Tarbawi: Jurnal Ilmu Pendidikan
p-ISSN: 1858-1080|e-ISSN: 2615-6547
Vol. 19, No. 1, June 2023, 13-24

Improving Critical Thinking Skills of Prospective Biology Teacher Students through Ethnoscience-Based Biology Learning

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Abstract. *Ethnoscience is one of the activities in transforming indigenous science into scientific science that can be implemented in the biology learning process. The implementation of the ethnoscience stage in biology learning perhaps can improve students' critical thinking skills, which is the aim of this research. This research is experimental research using a pretest-posttest control group design. The research population consisted of 36 students. The sample selection used a random sampling technique consisting of 2 classes (experimental and control), each class consisting of 18 students. Research data was obtained through pretest and posttest. There are 10 questions with 5 indicators of critical thinking skills through a minimal structure essay test. The results of the research show that there is an increase in students' critical thinking skills in understanding concepts that integrate native community knowledge into scientific knowledge through the ethnoscience stage compared to critical thinking skills that do not go through ethnoscience-based learning in biology learning. Therefore, ethnoscience-based learning is recommended to be applied in the learning process in other subjects such as biotechnology and bioappliance to help improve critical thinking skills and other skills in simplifying content-rich biological material.*

***Keywords**: Biology Learning, Critical Thinking Skills, Ethnoscience-Based Learning, Prospective Biology Teacher*

INTRODUCTION

A content-rich biology course provides for students to be able to practice and explain the outcomes they learn during the learning process. Biology learning addresses the natural phenomena surrounding them and applies them using a scientific approach which emphasizes direct experience such as experimentation or investigation (Nufus et al., 2018). Learning science should focus on developing communication skills as well as conceptual understanding (Budiyono et al., 2015; Pratiwi et al., 2019). However, in practice, learning takes place in discussions, lectures, and question-and-answer sessions rather than using a model that can enhance students' critical thinking abilities. As a result, only some students pay attention to the learning process in class. The student's lack of curiosity affects his capacity for critical thought (Saputri et al., 2018).

The absence of opportunities for students to participate in learning, the limited amount of learning experiences, and the lack of effort to develop argumentation skills that encourage students to think critically are the major issues with present education, in addition critical thinking cannot be obtained easily, therefore it takes a lot of intellectual exercise in reconstructing the brain to think (Wartono et al., 2019). Students' capacity for critical thinking in science suffers as a result. Additionally, the actual learning process has not maximized students' physical and psychological capacities to acquire more material, nor has it focused on their cognitive abilities (Ompusunggu, et al., 2016). This partly goes against what is demanded of pupils in the 21st century, who must not only learn subjects but also possess critical thinking skills, information, and communication technology skills, problem-solving skills, effective thinking skills and collaboration skills (Chaeruman, 2010).

How someone communicates and presents content that has been grasped is a sign of one's capacity for critical thought (Angeline et al., 2018). Critical thinking is the process of linking, evaluating, gathering, organizing, memorizing, and interpreting data on all facets of a situation or problem. Indicators of critical thinking include the following: (1) the capacity to comprehend and formulate the central issues; (2) the capacity to express reasons based on facts or evidence; (3) the capacity to make or select arguments that are logical, pertinent, and accurate; (4) the capacity to explain the intent of the argument made based on various points of view; and (5) the capacity to ascertain the ramifications of an argument taken as a decision.

In order to make a decision and carry it through, critical thinkers must be able to evaluate, reconstruct, and analyze knowledge (Haghparast et al., 2013). It goes without saying that the abilities can assist students in efficiently addressing social challenges, scientific problems, and practical problems (Hudha & Batlolona, 2017). Therefore, by using exercises and simulations, these skills can be included into a learning process (Von Colln-Appling & Giuliano, 2017). Although research conducted in an Indonesian learning context revealed students' deficiency in mastering the skills, critical thinking skills play a significant influence in students' performance in learning (Halpern, et al., 2012). Critical thinking skills play a major role in students' success in learning (Halpern, et al., 2012); however, research conducted within an Indonesian learning context showed students' insufficiency in mastering the skills, especially critical thinking skills (Kurniawati et al., 2015). Also, because of the implementation of incompatible and discouraging learning models, facts also prove that critical thinking skills of high school students in Malang, especially in Biology, fall into the low category (Corebima, 2016).

Through ethnoscience-based learning, which incorporates community original knowledge into scientific knowledge into a variety of activities carried out in daily life, students' existing skills can be improved. (Kencanawati & Angela, 2022). As in the learning process used by biology education students who use the regional resources as an ethnoscience-based learning media to simplify the content of the biology textbook. Because the emphasis is on knowledge systems or devices that are specific to a community because it is different from other societies, studying through the stages of ethnoscience seems easier and more pleasurable (Hadi & Ahied, 2017; Sudarmin & Asyhar, 2012).

Ethnoscience derives from the Greek and Latin words ethnos (nation) and scientia (knowledge). Accordingly, ethnoscience is information that a country, or more specifically, an ethnic group, or a certain social group, possesses as a system of knowledge and cognition that is typical of a particular culture (Parmin, 2017). Numerous learning models, such as discovery learning models, problem-based learning (PBL), project-based learning (PjBL), constructivism approaches, contextual learning, and others, can incorporate the ethnoscience approach. This implementation necessitates a change in the learning paradigm from teacher-centered learning to student-centered learning, from individual learning to collaborative learning, and from emphasizing the application of scientific knowledge to the process of reconstructing original science (knowledge that develops in society) into scientific science to increase critical thinking skills (Kencanawati et al., 2021; Sudarmin et al., 2018).

According to Sudarmin (2014), ethnoscience is local knowledge that is specific to a tribe or group. In a different meaning, ethnoscience is defined as the knowledge or beliefs passed down by community groups from one generation to the next that might affect how people interpret and comprehend society (Fasasi, 2017). From the perspectives of the two preceding experts, it can be concluded that ethnoscience is the process of fusing the traditional knowledge of a community or tribe that has been passed down from one generation to another with scientific knowledge.

Various ethno-science studies are continually being conducted and are connected to student character, critical and creative thinking abilities, and scientific literacy. Some of these, such creative teaching tools and worksheets for students that incorporate ethnoscience, can boost students' creativity (Andani et al., 2020). According to the article (Hikmawati et al., 2021) implementing ethnoscience-based science instruction increases students' critical thinking abilities and culturally sensitive attitudes. Then, by studying about ethnoscience while smoking fish, students can become more literate (Perwitasari et al., 2016).

METHOD

Experimental research can be interpreted as a research method used to find the effect of cause and effect between variables (Sugiyono, 2017). This study uses a quantitative method with an experimental approach. This experimental research used a pretest-posttest control group design (Frankel, Wallen & Hyun, 2015). The research population consisted of 36 students. The sample selection used a random sampling technique consisting of 2 classes (experimental and control), each class consisting of 18 students. Research data was obtained through pretest and posttest. There are 10 questions with 5 indicators of critical thinking skills through a minimal structure essay test, then the data was analyzed using a t-test to compare the increasing of critical thinking skills with and without ethnoscience approach in biology learning. Pretest-posttest control group design shown in Table 1.

Table 1. Pretest-Postest Control Group Design (Rusdi, 2020)

Experiment	Random Assignment	O_1	X	O_2
Control	Random Assignment	O_3	C	O_4

Information:
O_1 and O_3 = Random sampling was used to select both the experimental group and the control group
X = The treatment is in the form of learning using an ethnoscience approach
C = Learning without an ethnoscience approach in the control group
O_2 = Posttest in the experimental group given learning using an ethnoscience approach
O_4 = Pretest in the control group given learning without an ethnoscience approach

The sampling technique used in this study is random sampling. The homogeneity of variance test and the average similarity test were run on the student results of the tests prior to random selection. a random sample is taken once it is shown that the data has homogeneous variance and the same average. VA was selected as the experimental group, while VB was the control group.

the data collection technique in this study was a test. before the test was given to the experimental and control groups, the expert validated the test items first. after that, a test trial was carried out in vc. the trial results were analyzed to obtain questions that met the criteria for use. in this study, the test given was in the form of a critical thinking skills test consisting of 10 questions. the test questions were given to the experimental group students and the control group students. the following is a rubric or guideline for scoring critical thinking skills in table 3, adapted from Finken and Ennis (1993).

Table 3. Indicator Critical Thinking Scoring Rubric

Critical Thinking Indicators	Criteria	Score
	All concepts are correct, clear and specific	5
	Most of the concepts are correct, clear but specific	4

Focus	A small part of the concept is correct	3
	The concept of lack of focus or dubiousness	2
	All concepts are not true	1
Reason	All answer descriptions are correct, clear and specific, supported by reasons a strong, correct, clear argument	5
	Most of the answer descriptions are correct, clear, but not specific	4
	A small part of the explanation of the answers is correct and clear but the reasons and arguments are not clear	3
	Answer description does not support	2
	Reasons are not true	1
Organization	The flow of thinking is good, all concepts are interconnected and integrated	5
	The flow of thinking is good, most of the concepts are interrelated and integrated	4
	The flow of thinking is quite good, some concepts are related to each other	3
	The flow of thinking is not good, concepts are not interconnected	2
	The flow of thinking is not good	1
Prevalence	The Grammar is good and correct	5
	The Grammar is good and right, there are small mistakes	4
	The grammar is quite good and correct, there are spelling mistakes	3
	The Grammar is good, sentences are not complete	2
	The grammar is not good	1
Integration	All aspects appear to be evidence, good and balanced evidence	5
	All aspects appear to be evidence, but it is not balanced	4
	Most aspects appear correct	3
	Some aspects seem correct	2
	All aspects are incorrect	1

FINDINGS

The implementation of ethnoscience-based learning in biotechnology courses has been shown to increase students' interest in developing their critical thinking skills. In biology study They claimed in the response survey that they understood the idea of local plant knowledge about uses incorporated into scientific knowledge through the stages of ethnoscience better because of taking part in this learning activity, the example application in making potato dodol that used stage etnoscience, start from prepare material, cooking, boiling to labelling. This is consistent with studies by Kencanwati & Angela (2022) and Arifin (2019), who used indigenous flora to make potato dodol and Madura shrimp paste through a study of folklore that was assimilated into scientific knowledge through the stages of ethnoscience. Using scientific knowledge that is used in daily life and drawing conclusions based on data connected to scientific processes while applying biotechnology material are both part of the knowledge transformation process that students engage in. Most students participate actively in these activities, starting with group discussions and concluding with presentations in front of the class about the processes they have seen in people's lives that use local plants as snacks. This is also evident in practicum activities and classroom discussions related to context-related topics.

This can be interpreted as a learning process that empowers students more, where students act not as recipients of lessons through verbal explanations from lecturers but are more directed to be able to manage to learn and develop their learning (Prasasti, 2017). The focus of student activities is solving complex problems, and various forms of learning activities carried out by students (collecting relevant information, collecting data, testing models, learning new concepts needed to understand problems, etc.) are always in service to produce evidence-based solutions to problems and understanding the nature and development of scientific knowledge in participating productively in scientific practice (Awad & Barak, 2018). A comparison of the average N-Gain and standard deviation of critical thinking skills between the experimental and control groups is described in Table 2 below:

Table 2. ***Group statistics***

	Class	N	Mean	Std. Deviation	Std. Error Means
Critical Thinking skills	Experiment	18	.154439	.0841811	.0198417
	Control	18	.064723	.0350673	.0082655

The result of the research in Table 1 showe the critical thinking skills of the experimental class experienced a better improvement than the control class' critical thinking skills with a mean value of 0.154439 > 0.064723, so the smaller the standard deviation, the better the measurement results.

The data from the t-test analysis of students' critical thinking skills through ethnoscience-based learning in the experimental and control classes are presented in Figure 1 and Table 3 below.

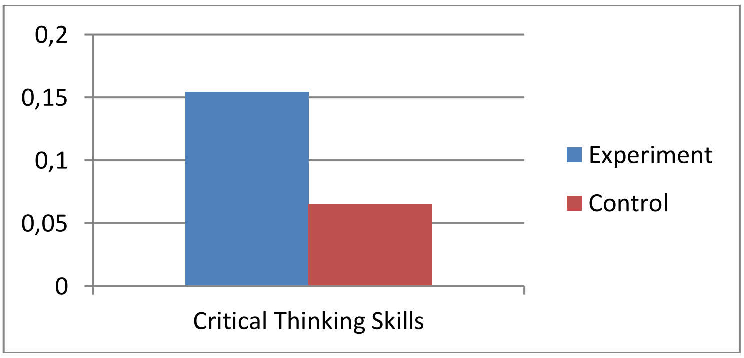

Figure 1. Mean of the critical thinking skills of the experimental and control class

Figure 1 shows that the critical thinking skills in the experimental class have improved better than the control class. Measurement of critical thinking skills through ethnoscience-based learning provides a better understanding than classes that do not apply ethnoscience-based learning. This is in line with Ennis' opinion which states that the concept of critical thinking is mainly based on specific skills such as observing, guessing, generalizing, reasoning, and evaluating reasoning. According to him, skills associated with critical thinking can be learned and can be transferred from one discipline to another. Ennis emphasizes subject-neutral principles and critical reasoning skills, namely logical principles that do not only apply to a particular discipline but can be applied universally (Ennis, 1993).

To deal with the complexity of issues brought on by the rapid advancement of technology and social movements in this day, critical thinking is crucial and becoming more and more necessary (Ulger, 2018). To train graduates who are capable of critical thinking, all educational institutions should use more optimal and effective measures (Alotaibi, 2013; Ulger, 2018; Ali & Awan, 2021). Because of these responsibilities, teachers play a significant role in helping students develop their critical thinking skills. Therefore, every pre-service teacher, especially pre-service science instructors, should be equipped with the ability to foster critical thinking skills in their students.

Table 3. Independent Sample Test

		Leavene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower	Upper
Critical Thinking Skills	Equal variances assumed	6.849	.013	4.174	34	.000	.0897152	.0214944	.0460333	.1333971
	Equal variances not assumed			4.174	22.728	.000	.0897152	.0214944	.0452211	.1342093

Based on the t-test, a significance value of 0.000 was obtained, meaning that the significance value was lower than the specified 0.05 significance level, so the null hypothesis was rejected. These results indicate that the critical thinking skills of the experimental class improved better than the control class' critical thinking skills.

DISCUSSION

The results showed that the learning biology based etnoscience to the subject matter biology classification of local plant affects students' critical thinking skills. According to Sudarmin et al. (2018), the ethnoscience approach is a method for developing a learning environment and designing learning experiences that incorporate culture as a component of the learning process. Students should become literate in science and technology because of their science education. One way to link the knowledge to be studied with the culture where students come from and connect science and culture is to emphasize the achievement of an integrated understanding rather than just an in-depth understanding of content-rich biology learning materials (Emdin, 2011; Fahrurrozi, 2015; Sayakti, 2003). This will influence the improvement of student academic results and make the learning process more meaningful (Emdin, 2011; Sardijo, 2005; Sayakti, 2003).

Learning with an ethnoscience approach is thought to be able to shift from teacher-centered learning (TCL) to student-centered learning (SCL), creating contextual and meaningful learning so that efforts to improve critical thinking skills, scientific literacy, and student's ability to apply scientific knowledge are successful (Sudarmin, 2014). Students can participate in learning activities that use an ethnoscience method since this sort of learning is packaged through observation, discussion, presentation, and praxis. Students' critical thinking abilities are accompanied by their learning activities when employing an ethnoscience approach, which demonstrates an improvement.

According to Wahyuni (2015) at this time learning science more often by doing reading activities, and memorizing material. Science itself is not learning that suppresses memorization (Maksic & Spasenovic, 2018). Science learning requires developing not only content knowledge, but procedural knowledge and cognitive knowledge (Kind & Osborne, 2017). Therefore, the implementation of science learning should be done contextually and scientifically to develop the ability to think, work and act scientifically as well as provide direct and meaningful experiences for students (Latifah et al., 2020).

The indicators of critical thinking skills are focus, reason, organization, prevalence and integration was adopted from Finken and Ennis (1993) explain the first steps that the focus indicator tells the measurement of the level of clarity of the theme of the topic discussed and students prove the the truth of the statements given. This can be seen in the average post-test of the experimental class which is better than the control class because the experimental class gets biology lessons with an ethnoscience approach that places more emphasis on students making direct observations. Students who gain knowledge through direct experience will be able to improve students' cognitive abilities for the better (Hastuti, 2014). This result is in line with the results of Kartimi's research (2014) which showed that the average student learning outcomes increased after the implementation of local cultural science-based biology learning.

The second steps in the stages of measuring the critical thinking abilities of experimental class students also appear to be better than the critical thinking abilities of control class students in the aspect of giving reasons in solving problems. Strong evidence and reasons to show the level of truth and clarity of the explanation given based on the facts obtained. This result is in line with the research results of Arfianawati et al. (2016) and Suputra et al. (2013) which shows that the average critical thinking ability of students in classes that study with MPKBE learning and the local wisdom-oriented GI (Group Investigation) learning model learning are greater than the average critical thinking ability of students in classes that study with conventional learning model.

The third steps of the thinking process involves students developing and processing the capacity to comprehend conclusions in a statement and relate it to all interconnected and integrated concepts as seen when they classify local plants they are familiar with and link them to the stage of ethnoscience whilst studying biology. According Mulnix (2012); Hughes and Lavery, 2014) that critical thinking is comprehensive introduction so you can do better reasoning in obtaining, developing, and processing the ability to understand the conclusions in a statement.

The fourth steps in the use of grammar uses standard rules and matches the task and the reasons presented in describing the identification of the plants encountered based on the characteristics they have in scientific language that is easy to understand. Although in the learning process students discuss natural events which include living creatures, both animals and plants and other natural events that are often found in the area us, but the existing Latin terms are still complicated to pronounce and remember (Anwar, 2013). The complexity of learning Latin names is basically because of the Latin names has taxonomic levels The use of scientific names or Latin names has an important role in naming of living things, especially in animals and plants. Student knowledge regarding the use of Latin terminology derived from the results of responses and reactions as a result or impression obtained during the process of learning biology activities (Kameswari, 2022).

In the final steps in measuring critical thinking skills that implement the ethnoscience stage in biology learning is the evaluation stage which explains the truth and clarity of the questions and answers given. Overall it shows that the experimental group has a better answer than the control class. This interaction is intended to provide an overview of improving students' critical thinking skills towards the implementation of an ethnoscience-based learning process in solving problems in the learning process and applying the application of science and how technology helps human life (Allchin, 2014). The interaction have been seen in reconstruction of community knowledge into scientific knowledge. Ethnoscience-based education can improve scientific thinking skills in the local culture. Ethnoscience-based learning is good for education and can enhance the local culture perspective (Nurcahyani et al., 2021).

The ethnoscientic approach to science learning comes from various local wisdoms or local cultures that can be explored as learning resources. These learning resources can be developed into various teaching materials to support science learning. This research shows that biology learning with ethnoscience content that integrates local regional wealth can improve students' scientific literacy and critical thinking skills. Involvement and direct interaction between students and the community in applying science and technology knowledge with ethnoscience is a major part of the research conducted.

CONCLUSSION

Based on the results, it is seen that for improving student's skills in critical thinking, ethnoscience is used to implement learning stages. It is possible to build learning experiences that incorporate culture as a component of the learning process by integrating indigenous knowledge into scientific knowledge and using the wealth of local plant life. Learning is made more meaningful for students and can improve academic performance and students' critical thinking skills by using a local cultural and environmental approach or an ethnoscientific approach as a learning resource. This research can be a reference for teachers and lecturer to apply etnhoscience based biology learning in other subject.

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