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SCIENCE LEARNING STRATEGY BASED ON ETHNO-SOCIOSCIENTIFIC ISSUES (ESSI): ANALYSIS OF CREATIVE THINKING ABILITY IN STUDENTS' SCIENCE RECONSTRUCTION

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ABSTRACT

This study aims to map science reconstruction, determine the profile of creative thinking skills, and assess the effectiveness of high school science learning strategies based on the ESsI approach. The research method is a mixed-method explanatory sequential design. The purposive sampling technique is based on the distance from the school location to the district center (City, Middle, and Village) in Wonosobo and Boyolali Regencies. The quantitative analysis techniques are normality and homogeneity testing, the t-test, and ANOVA, and the qualitative analysis is inductive-deductive. The results of the highest level of reconstruction in the PS (Potential Scientist Student) category of SMA C (village) are that students easily understand cultural traditions as science. The highest IDKS (I-do-not-know student) category is in SMA A (City), where students find it difficult to understand their own traditions and culture. In the highest OS (Outsider) category in SMA C (village), students find it very difficult to recognize and understand traditions and culture, so they are unable to understand science as a whole. While in the IOS (Inside Outsider) category, none of the schools are at the lowest level. The creative thinking skills profile of SMA B (middle) is the highest among SMA A (City) and SMA C (Village). This shows that all high schools that use the ESsI strategy for learning can empower creative thinking skills. The contribution of students' science reconstruction research is very important, particularly in light of cultural background, to determine freedom of thought based on life habits.

Keywords: creative thinking skills; ethnoscience; science reconstruction; SSI

INTRODUCTION

Science learning aims to develop students' skills that enable them to adapt to different conditions, think flexibly, creatively, critically, respect society, and be tolerant of ideas (Risdianto et al., 2020; Sihombing et al., 2025), which aligns with the independent curriculum. However, creative thinking skills remain low due to teachers' difficulty in determining learning strategies and in utilizing the surrounding environment to preserve local wisdom, both of which need improvement. The erosion of culture and traditions inherent in a region seems to be lost with modernization. Therefore, the problem of students' creative thinking has not been resolved by the design of a sustainable science learning strategy. One approach to providing students with opportunities to think creatively is to use an ethnoscience approach to preserve local wisdom.

The reason is that ethnoscience can appreciate students and improve the science pro-

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cess (Sudarmin et al., 2019b; Khoiri et al., 2022; Khoiri et al., 2024a; Khoiri et al., 2024b; Khery et al., 2025), learning outcomes, and science knowledge (Ardianti & Raida, 2022; Rahayu et al., 2025). The use of ethnoscience studies to master science concepts and appreciate community traditions and culture is very much needed. Creating an environment through an ethnoscience learning approach oriented towards strategic environmental resources with student activities (Derman & Gurbuz, 2018). The activities of thinking and preserving cultural diversity, traditions, and local wisdom are increasingly eroded by the current of globalization (Schröder, 2019). Social behavior is shifting more clearly, marked by the replacement of human roles by sophisticated digitalization systems (Alreemy et al., 2016), so it is important to design learning in the global era that meets the needs of competitive education graduates, while still upholding cultural traditions (Khoiri & Sunarno, 2018; Tresnawati et al., 2020).

The results of observations on the use of local wisdom in science learning in 17 (seventeen) high schools in Wonosobo Regency were 67%, and in Boyolali Regency were 65%. The facts found were that high school students were not yet able to recognize the local potential of their own region, lacked concern for the surrounding environment, and were apathetic towards the preservation of community culture. This is very concerning because high school students serve as a benchmark for Indonesia's golden generation, which is defined by the fulfillment of 21st-century skills, including creative thinking. Apathy towards local and regional wisdom is a trigger for the erosion of traditions and culture, which is increasingly evident amid the flow of globalization.

In fact, local potential, traditions, and culture listed in the ethnoscience approach are one of the efforts to shape student character (Usman et al., 2019; Sumarni & Kadarwati, 2020; Trisnowati et al., 2022; Primadianningsih et al., 2023). In addition, teachers have been aware of local potential and community culture, but only 40% use science problems as a science learning strategy, and these strategies have not been used to empower students' creative ideas. The importance of holistic learning integration that ensures quality education by providing students with opportunities to explore local wisdom, develop critical thinking skills, create open spaces for lifelong learning, and foster respect for traditions, culture, and social character is stated in SDG 4 (Nurkanti et al., 2026).

Education is not only a systematic and conscious development process, but also an effort to stimulate individual potential, preparing them to play an optimal role in society (Ardianto et al., 2026; Hariyono et al., 2026). By incorporating local wisdom and strategic considerations, students will be better able to adapt and respond to the environment. Mapping science reconstruction, determining the profile of creative thinking skills, and assessing the effectiveness of local wisdom-based science learning strategies using the Ethno-Socioscientific Issues (ESsI) approach are urgently needed to meet the demands of 21st-century learning skills. Learning activities through the ESsI approach can provide students with opportunities to improve creative thinking skills through science reconstruction, local wisdom literacy, and to map profiles to preserve local wisdom (Khoiri et al., 2026).

Based on the research gap, the trend of ethnoscience approaches and socioscientific issues strategies has been very diverse over the past 10 years, but has not been integrated into specific learning strategies that involve morals by presenting social issues (Nurhasnah et al., 2022). Social issues can be addressed with rational solutions because they involve social and cultural values (Qori et al., 2020; Sarwi et al., 2020a; Sarwi et al., 2020b; Khoiri et al., 2023). Social perspectives and scientific reasoning provide opportunities for conflict to arise and students' reflective abilities in solving problems, which are characterized by students' creative thinking skills and their indicators. The potential for generating debate, acculturation, and assimilation, characteristic of local wisdom approaches, has not been optimally implemented. The diversity of traditions, cultures, and local potential through science reconstruction activities is highly relevant for empowering the critical and creative thinking skills required for 21st-century learning (Ardianto et al., 2026).

Research that integrates Natural Sciences, Social Sciences, and Information Technology by integrating ethnoscience approaches, social issues strategies and utilizing Information Technology (IT)-based learning media is an alternative to mapping students' science reconstruction, determining students' creative thinking skill profiles based on indicators adapted from Torrance (Trisnayanti et al., 2020) The ethnoscience approach as a source of learning local wisdom in Wonosobo Regency includes: Dreadlocks Tradition, Opak Cassava production, natural conditions of the Dieng Plateau, Sikunir Hill, Purwaceng Plants, Carica, Sikidang Crater Tourism, Embun

Upas, and the shape of houses in the Dieng Plateau. Meanwhile, Boyolali Regency consists of the following issues: Tingkeban (Mitoni), Tedak Sinten, Ruwahan, Kenduri Weton, Kenduri Jajan Pasar, and Tiban Market (Mubarok, 2017).

The novelty of the research is to support previous research on integration of the Ethnoscience approach to preserve local wisdom that is increasingly eroded by the flow of globalization, using the strategy of social issues (Scosioscientific Issues) as a form of student response and concern for the issue of local wisdom that is developing, and being able to utilize IT-based learning media as a form of existence in facing modernization that can accommodate in mapping the profile of creative thinking skills of high school students. The science learning strategy, which combines natural and social sciences, is very appropriate when the learning format provides opportunities for students to think creatively. Students' learning opportunities are not only to think creatively but also to develop moral values through engagement with social issues, so that learning is more meaningful and sustainable, and to preserve the local wisdom of the region.

METHODS

This type of research uses a mixed-methods explanatory sequential design (Creswell, 2013), with quantitative data collection and analysis followed by qualitative data collection and analysis. Qualitative data is used to explain or deepen the results of quantitative data. Quantitative research focuses on comparative hypothesis testing and ANOVA (Analysis of Variance) tests to determine the effectiveness and contribution of the applied learning strategies. Qualitative research, on the other hand, describes the mapping of students' science reconstruction and creative thinking skill profiles.

The research procedure is presented in Figure 1.

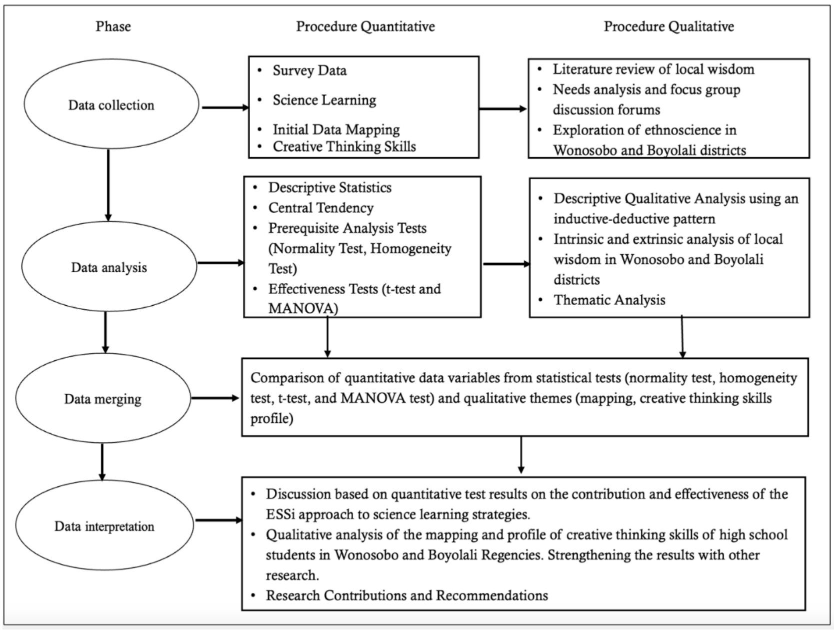

Figure 1. Mixed Methods Explanatory Sequential Design

The study population comprised 17 high schools in Wonosobo Regency and 31 in Boyolali Regency, Central Java Province. Purposive sampling was used based on the distance between the schools and the city centers of Wonosobo and Boyolali Regencies, categorized as (city, middle, and village). This determination was based on cultural background considerations.

The study sample consisted of 9 high schools: 3 in the city category (SMA A), 3 in the middle category (SMA B), and 3 in the village category (SMA C). The research design, a pre-test, post-test, and control group design, is presented in Table 1.

Table 1. Research Design

Group	Oa	Strategy	Ob
Experiment Group	O1	Local wisdom-based science learning strategy using the ESsI approach (X1)	O2
Control Group	O3	Local wisdom-based science learning strategy (X2)	O4

(Source: Creswell, 2013)

Data collection used initial observations for needs analysis, surveys, and observations of the implementation of the ESsI approach to science learning strategies. A creative thinking skills test, consisting of 15 essay questions based on the Creative Thinking subtest of the Torrance Test, was used to assess the impact of the ESsI learning strategy. This data served as the basis for effectiveness testing by comparing the experimental and control group samples. A questionnaire was used to identify teacher and student responses to the implemented learning strategy. A creative thinking skills questionnaire was used to confirm statements and assess the consistency of student answers across the test questions. Structured interviews were used to explore ethnoscience and the process of science reconstruction. Documentation was used for ethnoscience literature reviews, the review of previous research journals, and the documentation of research activities.

Quantitative data analysis techniques are used for the prerequisite test analysis. Normality tests used the Liliefors test with the One-Sample Kolmogorov-Smirnov Test, and homogeneity tests used the Bartlett test or Levene's Test of Equality of Error Variances (Creswell, 2013).

Comparative-hypothesis statistical tests used paired-samples t-tests to determine differences in the creative-thinking skill profiles of students in the experimental and control groups. The differences indicated the effectiveness of the learning strategy.

Furthermore, ANOVA was used to calculate group means across multiple dependent variables (Creswell, 2013). The ANOVA test identified the influence of the ESsI learning strategy in determining students' creative thinking skill profiles across five indicators: Fluency (X1), Flexibility (X2), Originality (X3), Elaboration (X4), and Redefinition (X5).

Qualitative data analysis techniques are used in inductive and deductive descriptive methods to interpret science reconstruction mapping data and to identify the contribution of science learning strategies to students' profiles of creative thinking skills.

RESULTS AND DISCUSSION

The results of the science reconstruction mapping for students in each SMA category are presented in Table 2. Students' science reconstruction mapping is divided into 5 categories, which indicate the level of ability in reconstructing science; the lower the level, the better.

Table 2. Science Reconstruction of Senior High School Category City, Middle, and Village

Category	City	Middle	Village
PS (Potential Scientist Student)	36,3%	35,6%	37,5%
OSK (Other Smart Kids)	38,1%	49,6%	23,9%
IDKS (I-do-not-know Student)	25,6%	11,7%	23,4%
OS (Outsider)	0,0%	3,1%	15,2%
IOS (Inside Outsider)	0,0%	0,0%	0,0%
Sum	100,0%	100,0%	100,0%

Table 2 shows that for schools in the city category, the highest reconstruction mapping is in the OSK category at 38.1%, and the lowest is in the IDKS category at 25.6%. The number of student respondents in this category was 91. There were no OS and IOS categories, meaning there were no students who did not know, or did not yet know, about the local wisdom surrounding them. This indicates good local wisdom literacy in the village school. There is understanding, sufficient literacy, and appreciation for local wisdom.

Schools in the Middle category have the highest mapping in the OSK category at 49.6%, while those in the OS category have the lowest at 3.1%. The number of student respondents in this category was 91. The OS category, with an average of 3.1%, indicates that some students still lack genuine scientific knowledge and current societal issues. There were no IOS categories, meaning that none of the students felt unfamiliar with their cultural environment. This potential certainly provides students with another resource for understanding local wisdom.

Schools in the village category have the highest reconstruction mapping in the PS category at 37.5%, while those in the OS category have the lowest at 15.2%. The number of student respondents in this category was 57. The OS category, with an average of 15.2%, indicates that many students feel alienated from local wisdom, making it increasingly difficult to provide hands-on experiences as a resource for science learning.

None of the school categories had any IOS. This indicates that students do indeed perceive the presence of local wisdom, societal issues, and customs in their lives, but their responsiveness and sense of ownership of local richness need improvement.

The analysis reveals varying levels of understanding cultural traditions as they relate to science among students in three schools categorized into distinct groups: Potential Scientist Students (PS), Other Smart Kids (OSK), I-Do-Not-Know Students (IDKS), Outsiders (OS), and Inside Outsiders (IOS). In SMA C (village), the PS group exhibited the highest reconstruction level, indicating that these students easily relate cultural traditions to scientific concepts. Contrastingly, in SMA B (middle), the OSK students demonstrated a need for adaptation in comprehending these traditions, though they were still able to engage with science comprehensively. The IDKS group at SMA A (City) struggled significantly, with 25.6% reporting difficulty in grasping their own cultural traditions, which impeded their ability to connect with scientific content. Additionally, SMA C also had the highest percentage of students classified as OS, at 15.2%, indicating a critical disconnect in recognizing and understanding cultural frameworks, further complicating their engagement with science. Notably, none of the schools contained students classified as IOS, who represent the lowest comprehension level in this context.

The creative thinking skills profile was derived from test results following implementation of the ESsI strategy, as shown in Figure 2.

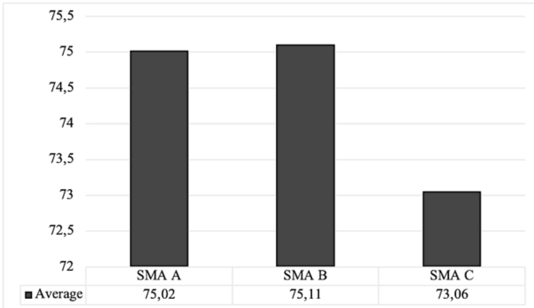

Figure 2. Effectiveness of Local Wisdom-Based Science Learning Strategies for High School Students Using the Ethno-Socioscientific Issues (ESsI) Approach

The average creative thinking skills profile for each school category shows that SMA B (middle) has the highest average, followed by SMA A (city) and SMA C (village). However, according to the reconstruction of science efforts, rural school students have the highest level. This means that science reconstruction mapping does not always significantly reflect creative thinking skills. Other factors, such as environmental awareness and positive responses to surrounding traditions and culture, are also unexamined. The influence of the environment and the flow of globalization differ among students in cities, middle, and villages in terms of their learning readiness.

The average creative thinking skill score for students in the experimental group was 78.6, with a learning completion rate of 62%. Creative thinking skill achievement was measured using pre- and post-tests for each indicator: fluency, flexibility, originality, elaboration, and redefinition. The average percentage for each indicator in determining creative thinking skill achievement is shown in Figure 3.

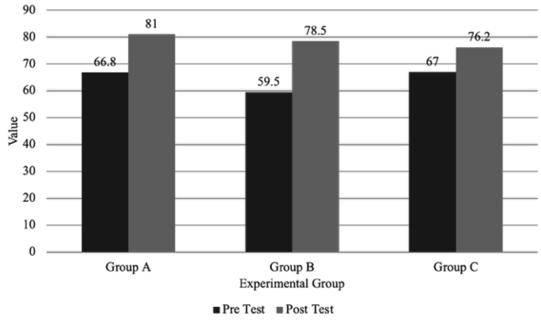

Figure 3. Creative Thinking Skills in the Experimental Class

Figure 3 shows that the pre-test and post-test data showed an increase in each indicator of creative thinking skills in the experimental group.

Group Pre-test Data before learning takes place using conventional learning. Post-test scores measure students' achievement in creative thinking skills after implementing science instruction that does not use ESsI (conventional). The achievement of students' creative thinking skills in the control group: the average is 70.9, with a learning completeness of 54%. Details of pre-test data on the achievement of creative thinking skills for each indicator. The pre-test, before learning, uses ESsI learning, with a creative thinking skills achievement of 65.2; the post-test data are students' creative thinking skills scores after learning, which does not use ESsI learning (conventional). The average percentage of achievement determination is shown in Figure 4.

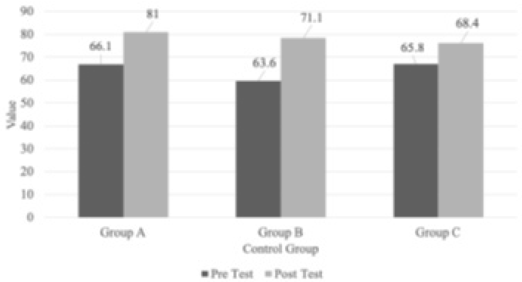

Figure 4. Creative Thinking Skills of the Control Group

Figure 4 shows that the control group's data on students' achievement in creative thinking skills increased slightly before and after conventional learning.

A t-test analysis was conducted to determine the effectiveness of ESsI learning in empowering students' creative thinking skills in the experimental class. The effectiveness indicator is the difference in post-test scores between the experimental and control classes, as presented in Table 3.

Table 3. t-test Analysis

Paired Differences	Value
Mean	7.64
Std. Deviation	6.37
Std. Error Mean	1.15
95% Confidence Interval of the Difference	Lower; 2.18 Upper; 3.21
t_{count}	3.71
df	70
Sig (2-tailed)	0.00

Table 3 shows Sig (2-tailed) (0.00 < 0.05). Ho is rejected, and H1 is accepted, indicating a difference in students' creative thinking skills between the experimental and control groups. The difference in students' creative thinking skills is reflected in the difference in the average post-test scores of the experimental and control groups (78.55-70.91 = 7.64), a mean Paired Difference indicating that the experimental group has higher average creative thinking skills than the control group. Therefore, the Experimental class using ESsI learning is effective in empowering students' creative thinking skills.

Based on the Creative Thinking one-way ANOVA test, the influence of the ESsI strategy learning group on creative thinking is significant (p = 0.000 <), indicating that the Class Group significantly influences creative thinking (Table 4).

Table 4. ANOVA

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	38713.116	8	4839.139	23.261	.000
Within Groups	52424.978	252	208.036		
Total	91138.094	260			

Table 4 presents a One-Way ANOVA analysis conducted using SPSS to explore the impact of ESsI strategy learning classes on creative thinking. The results suggest a significant effect, as indicated by the Corrected Model, where a Sig. value of 0.000 confirms the model's validity (p < 0.05). The analysis also confirms significance through the Welch's F test and Brown-Forsythe test, both yielding p-values of 0.000, allowing for the acceptance of the hypothesis (H1) that these classes significantly influence creative thinking.

Furthermore, the document discusses the Model Error Value, emphasizing that smaller values indicate a better model fit. An intercept value also demonstrates significance, as indicated by another Sig. value of 0.000, reflecting that the dependent variable can change in absence of the independent variable. Additionally, the R-squared value of 0.425 indicates that the independent variable accounts for 42.5% of the variation in the dependent variable. Finally, a post hoc test is referenced to examine pairs that exhibit significant differences in averages following the ANOVA analysis.

Table 5. Post Hoc Tests Multiple Comparisons

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
SMA A1	SMA A2	8.6326	3.47604	.245	-2.2439	19.5090
	SMA A3	26.6524*	3.90320	.000	14.4394	38.8654
	SMA B1	9.7582	3.50427	.125	-1.2066	20.7230
	SMA B2	3.3082	3.67203	.993	-8.1814	14.7979
	SMA B3	14.4257*	3.50427	.002	3.4609	25.3905
	SMA C1	7.3167	3.85017	.614	-4.7303	19.3638
	SMA C2	-4.1925	3.44927	.953	-14.9851	6.6002
	SMA C3	40.2292*	3.90320	.000	28.0162	52.4422
SMA A2	SMA A1	-8.6326	3.47604	.245	-19.5090	2.2439
	SMA A3	18.0198*	3.96992	.000	5.5981	30.4416
	SMA B1	1.1256	3.57844	1.000	-10.0712	12.3225
	SMA B2	-5.3243	3.74288	.888	-17.0357	6.3871
	SMA B3	5.7931	3.57844	.794	-5.4037	16.9900
	SMA C1	-1.3158	3.91780	1.000	-13.5745	10.9429
	SMA C2	-12.8250*	3.52460	.010	-23.8534	-1.7966
	SMA C3	31.5967*	3.96992	.000	19.1749	44.0184
SMA A3	SMA A1	-26.6524*	3.90320	.000	-38.8654	-14.4394
	SMA A2	-18.0198*	3.96992	.000	-30.4416	-5.5981
	SMA B1	-16.8942*	3.99466	.001	-29.3934	-4.3950
	SMA B2	-23.3442*	4.14261	.000	-36.3063	-10.3821
	SMA B3	-12.2267	3.99466	.061	-24.7259	.2725
	SMA C1	-19.3357*	4.30130	.000	-32.7943	-5.8770
	SMA C2	-30.8449*	3.94650	.000	-43.1934	-18.4964
	SMA C3	13.5768	4.34883	.051	-.0306	27.1842
SMA B1	SMA A1	-9.7582	3.50427	.125	-20.7230	1.2066
	SMA A2	-1.1256	3.57844	1.000	-12.3225	10.0712
	SMA A3	16.8942*	3.99466	.001	4.3950	29.3934
	SMA B2	-6.4500	3.76910	.739	-18.2434	5.3435
	SMA B3	4.6675	3.60586	.932	-6.6151	15.9501
	SMA C1	-2.4415	3.94286	.999	-14.7786	9.8956
	SMA C2	-13.9507*	3.55244	.004	-25.0661	-2.8352
	SMA C3	30.4710*	3.99466	.000	17.9718	42.9702
SMA B2	SMA A1	-3.3082	3.67203	.993	-14.7979	8.1814
	SMA A2	5.3243	3.74288	.888	-6.3871	17.0357
	SMA A3	23.3442*	4.14261	.000	10.3821	36.3063
	SMA B1	6.4500	3.76910	.739	-5.3435	18.2434
	SMA B3	11.1175	3.76910	.082	-.6760	22.9109
	SMA C1	4.0085	4.09268	.987	-8.7974	16.8144
	SMA C2	-7.5007	3.71803	.533	-19.1343	4.1329
	SMA C3	36.9210*	4.14261	.000	23.9589	49.8831

(I) Class	(J) Class	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
SMA B3	SMA A1	-14.4257*	3.50427	.002	-25.3905	-3.4609
	SMA A2	-5.7931	3.57844	.794	-16.9900	5.4037
	SMA A3	12.2267	3.99466	.061	-.2725	24.7259
	SMA B1	-4.6675	3.60586	.932	-15.9501	6.6151
	SMA B2	-11.1175	3.76910	.082	-22.9109	.6760
	SMA C1	-7.1090	3.94286	.680	-19.4461	5.2281
	SMA C2	-18.6182*	3.55244	.000	-29.7336	-7.5027
	SMA C3	25.8035*	3.99466	.000	13.3043	38.3027
SMA C1	SMA A1	-7.3167	3.85017	.614	-19.3638	4.7303
	SMA A2	1.3158	3.91780	1.000	-10.9429	13.5745
	SMA A3	19.3357*	4.30130	.000	5.8770	32.7943
	SMA B1	2.4415	3.94286	.999	-9.8956	14.7786
	SMA B2	-4.0085	4.09268	.987	-16.8144	8.7974
	SMA B3	7.1090	3.94286	.680	-5.2281	19.4461
	SMA C2	-11.5092	3.89406	.081	-23.6936	.6752
	SMA C3	32.9125*	4.30130	.000	19.4538	46.3711
SMA C2	SMA A1	4.1925	3.44927	.953	-6.6002	14.9851
	SMA A2	12.8250*	3.52460	.010	1.7966	23.8534
	SMA A3	30.8449*	3.94650	.000	18.4964	43.1934
	SMA B1	13.9507*	3.55244	.004	2.8352	25.0661
	SMA B2	7.5007	3.71803	.533	-4.1329	19.1343
	SMA B3	18.6182*	3.55244	.000	7.5027	29.7336
	SMA C1	11.5092	3.89406	.081	-.6752	23.6936
	SMA C3	44.4217*	3.94650	.000	32.0732	56.7702
SMA C3	SMA A1	-40.2292*	3.90320	.000	-52.4422	-28.0162
	SMA A2	-31.5967*	3.96992	.000	-44.0184	-19.1749
	SMA A3	-13.5768	4.34883	.051	-27.1842	.0306
	SMA B1	-30.4710*	3.99466	.000	-42.9702	-17.9718
	SMA B2	-36.9210*	4.14261	.000	-49.8831	-23.9589
	SMA B3	-25.8035*	3.99466	.000	-38.3027	-13.3043
	SMA C1	-32.9125*	4.30130	.000	-46.3711	-19.4538
	SMA C2	-44.4217*	3.94650	.000	-56.7702	-32.0732

Table 5 details the outcomes of the Tukey test concerning the ESsI strategy learning class. The analysis reveals the following differences: the comparison between SMA A1 and SMA A2 shows a difference of 8.6326 with a p-value of 0.245, leading to the acceptance of the null hypothesis (H0), indicating no significant difference exists between the two groups. In contrast, the difference between SMA A1 and SMA A3 is 26.6524, with a p-value of 0.000, supporting the alternative hypothesis (H1) and indicating a significant difference. Lastly, the comparison between SMA A1 and SMA B1 shows a difference of 8.7582 with a p-value of 0.125, again leading to the acceptance of H0 and confirming that there is no significant difference between the two groups. Those with a p-value < 0.05 that are significantly different are marked with a yellow block, while those with a p-value> 0.05 that are not significantly different are marked with a green block (Table 6).

Table 6. Tukey HSD[a,b,c]

Class	N	Subset				
		1	2	3	4	5
SMA C3	22	44.3627				
SMA A3	22		57.9395			
SMA B3	32			70.1662		
SMA B1	32			74.8338	74.8338	
SMA A2	33			75.9594	75.9594	
SMA C1	23			77.2752	77.2752	77.2752
SMA B2	27			81.2837	81.2837	81.2837
SMA A1	36				84.5919	84.5919
SMA C2	34					88.7844
Sig.		1.000	1.000	.098	.222	.075

Scores within the same subset show no difference, whereas scores across different subsets do. It shows that the ESsI strategy learning class for SMA C2 has the highest score, while SMA C3 has the lowest. Based on the ANOVA test above, this difference is significant (reject H1).

The implementation of the ESsI strategy in the experimental group, using waste literacy as a learning resource, enabled students to reconstruct science. Data obtained from the study included the implementation of ESsI learning at each meeting, the development of students' creative thinking skills through pre- and post-test data, and student and teacher responses after using ESsI. Feedback on students' responses to ESsI learning was one of the research objectives, based on student feedback and assessments of the teaching materials. A positive or negative response indicates whether students fully accept or reject the learning resource. A positive response indicates successful learning. To demonstrate the effectiveness of ESsI learning for students in the experimental group, the author presents the results of student responses obtained from the statement questionnaire method in Table 7.

Table 7. Student Response

Criteria	Strongly Disagree	Agree	Disgree	Strongly Disagree
Actual Score	686	121	56	62
Ideal Score	148	111	74	37
Percentage	74%	13%	6%	7%
Average	88%			

Table 7 shows that 88% of student responses fall into the "very responsive" category. The research success indicator falls into the "very responsive" category, indicating that ESsI learning can positively impact students' creative thinking skills.

The responses highlighted the interestingness and practicality of achieving objectives. ESsI learning is a unique and enjoyable new model, as it emphasizes that learning science is not just about formulas; rather, understanding the social environment serves as a meaningful learning resource. Students' responses to learning science while simultaneously recognizing traditions and culture based on social issues provide a unique and motivating learning environment for physics. ESsI learning, with explanatory activities, provides greater focus on the lesson because students directly observe (Sangsawang, 2020). Student responses to ESsI learning demonstrate the model's appeal.

Students develop a deeper understanding of concepts through ethnoscience, which connects learning material to social issues. ESsI (Ethno-Science in Inquiry) learning encourages students to confront complex problems creatively, aligning with Wallas's assertion that creativity requires stepping outside one's comfort zone. This approach fosters fluency and originality in thinking, evidencing improvements in creative problem-solving abilities. Enthusiasm for ESsI learning stems from several factors: the innovative integration of local traditions and cultural potentials from Wonosobo into science education, the acquisition of novel experiences and knowledge through community engagement, the enjoyable nature of the learning process which aids comprehension of scientific concepts, and the enhancement of students' awareness of environmental and community issues, alongside improved creative thinking skills.

Learning well-being, which emphasizes the significance of student engagement in quality learning, is central to the ESsI (Ethno-Science and Societal Issues) approach. This method offers students intellectual freedom, enabling them to navigate learning challenges without undue stress, thereby preserving their cognitive integrity. It cultivates creative thinking and environmental awareness, fostering both social interaction and personal development. The emphasis on student well-being within ESsI learning highlights the advantages of nurturing positive attitudes and a conscientious approach toward students' lives and surroundings. Furthermore, it notes the escalating enthusiasm for community traditions and cultures, driven by ethnoscience studies and societal issues, which are inherently investigative. Overall, ESsI E-Learning promotes transformative changes in behavior, knowledge, and creative skills, enriching students' experiences.

Teacher responses to ESsI learning are needed to assess its practicality, so that the analysis of these responses can serve as a product evaluation to improve and be used in the next research stage. Based on the teacher response questionnaire, the percentage of ESsI learning responses that include additional opinions and suggestions for ESsI E-Learning. Teacher responses to the implementation of ESsI Learning average 88%. The results indicate that ESsI's practicality is at or above 75%. Based on teacher responses with the highest percentage of answers on the indicator about "the use of ESsI implemented has changed students' perceptions". Phenomena related to local wisdom, such as knowledge that can be explained scientifically, can improve creative thinking skills. Responses with the lowest percentage on the indicator "the implementation of ESsI E-Learning must provide more time than the time planned in the learning plan".

Teachers' responses to the implementation of ESsI showed a positive impact on students' mastery of science concepts and creative thinking skills in high school. All three teachers responded positively to the planning, content, and presentation of ESsI. ESsI presented clear learning objectives encompassing core competency standards. Questions and assignments before students began learning were used to improve creative thinking skills and mastery of concepts. Teachers provided several additional opinions and suggestions regarding ESsI.

The analysis of student science reconstruction mapping reveals varying levels of understanding across different educational categories. In the Potential Scientist Student (PS) category, the highest level of comprehension, at 37.5%, was observed in SMA C (village), where students easily connect cultural traditions with scientific concepts. Conversely, students in the Other Smart Kids (OSK) category, particularly at SMA B (middle), show a need for better adaptation to effectively relate traditions and science. The I-do-not-know Student (IDKS) category exhibited the highest percentage of 25.6% in SMA A (City), indicating significant difficulty in grasping their own cultural context. The Outsider (OS) category peaked at 15.2% in SMA C (village), revealing challenges in recognizing and understanding traditions, which hindered their overall scientific comprehension. Notably, no schools fell under the Inside Outsider (IOS) category, suggesting a generally more connected understanding. Furthermore, differences in creative thinking skills were evident across classes implementing the ESsI strategy, with SMA C2 performing the best and SMA C3 the least effectively. Overall, the ESsI strategy proved beneficial for enhancing creative thinking in all participating schools.

Students' creative thinking skills improved after using ESsI Learning. The results showed that environmental learning resources using an ethnoscience approach could foster students' creative thinking. The indicator of formulating ideas in solving problems is part of the creative thinking skills to analyze scientific phenomena through ethnoscience studies developed in science learning. Controversial issues are an important factor in designing ideas to address problems students experience, thereby improving students' creative thinking and positive attitudes towards the environment.

Creative ideas emerge through a discovery learning process that provides students with opportunities to explore information sources. Strategic information sources on environmental issues make learning more meaningful and contextual. Ethnoscience, as a learning nuance, equips students with knowledge and character to appreciate regional cultures (Fadilah et al., 2023; Jannah et al., 2023; Khoiri & Sunarno, 2018; Solheri et al., 2022; Wiyanarti et al., 2024). ESsI learning characteristics focus on developing students' creative thinking skills through inquiry-based learning settings. Students are provided with information about ethnoscience in class, enabling them to understand better its potential, traditions, and culture (Sudarmin & Sumarni, 2018). Ethnoscience is used in class as a practical and independent learning resource. Student activities foster creative thinking skills.

ESsI learning can develop creative thinking skills, as evidenced by differences in students' creative thinking. The use of ethnoscience can foster students' creative thinking skills regarding their surroundings and train their independence in learning (Sudarmin & Sumarni, 2018; Reksiana, 2019; Sukawi et al., 2021; Wahid et al., 2021; Rizki et al., 2025). Ethnoscience-based teaching materials can provide positive feedback or responses to student work.

Learning success can be identified by students' creative thinking skills in interacting with others through the precise and systematic presentation of theories, conveying ideas clearly and easily to achieve learning objectives. Linking scientific problems to ethnoscience provides information that can inform students' creative ideas. If students' abilities to analyze, evaluate, and create well, it means they have understood the content or concepts being learned. Logically, students cannot communicate if they do not know what to convey.

Positive responses were demonstrated as indicators of motivation, as explored through the teaching materials presented, which provided information on ethnoscience and on scientific problems that utilize it. These activities fostered students' attention, interest, and concern in solving scientific problems. A crucial component of learning is motivation, a psychological drive that can help students improve their situation.

Science learning holds long-term promise for students' survival when they fully utilize their local and ethnoscience potential and do so optimally (Khoiri & Sunarno, 2018). Ethnoscience-based learning is the process of designing a learning environment that incorporates the nuances of tradition and culture. Research confirms that improving creative thinking skills using an inquiry-based learning approach aligns with the characteristics of 21st-century education.

The role of ethnoscience in reconstruction is important because contextual learning provides students with an understanding of science that can be implemented in real life. Students' integration with the environment can be achieved if learning is oriented towards the surrounding environment and studied meaningfully. To enable students to establish reciprocal relationships with their surroundings, students can recognize and understand the local potential of their region, so that regional environmental sustainability becomes an important factor in learning with ethnoscience. The characteristics of the ethnoscience approach in construction are a strategy and a design for learning experiences, creating a cultural and traditional environment integrated into the learning process (Sudarmin et al., 2020). The results of human creativity and initiative are developed as indigenous knowledge and can be transformed into formal science. The term ethnoscience can be studied in the context of traditional ecological knowledge, Indigenous Science, local culture, and local wisdom (Van Hooijdonk et al., 2020; Amelia et al., 2021; Sudarmin et al., 2024a; Selamat & Priyanka, 2024).

Learning using the ESsI strategy provides opportunities for students to have an applicable and meaningful understanding of concepts, while also being able to foster students' creative thinking skills (Wirama et al., 2023; Yulkifli et al., 2022; Sudarmin et al., 2024b; Sudarmin et al., 2024a; Dewi et al., 2025). Habits and needs of learning resources in a traditional and cultural environment to equip students to face the future. The relevance of ethnoscience learning to the real world encourages the formation of practical applications in science learning (Khoiri, 2019; Sudarmin et al., 2019a). Vocational science learning includes knowledge and positive attitudes toward local ethnoscience, enabling students to learn effectively and develop thinking skills through ethnoscience studies (Sangsawang, 2020).

Ethnoscience (knowledge rooted in local culture) and creative thinking are closely linked within the context of modern education. The ESsI model featured in this study offers a global perspective; the academic literature views it as an integrative approach that bridges gaps to foster cultural literacy, solve contextual problems through meaningful learning—based on teacher and student feedback—and stimulate creative thinking skills.

Future education through an ethnoscience approach provides students with opportunities to think creatively in scientific reconstruction activities involving waste materials and their handling. Future education with meaningful learning can instill in students the hope that lifelong learning will bring meaning to life and enable them to solve global problems.

SMA B (middle) has the highest average score of 75.11, compared to SMA A (city) at 75.02 and SMA C (village) at 73.06. However, when viewed from the reconstruction mapping of students' science efforts, SMA C (village) has the highest level. This means that the reconstruction mapping of science does not always significantly reflect creative thinking skills; instead, other factors, such as environmental awareness and positive responses to local traditions and culture, are not examined.

The influence of the environment and the flow of globalization on students in cities, middles, and villages varies, as does their respective learning readiness (Khoiri et al., 2019; Trisnayanti et al., 2019; Amelia et al., 2021; Khoiri et al., 2021). While the effectiveness is shown simultaneously all of SMA A (city), SMA B (middle), SMA C (village) (9 SMA Wonosobo Regency and 9 SMA Boyolali Regency) which use ESsI strategy learning can empower creative thinking skills (Sig. 0.000 <0.05 means the model is valid and the data is significant) which is strengthened by the R Squared value of 0.425 indicating that the ESsI strategy can influence creative thinking skills by 42.5%. The effectiveness of the ESsI strategy is characterized by creative learning activities that offer students opportunities to explore flexible and original thinking and to propose alternative solutions to conceptual problems within ethnoscience learning resources. It also provides meaningful, sustainable learning as a form of cultural identity rooted in societal norms.

The ESsI model offers a deconstruction of conventional science; the ethnoscience approach challenges the hegemony of Western (Eurocentric) science by demonstrating the scientific validity of local wisdom. This fosters creative thinking, enabling students to view reality from diverse multicultural and cross-cultural perspectives—drawing upon a multitude of viewpoints derived from reconstructed indigenous knowledge. Indicators of creativity—specifically flexibility and originality—are engaged as students integrate modern scientific concepts with local culture, thereby necessitating divergent thinking. Furthermore, this approach facilitates learning through knowledge construction, requiring students to employ creative thinking to translate cultural knowledge into the language of formal science (explicit knowledge) grounded in their own scientific reconstructions, reflecting their diverse educational backgrounds.

CONCLUSION

The mapping of students' science reconstruction showed that the highest rate in the PS was achieved in SMA C (village), where students easily understood cultural traditions as science. Meanwhile, in the OSK, students needed to adapt to understanding traditions and culture. However, they were still able to learn to understand science, as achieved by SMA B (middle). The highest IDKS was found in SMA A (city), where students struggled to understand their own traditions and culture (25.6%). The highest OS category was 15.2% in SMA C (village), where students found it very difficult and did not recognize or understand traditions and culture, thus preventing them from fully understanding science. The creative thinking ability profile for each school category shows that SMA B (middle) had the highest average score of 75.11, compared to SMA A (city) at 75.02 and SMA C (village) at 73.06. However, when viewed through the reconstruction of students' science efforts, SMA C (village) had the highest level. Effectiveness is shown simultaneously by all SMA A (city), SMA B (junior high school), SMA C (village) that use ESsI learning strategy can empower creative thinking ability (Sig. 0.000 <0.05 means the model is valid and the data is significant) which is strengthened by the R Squared value of 0.425 which shows that the ESsI strategy can influence creative thinking ability by 42.5%. This study provides an overview of students' science reconstruction based on cultural background to determine freedom of thought. The impact of research is evident in concrete solutions to address the challenges of globalization, preserve local wisdom, strengthen national character and cultural identity, develop students' thinking skills, and provide a source of contextual and meaningful science learning.

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