Application of ethnoscience-project-based learning to improve students' critical thinking skills

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Abstract
This study aims to improve critical thinking skills using Ethnoscience-Project Based Learning in science learning. This research is qualitative research. The type of this research is Classroom Action Research which is carried out in 2 cycles. The subjects of this study were 30 students from class VII of a junior high school in Surakarta, Central Java, Indonesia. The data collection techniques used is the tests method (critical thinking skills tests) and non-tests (observation sheets for syntax and documentation). The data validity test technique used is the triangulation method. The data analysis technique used is a qualitative description. The results showed that the percentage of each aspect of the skills had increased. The percentage of score on the Interpretation aspect from 26.67% to 83.33%, the Analysis aspect from 35% to 68.33%, the Explanation aspect from 23.33% to 91.67%, the Conclusion aspect from 41.67% to 96.67%, the Evaluation aspect from 33.33% to 90%, the Self-control aspect from 30% to 93.33%. The result of each cycle had increased according to the target of 20%. The conclusion of this study is the implementation of Ethnoscience-Project Based Learning can improve critical thinking skills of grade VII students of a junior high school in Surakarta.

1. Introduction

One of the competencies that is needed and essential to be possessed by every individual, especially students in the 21st century, to face all the information easily obtained is the ability to think critically. Critical thinking is a stage of thought patterns possessed by individuals in defining everything that is understood competently and skillfully in building patterns, applying, examining, integrating, or evaluating information or information collected through the process of observation, experience, contemplation, reaching conclusions (reasoning) or communication as a basis used for action (Ennis, 2011). The importance of critical thinking for students cannot be ignored because it is a core skill that equips them to face the complexity of the modern world. This competency is also important in dealing with the changes that continue to move in the workplace, and it shows that adaptability and problem-solving skills are the keys to success (Aizikovitsh-Udi & Cheng, 2015).

The facts on the ground state that the critical thinking skills possessed by students today are still low. Research conducted by Nuryanti et al. (2018) found that students' thinking skills in answering questions that test critical thinking skills produce relatively low data. This can be seen in the percentage results showing category B, which means that the aspect of identifying or compiling questions is only 40.46%. In this era, the development of knowledge and information needs to be balanced with critical thinking patterns in each individual in the problems experienced (Nafiah & Suyanto, 2014).

Based on the results of observations and interviews conducted by the author with teachers at a junior high school in Surakarta, Central Java, Indonesia in March 19th, 2024, The critical thinking skills of students in class VII at this junior high school are still relatively low, as seen from the results of students working on descriptive questions that have been adjusted to the critical thinking aspect. The average obtained by students is 23.33%. The results of interviews with science teachers show that the critical thinking skills of students in class VII are still low. Students find focusing challenging and have not used the appropriate learning model. Science learning in junior high schools emphasizes acquiring student learning experiences that are obtained directly by using and developing process skills and scientific attitudes (Depdiknas, 2007).

The learning process carried out by teachers also tends to forget local culture and environmental potential in the local area. According to Longnecker and Gondwe (2015), learning by combining local cultures can benefit students. Ethnoscience is a scientific understanding of a particular social group as a system of knowledge and cognition typical of a given culture (Parmin et al., 2015). An alternative to solving the problem of students' low critical thinking skills is a learning model. The right model to accommodate the problem of low critical thinking skills of students is the Project Based Learning learning model combined with the Ethnoscience approach. Integrating ethnoscience in Project Based Learning (PjBL) is intensely rational because it creates a critical environment.

Project-based learning consists of projects integrating various sciences that will provide opportunities for students to discuss and investigate topics based on environmental problems (Turgut, 2008). The PjBL learning model is one form of innovation in learning that can be used because PjBL aims to train students to think critically, creatively, and rationally, actively collaborate and communicate effectively, and be real between students (Saputra, 2013). Therefore, each student can answer through guiding questions (Lucas, 2005). From the explanation above, the Project Based Learning model is a learning model that requires students to be active in learning, be more creative, and think critically when dealing with problems encountered.

Ethnoscience emphasizes using local and traditional knowledge in science, allowing students to deeply understand the relationship between science and their culture (Damayanti et al., 2017). PjBL promotes active engagement and problem-solving, while ethnoscience provides a relevant cultural context. The use of the Etnoscience-Project-Based Learning model on average student learning activities is better than before using the Etnoscience-Project-Based Learning model (Sulistyowati et al., 2020). Therefore, research on critical thinking and the Etnoscience-Project-Based Learning method is important.

This study aims to review how applying the Ethnoscience-Project-Based Learning model can improve the critical thinking skills of class VII X students, especially in science learning on the Earth and Solar System material.

2. Method

The research was conducted in one of the junior high schools in Surakarta with 30 students from class VII of a junior high school in Surakarta, Central Java, Indonesia. The method used in this study is Classroom Action Research (CAR). Data sources were obtained from teachers and students. Data collection techniques in this study were tests, observations, interviews, and documentation. The data validity technique used triangulation techniques. The data analysis technique in this study was descriptive qualitative. The spiral method was used in the research procedure. This study was conducted in 2 cycles, each consisting of 3 meetings. Indicators of achievement of these skills can be seen based on an increase in critical thinking skills by ≥20% from the baseline (Irwanto et al., 2017).

3. Results and Discussion

The results of the analysis of students' critical thinking skills increase in each cycle. The increase in students' critical thinking skills can be seen from analyzing the answers to the critical thinking skills test questions given at the end of each. In cycle 1, all students have carried out the learning well. In addition, the scores obtained by students have increased from the pre-cycle, cycle one, and cycle 2, exceeding the baseline.

Critical Thinking Skills

According to Facione (2011), there are six indicators of critical thinking skills: Interpretation, Analysis, Concluding, Evaluation, Explanation, Self-Regulation. Table 1 shows the definition and indicators of each aspect.

Table 1. Critical Thinking Skills Aspect, Definition, and Indicator

Aspects of critical thinking skills	Definition	Indicator
Interpretation	The ability to understand and express the meaning or significance of an event.	Able to write something that is known
		Able to explain the meaning of information
Analysis	The ability to identify relationships between concepts, descriptions, or other forms that can express reasons, information, or opinions.	Able to explain information from a case
		Able to write down the problems of a case
Explanation	The ability to clearly state and substantiate reasons based on evidence, concepts, methodology and sound reasoning.	Able to explain the solution to a problem
		Able to explain concepts
Inference	The ability to identify and select the necessary elements is needed to form a reasoned conclusion.	Able to conclude based on correct concepts
Evaluation	The ability to judge the validity of the reasons or descriptions of one's perceptions or opinions, experiences, situations, decisions, and beliefs and to evaluate the logical strength of conclusions related to statements.	Able to write down the learning outcomes obtained
		Able to respond to questions given
Self-Regulation	The ability to monitor or control one's cognitive activities, the elements used in the thinking process and the results developed.	Able to manage time in completing tasks
		Able to follow the learning until completion

Data on the increase in scores for aspects of communication skills can be seen in Table 2.

Table 2. Critical Thinking Skills Percentage

Aspects of critical thinking	Percentage (%)		
	Pre-cycle	Cycle 1	Cycle 2
Interpretation	26,67	55	83,33
Analysis	35	46,67	68,33
Explaining	23,33	68,33	91,67
Concluding	41,67	85	96,67
Evaluating	33,33	53,33	90
Self-regulation	30	68,33	93,33

Table 2 shows that the results of critical thinking skills are obtained from essay questions that are adjusted to each aspect. Questions and examples of student answers on the Interpretation essential aspect of thinking skills are presented in Table 3.

Table 3. Questions on Interpretation aspects of Cycle 1

Example questions for Cycle 1: The Earth is divided by the equator, a line that runs right through the middle. The equator divides the Earth into two, the Northern Hemisphere and the Southern Hemisphere. Where is Indonesia located? What are the consequences of Indonesia's location?
Example of low score student answers: Indonesia's territory stretches from west to east, meaning that not all areas receive sunlight at the same time.
Example of high score student answers: at the equator Because it is located right on the equator, areas on the equator experience 2 seasons, namely the dry season and the rainy season.

Based on Table 2, the interpretation aspect shows that the average student increased from 26.67% to 55%. In this cycle 1, the scores of several students have not increased, namely students' number 14 and 27. Questions and examples of student answers in the interpretation aspect of cycle 2 on critical thinking skills are presented in Table 4.

Table 4. Questions on Interpretation aspects of Cycle 2

Example questions for Cycle 2: Last year 2019 we experienced a situation where during the day the sky suddenly became dark and then a few hours later the sun appeared. What event was happening? What caused the event?
Example of low score student answers:

possibility of dark to sunny change
Example of high score student answers: A solar eclipse occurs when the moon is between the sun and the earth so that the moon's shadow is visible from the earth. There are three types of eclipses, namely total, partial and annular solar eclipses.

Based on Table 2, the interpretation aspect shows that the average student increased from 55% to 83.33%. In this cycle, the scores of several students have not increased but have increased to the maximum score. In cycle 2, all children achieved the maximum score and exceeded the baseline. In this aspect, students find out basic things to understand, raise what is known about a problem and put forward a hypothesis (Utami et al, 2024).

The second aspect of the critical thinking skills indicator is the Analysis aspect. Questions and examples of student answers in the analysis aspect of critical thinking skills are presented in Table 5.

Table 5. Questions on Analysis aspects of Cycle 1

Example questions for Cycle 1:
Look at the picture below!

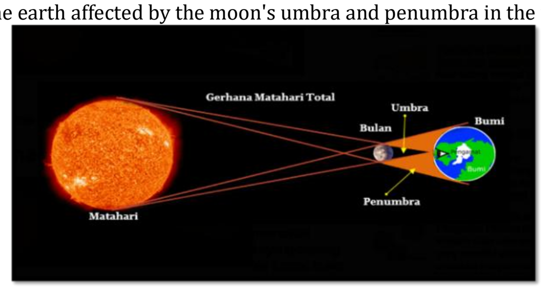
Comets are celestial bodies that come from the remains of the formation of the Solar System. Comets are often called tailed stars. Why can comets look bright?

Example of low score student answers: because the size of the comet is shining and many times bigger
Example of high score student answers: Because it is too close to the sun, the comet becomes hot and spews gas and dust. The prolonged heating causes the comet to glow in its core and narrow into a kind of light tail.

Based on Table 2, from the analysis aspect, it can be seen that the average student increased from 35% to 46.67%. In cycle 1 there are still students whose scores have not improved, namely numbers 14 and 30. Questions and examples of student answers in the analysis aspect of cycle 2 on critical thinking skills are presented in Table 6.

Table 6. Questions on Analysis aspects of Cycle 2

Example questions for Cycle 2:
Pay attention to the areas of the earth affected by the moon's umbra and penumbra in the picture!



The areas of the earth affected by the moon's umbra experience a total solar eclipse, while the parts of the earth affected by the moon's penumbra will experience a partial solar eclipse. What are the differences between a total and partial solar eclipse?

Example of low score student answers: total solar eclipse: the sun is covered by the moon which makes the day dark partial solar eclipse: only part of the sun is covered by the moon
Example of high score student answers: a total solar eclipse occurs when the sun is covered by the moon / hit by the umbra a partial solar eclipse occurs when the moon covers part of the sun / hit by the penumbra

Based on Table 2, in the analysis aspect, it can be seen that the average student increased from 46.67% to 68.33%. In cycle 2, there are still students whose scores have not improved; namely, numbers 14 and 30 have increased to reach the maximum score. In cycle 2, all children achieved the maximum score and exceeded the baseline. In this aspect, students are required to analyze what to do to answer the problem. Through project creation activities, critical thinking skills can be well organized by analyzing and interpreting data. (Sastrika, et. al., 2013).

The third aspect of the critical thinking skills indicator is the Explaining aspect. Questions and examples of student answers in the Explaining element of critical thinking skills are presented in Table 7.

Table 7. Questions on Explaining aspects of Cycle 1

Example questions for Cycle 1: Many people think that Mercury is the hottest planet in the Solar System, because it is the closest to the Sun. Is this true? Explain your reasons!
Example of low score student answers: true, because it is close to the sun
Example of high score student answers: no, because it lies in the existence of an atmosphere that envelops the planet

Based on Table 2, in the explaining aspect, there was an average increase from 23.33% to 68.33%. Several students had not experienced an increase, namely numbers 12 and 14. Other students were able to answer questions by explaining correctly. Questions and examples of student answers in the explaining aspect of cycle 2 on critical thinking skills are presented in Table 8

Table 8. Questions on Explaining aspects of Cycle 2

Example questions for Cycle 2: One day Abe and Beni wanted to see a rare natural phenomenon, a solar eclipse. According to the news Beni read, the solar eclipse would occur in 2 days. Beni asked Abe to make special glasses, but Abe refused, according to Abe, seeing a solar eclipse with the naked eye is permissible. Both of them insisted on their respective opinions. What do you think, whose opinion is right? Why is that opinion right?
Example of low score student answers: In my opinion, a solar eclipse is the rarest phenomenon because a solar eclipse occurs once every 2 years.
Example of high score student answers: Beni's opinion is the right opinion because we cannot see the solar eclipse directly, looking directly can cause eye pain/blindness

Based on Table 2, the average increase in explaining was from 68.33% to quite high, namely 91.67%. Several students who previously did not improve increased. In cycle 2, all children achieved maximum scores and exceeded the baseline. In this aspect, students can express opinions, discuss, understand problems, and students can also gain a deeper understanding of the learning material (Noviyanti, 2011).

The fourth aspect of the critical thinking skills indicator is the Concluding aspect. Questions and examples of student answers on the Concluding element of critical thinking skills are presented in Table 9

Table 9. Questions on Inference aspects of Cycle 1

Example questions for Cycle 1:
The solar system consists of the Sun as its center, eight planets orbiting the Sun. The eight planets are divided into inner planets and outer planets. Inner planets are planets that are located between the sun and the asteroid belt, and have a shorter distance than the average distance of the planet Earth to the sun, which is 149 million kilometers.

Planet Name	Characteristic features
Jupiter	Located about 778 million kilometers from the sun
Mercury	Located 57.9 million kilometers from the sun
Saturn	Located 1,433.5 million kilometers from the sun
Venus	Located 108 million kilometers from the sun

From the table above, which planets are included in the inner planets and outer planets?

Example of low score student answers:

inner planets: mercury outer planets: venus, saturn, jupiter
Example of high score student answers: inner planets: mercury and venus outer planets: jupiter and saturn

Based on Table 2, in the aspect of concluding, the average increased from 41.67% to quite large, namely 85%. In this aspect, there is 1 student who has not improved, namely number 28. Questions and examples of student answers in the aspect of concluding cycle 2 on critical thinking skills are presented in Table 10

Table 10. Questions on Inference aspects of Cycle 2

Example questions for Cycle 2:
Look at the following table!

Star	Not a Star
Has its own light	The light produced comes from Other light sources
Can emit radiation and heat	Produces less heat
Having a heavier mass than other objects	Has a smaller size

Based on the table above, is the sun included in the group of stars? Give your reasons!

Example of low score student answers:
no, because the stars are at night while the sun is during the day

Example of high score student answers:
The sun is included in the group of stars because it has its own light, emits heat radiation, and also has a heavier mass than other celestial bodies and it turns out that the sun is classified as the smallest star because of its smaller size compared to other stars.

Based on Table 10, in the aspect of inference the average increased from 85% to 96.67%. In the aspect of students, there was an increase in scores. In cycle 2 all children achieved maximum scores and exceeded the baseline. In this aspect, students can create and determine conclusions from problems related to the products produced (Permata et al., 2024).

The fifth aspect of the critical thinking skills indicator is the Evaluation aspect. Questions and examples of student answers in the Evaluation aspect of critical thinking skills are presented in Table 11.

Table 11. Questions on Evaluation aspects of Cycle 1

Example questions for Cycle 1: We see the sun moving as if from east to west. Therefore, we often say that the sun rises in the east and sets in the west. What causes the sun to rise and set? Explain your answer!
Example of low score student answers: movement in a path called revolution
Example of high score student answers: the existence of rotation because the earth rotates on its axis, causes day and night

Based on Table 2, in the Evaluation aspect there was an average increase from 33.33% to 53.33%. There were 2 students who had not improved, namely numbers 8 and 17. Questions and examples of student answers in the Evaluation aspect of cycle 2 on critical thinking skills are presented in Table 12.

Table 12. Questions on Evaluation aspects of Cycle 2

Example questions for Cycle 2: The sun shines from morning to evening. All living things living on earth are exposed to the sun's rays. The sun plays a very important role in life on Earth. In your opinion, what benefits do you feel in your life with the presence of the sun? What is the role of the sun for plants?

Example of low score student answers: can get vitamin c in the morning increase plant growth
Example of high score student answers: warms the body, increases body immunity, becomes a healthy living recipe used by plants to carry out photosynthesis

Based on Table 2, in the Evaluation Aspect, there was an average increase from 53.33% to 90%. There were 2 students who had not improved, namely numbers 8 and 17 experienced an increase in cycle 2. In cycle 2 all children achieved maximum scores and exceeded the baseline. In this aspect, students can estimate, test, work together in groups to find solutions to problems encountered during project creation (Nurpaidah, 2023).

The sixth aspect of the critical thinking skills indicator is the Self-Regulation aspect. Questions and examples of student answers on the Self-Regulation aspect of critical thinking skills are presented in Table 13.

Table 13. Questions on Self-Regulation aspects of Cycle 1

Example questions for Cycle 1: Based on the project you have created, answer the following questions: Why is the planet Venus nicknamed the morning star? Which planet is the largest in your miniature?
Example of low score student answers: to know the general characteristics of the planets, the sun and mercury
Example of high score student answers: because the planet Venus shines the brightest the largest: Jupiter and the smallest: Mercury

Based on Table 2, the Self-Regulation Aspect experienced an average increase from 30% to 68.33%. In this aspect, students who have not improved are numbers 4 and 8. Questions and examples of student answers in the Self-Regulation aspect of cycle 2 on critical thinking skills are presented in Table 14.

Table 14. Questions on Self-Regulation aspects of Cycle 2

Example questions for Cycle 2: Based on the project you have made, answer the questions below! a. Does the position of the sun, moon and earth affect the occurrence of an eclipse? b. Is it possible for the sun to be between the earth and the moon?
Example of low score student answers: yes, because the sun is covered by the moon, opposite it is the earth solar eclipse phenomenon
Example of high score student answers: Yes, the position of the sun, moon and earth can affect No, it is not

Based on Table 2, in the Self-Regulation Aspect, there was an average increase from 68.33% to 93.33%. In this aspect, students who had not improved experienced increased scores. In cycle 2, all children achieved maximum scores and exceeded the baseline. Students can estimate, test, work together in groups to find solutions to problems encountered during project creation (Nurpaidah, 2023).

Ethnoscience-Project Based Learning

The implementation of learning cycles 1 and 2 uses the Ethnoscience-Project Based Learning model on the Earth and Solar System material, which consists of 6 phases/stages. The integration of ethnoscience-PjBL with the material of the earth and solar system so that it can improve students' critical thinking skills can be seen in T**able** 15.

Table 15. Integration of PjBL-Ethnoscience and Critical Thinking Skills in Earth and Solar System Material

PjBLsintax	Ethnoscience on Earth and the Solar System	Critical thinking skills
Start with the essential question	Identify local issues using the topic of the Morning Star and the myth of eclipses on the island of Java	Interpretation
Design a plan for the project	Designing a project that is relevant to the identified topic	Analysis
Create a schedule	Create a project activity planning timeline so that project implementation can be carried out systematically and sequentially.	Analysis
Monitor the students and the progress of the project	Guidance by teachers during the learning process and monitoring students in completing projects	Evaluation, Self Regulatioj
Assess the outcome	Teachers give grades on students' project results	Explanation
Evaluate the experience	Reflection of students' experiences during the project	Inference

The start with essential question phase begins with showing a video to determine basic questions in starting the project. Activities that start with the essential question phase are in line with the interpretation aspect. This is in line with research by Utami et al. (2024), where students find out basic things to understand, raise what is known about a problem, and put forward hypotheses.

In the design a plan for the project phase, the teacher directs students to plan what kind of project will be made with their group. In the create a schedule phase, the teacher directs students to make further plans, such as choosing the tools and materials to be used and the length of time needed to complete the project. Activities in this phase are in line with the analysis indicators where students are required to analyze what must be done to answer problems or to complete the project, namely by designing in advance and estimating the time of completion (Utami, F. H. et al., 2024).

In the monitor of the students and the progress phase, students are directed to start working on and making their products. At this stage, the teacher monitors the students' progress and facilitates students to ask questions if they have any questions (Fitriyah & Ramadani, 2021). This phase is in line with the evaluation aspect where through monitoring by the teacher, students can estimate, test and find solutions to problems found during the project creation.

In the assess the outcome phase, students are directed to present the results of the project in front of the class (Fitriyah & Ramadani, 2021). Activities in this phase are in line with the explanation aspect. This is in line with the opinion of Noviyanti, (2011) that when students communicate such as expressing opinions, discussing, and understanding problems in people's lives, students can gain a better understanding of the learning material.

In the evaluate the experience phase, students are directed to evaluate the projects that have been made again and make conclusions related to the projects that have been made. Activities at this stage are in line with the inference aspect, where students can draw conclusions from problems related to the products produced (Utami, F. H., et al., 2024).

Based on Classroom Action Research (CAR), applying the Ethnoscience-Project-Based Learning model to the Earth and Solar System material consisting of 2 cycles increased the critical thinking skills of class VII X students according to the target.

Project-based learning is one of the models that can help achieve 4Cs skills, one of which is critical thinking (Wibowo, 2014). PjBL is a project-based learning model that emphasizes contextual learning through projects. Project-based learning consists of projects that integrate various sciences that will provide opportunities for students to discuss and provide opportunities to investigate topics based on real-life problems (Turgut, 2008).

According to Sardjiyo and Pannen (2005), the ethnoscience approach is a learning strategy that creates a learning environment and designs student learning experiences that utilize the surrounding culture as a medium for science learning. A culture that is included in science learning can bring benefits and is able to improve the quality of understanding in students; ethnoscience can help students explore and align facts and phenomena that exist in society and their environment that can be drawn with scientific knowledge (Melyasari et al., 2018). Ethnoscience is natural knowledge in the form of language, customs and culture, morals, and technology created by particular social groups (Sudarmin, 2014). Ethnoscience encourages teachers and education practitioners to teach science based on culture, local wisdom, and problems in society so that students can understand and apply the science they learn in class to solve problems they encounter in everyday life, making science learning in class more meaningful (Shidiq, 2016). Ethnoscience is a modification of indigenous science (knowledge inherent in a particular group) into scientific science. Science learning produces an understanding of the relationship between science, technology, and society (Rahayu & Sudarmin, 2015).

PjBL, integrated with an ethnoscience approach, can critically engage students. Ethnoscience emphasizes the use of local and traditional knowledge in science, allowing students to develop a deep understanding of the relationship between science and their culture (Damayanti et al., 2017). PjBL involves problem-solving, while ethnoscience provides a relevant cultural context. This integration stimulates critical thinking because students understand scientific concepts and see them in a social and cultural context (Mirnawati et al., 2021). Science learning will be easier for students to understand if it is connected to the surrounding environment that can be seen directly by students (Shofiyah et al., 2020)

4. Conclusion

Based on the results of classroom action research conducted in the pre-cycle, cycle 1, and cycle 2, it can be concluded that the critical thinking skills of class VII X students at a junior high school in Surakarta have increased. The percentage of the score on the interpretation aspect from pre-cycle was 26.67% to 55% in cycle 1 and increased to 83.33% in cycle 2. The percentage of the score on the analysis aspect from pre-cycle was 35% to 46.67% in cycle 1 and increased to 68.33% in cycle 2. The percentage of the score on the explanation aspect from pre-cycle was 23.33% to 68.33% in cycle 1 and increased to 91.67% in cycle 2. The percentage of the score on the conclusion aspect from pre-cycle was 41.67% to 85% in cycle 1 and increased to 96.67% in cycle 2. The percentage of the score on the evaluation aspect from pre-cycle was 33.33% to 53.33% in cycle 1 and increased to 90% in cycle 2. The percentage of the score on the self-control aspect from pre-cycle 30% to 68.33% in cycle 1 and increased to 93.33% in cycle 2.

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