

Ethnoscience-Based Inquiry Learning to Increase Students' Critical Thinking Skills and Collaboration Skills

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Abstract: The goal of this study is to increase students' CTS and CS about quantity and unit material using ethnoscience-based inquiry learning. The study utilized a non-equivalent control group design with two classes: experimental and control. The sample in this study were students of class X IPA 7 and X IPA 8, who were chosen using purposive sampling procedures. The research sample comprised 71 students. The research data was gathered using 15 multiple-choice questions, a CTS questionnaire, and a CS questionnaire. Normality, homogeneity, the t-test, and correlation tests were employed to analyze the data. Based on the research findings, students' CTS and CS rose in the experimental class, with N-gain values of 0.71 (high) and 0.60 (medium). The experimental and control courses showed significant differences in students' CTS and CS outcomes (Sig. < 0.05). Aside from that, there is a very strong correlation between students' CTS and CS results in learning, with $r = 0.938$. It may be concluded that using an ethnoscience-based inquiry paradigm can help students enhance their CTS and CS. Thus, it is possible to infer that ethnoscience-based inquiry learning may increase students' CTS and students' CS. There is a very strong correlation between CTS and students' CS.

Keywords: Ethnoscience; Collaboration Skills; Critical Thinking Skills; Inquiry

Introduction

In the twenty-first century, critical thinking skills (CTS) are required to solve issues and develop answers. CTS, including higher-order thinking activities (HOTS), have received significant attention in recent decades (Afandi et al., 2021). CTS is a skill that prepares pupils to solve issues (Mulhayatiah et al., 2019). CTS has a clear correlation with a variety of cognitive abilities (Orhan, 2022). CTS is important in the learning process because it affects how students think critically and apply the scientific topics they are studying. Students' CTS remains poor and requires particular attention to enhance it (M. M. Sari et al., 2024). Some students can

answer correctly but are not able to provide reasons related to physics concepts.

Collaboration skills (CS) are abilities for collaborating among students to solve an issue, as well as a mindset that every individual must have (Syafii, 2023). CS teaches students how to work together in groups to tackle current challenges. Students must develop these talents to compete on a global scale because CS can help students develop a more tolerant and sensible approach to problem resolution (Trisnawati & Mahmudi, 2023).

According to PISA, Indonesia's performance remains below the international average. The 2018 PISA results reveal that Indonesia is rated 72nd out of 77

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nations in terms of science skills, with a score falling from 489 to 396 points (OECD, 2019). Several findings indicate that students' CTS in physical science learning is still relatively low (Musyarrof et al., 2018; Purwanto et al., 2019; Rahayu et al., 2019). Several other findings also indicate that students' CS in physical science learning is still relatively low and still needs attention (Firman et al., 2023; Hermawan et al., 2017; Sari et al., 2022). This circumstance demonstrates the need for changes in the learning process, particularly in increasing students' CTS and CS.

The results of the initial review at SMAN 1 Mutiara show that the average UNBK or UNKP score at SMAN 1 Mutiara in the last 3 years, namely in 2017 it was 33.33, in 2018 it was 28.78, and in 2019 it was 35.00. PAS scores in 2021 and 2022 for physics subjects were obtained on average, respectively, 58 and 67. These results are still below the minimum completeness criteria for class X, namely 75. Several factors cause CTS and CS to not be significant at SMAN 1 Mutiara, including teachers have not trained students with high-level questions in the physics teaching and learning process, very abstract physics concepts have rarely been presented in concrete ways at school, the community and school environment have not been used as learning media to improve critical thinking, cooperation skills between individual students are still weak, and students are less likely to contribute to solving problems in groups.

So far, the learning has not been fully integrated into the classroom environment or community. Introduction to regional culture is rarely related to the content being taught. Students' ability to actively contribute is still inadequate, therefore they are less able to communicate their opinions. Students are also not yet proficient in effective group work, implying that CTS and CS have received insufficient training.

Based on the issues raised above, adjustments are required in the physics learning process. Implementing an inquiry learning paradigm that may develop students' CTS is one way to increase learning quality. Several study results demonstrate that learning may increase CTS by completing a series of challenging activities that incorporate life problem circumstances and practices (Maknun, 2020; Pujani, 2022). The inquiry learning paradigm requires students to actively develop information that is not immediately transferred by the teacher (Agustina et al., 2020; Harjilah et al., 2019; Parwati et al., 2020). Other research shows that inquiry has a positive effect on students' innovative thinking skills (Nurmayani et al., 2018; Solihin et al., 2018; Wulandari et al., 2022). Aside from that, inquiry helped pupils enhance their critical and social thinking abilities (Herlina, 2022; Murni, 2020; Musliman & Kasman, 2022).

One strategy to increase the quality of critical thinking in the learning process is to incorporate

environmental variables such as local culture, knowledge, and ethnosience. Students are tied by the culture of life and nature from birth, even before they begin formal schooling. So, ethnosience is a system of knowledge that includes describing nature (Verawati et al., 2022). Physics learning based on local wisdom is supposed to drive students to learn more and improve their grasp of the physics curriculum. Aside from that, the local character may be trained for pupils by applying local wisdom in physics study (M. Wati et al., 2020). Ethnosience is a transition activity between the original knowledge of society and scientific knowledge. Original scientific knowledge consists of all information connected to the realities of society (Risdiyanto et al., 2021).

There have been many studies that explain ethnosience (Ardianti et al., 2023; Efendi & Muliadi, 2023; Lestari et al., 2021; Parmin & Fibriana, 2019; Zulirfan et al., 2023). Other studies explain about ethnosience-inquiry-based learning (Hardianti & Setiawan, 2023; Hastuti et al., 2022; Tahya & Saija, 2023; S. Wati et al., 2021). Besides, the increase in students' CTS through ethnosience-based learning, including the results of research from (Elfrida et al., 2023; Haryanto & Kencanawati, 2023; Idul & Fajardo, 2023; Isvida et al., 2024; Risdiyanto et al., 2020). Other studies have shown that inquiry-ethnosience-based learning helps improve CTS (Kurniawan & Syafriani, 2021; Prayogi et al., 2023; Verawati et al., 2022). However, until our research, there had been no research that explained the influence of ethnosience-based inquiry learning on students' CTS and CS simultaneously during classroom learning. In fact, CTS can influence CS in learning (Trisnawati & Mahmudi, 2023).

Based on the description above, researchers are interested in knowing whether ethnosience-inquiry-based learning can improve CTS and CS in physics learning. So, the aims of this research are to increase students' CTS and students' CS through ethnosience-based inquiry learning. Researchers also want to know the relationship between CTS and students' CS.

Method

The type of research used is quasi-experimental. The research design used in this research is Non-Equivalent Control Group Design. This research uses two classes, namely the experimental class and the control class. The experimental class is the class that receives treatment by applying ethnosience-based inquiry learning, while the control class is the comparison class that only uses the conventional model. The experimental class and control class in this study were given a pretest and posttest to be able to see

differences in the critical thinking abilities of the two classes. The Non-Equivalent Control Group Design in this research can be seen in Table 1.

Table 1. Non-Equivalent Control Group Design

Group	Pretest	Treatment	Posttest
Eksperiment	O1	X	O2
Control	O1	-	O2

(Irwandi et al., 2024)

Note:

O1 : Pretest

O2 : Posttest

X : Ethnoscience-Based Inquiry Learning

The population in this study were all class X students of SMAN 1 Mutiara. The sample in this study was taken using a purposive sampling technique, namely based on the same or homogeneous average score of students for cognitive abilities based on the results of daily grades, tests, and exams for class X IPA 7 students as the control class and class X IPA 8 as the experimental class. The total sample in this study was 71 students.

Primary data was collected through tests and questionnaires, while secondary data was obtained

through observation and documentation studies. CTS is measured using a test instrument in the form of multiple-choice questions and a questionnaire that is guided by the CTS indicator (Ennis, 1985, 1996, 2013). The pretest and post-test questions used in this research were adopted from the questions used in the research by (Andini, 2019) and (Hanum et al., 2023). The CS questionnaire instrument used was adopted from research (Hardianti, 2021) which is arranged based on indicators from (Greenstein, 2011). As a result, the validity and reliability of the instrument were no longer tested in this study. The test was administered twice: as a pretest and a posttest. Meanwhile, after the posttest, questionnaires were sent to students to collect data on their CTS and CS.

The collected data was next examined for normality and homogeneity. Following the normality test, the data homogeneity test is performed. This stage seeks to determine if the data from the control and experimental classes are homogenous or not. Normality and homogeneity tests were performed using SPSS software. Figure 1 shows the flow of this research.

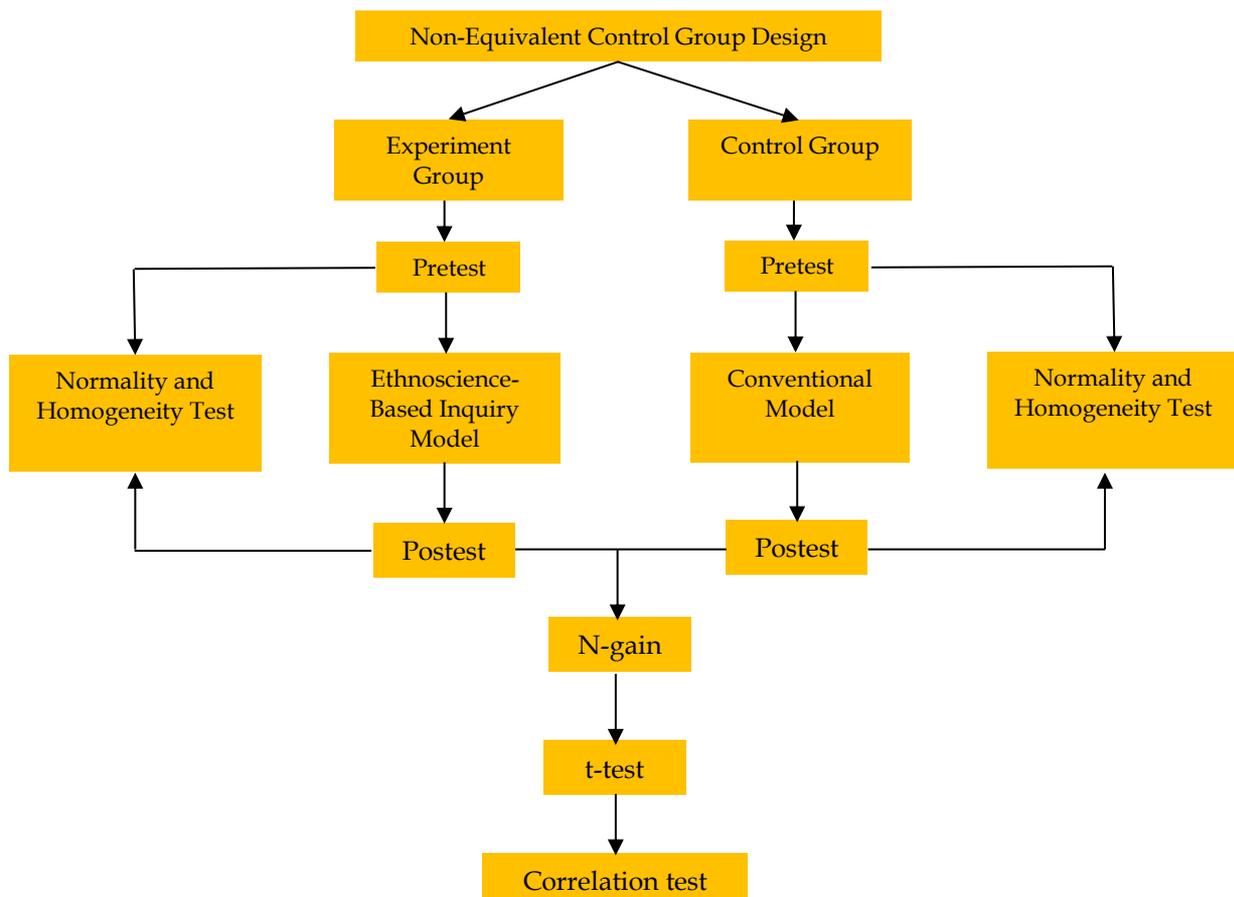


Figure 2. Research Flowchart

Table 2. Provides an interpretation of the statistical data.

Table 2. Interpretation of Statistical Data

Test	Value	Conclusion
Normality	Sig. > 0.05	Data is normally distributed
	Sig. < 0.05	Data is not normally distributed
Homogeneity	Sig. > 0.05	The data is homogeneous
	Sig. < 0.05	The data is not homogeneous
t-test	Sig. (2-tailed) > 0.05	There are no significant data differences between the two classes/groups
	Sig. (2-tailed) < 0.05	There are significant data differences between the two classes/groups

The increase in CTS can be determined by calculating the N-gain value, which aims to measure changes in students' skills. The N-gain test is carried out using the equation developed by (Hake, 1998). The criteria for the N-gain test results can be seen in Table 3.

$$N_{\text{-gain}} = \frac{S_{\text{posttest}} - S_{\text{pretest}}}{S_{\text{maks}} - S_{\text{pretest}}} \quad (1)$$

Table 3. N-Gain Criteria

Gain (g)	Criteria
$(g) \geq 0.70$	High
$0.30 \leq (g) < 0.70$	Medium
$(g) < 0.30$	Low

After the N-gain test, the next step is to compare the CTS between the experimental and control classes. The same methods are used with CS data. After that, a correlation test was performed on the two variables, CTS and CS. The correlation test employs Pearson Product-Moment Correlation using the criteria listed in Table 4.

Table 4. Pearson Product-Moment Correlation (r) Criteria

r	Criteria
0.00 - 0.10	Negligible correlation
0.11 - 0.39	Weak correlation
0.40 - 0.69	Moderate correlation
0.69 - 0.70	Strong correlation
0.70 - 1.00	Very strong correlation

(Schober et al., 2018)

Result and Discussion

Critical Thinking Skills Data

Table 5 provides a summary of the normality test data based on the research findings. After determining the normality of the data, the next step is to compare the CTS in the pretest and posttest outcomes between the

experimental and control classes. The findings are shown in Table 6.

Table 5. Results of Normality Test on CTS

Class	Kolmogorov-Smirnov		
	Statistic	df	Sig.
Experiment	.137	35	.095
Control	.117	36	.200

Table 6. Results of N-gain Test on CTS

Class	Pretest	Posttest	Gain	Category
Experiment	37.40	80.60	0.71	High
Control	33.64	64.56	0.47	Medium

Based on Table 5, it is known that each experimental class and control class obtained a sig value. > 0.05. This means that the data from both classes are normally distributed. Meanwhile, in Table 6, it is concluded that the N-gain test results in the experimental class were 0.71 (high), while in the control class, it was 0.47 (medium). Before proceeding with the t-test, the data above must be tested for homogeneity. The results of the CTS data homogeneity test can be seen in Table 7.

Table 7. Results of Homogeneity Test on CTS

Levene Statistic	df1	df2	Sig.
.079	1	69	.543

Based on Table 7, it is known that the homogeneity test results obtained sig. > 0.05. This means that the CTS data is homogeneous. After proving that the CTS test data is normal and homogeneous, the next step is to carry out a t-test. The t-test aims to determine the specific significance between data from the two classes. The results of the t-test for CTS data can be seen in Table 8.

Table 8. Results of Independent Sample T-Test on CTS

CTS Value	T-test for Equality of Means		
	t	df	Sig. (2 tailed)
Equal variances assumed	5.713	69	.000
Equal variances not assumed	5.712	68.931	.000

Based on Table 8, the Sig value is obtained < 0.05. This means that there was a significant difference in CTS between the experimental class and the control class. Figure 2 shows the results of the N-gain test in the experimental and control classes on students' CTS.

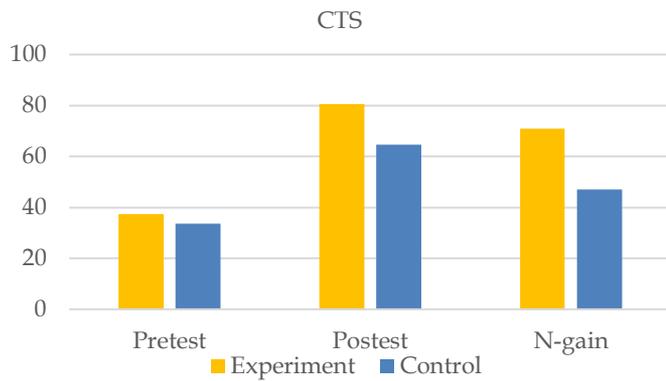


Figure 2. N-gain Test Results on Student's CTS

Collaboration Skills Data

At this stage, the first step taken was to test the normality of the CS data. Table 9 shows the results of the CS data normality test. Next, an N-gain test was carried out to determine the difference in CS in the pretest and posttest results between the experimental class and the control class. The results can be seen in Table 10.

Table 9. Results of Normality Test on CS

Class	Kolmogorov-Smirnov		
	Statistic	Df	Sig.
Experiment	.087	35	.200
Control	.112	36	.200

Table 10. Results of N-gain Test on CS

Class	Pretest	Posttest	Gain	Category
Experiment	71.86	88.71	0.60	Medium
Control	71.47	79.97	0.29	Low

Based on Table 9, it is known that each experimental class and control class obtained a sig value. > 0.05 . This means that it can be concluded that the data from both classes are normally distributed. Meanwhile, based on Table 10, it can be concluded that the N-gain test result in the experimental class is 0.60 (medium), while in the control class it is 0.29 (low). Before proceeding with the t-test, the data above must first be tested for homogeneity. The results of the CS data homogeneity test can be seen in Table 11.

Table 11. Results of Homogeneity Test on CS

Levene Statistic	df1	df2	Sig.
1.581	1	69	.213

Based on Table 11, it is known that the homogeneity test obtained sig. > 0.05 . This means that CS data is also homogeneous. After proving that the CS test data is normal and homogeneous, the next step is to carry out a t-test. The t-test aims to determine the specific significance between data from the two classes. The results of the CS data t-test can be seen in Table 12.

Table 12. Results of Independent Sample T-Test on CS

CS Value	T-test for Equality of Means		
	t	df	Sig. (2 tailed)
Equal variances assumed	14.972	69	.000
Equal variances not assumed	14.931	65.744	.000

Based on Table 12, the Sig value is obtained < 0.05 . This means that there was a significant difference in CS between the experimental class and the control class. Figure 3 shows the results of the N-gain test in the experimental and control classes on students' CS.

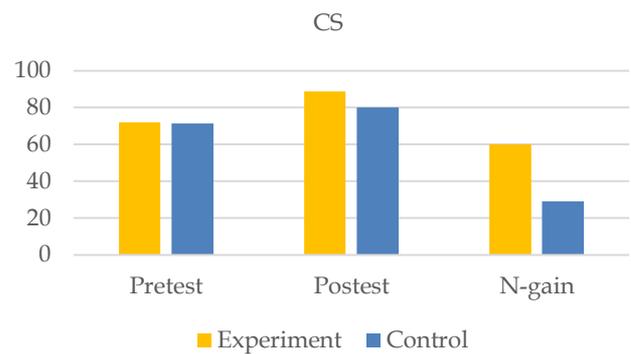


Figure 3. N-gain Test Results on Student's CS

After analyzing the data on CTS and CS, the next step is to test the correlation between the two variables, namely CTS and CS. The results of the correlation test can be seen in Table 13.

Table 13. Correlation Test Results between CTS and CS

		CTS	CS
CTS	Pearson Correlation	1	.938**
	Sig. (2-tailed)		.000
	N	71	71
CS	Pearson Correlation	.938**	1
	Sig. (2-tailed)	.000	
	N	71	71

Note: ** Correlation is significant at the 0.01 level (2-tailed)

Based on Table 13, it can be concluded that there is a very strong correlation between CTS and CS, namely with $r = 0.938$. These results are relevant to the research results from (Santoso et al., 2021) which state that CS has a positive influence on CTS with a value of $r = 0.78$ (very strong correlation). Other research results also state that CS can have a positive and significant influence on building CTS (Alharbi et al., 2022; Ramdani et al., 2022).

Based on the data analysis above, it can be concluded that the ethnoscience-based inquiry learning model can improve students' CTS and CS. This can be proven by the results of the N-gain test in the CTS experimental class which obtained a high category (0.71). Likewise, the results of the N-gain test in the CS

experimental class obtained the medium category (0.60). These results show that the experimental class obtained much better results compared to the control class (which used conventional learning models). These results are supported by research results from (Haryanto & Kencanawati, 2023; Isvida et al., 2024; Risdianto et al., 2020) which state that integrated and ethnoscience-based learning can increase students' CTS. The results of this study also show that CTS has a very strong correlation with CS. That means the ethnoscience-based inquiry learning model can also improve students' CS in learning.

Conclusion

Based on the results of data analysis, it can be concluded that ethnoscience-based inquiry learning can increase students' CTS and students' CS. There is a very strong correlation between CTS and students' CS.

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Author Contributions

Conceptualization, C. N. F., S., R. S.; methodology, C. N. F., S., R. S.; validation, C. N. F., S., R. S.; formal analysis, C. N. F., S., R. S.; investigation, C. N. F., S., R. S.; resources, C. N. F., S., R. S.; data curation, C. N. F., S., R. S., T. M. H. R.; writing – original draft preparation, C. N. F., S., R. S., T. M. H. R.; writing – review and editing, C. N. F., S., R. S., T. M. H. R., E., S. S.; visualization, C. N. F., S., R. S., T. M. H. R., E., S. S. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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