International Journal of Instruction
e-ISSN: 1308-1470 ● www.e-iji.net

July 2023 ● Vol.16, No.3
p-ISSN: 1694-609X
pp. 777-796

Article submission code: 20220811134920

Received: 11/08/2022
Revision: 03/02/2023

Accepted: 01/03/2023
OnlineFirst: 09/05/2023

Analysis of Science Concept Mastery, Creative Thinking Skills, and Environmental Attitudes After Ethno-STEM Learning Implementation

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This research aims to analyze differences in science concept mastery, creative thinking skills, and environmental attitudes based on students' achievement levels after implementing Ethno-STEM learning. The method used in this study was quasi-experimental with one group pretest-posttest design. The population in this study was 194 seventh-grade students of SMP Negeri 2 Pekalongan. With the convenience sampling technique, 64 seventh-grade students were selected as samples and divided into upper, middle, and lower-achievement groups. Data were collected through an objective science concept mastery test, essay creative thinking skill test, and environmental attitudes scale. The results showed significant differences in science concept mastery in the upper and middle-achievement groups in the moderate category, while the lower-achievement group was in a low category. There were also significant differences in creative thinking skills for the upper and middle-achievement groups in the moderate category, while the lower-achievement group was in a low category. The environmental attitude test showed no significant difference between the pretest and posttest for all achievement groups.

Keywords: Ethno-STEM, science concept mastery, creative thinking skills, environmental attitudes, learning implementation

Citation: Izzalı, S. N., Sudarmin., Wiyanto., & Wardani, S. (2023). Analysis of science concept mastery, creative thinking skills, and environmental attitudes after Ethno-STEM learning implementation. *International Journal of Instruction*, *16*(3), 777-796. https://doi.org/10.29333/iji.2023.16342a

INTRODUCTION

The world has developed into a disruption era with fundamental dynamical changes in education service and field two decades of the 21st century (Oey-Gardiner et al., 2017). Science learning focuses on students' competence, including attitude, knowledge, and skills in this era. Learning and innovation skills required to succeed in the 21st-century era are 4C: critical thinking, communication, collaboration, and creativity (Trilling & Fadel, 2012). Concept mastery is essential for intellectual development (Maknun, 2015). Mastery involves cognitive skills, which is crucial to measure science learning success. Science concept mastery will be successful when students can simplify abstract materials to be more understandable, interpretative, and applicable to daily life (Baumfalk et al., 2019). In addition, the preference for appropriate learning strategies can influence science concept mastery (Wilujeng et al., 2020).

Creative thinking is needed in the 21st century (Horvathova, 2015; Sumarni & Kadarwati, 2020). It should be developed so students can solve daily problems (Soyadı, 2015; Gilhooly et al., 2015; Retnawati et al., 2018). Appropriate learning activities improve students' problem-solving creativity (Wardani et al., 2017). Therefore, developing learning which improves creative thinking skills is necessary (Sumarni & Kadarwati, 2020). Studies showed that students' creative thinking skills are low, as indicated by low or undeveloped achievement indicators (Tamba et al., 2017; Sumarni & Kadarwati, 2020). Data from PISA in 2018 revealed that Indonesian students' creative thinking skills were poor (OECD, 2019), indicating that students are not thoroughly taught how to think creatively.

The aspect of scientific competence in the 2013 curriculum states that one of the scientific attitudes that can be developed is environmental attitudes (Kemdikbud, 2017). As a part of society, students need to be educated to foster environmental attitudes (Rakhmawati et al., 2016). Students who study at a certain level of education are the nation's next generation, who are expected to have better quality than the previous generation (Wiyanto et al., 2014). Knowledge is related to environmental attitudes (Kumurur, 2008; Taufiq et al., 2014). Students' cognitive understanding of the environment will influence their environmental attitudes. Thus, students' knowledge of environmental care is expected to correlate with environmental attitudes positively.

One of the developed innovative learning in some countries is using the Science, Technology, Engineering, and Mathematics (STEM) approach. The principles of this learning approach encourage creativity and problem-solving skills. STEM approach influences academic achievement, creative thinking skills, scientific attitudes, and process skills (Baran et al., 2016; Yildirim, 2016). This approach is used to naturally reconstruct indigenous knowledge of natural batik coloring (Sudarmin et al., 2020). Batik is an intangible cultural heritage practice representing Indonesian art and culture (Wang, 2018). One of the well-known batik cities in Indonesia is Pekalongan. Batik is not only a part of people's lifestyle in Pekalongan but also has an essential role in daily life in expressing happiness or sadness (Paramita, 2010). Batik, as Indonesian culture, should be conserved.

The domination of western science and norm in non-western countries developing STEM curricula based on western knowledge can bring up “We, as academics, are like a stranger in our own country (p.53)” (Abonyi et al., 2014). Putting cultures into learning activities through STEM education at school is to keep the inherited methods and cultural practices (Kang & Peters, 2019). Meanwhile, to effectively put local wisdom into the school curriculum, a cross-border epistemological blend between indigenous knowledge and western science is needed in terms of epistemological and ontological, which demand teachers’ knowledge and pedagogical skill (Chahine & De Beer, 2021).

This research aims to analyze differences in science concept mastery, creative thinking skills, and environmental attitudes based on students’ achievement levels after implementing Ethno-STEM learning. The following are research questions that will be revealed:

RQ1: Is there a significant difference in students’ science concept mastery before and after Ethno-STEM learning implementation?

RQ2: Is there a significant difference in students’ creative thinking skills before and after Ethno-STEM learning implementation?

RQ3: Is there a significant difference in students’ environmental attitudes before and after Ethno-STEM learning implementation?

The following are the hypotheses in this research:

1) There is a significant difference in students’ science concept mastery before and after Ethno-STEM learning implementation.
2) There is a significant difference in students’ creative thinking skills before and after Ethno-STEM learning implementation.
3) There is a significant difference in students’ environmental attitudes before and after Ethno-STEM learning implementation.

Context and Review of Literature

Concept mastery is students’ ability to understand a concept after learning activities. Concept mastery can be interpreted as students’ ability to make sense scientifically in theory and everyday life application (Dahar, 2003). Students’ concept mastery in high school physics courses influences the problem-solving process and knowledge application when scientific creativity can conduct investigations. In addition, concept mastery will enable one to present, interpret, and apply the material in a more comprehensible format (Wicaksono et al., 2017). According to Wicaksono et al. (2017), there is a significant improvement in students’ scientific creativity and concept mastery.

According to Costa (1985), complex thinking is a higher-order process consisting of critical thinking, creative thinking, problem-solving, and decision-making. As for creative thinking, according to Perkins (Costa, 1985), it is the ability to form new combinations of ideas to fulfill a need or obtain a result (product) that is original and under the main criteria of the question. Creative thinking can be defined as a whole series of cognitive activities that individuals use according to particular objects, problems and conditions, or types of efforts towards specific events and problems based on individual capacities (Birgili, 2015). In a learning environment that allows creative thinking, thinking is valued more than knowledge. In science education, students are expected to seek to acquire knowledge rather than absorb it by memorizing information (Şener & Taş, 2017).

Milfont (2009) defines environmental attitudes as a psychological tendency expressed by evaluating the surrounding environment through several favorable and unfavorable levels. Gifford and Sussman (2012) define environmental attitudes as concern for the environment or environmental problems. In contrast, Franzen and Vogl (2013) define environmental attitudes as personal insight into human behavior that harms the environment and the desire to protect it. Based on these definitions, it can be concluded that environmental attitudes are attitudes and actions that always try to prevent damage to the surrounding natural environment and develop efforts to repair the natural damage that has already occurred.

Previous researchers have conducted studies about Ethno-STEM: entrepreneurship character development through Ethno-STEM (Sudarmin et al., 2019; Sudarmin et al., 2019), the implementation of Ethno-STEM learning to improve critical thinking at the primary level (Prasadi et al., 2020), Ethno-STEM project-based learning which impacts senior high school students' creative and critical thinking (Sumarni & Kadarwati, 2020), implementation of Ethno-STEM-based science learning in vocational level to improve students' HOTS (Agussuryani et al., 2020), application of E-book of Ethno-STEM which impacts on high school students' science generic skill (Azalia et al., 2020), and college students' creative and innovative skill profile in designing chemistry batik after joining Ethno-STEM class (Sudarmin et al., 2020). However, analysis of students' science concept mastery, creative and critical thinking, and environmental attitudes after Ethno-STEM-based science learning were not presented. Besides, this approach may give good teaching practice in improving science concept mastery, creative thinking skills, and environmental attitudes. Hence, this study presents those three areas.

METHOD

Participants

The location for this study was a private secondary school in Pekalongan. The school uses the 2013 Indonesian curriculum for teaching and learning and Indonesian as a daily language.

The method used in this study was quasi-experimental with one group pretest-posttest design. The population in this study were 194 seventh-grade students of SMP Negeri 2 Pekalongan in the 2019/2020 academic year. The school has six seventh-grade classes. The researcher took three classes for instrument trials; one for limited trials and two for samples. Sampling was done by using the convenience technique. Fraenkel et al. (2012) stated that the convenience technique is used because a group of people is (conveniently) available for research.

Instruments

The development of instruments and documents for Ethno-STEM learning tools has been carried out. This study used test and non-test instruments. The test instrument was developed to measure science concept mastery and creative thinking skills in the Characteristics of Substances learning material in Chapter 3. Science concept mastery tests were prepared based on Bloom's Taxonomy, revised by Anderson (Anderson & Krathwohl, 2001), while the creative thinking skills test is prepared based on the Creative Thinking Skills of Torrance Test indicators (The Alberta Teachers Association, 2007). Experts declared that 22 multiple-choice questions for science concept mastery and eight essay questions for creative thinking skills were valid in content and construction.

The non-test instrument was developed to measure environmental attitudes. Environmental attitudes are compiled based on indicators adapted from the Environmental Attitudes Inventory (EAI) instrument developed by Milfont & Duckitt (2010) and Environmental Attitudes Indicators by the Directorate of Environmental Statistics (BPS, 2015). Experts declared that 13 items were valid in content and construction. The instrument was also tested previously on students other than research subjects. Validation was carried out in the following steps: (1) focus group discussions with junior high school science teachers in Pekalongan Municipality at the Science Teacher Association forum; (2) expert validation; (3) limited trials. The Ethno-STEM science learning tool documents include syllabi, lesson plans, and teaching materials (Izzah et al., 2020).

The reliability of the test instrument was tested using Cronbach's Alpha coefficient formula and showed a result of 0.654 (reliable category). SPSS 25 calculation results for the reliability of the questionnaire instrument showed a Cronbach's Alpha value of 0.627 (reliable category). The criteria for reliability level are stated in Table 1.

Table 1
Reliability level

α Value	Reliability Level
0.0 – 0.2	Unreliable
>0.20 – 0.40	Slightly Reliable
>0.40 – 0.60	Quite Reliable
>0.60 – 0.80	Reliable
>0.80 – 1.00	Very Reliable

Source: (Hair et al., 2010)

Data Collection Procedures

The types of data, techniques, instruments, and data sources in this study are presented in Table 2.

Table 2
Types of data, techniques, instruments, and data sources

No	Type	Technique	Instrument	Source
1	Science Concept Mastery	Written multiple-choice test	Question sheet	Students
2	Creative Thinking Skills	Written essay test	Question sheet	Students
3	Environmental Attitude	Scale	Scale sheet	Students

Procedures

Before implementing Ethno-STEM, students' learning achievements were grouped based on the daily test result for Units 1 and 2, with a minimum score of 39 and a maximum score of 100. Grouping was based on the normal distribution model (Azwar, 2012). The range of values is 39-100, so each standard deviation unit is σ = 61/6 = 10.16. The students' average score was 71,65. Groupings are presented in Table 3.

Table 3
Grouping of students' achievements

Score	Total	Achievement Group
81,82≤x	24	Upper
61,48≤x<81,82	27	Middle
x<61,48	13	Lower
Total	64	

Source: (Azwar, 2012: p.150)

The implementation time for Ethno-STEM science learning is 15 lesson hours with six meetings, starting with the pretest and ending with the posttest. The Ethno-STEM science learning material is Chapter 3, Characteristics of Substances, with the theme of Ethnoscience in making batik.

Data analysis

Data analysis techniques in this study included descriptive and inferential analysis. Descriptive analysis was carried out to describe the data from the questionnaire qualitatively in the form of information description based on specific categories and quantitative form (percentage and average N-gain). N-gain descriptive analysis used N-gain criteria according to Hake (2008). The criteria for the N-gain achievement level are presented in Table 4.

Table 4
Criteria of n-gain achievement level

Average Value	Level
0.70 – 1.00	High
0.30 – 0.69	Moderate
0.00 – 0.29	Low

Source: (Hake, 2008)

The inferential analysis uses a two-tailed t-test if the data is normally distributed. Previously, a requirement test was carried out as a basis for testing hypotheses: a normality test with the One-sample Kolmogorov-Smirnov test and a homogeneity test with Levene's test. Thus, tests for increasing science concept mastery, creative thinking skills, and environmental attitudes before and after implementing Ethno-STEM science learning used a two-tailed t-test. The test used Statistics Product and Service Solution (SPSS) v.25 for the paired sample t-test, one sample Kolmogorov-Smirnov Test for normality, and Levene's test for homogeneity.

FINDINGS

Science Concept Mastery After Ethno-STEM Learning Implementation

Students' mastery of characteristics of substance as prior knowledge was measured through a pretest. In contrast, the students' mastery measurements after Ethno-STEM learning were done through posttest. The measurement of concept mastery is presented in Figure 1.

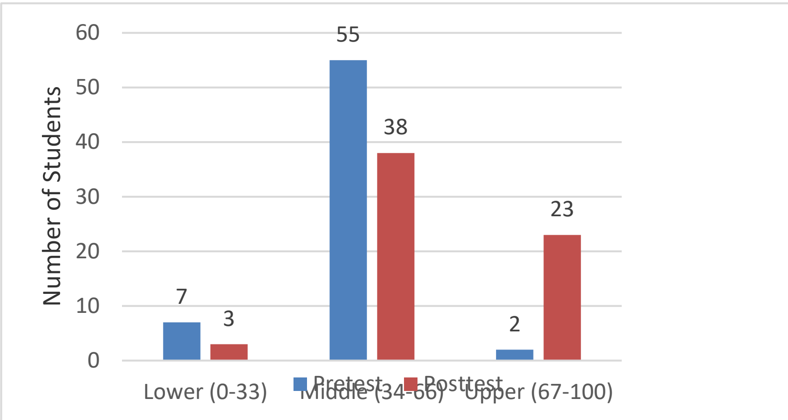

Figure 1
Level of students' science concept mastery

The normality test used the One-sample Kolmogorov-Smirnov test in SPSS to measure students' science concept mastery. From the test, the score of Asymp. Sig. (2-tailed) was 0,151 for the pretest and 0,461 for the posttest, which gap was 0.05. These data were regarded as the normal distribution. The homogeneity test was done using Levene's test. The pretest and posttest showed that the score of Sig. was 0,422, more than 0.05, which was considered homogenous. Paired sample t-test pointed score of Sig. (2-tailed) was 0,000 or less than 0,005, indicating a significant difference in students' science concept mastery on the pretest and posttest. Data from normality, homogeneity, and paired-sample t-test results are presented in Table 5.

Table 5
Normality, homogeneity, and paired-sample t-test results of science concept mastery

Data	One-Sample Kolmogorov-Smirnov Test		Levene's Test	Paired-Sample t-Test	
Pretest	*Asymp. Sig.* (*2-tailed*) 0,151>0,05	Data is normally distributed.	*Sig.*0,422> 0,05 Homogenous	*Sig.* 0,000< 0,05	Both data are correlated.
Posttest	*Asymp. Sig.* (*2-tailed*) 0,461>0,05	Data is normally distributed.		*Sig.* (*2-tailed*) 0,000< 0,05	There is a significant difference.

The average N-gain of the pretest and posttest measuring students' science concept mastery revealed that the upper achievement group obtained the highest average N-gain. The levels of N-gain achievement for the upper and middle achievement groups are moderate (0,3 ≤ N-gain ≤ 0,69), and the lower achievement group is categorized as low. The test results are presented in Table 6.

Table 6
N-gain score of students' science concept mastery based on achievement group

Achievement Group	Average			Achievement Level
	Pretest	Posttest	N-Gain	
Upper	43,50	67,50	0,462	Moderate
Middle	52,50	67,50	0,349	Moderate
Lower	32,50	43,50	0,193	Low

The data presented are further analyzed using the Mann-Whitney test, and the result is displayed in Table 7. The table shows a significant difference in N-gain between the upper-lower, upper-middle, and middle-lower groups.

Table 7
Difference test results of average n-gain of students' science concept mastery in achievement group

Achievement Group	N	Average N-Gain		
		Upper-Lower	Upper-Middle	Middle-Lower
Upper	24			
Middle	27			
Lower	13			
Z		-4,153	-3,227	-3,142
Asymp Sig. (*2-tailed*)		0,000	0,001	0,002
Conclusion		Significantly different	Significantly different	Insignificantly different

Creative Thinking Skills after Ethno-STEM Learning Implementation

Students' creative thinking skills of characteristics of substance as prior knowledge were measured through a pretest. In contrast, the students' creative thinking skills measurements after Ethno-STEM learning were done through posttest. The measurement of creative thinking skills is presented in Figure 2.

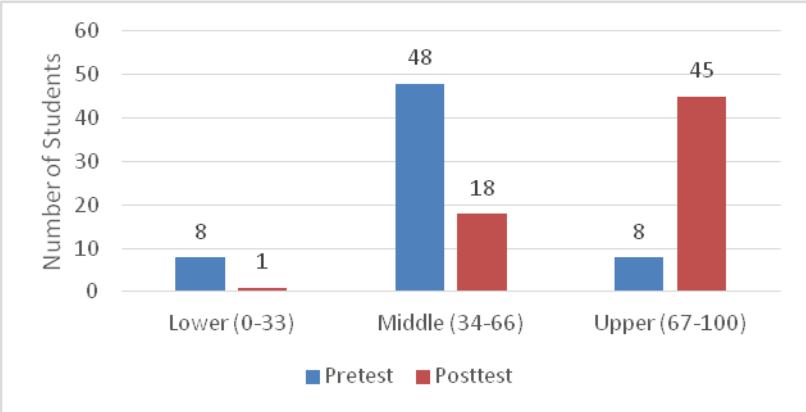

Figure 2
Level of students' creative thinking skills

A normality test used the One-sample Kolmogorov-Smirnov test in SPSS to measure students' creative thinking skills. From the test, the score of Asymp. Sig. (2-tailed) was 0,052 for pretest and 0,302 for posttest, which gap was 0.05. These data are regarded as a normal distribution. The homogeneity test was done using Levene's test. The pretest and posttest showed that the score of Sig. was 0,150, more than 0.05, which was considered homogenous. Paired-sample t-test pointed score of Sig. (2-tailed) was 0,000 or less than 0,05, indicating a significant difference in students' creative thinking skills on pretest and posttest. Data from normality, homogeneity, and paired-sample t-test results are presented in Table 8.

Table 8
normality, homogeneity, and paired-sample t-test results of creative thinking skills

Data	One-Sample Kolmogorov-Smirnov Test		Levene's Test	Paired-Sample t-Test	
Pretest	Asymp. Sig. (2-tailed) 0,151>0,05	Data is normally distributed.	Sig.0,150> 0,05 Homogenous	Sig. 0,000< 0,05	Both data are correlated.
Posttest	Asymp. Sig. (2-tailed) 0,461>0,05	Data is normally distributed.		Sig. (2-tailed) 0,000< 0,05	There is a significant difference.

The average N-gain of the pretest and posttest measuring students' creative thinking skills revealed that the upper-achievement group obtained the highest average N-gain. The rate of N-gain achievement for the upper and middle achievement groups is moderate (0,3 ≤ N-gain ≤ 0,69), and the lower achievement group is categorized as low. The test results are in Table 9.

Table 9
N-gain score of students' creative thinking skills based on achievement group

Achievement Group	Average			Achievement Level
	Pretest	Posttest	N-Gain	
Upper	55,63	78,58	0,506	Moderate
Middle	50,41	66,89	0,334	Moderate
Lower	45,85	60,61	0,268	Low

The data presented are further analyzed using the Mann-Whitney test, and the result is displayed in Table 10. Based on the table, there is a significant difference in N-gain between the upper-lower and upper-middle groups. In comparison, the middle-lower group is not significantly different.

Table 10
Difference test results of average n-gain of students' creative thinking skills in achievement group

Achievement Group	N	Average N-Gain		
		Upper-Lower	Upper-Middle	Middle-Lower
Upper	24			
Middle	27			
Lower	13			
Z		-3,818	-3,578	-1,611
Asymp Sig. (2-tailed)		0,000	0,000	0,107
Conclusion		Significantly different	Significantly different	Insignificantly different

Environmental Attitudes After Ethno-STEM Learning Implementation

Students' environmental attitudes of characteristics of substances as prior knowledge were measured through a pretest. In contrast, after Ethno-STEM learning, students' environmental attitudes measurements were done through posttest. The measurement results are displayed in Figure 3.

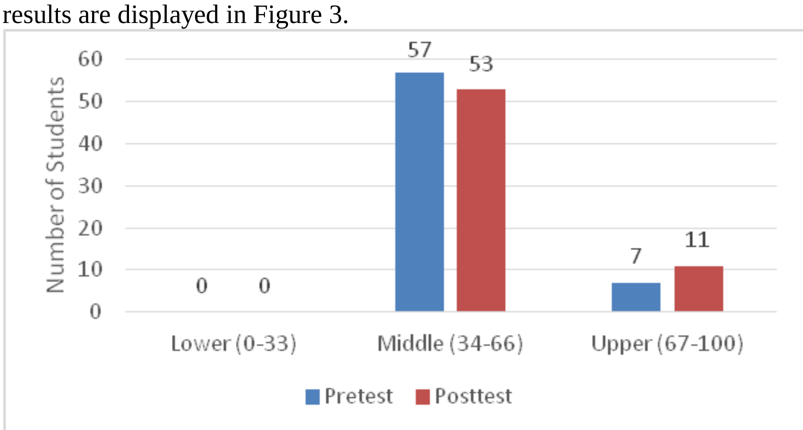

Figure 3
Level of students' environmental attitudes

Figure 3 presents students' environmental attitudes from middle and upper achievement group in pretest and posttest. The decrease in the number of students is insignificant in the middle group, from 57 to 53. The number of students is also not significantly increased for upper achievement group, from 7 students in the pretest to 11 in the posttest.

The normality test for questionnaire results was done using the One-sample Kolmogorov-Smirnov test in SPSS to measure students' environmental attitudes. From the test, the score of Asymp. Sig. (2-tailed) was 0,269 for pretest and 0,127 for posttest, which gap was 0.05. These data are regarded as a normal distribution. The homogeneity test used Levene's test. The pretest and posttest showed that the score of Sig. is 0,458, more than 0.05, which is considered homogenous. Moreover, the paired-sample t-test pointed score of Sig. (2-tailed) was 0,086 or more than 0,005, indicating no significant difference in students' environmental attitudes on the pretest and posttest. Data from normality, homogeneity, and paired-sample t-test results are presented in Table 11.

Table 11
Normality, homogeneity, and paired-sample t-test results of environmental attitudes

<table>
<tr><th>Data</th><th colspan="2">One-Sample Kolmogorov-Smirnov Test</th><th>Levene's Test</th><th colspan="2">Paired-Sample t-Test</th></tr>
<tr><td>Pretest</td><td>Asymp. Sig. (2-tailed) 0,269>0,05</td><td>Data is normally distributed.</td><td rowspan="2">Sig.0,458> 0,05 Homogenous</td><td>Sig. 0,181> 0,05</td><td>Both data is not correlated.</td></tr>
<tr><td>Posttest</td><td>Asymp. Sig. (2-tailed) 0,127>0,05</td><td>Data is normally distributed.</td><td>Sig. (2-tailed) 0,086> 0,05</td><td>There is no significant difference.</td></tr>
</table>

The average N-gain of the pretest and posttest measuring students' environmental attitudes revealed that upper and middle achievement groups had insignificant differences in average N-gain. The level of N-gain achievement for the upper, middle, and lower achievement groups was considered low ($0,3 \leq$ N-gain $\leq 0,69$). The test results are presented in Table 12.

Table 12
N-gain score of students' environmental attitudes based on achievement group

Achievement Group	Average			Achievement Level
	Pretest	Postttest	N-Gain	
Upper	31,33	31,42	-0,01069	Low
Middle	29,52	31,07	0,087	Low
Lower	31	31,3846	0,0002	Low

The data presented are further analyzed using the Mann-Whitney test, and the result is displayed in Table 13. The table shows no significant difference in N-gain between the upper-lower, upper-middle, and middle-lower groups.

Table 13
Significance test results of average n-gain of students' environmental attitudes in achievement groups

Achievement Group	N	Average		
		Upper-Middle	Upper-Lower	Middle-Lower
Upper	24			
M	27			
Low	13			
Z		-0,307	-0,306	-0,540
Asymp Sig. (*2-tailed*)		0,759	0,760	0,589
Conclusion		Insignificantly different	Insignificantly different	Insignificantly different

DISCUSSION

Science Concept Mastery After Ethno-STEM Learning Implementation

Science learning is conducted based on constructivism learning theory which develops science concept mastery based on learning experiences. Students get learning experience using dynamic strategy through experiments, projects, and problem-understanding in real life (Bada & Steve, 2016). Learning science includes not only scientific concepts and scientific theories but also scientific processes through internships. However, teachers rarely do this due to insufficient internship time, inadequate facilities, and a lack of solid teaching materials (Wahyu et al., 2020). The Ethno-STEM approach provides students with learning experiences about real daily life problems.

Figure 1 shows 23 students with an upper level of concept mastery for the posttest. The number increased from only two students during the pretest. Meanwhile, lower and middle-level students decreased from the pretest to the posttest. The result of the paired-sample t-test in significance level 5% gained Sig. (2-tailed) 0,000 or less than 0,05, showing a significant level of science concept mastery in the pretest and posttest. It indicates that implementing the Ethno-STEM approach as Ethnoscience in batik-making process can improve students' science concept mastery. This statement is in line with a previous study that STEM-based learning improves students' science concept mastery in the seventh grade of junior high school (Wandari et al., 2018).

Implementing the Ethno-STEM approach in science learning, which is Ethnoscience in batik making process using project-based learning, positively affects students since they learn through local culture to get knowledge. Abonyi et al. (2014) stated that ethnoscience-based learning in the classroom involves designing a practical model integrating local culture with a balanced cosmopolitan knowledge system. Implementing Ethnoscience makes learning science easier by relating the surrounding cultural science (Sumarni et al., 2020). Moreover, using video integrated with the local potential of *Pembangkit Listrik Tenaga Mikro Hidro* effectively improves students' concept mastery (Wilujeng et al., 2020). During the learning process using PjBL, students integrated STEM concepts in making aqua phonic and green wall projects to conceive materials about the ecosystem and environmental change (Suciari et al., 2021). STEM project-based learning has a better impact on students' concept mastery (Hanif et al., 2019).

Creative Thinking Skills After Ethno-STEM Learning Implementation

One of the skills in this 21st century is creative thinking (Trilling & Fadel, 2012; Chalkiadaki, 2018). Concept mastery should relate to creative thinking skills (Wicaksono et al., 2017). Figure 2 reveals that 45 students are grouped into the upper-level group of creative thinking skills in the posttest. It indicates an increase compared to the pretest number, which only had seven students. Oppositely, the number of students in middle and lower levels decreased from 56 to 19. The result of the paired-sample t-test in significance level 5% gained Sig. (2-tailed) 0,000 or less than 0,05 indicated a significant difference between students' creative thinking skills scores in the pretest and posttest. It is revealed that implementing Ethno-STEM as Ethnoscience in the batik-making process genuinely improved students' thinking skills. Similarly, Sumarni and Kadarwati (2020) stated that Ethno-STEM project-based learning has significantly affected students' creative and critical thinking improvement.

The Ethno-STEM approach positively impacts students due to the influences of learning activities teachers apply. Learning requires improved creative thinking (Purnomo et al., 2021). Students' skills will not improve by themselves if it is not developed by the teachers throughout the learning activities (Wardani et al., 2017). The teacher's role is not to impart information but to be a learning companion, creating and managing meaningful learning experiences and stimulating students' thinking through real-world problems (Wahyuddin et al., 2022). Creative thinking skills in science learning provide new perspectives for students to discover answers to science problems in daily life (Sumarni & Kadarwati, 2020). Another study concluded that students' creative and innovative character profile after Ethno-STEM implementation is very good (Sudarmin et al., 2020). Moreover, Wicaksono et al. (2017) found a significant improvement in students' creativity and concept mastery.

Environmental Attitudes After Ethno-STEM Learning Implementation

STEM helps students understand the concept and learn real-life problems (Çalışıcı & Benzer, 2021). STEM education includes learning activities that fully integrate science, technology, engineering, and mathematics and are applicable in everyday life (Puchongprawet & Chantraukrit, 2022). Environmental awareness relates to environmental attitudes. Most studies showed that positive attitudes toward the environment relate to environmental awareness (Mifsud, 2012). Schools are vital in educating students to be active and responsible for the environment (Torkar, 2016). A study by Helvaci and Helvaci (2019) found that implementing an interdisciplinary environmental education approach positively affects students related to E-STEM (Environment-STEM). The initial study result supports this finding that STEM implementation has developed positive attitudes (Gülhan & Şahin, 2016; Tseng et al., 2013; Yamak et al., 2014).

Figure 3 shows that the number of students who experienced an increase in environmental attitudes in the posttest is 11, of which there were only seven students in the pretest. Besides, the number of students at the middle and upper levels decreased from 57 to 53 and 7 to 11, respectively, from the pretest to the posttest. The increase and the decrease of students are not significant, as proved by the results of paired sample t-test in significance level 5%, which gained Sig. (2-tailed) 0,086 or more than 0,05 indicating no significant difference between the result of environmental attitudes measurement in the pretest and posttest. It shows that implementing the Ethno-STEM approach as Ethnoscience in the batik-making process does not improve environmental attitudes. In line with Hasiloglu and Kunduraci (2018), even though students got satisfying scores on "The Attitudes Toward the Environment Scale" (ATES), some of them could not reflect environmental attitudes in daily activities. Besides, in another study, students' posttest scores of environmental knowledge revealed that scientific arguments-oriented teaching significantly improved students' knowledge. However, there was no significant difference in scores of environmental attitudes (U= 311,5 = 0,129) (Hamalosmanoglu & Varinlioglu, 2019).

Rahman (2016) shows that predictors (knowledge, attitudes, responsibility, personality, trust, social influence, information sources, and facility environment management) contributed 44% to environmental attitudes. The most contributing factors are influence and social trust, followed by environment management facilities, attitudes, and personal responsibilities. Nonetheless, environmental awareness does not contribute to attitudes yet influences attitudes and behavior.

CONCLUSION

From the analysis, there are some conclusions discovered. First, using Ethno-STEM as Ethnoscience in the batik-making process improves science concept mastery. The N-gain average of science concept mastery for the upper and middle achievement groups was moderate, while the lower achievement group was in a low category. There is a significant difference in science concept mastery in the upper-middle, upper-lower, and middle-lower achievement groups.

Second, using Ethno-STEM as Ethnoscience in the batik-making process improves students' creative thinking skills. The average N-gain of this skill for the upper and middle achievement groups was moderate, while the lower achievement group was in a low category. There is a significant difference in creative thinking skills between the upper-middle and upper-lower achievement groups. In contrast, this significant difference was not revealed between the upper and lower achievement groups.

Third, no significant difference was found in the pretest and posttest analysis of students' environmental attitudes. The average N-gain of upper, middle, and lower achievement groups was low. The environmental attitude of students in upper-middle, upper-lower, and lower-middle achievement groups was not significantly different.

The researchers recommend that science teachers utilize Ethno-STEM approach for science learning integrated with relevant local wisdom and complemented by project activities in the form of real problem-solving activities to improve students' concept mastery, creative thinking skills, and environmental attitudes. After Ethno-STEM learning implementation that can improve students' science concept mastery and creative thinking skills, further analysis is needed to determine the influence between variables in the study using path analysis. The result of the study, which shows that Ethno-STEM learning has a low impact on students' environmental attitudes, indicates that further study should be conducted. Another learning that can improve such attitudes can be used without leaving out local wisdom as a learning source.

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