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The Effect of an Ethnoscience-Based Guided Inquiry Learning Model on Students' Critical Thinking Skills

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ABSTRACT

This study aims to examine the effect of an ethnoscience-based guided inquiry learning model on students' critical thinking skills in physics learning, particularly on sound wave topics. The study employed a quantitative approach with a quasi-experimental design and purposive sampling technique. The participants consisted of two Grade XI classes at SMAN 1 Dewantara with a total of 44 students, including 22 students in the experimental group and 22 students in the control group. Data were collected through critical thinking skills tests administered as pretests and posttests, as well as student response questionnaires. The results showed a significant difference in posttest scores, indicating that the ethnoscience-based guided inquiry learning model had a positive effect on students' critical thinking skills. Students' responses were also very positive, with an average score of 86.79%, suggesting that the model is interesting and feasible to be implemented in physics learning. The main contribution of this study is providing empirical evidence that the integration of ethnoscience in physics learning strengthens the connection between scientific concepts and local cultural contexts, making learning more meaningful, contextual, and relevant to students' characteristics.

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1. INTRODUCTION

Education is a process through which individuals or communities acquire and transmit norms, values, and skills from one generation to the next through both formal and informal means, such as classroom instruction, fieldwork, and research activities (Anggraeni & Septian, 2019). The primary goal of formal education is to help learners develop into individuals with strong character, sound moral principles, and the ability to make meaningful contributions to their communities, regions, and nation. Education plays a fundamental role in shaping human character and guiding future civilization toward positive transformation, thus serving as a major driving force in human development. In Aceh, education is a crucial component of regional economic and social growth, as it contributes significantly to the formation of character, ethical values, and the ability of individuals to adapt to rapid social change. Physics, in particular, is often perceived by students as a difficult subject due to its abstract concepts and high mathematical demands. As a scientific discipline, physics is grounded in the scientific method,

emphasizing the investigation of natural phenomena and the construction of knowledge through observation, hypothesis formulation, experimentation, and the application of established principles and empirical evidence (Widayanti, 2022).

Critical thinking is one of the essential higher-order thinking skills that must be developed through effective learning processes, particularly in science education. It involves the ability to analyze information, evaluate evidence, draw logical conclusions, and make reasoned decisions when facing complex problems (Facione, 2013). In physics learning, critical thinking is indispensable because students are required not only to understand concepts but also to apply scientific reasoning to explain natural phenomena and solve real-world problems (Tika Widiya Ningrum, 2024). However, several studies have reported that students' critical thinking skills remain relatively low due to teacher-centered instructional practices that emphasize memorization rather than inquiry and reasoning (Rahim, 2023). Therefore, learning approaches that actively engage students in scientific inquiry, problem-solving, and reflective thinking are urgently needed to enhance critical thinking skills in physics classrooms (Amanda, 2017). Integrating meaningful learning contexts, such as local culture-based or ethnoscience approaches, can further strengthen students' engagement and deepen conceptual understanding, thereby fostering critical thinking development (Hidayati, 2024).

Based on classroom observations and interviews with physics teachers at SMAN 1 Dewantara, although the implementation of physics education at the school can be categorized as relatively effective, several fundamental problems in the learning process remain evident. The primary issues include students' low level of critical thinking skills, the use of less effective instructional models, and the formulation of learning questions that have not sufficiently encouraged students to engage in deep and analytical thinking. Furthermore, students are not adequately equipped with learning strategies and instructional tools that support systematic and structured problem-solving in physics. This condition indicates that physics instruction has not fully accommodated the development of higher-order thinking skills as required by the current curriculum (Ayuningtyas & Supardi, 2015). Therefore, a more contextual and meaningful learning approach is needed. Ethnoscience-based physics learning in Aceh offers a relevant alternative by integrating physics concepts with local culture and indigenous knowledge, which can enhance students' critical thinking skills and conceptual understanding (Fahrudin et al., 2022). Through this approach, students are provided with opportunities to learn more deeply and broadly within the framework of the Merdeka Curriculum, utilizing diverse learning resources that are closely related to their local environment and cultural experiences, while strengthening their understanding of fundamental physics principles embedded in everyday life. Guided inquiry learning is an effective solution to address the problem of students' low critical thinking skills in physics learning. Well-designed guided inquiry provides clear direction and systematic guidance throughout the inquiry process through structured learning protocols and guiding questions (Lia Nurmayani, Aris Doyan, 2018). Consequently, guided inquiry learning is considered effective in creating meaningful learning experiences, increasing student engagement, and enhancing critical thinking skills essential for physics education (Pardede et al., 2024).

The implementation of the guided inquiry learning model becomes more effective when it is integrated with an ethnoscience approach rooted in local culture. Through the ethnoscience approach, students are not only engaged in scientific inquiry processes but also develop an appreciation for Acehese culture and the community's traditional knowledge of natural phenomena (Asriyadin, 2025). Schools located in rural or remote areas can utilize various locally available resources, such as traditional musical instruments, folk games, and natural materials, as contextual learning media for physics grounded in Aceh's local wisdom (Naila Rosyidah, 2025). This approach also serves as a solution for schools with limited access to learning media, as traditional games and tools can be directly created using simple materials that are easily accessible in the surrounding environment. By integrating ethnoscience-based physics learning into the guided inquiry model, students are provided with opportunities to investigate real physical phenomena, pose questions, conduct observations, and draw conclusions independently, thereby enhancing their critical thinking skills (Manggul & Pratiwi, 2025). One example

of the application of ethnoscience in physics learning in Aceh is the use of *Serunee On U*, a traditional wind instrument made from young coconut leaves, which can be employed as a learning medium to facilitate contextual understanding of sound and wave concepts.

Ethnoscience is an educational approach that integrates scientific knowledge with local culture and indigenous wisdom derived from community practices. This approach positions culture not merely as a contextual background but as a valuable source of knowledge that can support meaningful learning. In science education, particularly physics, ethnoscience serves as a bridge between abstract scientific concepts and students' real-life experiences, allowing learners to construct knowledge more concretely and authentically. By connecting science learning to local cultural contexts, ethnoscience encourages students to view science as part of their lived reality rather than as isolated theoretical content (Safarati & Zuhra, 2024). These characteristics make it an effective and meaningful learning medium for teaching sound wave concepts in physics (Fajeriadi, 2024). Ethnoscience-based learning using is strongly linked to the development of students' critical thinking skills. Critical thinking is a higher-order cognitive skill that includes the ability to analyze information, evaluate evidence, identify relationships, and draw logical conclusions (Rendi, Marni, 2024). In traditional physics instruction, critical thinking skills are often underdeveloped due to teaching practices that prioritize formula memorization and procedural problem-solving over inquiry and reasoning. As a result, students frequently struggle to apply physics concepts to real-world situations or to explain physical phenomena logically.

Integrating ethnoscience into physics learning addresses this challenge by creating a learning environment that encourages inquiry and reflection (Sotero, 2020). Students are not simply provided with answers; instead, they are guided to investigate, test ideas, and reason based on evidence. The effectiveness of ethnoscience-based learning is further enhanced when combined with a guided inquiry learning model (Fitri et al., 2024). Guided inquiry provides structured support through well-designed learning stages and guiding questions, while still allowing students to independently explore and construct understanding. In this model, teachers act as facilitators who guide students through inquiry processes, such as problem identification, hypothesis formulation, data collection, analysis, and conclusion drawing (Kastaun, 2021). This structured inquiry approach is particularly suitable for ethnoscience-based learning, as it helps students systematically connect cultural artifacts like *Serunee On U* with scientific concepts. Through guided inquiry activities involving *Serunee On U*, students are actively engaged in observing sound production, conducting simple experiments, discussing findings, and reflecting on results. These activities directly promote key indicators of critical thinking, including interpretation, analysis, evaluation, and inference. Students learn to justify their conclusions based on observations and evidence rather than relying solely on teacher explanations. Over time, this process strengthens their ability to think critically and independently when encountering new scientific problems (Fatmi et al., 2024).

The novelty of this study lies in the integration of an ethnoscience-based guided inquiry learning model with the use of *Serunee On U* as a physics learning medium to enhance students' critical thinking skills on sound wave topics. Unlike previous studies that generally examined guided inquiry or ethnoscience separately, this study combines both approaches within a systematic, contextual, and local wisdom-based instructional framework. This integration not only strengthens students' conceptual understanding of physics but also positions local culture as an authentic learning resource directly involved in the scientific inquiry process. Therefore, this study offers an innovative approach to physics learning that is relevant to students' characteristics, aligned with the Merdeka Curriculum, and responsive to the need for developing critical thinking skills.

2. METHODS

This study employed a quantitative approach with a quasi-experimental design to examine the effect of an ethnoscience-based guided inquiry learning model using on students' critical thinking skills in physics learning. The research was conducted at SMAN 1 Dewantara during the 2024–2025 academic

year. The population consisted of all Grade XI students, and purposive sampling was used to select two classes with similar academic characteristics. One class (22 students) was assigned as the experimental group and received instruction using the guided inquiry model integrated with an ethnoscience approach through, while the other class (22 students) served as the control group and was taught using conventional teaching methods. Data were collected using a critical thinking skills test administered as pretest and posttest, as well as a student response questionnaire. The test items were designed based on critical thinking indicators, including analysis, evaluation, inference, and reasoning related to sound wave concepts. All instruments were validated by experts prior to use. The learning intervention was conducted over several instructional sessions. In the experimental group, learning activities followed the stages of guided inquiry, including problem orientation, question formulation, hypothesis development, data collection through observation and simple experiments using *Serunee On U*, data analysis, and conclusion drawing. The control group received teacher-centered instruction supported by textbook-based exercises. Data were analyzed using descriptive and inferential statistical techniques with the assistance of SPSS version 26 to determine differences in students' critical thinking skills between the two groups.

3. RESULT AND DISCUSSION

3.1. Descriptive Results of Students' Critical Thinking Skill

Students' critical thinking skills were measured using an essay-based test instrument with scores ranging from 0 to 100, encompassing five main indicators: (1) problem identification, (2) providing scientific explanations, (3) analyzing conceptual relationships, (4) drawing conclusions, and (5) evaluating investigation results. The assessment was conducted through pretests and posttests administered to both the experimental and control groups. Descriptively, the analysis revealed that the students' initial critical thinking skills in both groups were relatively equivalent. This is reflected in the mean pretest scores, which were 62.4 for the experimental group and 61.9 for the control group. This similarity in pretest scores indicates that both groups were in comparable initial conditions prior to the implementation of the instructional treatment. Following the learning intervention, improvements in critical thinking skills were observed in both groups; however, the increase in the experimental group was more substantial than that in the control group. The experimental group achieved a mean posttest score of 82.7, while the control group attained a mean score of 74.1.

Table 1. Average Pretest and Posttest Scores for Critical Thinking Skills

Group	Pretest (Mean)	Posttest (Mean)
Experiment	62,4	82,7
Control	61,9	74,1

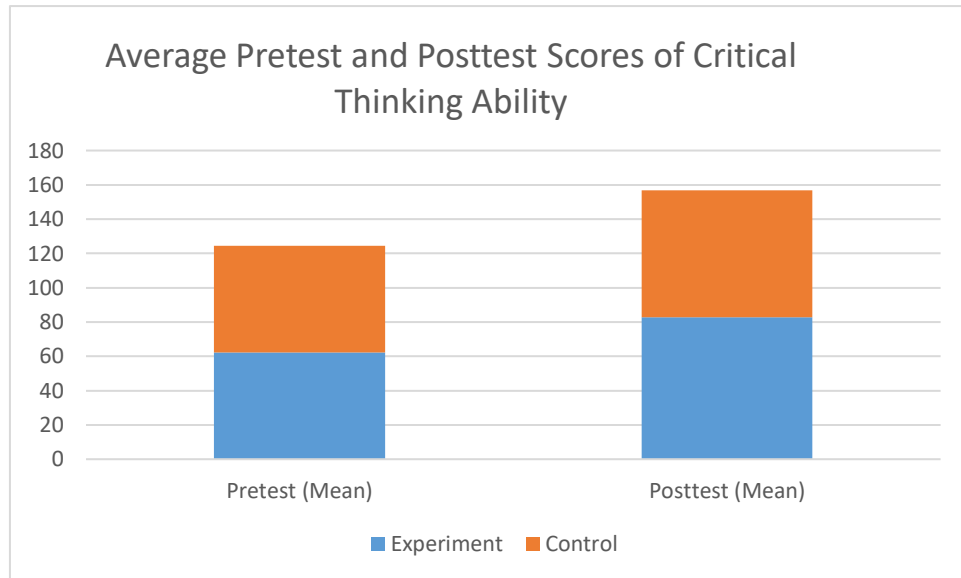


Figure 1. Graph of Average Pretest and Posttest Scores for Critical Thinking Skills

The diagram comparing pretest and posttest scores demonstrates a clear difference in the magnitude of improvement between the two groups. In the experimental group, the increase in posttest scores is noticeably higher than that of the control group. This visual representation reinforces the descriptive analysis results, indicating that ethnosience-based learning is more effective in promoting deeper cognitive engagement among students. Visually and experientially, students who learned using *Serunee On U* as an ethnosience-based learning medium gained contextual learning experiences, enabling them to relate sound and wave concepts to real phenomena within Acehese culture. This process encouraged students to actively observe, pose questions, analyze the sounds produced, and draw physics-based conclusions derived from their independent investigations.

3.2. Results of the Analysis Prerequisite Test

Before conducting the hypothesis test, the data was first analyzed using the SPSS application to fulfill the prerequisite tests, namely the normality test and the homogeneity test.

a. Normality Test

The normality test was conducted using the Shapiro–Wilk Test because the sample size was less than 50. The decision-making criteria were: 1. If the Sig. value > 0.05 → the data is normally distributed, 2. If the Sig. value ≤ 0.05 → the data is not normally distributed.

Table 2. Results of the Posttest Data Normality Test

Group	Statistik	Sig.
Experiment	0,962	0,231
Control	0,954	0,176

The results of the normality test show that the significance value in the experimental class (0.231) and the control class (0.176) is greater than 0.05, so it can be concluded that the posttest data on critical thinking skills in both groups are normally distributed.

b. Homogeneity Test

The homogeneity of variance test was conducted using Levene's Test with the following criteria: 1. Sig. > 0,05 → homogeneous data, 2. Sig. ≤ 0,05 → the data is not homogeneous.

Table 3. Results of the Homogeneity of Variance Test

Levene Statistic	df1	df2	Sig.
1,284	1	58	0,262

The significance value was 0.262 > 0.05, thus it can be concluded that the posttest data for both groups had homogeneous variance. With the normality and homogeneity tests met, the analysis can be continued using parametric statistical tests.

3.3. Hypothesis Test Results

Hypothesis testing was conducted using an independent t-test (Independent Samples t-Test) to determine the average difference in critical thinking skills between the experimental class and the control class in the posttest.

The research hypothesis is formulated as follows:

H_0 : There is no difference in students' critical thinking skills between classes using the *Serunee On U* ethnoscience-based guided inquiry model and conventional classes.

H_1 : There is a difference in students' critical thinking abilities between classes that use the *Serunee On U* ethnoscience-based guided inquiry model and conventional classes.

Table 4. Results of the Independent t-Test Posttest

Group	Mean	Std. Dev.
Experiment	82,7	6,8
Control	74,1	7,4
t	df	Sig. (2-tailed)
4,63	58	0,000

The t-test results showed a significance value of 0.000 < 0.05, so H_0 was rejected and H_1 was accepted. This indicates that there is a significant difference in critical thinking skills between students who learn using the *Serunee On U* ethnoscience-based guided inquiry model and students who learn with conventional learning. Pedagogically, students who learn through the *Serunee On U* ethnoscience integration experience gain a more contextual and meaningful learning experience. *Serunee On U*, as an Acehese cultural artifact, enables students to connect the concepts of sound and waves to real-world phenomena in their environment. This process encourages active student engagement in observing the sound formation process, asking critical questions, analyzing the relationship between tube length and sound frequency, and drawing conclusions based on data-driven investigations. The guided inquiry model provides a systematic framework that helps students construct knowledge independently, while the ethnoscience approach strengthens the relevance and familiarity of the material to everyday life (Karen K Resendes, 2015). The combination of these two approaches has proven effective in developing critical thinking skills, particularly in the areas of analysis, evaluation, and scientific conclusion-making.

Discussion

The results of the study indicate that the implementation of the ethnoscience-based guided inquiry model through *Serunee On U* significantly improves students' critical thinking skills in physics learning. The increase in critical thinking scores in the experimental class was higher than that in the control class, while the equivalence of pretest scores indicates that the difference was caused by the learning treatment rather than by students' initial abilities. These findings confirm that integrating ethnoscience within the guided inquiry framework is able to create more meaningful and contextual learning experiences, in line with the goals of 21st-century science education that emphasize the development of higher-order thinking skills. Students' active involvement in observing, formulating problems, investigating, analyzing, and drawing conclusions is a key factor in fostering critical thinking development. The use of *Serunee On U* as a cultural context in learning strengthens students' understanding of sound and wave concepts by connecting physics theory with their real-life experiences. This culture-based learning approach not only enhances students' analytical and reflective abilities but also fosters their appreciation of Acehnese local wisdom. Compared to conventional, teacher-centered learning with limited exploration, the ethnoscience-based inquiry approach is more effective in stimulating students' evaluation, reasoning, and scientific thinking. Therefore, the ethnoscience-based guided inquiry model through *Serunee On U* is recommended as an innovative and relevant strategy to improve the quality of physics learning, particularly in developing students' critical thinking skills in a contextual and sustainable manner.

4. CONCLUSION

This study concludes that the ethnoscience-based guided inquiry learning model using *Serunee On U* has a positive and significant effect on students' critical thinking skills in physics, particularly on sound wave topics. The comparable pretest results and the higher posttest improvement in the experimental group indicate that the learning gains were driven by the instructional treatment. Students' very positive responses also suggest that the model is engaging, contextual, and supportive of conceptual understanding. Practically, physics teachers are encouraged to integrate guided inquiry with local cultural resources to make learning more meaningful and to foster critical thinking. However, this study is limited by its small sample size and focus on a single topic. Future research should involve larger samples, explore other physics concepts, and examine the long-term impact of ethnoscience-based inquiry on various 21st-century skills.

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