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## The Effectiveness of Inquiry-Based Learning Instrument to Enhance Student's Critical Thinking Skills

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**Abstract.** The limitations of inquiry-based learning tools have an impact on the low critical thinking skills of elementary students in science learning. This study aims to examine the effectiveness of inquiry-based learning tools to improve critical thinking skills. The study design is a quasi nonequivalent control group experiment. The experimental class was treated with inquiry-based learning devices, the control class was implemented with STAD-based learning devices. The population and sample in this study were students in grades IVA and IVB at SDN Kepanjen 2 and SDN Panggungrejo 4. This study was conducted for one month from August to September 2022. The instrument used was a critical thinking skills test. The validity test is calculated based on the Aiken index. Data were analyzed based on the pair t-test. The results of this study indicate a very significant difference in students' critical thinking skills. The average score of students' critical thinking before the use of inquiry learning tools in the experimental class was 53.59 and after being used was 82.44. Control group students have an average critical thinking ability of 42.35 and thereafter 59.88. There are factors that affect the effectiveness of inquiry-based learning tools including the validity of the device, the difference in the average score of critical thinking skills which is very significant for students in the experimental and control groups, the responses of students and teachers, and the implementation of learning. In conclusion, instructional inquiry tools are effective for improving critical thinking skills. This study recommends the development of inquiry-based learning tools to improve students' critical thinking skills.

**Keywords.** Critical Thinking Skills; Inquiry Learning; Learning Instrument

**Abstrak:** Keterbatasan perangkat pembelajaran berbasis *inquiry* berdampak pada rendahnya keterampilan berpikir kritis siswa SD pada pembelajaran IPA. Studi ini bertujuan mengkaji efektivitas perangkat pembelajaran berbasis *inquiry* untuk meningkatkan keterampilan berpikir kritis. Desain studi ini *quasi experiment nonequivalent control group*. Kelas eksperimen diberikan perlakuan perangkat pembelajaran berbasis *inquiry*, kelas kontrol diimplementasikan perangkat pembelajaran berbasis STAD. Populasi dan sampel dalam studi ini adalah siswa kelas IVA dan IVB SDN Kepanjen 2 dan SDN Panggungrejo 4. Studi ini dilakukan selama satu bulan dimulai Agustus sampai September 2022. Instrumen yang digunakan adalah tes keterampilan berpikir kritis. Validitas tes dihitung berdasarkan indeks Aiken. Data dianalisis berdasarkan uji *paired t-test*. Hasil studi ini menunjukkan ada perbedaan yang sangat signifikan keterampilan berpikir kritis siswa. Rata-rata skor berpikir kritis siswa sebelum penggunaan perangkat pembelajaran inkuiri pada kelas eksperimen 53,59 dan setelah digunakan 82,44. Siswa kelompok kontrol memiliki rata-rata kemampuan berpikir kritis sebesar 42,35 dan

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setelahnya 59,88. Terdapat faktor-faktor yang memengaruhi efektivitas perangkat pembelajaran berbasis *inquiry* diantaranya validitas perangkat, hasil perbedaan rata-rata skor keterampilan berpikir kritis yang sangat signifikan pada siswa kelompok eksperimen dan kontrol, respon siswa dan guru, dan keterlaksanaan pembelajaran. Kesimpulannya perangkat instruksional *inquiry* efektif untuk meningkatkan keterampilan berpikir kritis. Studi ini merekomendasikan pengembangan perangkat pembelajaran berbasis *inquiry* untuk meningkatkan keterampilan berpikir kritis siswa.

**Kata kunci:** *Inquiry Learning*; Keterampilan Berpikir Kritis; Perangkat Pembelajaran

## INTRODUCTION

The rapid advancement of technology requires individuals to have the competencies required in the 21st century. Critical thinking and problem solving, communication, collaboration, creativity, and innovation are competencies that individuals in this century must have (Afandi et al., 2019; Chu et al., 2017). Therefore, in education, teachers should strengthen students' abilities to meet the demands of global competencies that are needed at this time. Students should have critical thinking skills as a fundamental ability in the 21st century (Lubis et al., 2022). In this century critical thinking skills are very important to have because someone who has this ability is expected to grow into an individual who is ready to meet the needs of the global community. One expert who defines critical thinking skills is Ennis. Ennis defines critical thinking as thinking rationally to determine responses and actions towards something. Indonesia is ranked 44th out of 47 participating countries in the TIMSS ranking (TIMSS, 2015). This proves that students' analytical thinking skills are in the low category.

The effort to elaborate students' critical thinking skills is to improve the quality of learning. Many factors can be empowered to improve the quality of learning, one of which is learning tools (Prasinta et al., 2018). Everything that the teacher prepares before the lesson is a learning tool (Majid & Rohman, 2015). Syllabus, Learning Implementation Plan (RPP), Student Activity Sheet (LKPD), and assessment are examples of learning tools. Learning devices are important elements that affect all learning activities. Students will be motivated to participate actively in learning if they have access to learning resources that support the growth of critical thinking skills.

Several literatures indicate an effective instructional model to improve students' critical thinking. Inquiry-based learning, problem-based learning, and project-based learning are some of these learning models (Aránguiz et al., 2020; Mahanal, 2019; Suryanti et al., 2018). The inquiry learning paradigm can be used to train students in elaborating their critical thinking skills (Maknun, 2020). Inquiry is based on constructivist learning theory which emphasizes the importance of building students' knowledge (Cleovoulou, 2018). Inquiry allows students to develop conceptual understanding of scientific phenomena and inquiry skills (van Uum et al., 2016). Therefore, learning using inquiry can encourage students to learn through concrete experiences so that students have holistic knowledge of a phenomenon.

Majority of LKPD used in elementary schools does not facilitate the development of students' thinking skills. The results of observations on the LKPD used in SDN 1 Kepanjen, SDN 7 Kepanjen, SDN Panggungrejo 4, and SDN 2 Kepanjen found that the

LKPD used in learning was purchased from the publisher. The results of the LKPD content analysis contain learning materials and practice questions. The practice questions presented in the LKPD require rote answers and do not practice problem solving skills. In online learning, students use conventional worksheets so that the science learning process becomes less than optimal.

These findings are also in line with the results of a literature study which shows that the RPP and LKPD used in SD so far have not directed students to inquiry-based learning activities and High Order Thinking Skills (HOTS) (Widiarta et al., 2019). The use of teaching devices by teachers only considers administrative needs (Yusuf et al., 2019). Based on observations and literature studies, it is interpreted that the learning tools that have been used so far in elementary schools have not met the demands of the 2013 curriculum in developing students' thinking skills at a higher cognitive level. Therefore it is very important to conduct research that examines the effectiveness of learning tools to improve elementary students' critical thinking skills. The novelty of this study is that the learning devices used in the research facilitate online and offline learning so that they can meet students' needs for authentic learning to the fullest. The content presented in inquiry-based learning tools is adapted from concrete events in everyday life. The learning steps presented in this learning tool are adapted from Llewellyn through six stages (Llewellyn, 2013).

Observation data on learning instrument that have been used in several elementary schools are also complemented by data from preliminary research conducted at SDN 7 Kepanjen, SDN Panggungrejo 4, SDN 2 Kepanjen, it is known that from the initial test results students' critical thinking skills are in the low classification of formulating problem 43%. Based on the background of this problem, an innovative solution to inquiry-based learning tools is needed to improve the critical thinking skills of elementary school students.

## METHOD

This study examines the effectiveness of inquiry-based learning tools capable of cultivating critical thinking in elementary school students. This study develops instructional inquiry tools in the form of lesson plans, worksheets, and assessments that have been validated by professionals in the field of education science. A quasi-experimental non-equivalent control group design was used in this study to compare critical thinking skills between the experimental class and the control class. Inquiry-based learning tools are used in the experimental class, while STAD (Student Team Achievement Division)-based learning tools are used in the control class. The duration of this study is one month starting from August to September 2022. The application of inquiry-based learning tools is carried out according to the stages of inquiry learning adapted from Llewellyn in natural science learning on sound waves in Table 1 (Llewellyn, 2013).

**Table 1.** Inquiry Learning syntax

No	Syntax	Teacher Activities	Student Activities
1	Exploring phenomena	Play videos about the phenomenon of sound sources	Pay attention to the teacher's explanation and

		in everyday life, explain learning topics, direct students to pay attention to video shows and read text	the video that is shown, read the text to examine the phenomenon to be investigated
2	Focusing questions	Instruct students to answer questions in LKPD which will be followed up at the investigation stage	Answer the questions that have been presented in the LKPD
3	Planning an investigation	Guiding students to recognize independent and dependent variables and formulate hypotheses	Pay attention to the teacher's explanation and formulate an investigative hypothesis
4	Conduct investigation	Guiding students doing investigations	Do an investigation
5	Analyze data and evidence	Directing students to record the results of the investigation	Record the results of the investigation
6	Build and communicate new knowledge	Guiding students in concluding the results of the investigation	Summarize the results of the investigation according to the data

Grade IVA and IVB students at SDN Kepanjen 2 and SDN Panggungrejo 4 were used as the population and research sample. The experimental group consisted of 26 students from class IVB at SDN Panggungrejo 4 and the control group consisted of 27 students from class IVA at SDN Kepanjen 2. Data collection used a test instrument. The test instrument is in the form of six essay questions. This question is prepared based on the indicators of each component with a rating scale of zero to five. Students take this test both before and after learning (pretest)-(posttest). In this study, critical thinking skills refer to the top three levels of cognitive dimensions of Bloom's taxonomy. Critical thinking skills as a representation of higher order thinking skills include the dimensions of the cognitive process of analyzing and evaluating. Data on students' critical thinking skills were collected using the instruments in Table 2.

**Table 2. Test Instrument Grids**

The Cognitive Process Dimension	Indicator	Question Number
<b>Analyze</b>	Analyze	
<b>1. Examine phenomena</b>	1. Examine the sound source through the text	1
<b>2. Formulate the problem</b>	2. Formulate problems related to sound sources through text	2
3. Formulate hypotheses	3. Formulate hypotheses related to sound sources	3
4. Analyze data	4. Analyze the data from the sound source experiment	4

Evaluate	Evaluate
1. Provide arguments	1. Provide arguments based on the 5
2. Summarize the data	experimental results of sound sources 6
	2. Summarize the experimental results of sound sources

This research instrument has been validated by three experts in the field of science learning. Measurement of the expert agreement index based on the Aiken index is used to show the validity of the instrument (Ratumanan & Laurens, 2015). The results of measuring instrument validity based on the Aiken Index can be seen in Table 3.

**Table 3. Test Instrument Validity**

Question Items	Validity	Category
1	1.00	Very Valid
2	0.89	Very Valid
3	1.00	Very Valid
4	1.00	Very Valid
5	0.67	Valid
6	0.78	Valid

Based on Table 3, it is known that the rater's agreement index on the test instrument in the first to fourth items is very valid, in the fifth and sixth items it is in the valid category. Judging from these results, valid test instruments are used in learning to measure students' critical thinking skills. Statistical Package for Social Sciences (SPSS) version 26 was used to evaluate the quantitative descriptive results of this study. The homogeneity of the data was analyzed based on the Levene test and the normality of the data was analyzed based on the Kolmogorov Smirnov test. The mean scores of the experimental and control classes were then compared using paired sample t-tests to find out whether there were significant differences in students' critical thinking skills between before and after the implementation of inquiry-based learning instrument.

## RESULTS AND DISCUSSION

The effectiveness of inquiry-based learning devices is determined from the results of tests of students' critical thinking skills. The learning device is effective if the student's high-order thinking skills test scores between before and after the implementation of the inquiry-based learning device increase. The procedure in this effectiveness test is that before learning students are given a pre-test, at the learning stage in the experimental group an inquiry-based learning device is used, while in the control group a STAD-based learning device is used. The results of the students' pre-test and post-test were analyzed for normality and homogeneity as a condition for conducting a t-test. If the data is normally distributed and homogeneous, a paired sample t-test will be carried out to find out significant differences in students' critical thinking skills. The normality and homogeneity test results will be presented in Table 3 and Table 4.

**Table 3. Normality Test Results**

Tests of Normality				
	Grade	Kolmogorov-Smirnov <sup>a</sup>		
		Statistic	df	Sig.
Critical Thinking Skills	Pre-test Experiment (Inquiry)	.105	26	.200*
	Post-test Experiment (Inquiry)	.150	26	.137
	Pre-test Control (STAD)	.138	27	.200*
	Post-test Control (STAD)	.134	27	.200*

Based on Table 3, it was found that the significance value in the experimental and control groups with the Kolmogorov-Smirnov test was  $> 0.05$ , which means that the data from both groups came from populations with normal distribution.

**Table 4. Homogeneity Test Results**

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Critical Thinking Skills	Based on Mean	3.180	1	51	.080
	Based on Median	2.386	1	51	.129
	Based on Median and with adjusted df	2.386	1	42.163	.130
	Based on trimmed mean	3.121	1	51	.083

Based on Table 4, it was found that the significance value in the experimental and control groups was  $0.080 > 0.05$ , which means that the variety of data from the two groups was homogeneous. The results of the normality and homogeneity tests manifest that the data from the experimental and control groups are normally distributed and homogeneous so that they meet the requirements for the t-test. The t-test used is the paired sample t-test, Table 5 displays the results of the paired sample t-test.

**Table 5. Paired Sample t-test results**

Paired Samples Statistics						
		Sig. (2-tailed)	Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest_Eksperimen	.000	53.5896	26	6.72819	1.31951
	Posttest_Eksperimen		82.4365	26	8.03188	1.57518
Pair 2	Pretest_Kontrol	.000	42.3452	27	13.76971	2.64998
	Posttest_Kontrol		59.8767	27	11.81989	2.27474

Based on Table 5 it is known that there is a very significant average difference in students' critical thinking skills, it is known from the significance value in the

experimental group and the control group is  $0.00 < 0.05$ . Referring to Table 5, it is known that there are very dominant differences in students' critical thinking skills before and after using inquiry-based learning tools. The average score of students' critical thinking in the experimental class and the control class differed significantly. Before the use of inquiry learning tools, experimental class students had an average critical thinking ability of 53.59 and after being used it was 82.44. Before using STAD teaching materials, control group students had an average critical thinking ability of 42.35; after using it, they have 59.88. Based on these findings, it was determined that the use of inquiry-based learning tools had a positive impact on students' critical thinking skills, this was indicated by the average experimental class students having higher critical thinking skills than control class students.

Referring to the results of empirical studies, there are a number of factors that contribute to the effectiveness of inquiry-based learning tools. The first factor is the fact that inquiry-based learning tools have been approved for validity by professionals, thus making them suitable for use in science teaching to develop critical thinking skills. This is in line with Melati's opinion which states that valid instructional tools can facilitate appropriate learning so that learning objectives are achieved (Melati et al., 2019). The second factor, the average score of students' critical thinking in the experimental class and the control class was significantly different. As shown in Table 3, the use of inquiry instructional tools improves the critical thinking skills of grade IV students in science learning.

A significant difference in the average students' critical thinking skills was seen explicitly between the experimental and control classes. Experimental class students on average have better critical thinking skills than control class students. These findings are in line with the results of Wale and Bishaw's research, which stated that inquiry-based learning is recommended to help students develop the essence of critical thinking such as providing theoretical views, assessment, consideration, inference, and self-regulation (Wale & Bishaw, 2020). Other research results state that inquiry-based learning tools train scientific inquiry skills such as identifying, formulating problems, making hypotheses, collecting data to conclude so that students can learn more contextually (D. S. Wulandari et al., 2022). Student independence and student activity are trained through inquiry learning so that this learning is claimed to be effective in improving students' critical thinking skills (Triyono & Suparman, 2019).

The third factor, referring to students' responses to the effectiveness test in general, students gave a positive response to the implementation of the device, especially in the LKPD aspect, the learning atmosphere in the class, the way the teacher taught, the language in the LKPD, experimental activities, the suitability of the test with the material being taught, and the ease in understand science material which gets a percentage of 100%. The students' responses indicated that the inquiry-based learning tools that had been developed were able to arouse students' interest and assist them in understanding science content as a whole. Students who are motivated to learn will provide better learning outcomes (Moh Khoizi Eriyanto et al., 2021; Peng & Fu, 2021; Supratno et al., 2021).

The fourth factor, namely the teacher's good response to inquiry-based learning tools, claims that the inquiry learning model makes students engaged and enthusiastic in

learning science. The teacher's response is a sign that learning tools are easy to use in learning or in other words practical (Chotimah & Festiyed, 2021). The developed LKPD has an attractive design, equipped with pictures and QR CODE so as to increase students' curiosity. Learning steps encourage students to actively participate in learning activities so as to train students in critical thinking.

Based on the teacher's statement, it can be interpreted that the implementation of inquiry tools is effective in learning science. Inquiry-based learning tools received positive responses from both teachers and students. The inquiry learning model makes students active and enthusiastic in science lessons. The learning activities provided in inquiry-based learning tools facilitate the development of students' thinking skills on a higher dimension of cognitive processes. This learning device provides learning activities that are different from conventional learning devices that already exist in schools. All learning activities in inquiry-based learning tools emphasize students' ability to look critically, question, and explore a phenomenon seen from a scientific perspective, this activity is an advantage in inquiry-based learning.



Figure 1. Experiment Group



Figure 2. Control Group

The fifth factor, based on the results of observing the implementation of learning as shown in Figure 1. Students in the experimental class are constructing and communicating new knowledge obtained based on the results of the investigation. Based on the results of the investigation, students can find out that the tone produced by the angklung is affected by the length of the angklung tube. Based on the picture, it can be seen that through inquiry-based worksheets with investigative assignments, students actively create their own knowledge. In Figure 2. the control class students in groups are discussing how the angklung produces sound. Students are active in working together to take turns playing the angklung musical instrument.

Proof of the effectiveness of inquiry-based learning tools can be seen based on Figure 1. Investigations in inquiry activities are carried out based on investigative questions initiated by the teacher. This activity encourages students' curiosity so that it leads students to make conjectures or hypotheses that must be proven true through experimental activities. After carrying out the experimental activities students can find out that the difference in the tone of the angklung is affected by the length of the sound tube of the angklung, at this stage students are also required to provide arguments against the phenomenon of the difference in the tone of the angklung. This activity



encourages students' critical thinking to correlate assumptions and evidence based on experimental results.

At the end of the inquiry stage students communicate the knowledge gained that the shorter the sound tube of the angklung, the louder the tone produced. On the other hand, in the control class STAD-based learning tools were implemented, in the early stages the teacher presented material about sound sources in everyday life, then students discussed and conducted experiments on one of the sound sources, namely the angklung musical instrument, students identified and explained how angklung can produce sound. The next stage is publication, students present the results of experiments that have been carried out. In the final stage students are given quizzes in groups by the teacher, the group that manages to collect the most scores will be given an award.

Learning activities that use STAD-based learning tools and inquiry-based learning tools are different from one another. The difference lies in the stages and activities in learning. In inquiry learning students are directed to acquire their own knowledge through investigative activities. Students are required to be able to scientifically prove conjectures, analyze, interpret and then communicate the knowledge they have acquired. The findings of this study are relevant to Wulandari's research which states that the inquiry model is considered effective in improving critical thinking skills because it provides opportunities for students to learn in real situations (D. S. Wulandari et al., 2022). Whereas in learning with the STAD strategy the teacher has provided knowledge beforehand, at the discussion stage students also carry out experiments aimed at clarifying the material. In the final stage students are given quizzes and awards in groups so that students are trained to have good cooperation skills. This is in line with the belief that STAD is the most commonly used cooperative learning paradigm, STAD encourages student involvement in working together to achieve common goals (T. Wulandari et al., 2017).

Learning tools are manifested as effective if they can assist students in developing the required competencies (Plomp, 2013). This explanation leads to the conclusion that inquiry-based learning tools are valid and useful because they have succeeded in helping students achieve their academic goals. The findings of the data analysis indicate that using this tool can help students develop critical thinking skills. The increased pretest and posttest results of the experimental class students prove that inquiry-based learning has succeeded in elaborating critical thinking skills. Starting with identifying phenomena, developing questions, conducting investigations, accumulating and evaluating data, and making inferences are the steps of activities using the inquiry model. The findings of this study lead to the conclusion that inquiry-based instructional tools are useful for improving critical thinking skills. The use of inquiry-based LKPD increases the efficiency of the educational process, assists student understanding, presents data, analyzes and conveys conclusions. Teachers and students can use this tool as a guide when carrying out learning activities that involve investigations.

## **CONCLUSION**

Significantly inquiry-based learning instrument on sound waves material improve the critical thinking skills of fourth grade elementary school students. These findings indicate that inquiry-based learning tools are successful in assisting students in fulfilling

their learning objectives, these devices have effectiveness in improving critical thinking skills of fourth graders in elementary school. The use of learning tools increases the efficiency of the educational process, aids student understanding, presents facts, and makes it easier to analyze and draw conclusions. Teachers and students can utilize inquiry-based learning tools as guidelines when carrying out learning activities that involve investigative assignments and train students to build cognitive, psychomotor, and scientific attitudes.

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