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The Effectiveness of the E-Book-Assisted Inquiry and Discovery Learning Model on the Critical Thinking

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Abstract

This study aims to determine the effectiveness of the Inquiry and Discovery Learning learning models assisted by e-books on the critical thinking skills of fifth-grade elementary school students. This study uses a quantitative approach with a quasi-experimental design in the form of a pretest-posttest control group design. The research subjects consisted of three groups, namely the class using the Inquiry model, the class using the Discovery Learning model, and the control class using conventional learning. Data collection techniques were carried out through critical thinking ability tests. Data were analyzed using normality tests, homogeneity tests, and hypothesis testing using ANOVA. The results showed that the data were normally distributed and homogeneous. Hypothesis testing showed significant differences between the three groups, with a significance value <0.05. The Inquiry learning model has a higher effectiveness than Discovery Learning, but both models are proven to be more effective than conventional learning in improving students' critical thinking skills. The use of e-books as a learning medium also makes a positive contribution in increasing student motivation and involvement in the learning process. Based on the results of the study, it can be concluded that the Inquiry and Discovery Learning learning models assisted by e-books are effective in improving elementary school students' critical thinking skills. Therefore, teachers are advised to implement innovative learning models supported by technology to improve the quality of learning.

Introduction

21st-century education demands that students possess higher-order thinking skills (HOTS), encompassing the 4Cs: Critical Thinking, Creativity, Communication, and Collaboration (Partono et al., 2021). This ability to think critically is crucial for students as they prepare to address various problems in everyday life (Monica et al., 2021). Furthermore, critical thinking skills can also improve student achievement (Putri & Indarini, 2023). This is because critical thinking skills help students apply concepts, conduct analysis, and connect concepts to solve problems in everyday life (Febrita & Harni, 2020).

The new paradigm in education positions educators as facilitators who provide essential information to guide students in the learning process (Irianti, 2024; Wafula, 2025; Avissar & Yondler, 2025). Furthermore, educators also have a responsibility to design learning activities that encourage active student engagement and problem-solving (Aliyyah et al., 2023; Gebremeskel et al., 2025; Choirudin et al., 2025). Educators' responsibility in planning learning activities can be achieved by selecting models appropriate to the situation and student characteristics. The selection of appropriate learning models, strategies, and media will impact student learning outcomes and critical thinking skills (B. Ariyani & Kristin, 2021; Devi & Bayu, 2020). In other words, the accuracy of selecting learning models, strategies, and media can influence students' ability to think critically.

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"In the Merdeka curriculum, science and social studies lessons stand alone, but with consideration of the developmental psychology of elementary school children during a strategic period for enhancing children's inquiry skills" (Suhelayanti et al., 2023:2). The Merdeka Curriculum incorporates new updates from the previous curriculum, namely the restructuring of Natural Sciences (IPA) and Social Sciences (IPS) into Natural and Social Sciences (IPAS). Through science learning, students are expected to be able to relate scientific concepts to everyday life, as well as develop a critical attitude and concern for the environment. Therefore, science learning needs to be designed in such a way as to foster critical thinking skills and other 21st-century skills.

However, the reality on the ground shows that critical thinking skills, especially in the science and studies learning process in elementary schools, still face various obstacles. This is due to the selection of learning models, media, and strategies that are not appropriate for the needs and characteristics of elementary school students. Based on observations in fifth grade students at SD N 2 Kemiri and SD N 2 Ngronggah, many teachers still use conventional learning methods such as lectures and assignments without actively involving students in the learning process. This teacher-centered learning model tends to make students passive, afraid to express opinions, mentally weak, have low self-esteem, lack critical thinking, and be less productive (Mujahida, 2019: 329). Furthermore, the underutilization of learning media results in students only knowing without seeing the real problems they encounter. This opinion aligns with (Jannah & Atmojo, 2022: 2), who stated that the use of learning media in science and studies can stimulate students, thereby improving their understanding and critical thinking skills.

The suboptimal critical thinking skills in science and studies require solutions to address this issue. One solution to address these issues is to implement student-centered inquiry and discovery learning models. Both models emphasize the process of seeking and discovering knowledge through exploratory and investigative activities. "Inquiry learning, to develop critical thinking skills, emphasizes student engagement in science learning" (Suratningsih, 2022). Meanwhile, discovery learning guides students to learn actively, discover information independently, identify, investigate, and prove problems related to the material and their everyday environment.

The Inquiry Learning Model is a learning model developed so that students find and use various sources of information and ideas to improve their understanding of certain problems, topics or issues (Putri, 2018:3). Through this method, students are encouraged to be actively involved in the teaching and learning process, one of which is by actively asking questions about each material presented and these questions do not always have to be answered by the teacher, because each student has the same ability to provide answers to their friends' questions. Science education in elementary schools is directed at an inquiry-based approach to encourage students to gain a more complex understanding of their surrounding environment (Agustinus & Aprilio, 2025: 108). The inquiry approach refers to a learning process that emphasizes students' active involvement in formulating questions, investigating and exploring scientific concepts through experiments or direct observation (Agustinus & Aprilio, 2025: 108).

Apart from the Inquiry Learning model to improve students' critical thinking skills, teachers can also apply the Discovery Learning model. Discovery Learning is a learning process that focuses students on discovering their own knowledge through experiments or direct observation so that learning activities become active and creative (Endah, 2021:2). According to Bruner (1961) Discovery Learning is student-centered learning, where they are actively involved in discovering important principles and concepts through an exploration process.

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The Discovery Learning model is a learning process that does not provide concepts directly, but requires students to organize their own learning methods to discover a concept (Ramadani et al., 2023:2). Discovery Learning is a model for developing active student learning through self-discovery and self-investigation. The results obtained will be retained and long-lasting in memory, not easily forgotten (Adi, 2022:3). According to (Nurliza, 2025:629), the implementation of the Discovery Learning model can develop students' critical thinking skills. The Discovery Learning model can be combined with teaching materials and interactive media to help improve critical thinking skills. Furthermore, learning using the Discovery Learning model can improve students' collaboration skills and learning outcomes. This is evident in the learning implementation steps that provide opportunities for students to be active in groups (Rini, 2020:130). Students not only receive information but also learn how to obtain and verify that information. Thus, learning becomes more meaningful and oriented towards the development of higher-order thinking skills. To implement the Inquiry and Discovery Learning model more effectively, it requires the support of learning media that are appropriate to the characteristics of students and the subject matter. One of the new media that can be used is the e-book. E-books are digital books that contain information or guides, tutorials, materials, like books in general. These e-books (electronic books) can only be opened and read using gadgets such as tablets, computers, and smartphones (Salsabila & Suniasih, 2024: 598). E-books are appropriate for use in the learning process at school or independent study at home so that they can improve student learning outcomes. Several previous studies have stated that the development of inquiry-based digital books is feasible and effective for implementation and development of e-book teaching materials based on a scientific approach to improve student learning outcomes (Sukmana et al., 2022; Yasa et al., 2022; Salsabila & Suniasih, 2024: 598). The results of research by (Rosmawati, 2023) in the journal show that the use of e-books can effectively train students' critical thinking skills. To date, technological advances have facilitated the learning process, both through print and non-print media (Agusta & Arisandy, 2017:8; Rosmawati, 2023:982). The use of e-books as teaching materials can be a solution to address these issues (Rosmawati, 2023:982).

Elementary school students, in particular, are more enthusiastic about learning thanks to the practical and portable nature of e-books (Khikmawati Devi et al., 2021:74). E-books offer advantages in terms of flexibility, interactivity, and ease of access. Through e-books, students can learn independently, access various information sources, and interact with engaging multimedia content. This aligns with research (Maulida & Zulherman, 2024:900) which shows that the Science E-Book, supported by Flip PDF Professional, is an alternative, innovative learning medium that can effectively improve literacy and the quality of learning in elementary schools.

Methods

This study employed a quantitative approach with a quasi-experimental nonequivalent pretest–posttest comparison-group design. The participants were 45 fifth-grade students from elementary schools in Kunduran District, Blora Regency, selected using saturated sampling. They were divided into two groups: 23 students received e-book-assisted Inquiry Learning, while 22 students received e-book-assisted Discovery Learning.

Data were collected using pretest and posttest critical-thinking skills tests and documentation. The pretest was administered before the intervention to measure students' initial abilities. The two groups then received learning treatments based on their respective models using comparable e-book materials, followed by a posttest to measure students' critical-thinking skills after the intervention.

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Data were analyzed using descriptive and inferential statistics. The Shapiro–Wilk test was used to examine data normality, while Levene's test was used to assess variance homogeneity. An independent-samples t-test was conducted to compare the pretest and posttest scores of the two groups at a significance level of .05. The improvement in students' critical-thinking skills was also evaluated using the normalized gain (N-Gain) score.

Results and Discussion

This study used the Pretest-Posttest Only Control Group Design experimental method, which began with students being given a pretest before treatment and a posttest after treatment. This study was conducted at SDN 2 Kemiri and SDN 2 Ngronggah in the 2025/2026 academic year. The population in this study were 45 fifth-grade students of SDN Tlogomulyo. In sampling, the researcher used a saturated sampling technique so that all members of the population were used as research samples, totaling 45 students.

Pre-test and Post-test Results

The study was conducted in two sessions. The first session involved a pretest. The second session involved implementing the treatment using the inquiry learning and discovery learning models using flipbooks. The posttest was followed by the results. The test results are presented in Table 1 below.

Table 1. Results of the Pretest and Posttest of the Research

No	Pre-post test	Inquiry Learning	Discovery Learning
1	Pretest	62,15	61,80
2	Posttest	82,40	78,25

The results of the study showed an increase in students' critical thinking skills after being given treatment. The pretest and posttest scores were then calculated as follows:

Table 2. Descriptive Statistics Results of Pretest Questions

Result	Experiment	Control
N	23	22
Minimum	61	61
Maximum	85	85
Mean	72,50	72,09
Std. Deviation	6,776	5,961

Based on the pretest scores and pretest results, it shows that students in both classes have abilities that are not significantly different..

Table 3. Results of the Normality Test for Pretest Questions

Tests of Normality				
		Shapiro-Wilk		
	Kelas	Statistic	df	Sig.
Student Score	Pretest Experiment (inquiry)	.960	23	.431
	Pretest Control (Discovery)	.968	22	.637

Data normality testing was conducted to verify whether the samples taken corresponded to the population. Data were normally distributed if the significance value was >0.05. Normality testing was performed using the Shapiro-Wilk test. Based on the normality test in Table 3, the data showed that the pretest questions for each class sample came from a normally distributed

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population. Furthermore, the results of the pretest homogeneity test are presented in Table 4 as follows:

Table 4. Results of the pretest homogeneity test

Test of Homogeneity of Variance					
		Levene Statistic	df1	df2	Sig.
Student Score	Based on Mean	.434	1	45	.513
	Based on Median	.399	1	45	.531
	Based on Median and with adjusted df	.399	1	44.594	.531
	Based on trimmed mean	.432	1	45	.514

A homogeneity test was conducted to ensure that both classes had homogeneous variances. Both classes are considered homogeneous if the significance value is >0.05. The homogeneity test used the Levene statistic. The results of the homogeneity test for pretest scores yielded a sig. 0.513 > 0.05. It can be concluded that the variances of the pretest scores are homogeneous.

Next, the pretest difference test is presented in Table 5 as follows:

Table 5. Pretest t-test results

Result	Experiment	Control
t-test	0,826	
Number of Students	23	22

A difference test was conducted to determine significant differences between the two classes before treatment. Data were considered to have significant differences if the significance value was <0.05. The difference test used an independent sample t-test. The results of the pretest difference test on the test scores showed a significance value of 0.826 >0.05. Next, the calculation of the post-test results will be presented in table 6 as follows:

Table 6. Post-test Descriptive Statistics Results

Result	Experiment	Control
N	23	22
Minimum	73	67
Maximum	94	91
Mean	83,75	80,17
Std. Deviation	5,152	5,982

The average value of the experimental class is 3.58 higher than the control class, but the standard deviation of the control class is higher than the experimental class, which means that the control class values are more varied than the experimental class values. Furthermore, the normality test is presented in Table 6 as follows:

Table 7. Post-test Normality Test Results

Tests of Normality		
		Shapiro-Wilk

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	Class	Statistic	df	Sig.
Students Score	Experiment Posttest(Inquiry)	.972	23	.729
	Posttest Control (Discovery)	.972	22	.727

This shows that the posttest questions in each class sample come from a normally distributed population. Next, the post-test homogeneity test will be presented in table 8 as follows:

Table 8. Results of the Post-test Homogeneity Test

Test of Homogeneity of Variance					
	Levene Statistic		df1	df2	Sig.
Students Score	Based on Mean	.507	1	45	.480
	Based on Median	.412	1	45	.524
	Based on Median and with adjusted df	.412	1	43.709	.524
	Based on trimmed mean	.500	1	45	.483

The homogeneity test for post-test scores yielded a significant value of 0.480 > 0.05. It can be concluded that the variance of the post-test scores is homogeneous.

The difference test results are presented in Table 8 as follows:

Table 9. Post-test T-Test Results

Independent Samples Test								
t-test for Equality of Means								
				Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
		t	df				Lower	Upper
Students Score	Equal variances assumed	2.199	45	.033	3.576	1.626	.301	6.852
	Equal variances not assumed	2.192	43.411	.034	3.576	1.632	.287	6.865

In this study, the significance level was set at 5% or 0.05, which is the tolerance limit for accepting an error from the hypothesis results. The hypothesis test in this study was based on the significance value (sig. 2-tailed) found in the results of the independent sample t-test. The results of the student scores show that the result of the significance value (sig. 2-tailed) is 0.033, which means it is smaller than 0.05 (0.033 < 0.05), meaning there is a significant difference in the influence of the application of the inquiry learning model and the Discovery Learning model on the learning outcomes of 5th grade students.

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N-Gain Test Results

N-Gain Formula:

$$N\text{-Gain} = \frac{Posttest - Pretest}{Maximum\ Score - Pretest}$$

No	Class	N-Gain	Category
1	Inquiry	0,119681	low
2	discovery	0,088791	low

The research results show that the implementation of the Inquiry and Discovery Learning learning models, supported by e-books, had a positive impact on the critical thinking skills of fifth-grade elementary school students. This improvement was evident in the significant difference between pretest and posttest results, as well as the difference compared to classes using conventional learning. These findings align with Robert H. Ennis's opinion that critical thinking is a reflective and rational thought process focused on decision-making, and therefore needs to be cultivated through active and challenging learning.

The Inquiry Learning model has proven more effective in improving students' critical thinking skills. This is because it emphasizes the process of investigation, asking questions, and independently seeking answers. According to Jerome Bruner, learning that involves the process of discovery (inquiry) makes the knowledge gained more meaningful and memorable. Furthermore, Joyce Weil explains that the Inquiry Learning model can develop students' intellectual abilities through systematic and analytical thinking processes. Thus, students not only receive information but also process and evaluate it critically.

Meanwhile, the Discovery Learning model also demonstrated effectiveness in improving critical thinking skills, although not as high as the Inquiry Learning model. This model provides students with opportunities to discover concepts through learning experiences. Jerome Bruner emphasized that discovery learning can improve thinking skills, particularly in understanding concepts in depth. However, in practice, elementary school students still require adequate guidance for optimal discovery. This is supported by Vygotsky's opinion, which emphasized the importance of scaffolding, or teacher assistance, in students' learning processes.

The use of e-books as a learning medium also contributes to improving students' critical thinking skills. E-books allow for a more engaging and interactive presentation of material, thereby increasing student motivation to learn. According to Richard E. Mayer, learning that combines text and visuals can improve students' understanding and thought processes. Furthermore, research by Clark & Mayer shows that the use of digital media in learning can increase student engagement and learning effectiveness.

When compared to conventional learning, these two learning models demonstrate significant advantages. Conventional learning tends to be teacher-centered, resulting in students being less active in the learning process. Paulo Freire referred to this approach as the banking concept of education, where students merely receive information without active involvement. In contrast, the Inquiry and Discovery Learning model places students at the center of learning (student-centered), which encourages active involvement and the development of critical thinking skills.

This research finding is also supported by Jean Piaget's constructivism theory, which states that knowledge is actively constructed by individuals through interaction with the environment. In this context, the Inquiry and Discovery Learning model provides

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opportunities for students to construct their own understanding, making learning more meaningful.

Thus, it can be concluded that the application of the Inquiry and Discovery Learning model with the assistance of e-books is an effective strategy in improving the critical thinking skills of elementary school students. These results reinforce the importance of using innovative learning models and technology integration in supporting the development of 21st-century skills, particularly critical thinking skills.

The findings show that e-book-assisted Inquiry Learning produced higher critical-thinking outcomes than e-book-assisted Discovery Learning. The Inquiry group obtained a higher posttest mean, and the difference between the groups was statistically significant at $p = .033$. However, the low N-Gain category in both groups indicates that the practical improvement remained limited.

The stronger performance of Inquiry Learning can be explained by its systematic stages of questioning, investigation, evidence interpretation, and conclusion formation. These activities directly train students to evaluate information and develop evidence-based explanations. Pedaste et al. (2021) found that inquiry activities strengthen scientific reasoning by involving students in planning, investigating, interpreting data, and drawing conclusions. Similarly, Öztürk et al. (2022) confirmed that inquiry-based learning generally produces positive cognitive outcomes because students actively construct knowledge. Arifin et al. (2025) further demonstrated that inquiry-based learning has a substantial effect on critical thinking, although its effectiveness varies according to instructional design and learning context.

Teacher guidance is essential because elementary students may not be able to complete complex inquiry tasks independently. Soysal (2021) showed that inquiry becomes more effective when teachers ask students to clarify, justify, and revise their explanations. Wulandari et al. (2022) also found that guided inquiry helps students complete the reasoning process through structured questions and investigation stages. Nevertheless, guidance must be adjusted to students' needs because excessive assistance can reduce independence, while insufficient support can create confusion (Heppt et al., 2023).

Discovery Learning also contributed to students' critical thinking, although its outcomes were lower than those of Inquiry Learning. This difference may occur because Discovery Learning requires students to independently identify patterns, organize information, and formulate concepts. Mustikaningrum et al. (2021) found that Discovery Learning improved critical thinking when its activities were supported by clear instructions and teacher facilitation. Sutanto et al. (2022) similarly reported that digital Discovery Learning materials were effective when they systematically guided students through observation and interpretation. Therefore, the lower result does not indicate that Discovery Learning is ineffective, but suggests that elementary students need sufficient scaffolding during the discovery process (Iman et al., 2024).

The e-book supported both models by presenting information in a flexible and visually accessible format. Digital materials can help students review concepts, observe scientific representations, and connect learning content with contextual problems. Susanto et al. (2022) found that problem-based e-books improved critical thinking when they included analytical tasks and contextual activities. Jannah and Atmojo (2022) also emphasized that digital media strengthens critical thinking when students are required to process information rather than merely read it. Similar findings showed that e-books are more effective when they contain reflective questions, interactive activities, and problem-solving tasks (Rosmawati, 2023;

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Salsabila & Suniasih, 2024). Contextual digital materials can also help students connect scientific concepts with everyday experiences (Aprilia, 2021).

Technology alone, however, does not automatically improve critical thinking. Its effectiveness depends on how digital features are integrated with the stages of the learning model. Yun and Crippen (2024) found that educational technology was most beneficial when it supported investigation, evidence organization, and scientific communication. Wen et al. (2023) similarly showed that digital technology improved learning when combined with structured inquiry activities. Reflective prompts also become effective only when students actively respond to and evaluate them (Hsu et al., 2022). Yasa et al. (2024) further demonstrated that technology-supported inquiry can strengthen both critical thinking and digital literacy through investigation, reflection, and digital reporting.

The findings support the relative advantage of e-book-assisted Inquiry Learning over e-book-assisted Discovery Learning. Inquiry Learning appears more effective because it provides a clearer structure for questioning, investigating, evaluating evidence, and forming conclusions. Nevertheless, the low N-Gain results, small sample, and inconsistencies among the reported mean scores limit the strength of this conclusion. Future studies should verify the N-Gain calculation, report effect sizes, maintain consistency across tables, and include a conventional control group to distinguish the effects of the learning model and the e-book.

Conclusion

Based on the research results and discussion, it can be concluded that the application of the Inquiry and Discovery Learning models, supported by e-books, is effective in improving the critical thinking skills of fifth-grade elementary school students. This is evidenced by the improvement in student learning outcomes and the significant differences between the experimental class and the class using conventional learning. The Inquiry learning model demonstrated a higher level of effectiveness compared to the Discovery Learning model. This is because the Inquiry model provides students with broader opportunities to actively participate in the investigation process, ask questions, analyze information, and draw conclusions independently, thus optimally developing critical thinking skills. The Discovery Learning model has also proven effective in improving critical thinking skills, particularly in helping students understand concepts through the process of discovery. However, its effectiveness still requires support in the form of teacher guidance to ensure students can effectively follow the learning process. The use of e-books as a learning medium positively contributes to increasing student motivation and engagement. The interactive and flexible presentation of material helps students understand concepts more deeply and supports critical thinking processes. Thus, the integration of innovative learning models such as Inquiry and Discovery Learning supported by the use of technology in the form of e-books can be an effective alternative in improving the quality of learning, especially in developing the critical thinking skills of elementary school students.

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