientific research findings to develop new knowledge (Hisyam & Handayani, 2024). The benefits obtained by learners in using inquiry-based learning include a better understanding of basic concepts and ideas, helping to improve memory retention and the ability to transfer knowledge to new learning situations, and encouraging the development of learners' conceptual understanding (Eriyanti et al., 2023). In addition, learners reconsider their hypotheses by considering acceptance, and rejection (Kawuwung et al., 2023).

Conclusion

The results indicated that employing E-LKPD through guided inquiry significantly influenced outcomes, with the experimental group achieving an average N-gain of 84.21%, while the control group reached 68.11%. This demonstrates that science education utilizing E-LKPD centered on guided inquiry effectively enhances students' critical thinking abilities, as evidenced by the comparison of average pretest and posttest scores. Therefore, it can be concluded that this approach to learning prioritizes the application of concepts to clarify variables, leading to a deeper understanding among students regarding the movements of the Earth and the Moon.

Conflict of Interests

The author declares that there is no conflict of interest in this research and manuscript.

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