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Socioscientific Issues (SSI) Strategy Adjacent to Ethnoscience: A Critical Analysis of Science Reconstruction

Ahmad Khoiri[1*], Moh Irma Sukarelawan[2], Mohd Fauzi Sedon[3], Che Nidzam Che Ahmad[4], Sukarmin Sukarmin[5], Qori Agussuryani[6], Misbah Misbah[7]

[1]Department of Physics Education, Universitas Sains Alqur an, Wonosobo, Central Java, Indonesia
[2]Department of Physics Education, Universitas Ahmad Dahlan, Yogyakarta, Indonesia
[3]Department of Visual Arts, Universiti Pendidikan Sultan Idris, Malaysia
[4]Department of Biology, Universiti Pendidikan Sultan Idris, Malaysia
[5]Department of Physics Education, Universitas Sebelas Maret Surakarta, Indonesia
[6]Lecture of Science Education, Universitas Sains Alqur an, Wonosobo, Central Java, Indonesia
[7]Department of Physics Education, Universitas Lambung Mangkurat, Banjarmasin, Indonesia

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Corresponding Author:
Ahmad Khoiri
akhoiri@unsiq.ac.id

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Abstract: Low students' reconstruction skills in understanding science through local issues in society. The purpose of the study was to analyze the categorization of science reconstruction skills and test the effectiveness of the ethnoscience-adjacent Socioscientific Issues (SSI) strategy. Type of quasi-experimental quantitative research with independent sample type t-statistical design. Purposive sampling technique with a total of 65 high school students from 3 different schools clustered, namely schools in the village category, intermediate category, and city category. School categories are based on mileage from the city center. The data collection tool uses student science reconstruction tests and SSI strategy implementation questionnaires. The effectiveness of the SSI strategy consists of pretest and post-test data of students' science reconstruction skills. Data analysis techniques use the t-test and Manova test. The results showed that the categorization of students' science reconstruction skills was dominant in the Other Smart Kids (OSK) category by a p-value of 0.026 < 0.05; Students felt unfamiliar with the culture being studied, even though students' knowledge of science increased. The MANOVA test obtained the results of the experimental class (known with KE) = 0.674 and the F_{count} KE = 17.974, showing that the SSI strategy with ethnoscience proximity was very effective in empowering student's science reconstruction skills simultaneously (SMA A, B, and C) with significant influence. Research recommendations that science reconstruction skills give the meaning of learning about how to appreciate and preserve the traditions and culture of society as a formation of the nation's character.

Keywords: Ethnoscience; Science learning science; Learning SSI; Students reconstruction.

Introduction

Students studying science must adapt to various situations, respect others, and be tolerant of different points of view (Okwara & Upu, 2017; Tendrita et al., 2016). As stated in the Minister of Education and Culture of the Republic of Indonesia in 2016 Number 24 concerning the basic skills of high school physics subjects and core competencies in the 2013 curriculum, the Ministry of Education and Culture has adopted the objectives of science education. Effective learning strategies are based on the characteristics of science learning ability.

Creating the environment through an ethnoscience learning approach is oriented towards strategic environmental sources with student activities (Derman & Gurbuz, 2018; Fischer et al., 2015; Murniawaty, 2019). The role of humans is replaced by sophisticated digitalization systems, which cause social behavior to change even more (Alreemy et al., 2016; Cataluña et al., 2015). Therefore, preparing for the global era with competitive education graduates is very important

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while still upholding cultural traditions (Khoiri & Sunarno, 2018). When using local traditions and culture as a contextual learning approach, unique techniques are needed.

Socioscientific Issues (SSI) is a specific learning methodology that incorporates morality through handling social problems (Setyaningsih et al., 2019). Due to the social and cultural values, it contains, the SSI may have a logical solution. Social perspective and scientific reasoning provide students with reflective problem-solving skills and opportunities for conflict (Graffigna et al., 2011). SSI is divided into three categories to achieve learning objectives and as a meaningful learning process: pre-reflective, quasi-reflective, and reflective.

Preliminary study findings reveal that 70% of students seek to reconstruct traditional knowledge held by their community into scientific knowledge, have difficulty adjusting to their new environment, and have an inaccurate perception of local traditions and cultures. Siska et al. (2019) stated the difficulty of students' ability to present the environment through their reasoning ability to support this fact. Another reality is that educators have not been able to implement social justice-based learning practices. They are still constrained by a curriculum that uses textual references. Although SSI strategies can improve students' critical thinking ability, questioning skills, cognitive outcomes, and reflective ability of the environment, learning objectives are more of a capacity for learning competencies (Fahrizal & Badrun, 2022; Tsai, 2018; Wulandarai et al., 2017).

Observations on environmentally oriented physics learning were carried out in 15 high schools throughout Wonosobo Regency. The observation results showed that 67% of high schools used science reconstruction-based learning strategies. High school students do not yet know their area's local potential and lack concern for the community's environment and culture. The local potential, traditions, and cultures listed in the ethnoscience approach are one of the efforts to build student character. Teachers already know the potential and local culture of the Wonosobo people, but only 40% of teachers can take advantage of science problems. The limitation of ethnoscience-based environmental learning strategies is that it takes time to design learning tools. On the other hand, the diversity of student backgrounds determines the conditions and knowledge of different student traditions.

The lack of SSI is applied in fostering students' science reconstruction skills in overcoming environmental problems used in science learning, so it is very important to examine the categorization of diverse student science reconstruction skills based on student backgrounds and analyze the effectiveness of SSI strategies implemented in science learning. Therefore, this study aims to analyze science reconstruction skills and test the effectiveness of ethnoscience-adjacent SSI strategies.

Method

Quasi-experimental research method with independent sample type t-statistic design. Sixty-five high school students from 3 different clustered schools (village, intermediate, and city category schools) were selected using the Purposive sampling technique. Categorization of schools by the mileage from the city center. The purpose of the sample was to consider the student's background that influences the ethnoscience knowledge that each student has is different to determine the categorization of students' science reconstruction skills. The distribution of research samples is presented in Table 1.

Table 1. Distribution of Research Samples

SMA	Category	Male	Female	Sum
A	Village (30 km)	11	11	22
B	Madya (15-29 km)	9	13	22
C	City (0-14 km)	10	11	21
	Sum	30	35	65

The sample was taken based on the respondents' will by providing a statement of ability and a research code of ethics. The three sample criteria include: (1) The samples taken were students who had active status in the schools that were used as the study population, (2) Students aged 16 to 18 years, and (3) high schools determined based on the clustering of regional locations from the city center (Wonosobo Regency, Central Java, Indonesia). Table 1 shows three senior high schools with the experimental class using the SSI strategy with ethnoscience proximity and the control class using the SSI strategy without an ethnoscience approach (conventional).

Data collection in the form of pretests before the implementation of SSI with ethnoscience proximity and post-test after the implementation of SSI with ethnoscience proximity to the science reconstruction skills of students from the experimental class. While the control class of SSI implementation without using Ethnoscience (conventional). Learning response questionnaire using SSI strategies with ethnoscience proximity to determine the implementation of SSI in learning science.

The data analysis technique uses a t-test to test the effectiveness of the ethnoscience-adjacent SSI strategy in empowering students' science reconstruction skills. Manova (Multivariate Analysis of Variance) test to analyze the entire sample of simultaneous, experimental, and control classes based on the student's science reconstruction skills categories. Manova test analysis to determine the effectiveness of SSI strategies in developing the naturalness of student science reconstruction simultaneously (Diani et al., 2020). Manova test as an analytical tool to assess the level of meaningfulness (significance) of the influence of 1 qualitative free variable on the > 1 dependent variable that is quantitatively scaled (interval or ratio scale). The terms or assumptions of the Manova test are 1) Significant correlation between dependent variables using the Pearson Product Moment Test; 2) normally distributed trial subjects using the Lilliefors test; 3).

The population is derived from a homogeneous variant using the Levene Test; 4) The homogeneity of covariance or the similarity of covariance of dependent variables between groups does not differ markedly using the Box's M Test; 5) Consequences if the assumption of normality is not met then it can be used bootstrap, and if homogeneity is not met then post hoc test or further test using Games Howell test; 6) The effectiveness of the SSI strategy is based on testing the research hypotheses, namely: Hypothesis Null (Ho); "Ethnoscience-based SSI strategy is not effective in improving students' science reconstruction skills" while the alternative hypothesis (Ha); "The ethnoscience-based SSI strategy is effective in improving students' science reconstruction skills". Criteria are accepted or rejected by Ho as a form of statistical conclusion, then analysis is carried out.

Result and Discussion

Table 2 presents the results of student reconstruction analysis through SSI strategies. Table 3 shows the fulfillment of the assumptions of normality and homogeneity, so Wilk's Lambda test is presented in Table 4. Furthermore, based on Table 2, the normality test presented in Table 3 continues.

Table 2. Descriptive Statistics

Criteria	X	Mean	Std. Deviation	N
Potential Scientist Student (Y1)	SSI	2.0156	0.70120	32
	Conventional	1.9697	0.64879	33
	Total	1.9923	0.67019	65
Other Smart Kids (Y2)	SSI	1.7188	0.63421	32
	Conventional	1.6970	0.58549	33
	Total	1.7077	0.60527	65
I Don't Know Student (Y3)	SSI	2.3281	0.51758	32
	Conventional	2.2424	0.46973	33
	Total	2.2846	0.49188	65
Outsider (Y4)	SSI	1.8125	0.39656	32
	Conventional	1.8182	0.39167	33
	Total	1.8154	0.39100	65
Inside Outsider (Y5)	SSI	1.7725	0.69755	32
	Conventional	1.7172	0.69157	33
	Total	1.7154	0.59140	65

Table 3. Tests of Normality

Criteria	X	Kolmogorov-Smirnova			Shapiro-Wilk		
		Statistic	df	Sig.	Statistic	df	Sig.
Potential Scientist Student (Y1)	SSI	0.241	32	0.079	0.878	32	0.092
	Conventional	0.276	33	0.075	0.877	33	0.101
Other Smart Kids (Y2)	SSI	0.296	32	0.097	0.771	32	0.100
	Conventional	0.334	33	0.090	0.744	33	0.100
I Don't Know Student (Y3)	SSI	0.268	32	0.064	0.882	32	0.092
	Conventional	0.273	33	0.067	0.862	33	0.091
Outsider (Y4)	SSI	0.494	32	0.080	0.478	32	0.110
	Conventional	0.497	33	0.082	0.471	33	0.110
Inside Outsider (Y5)	SSI	0.334	33	0.080	0.744	33	0.100
	Conventional	0.268	32	0.064	0.882	32	0.092

a. Lilliefors Significance Correction

Table 4 shows the homogeneity variance test as a condition of the second condition of the One Way ANOVA test. The result is that Y1 sig or p-value > 0.05 then H0 is accepted or in other words, the variable is bound to Y1 homogeneous variance, and Y2 sig or p-value > 0.05 then accepts H0 or which means the variable bound to Y2 homogeneous variance, as well as Y3, Y4, and Y5. Next is presented in Table 5.

Table 4. Multivariate Test

Effect		Value	F	Hypothesis df	Error df	Sig.
Intercept	Pillai's Trace	0.979	17.974b	4.000	60.000	0.000
	Wilks' Lambda	0.674	17.974b	4.000	60.000	0.000
	Hotelling's Trace	45.663	17.974b	4.000	60.000	0.000
	Roy's Largest Root	45.663	17.974b	4.000	60.000	0.000
X	Pillai's Trace	0.010	6.877b	4.000	60.000	0.043
	Wilks' Lambda	0.878	6.877b	4.000	60.000	0.043
	Hotelling's Trace	0.010	6.877b	4.000	60.000	0. 043
	Roy's Largest Root	0.010	6.877b	4.000	60.000	0. 043

a. Design: Intercept + X
b. Exact statistic

Table 5. Levene's Test of Equality of Error Variances

		Levene Statistic	df1	df2	Sig.
Potential Scientist Student (Y1)	Based on Mean	0.185	1	63	0.779
	Based on Median	0.242	1	63	0.625
	Based on Median and with adjusted df	0.242	1	62.952	0.625
	Based on trimmed mean	0.312	1	63	0.578
Other Smart Kids (Y2)	Based on Mean	0.187	1	63	0.767
	Based on Median	0.126	1	63	0.723
	Based on Median and with adjusted df	0.126	1	62.994	0.723
	Based on trimmed mean	0.189	1	63	0.666
I Don't Know Student (Y3)	Based on Mean	0.474	1	63	0.594
	Based on Median	0.325	1	63	0.571
	Based on Median and with adjusted df	0.325	1	61.640	0.571
	Based on trimmed mean	.462	1	63	0.499
Outsider (Y4)	Based on Mean	.014	1	63	0.808
	Based on Median	.003	1	63	0.954
	Based on Median and with adjusted df	.003	1	62.990	0.954
	Based on trimmed mean	0.014	1	63	0.908
Inside Outsider (Y5)	Based on Mean	0.014	1	63	0.708
	Based on Median	0.003	1	63	0.959
	Based on Median and with adjusted df	0.003	1	62.990	0.959
	Based on trimmed mean	0.014	1	63	0.999

Tests the null hypothesis that the error variance of the dependent variable is equal across groups.
a. Design: Intercept + X

Based on Table 5 can be continued with the analysis of the results of the one-way Anova test presented in Table 6. Variable X significantly influences Y1, Value F Calculate 0.075 with a p-value of 0.045 < 0.05, then received H1, meaning the effect is significant. Variable X has a significant influence on Y2. Calculated F Value 0.021 with a p-value of 0.026 < 0.05, then received H1, meaning the effect is significant. The variable X exerts a significant influence on Y3. Value F Calculate 0.489 with p value 0.047 < 0.05, then receive H1, meaning the effect is significant. Variable X significantly influences Y4, Value F Calculate 0.003 with a p-value of 0.044 < 0.05, then receive H1, meaning the effect is significant. Variable X significantly influences Y5, Value F Calculate 0.003 with p-value 0.049 < 0.05 then receive H1, meaning the effect is significant.

Table 6. Tests of Between-Subjects Effects

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	Potential Scientist Student (Y1)	0.044a	1	0.044	0.085	0.045
	Other Smart Kids (Y2)	0.007b	1	0.007	0.021	0.026
	I Don't Know Student (Y3)	0.129c	1	0.129	0.489	0.047
	Outsider (Y4)	0.001d	1	0.001	0.003	0.044
	Inside Outsider (Y5)	0.033a	1	0.033	0.085	0.049
Total	Potential Scientist Student (Y1)	27.712	65			
	Other Smart Kids (Y2)	22.439	65			
	I Don't Know Student (Y3)	14.369	65			
	Outsider (Y4)	8.784	65			
	Inside Outsider (Y5)	27.802	65			

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Total	Potential Scientist Student (Y1)	27.712	64			
	Other Smart Kids (Y2)	22.439	64			
	I Don't Know Student (Y3)	14.369	64			
	Outsider (Y4)	8.784	64			
	Inside Outsider (Y5)	27.802	64			

a. R Squared = 0.001 (Adjusted R Squared = -0.015)
b. R Squared = 0.000 (Adjusted R Squared = -0.016)
c. R Squared = 0.008 (Adjusted R Squared = -0.008)
d. R Squared = 0.000 (Adjusted R Squared = -0.016)

Furthermore, the results of the normality test on each one-way Anova test. Where the result is that the sig or p-value of all residuals > 0.05, then all residual normality tests use the lilliefors test to receive H1, which means normal distribution presented in Table 7.

Table 7. One-Sample Kolmogorov-Smirnov Test

		Potential Scientist Student (Y1)	*Other Smart Kids (Y2)*	*I Don't Know Student (Y3)*	*Outsider (Y4)*	*Inside Outsider (Y5)*
N		65.0000	65.0000	65.0000	65.0000	65.000
Normal	Mean	1.99230	1.70770	2.28460	1.97730	1.8823
Parameters a,b	Std. Deviation	0.57019	0.70527	0.45188	0.66619	.76669
Most Extreme	Absolute	0.25800	0.31600	0.28200	0.25800	.255
Differences	Positive	0.23400	0.24800	0.27200	0.23400	.244
	Negative	-0.25800	-0.3160	-0.1740	-0.2580	-0.268
Test Statistic		0.25800	0.46600	0.27200	0.39700	0.268
Asymp. Sig. (2-tailed)		0.070c	0.095c	0.087c	0.081c	0.065c

a. Test distribution is Normal.
b. Calculated from data.
c. Lilliefors Significance Correction.

Reconstruction of public science against the original science appears to be a knowledge of myths, superstitions, and perceptions that can be accounted for (Daniel Tan & Kim, 2012; Sudarmin et al., 2014). The knowledge that will be transformed by describing based on experience, verification, and data reduction for a whole concept into scientific science. The boundaries of student thinking as an effort to reconstruct are categorized into five groups (Fitria & Wisudawati, 2018) and presented in Figure 1.

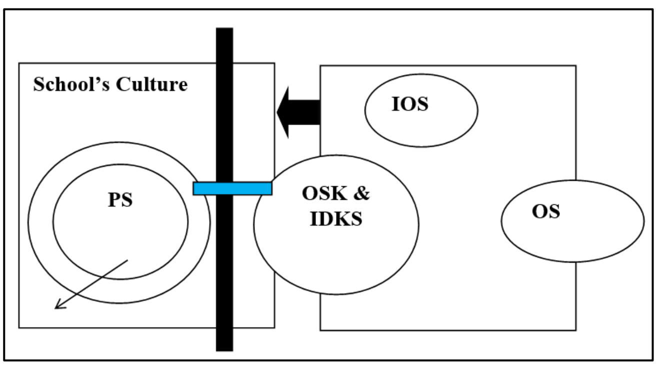

Figure 1. The process of reconstruction of the original science

Figure 1 shows five reconstruction business groups, namely; 1) PS (Potential Scientist Student) groups of students easily cross a culture without borders between scientific science and the daily culture of students. 2) OSK (Other Smart Kids) is a group of students who can understand the culture well but still recognize science as a foreign culture. 3) IDKS (I Don't Know student) has serious problems but tries to study them constantly. The result is only memorizing concepts instead of understanding science. 4) OS (Outsider) is an alienated group that cannot cross the culture due to the cultural power of the student's daily life. 5) IOS (Inside Outsider) group feels cultural discrimination and does not gain knowledge of science. Science learning is meaningless for students' lives.

The highest category of reconstruction efforts is in the Potential Scientist Student (PS) category, where students learn science easily because it is directly related to student life (Table 6). In the lowest category of Inside Outsider (IOS), students feel discrimination or alienation towards cultures studied in scientific science, and categorization is considered difficult to develop because students cannot get out of their zones. Cultural meaningfulness and alienation are the determining factors in exploring learning resources for the ethnoscience-adjacent environment (Khoiri et al., 2021).

Not all students can accept and understand Ethnoscience and social issues in the environment (Table 6) shows that OSK categorization has better results than other reconstruction categorizations. This category shows that students still feel unfamiliar with new knowledge adjacent to Ethnoscience, even though they can understand it. This fact is corroborated (Cristea, 2016; Espeja & Lagarón, 2015) that the implementation of SSI requires exercises to prepare students to understand the existing culture.

Based on the assessment (Table 2) post-test of science reconstruction questions, there are still 10%-15% of students who have not finished learning temperature and heat, identified by answering questions directly related to contextual events of environmental issues. Ogawa's theory that students' adjustment to scientifically constructive science has five categories, namely; 1) PS: Potential Scientist Students are a group of students who easily cross the culture without borders between scientific science and the daily culture of students. 2) OSK: Other Smart Kids is a group of students recognizing science as a foreign culture. 3) IDKS: I Don't Know; students are having serious problems but trying to learn them continuously. The result is just memorizing concepts instead of understanding them. 4) OS: Outsiders are an alienated group that is unable to cross cultures due to the cultural power of students' daily lives, and 5) IOS: Inside Outsider, groups of students who experience discrimination are unlikely to be 100% likely to become Potential Scientist Students because the different student and school backgrounds are important reasons in accommodating students' learning needs.

The results of research on online learning with the SSI strategy of students who do not have internet access, limited infrastructure is an obstacle for students to participate in learning, as evidenced by not all student responses being met (Wulandarai et al., 2017). Learning loss SSI that learning information-based investigations that are difficult to control by teachers is the reason for the skills are not optimal, there are still students who have not been completed, the reconstruction and explanatory process that students must do offline because teacher guidance is still needed to be replaced with online learning, even though SSI e-learning has been prepackaged (Khoiri et al., 2019; Trisnayanti et al., 2019).

Construction requirements relate to the use of language and sentences in ethnoscience studies, students' difficulty level, and the relevance of physics material to ethnoscience studies. The use of traditional and cultural language contains the meaning of science that is easy for students to digest so that students can carry out the data reconstruction and explanatory process. Technical requirements and information on social issues attract students' attention and response, which is important for student life so that learning with SSI becomes meaningful and contextual.

Conclusion

Categorization of science reconstruction skills of students using the SSI strategy with ethnoscience proximity in 5 categories, namely: 1) PS (Potential Scientist Student), 2) OSK (Other Smart Kids), 3) IDKS (I Don't Know student), 4) OS (Outsider) and 5) IOS (Inside Outsider). Categorizing students' science reconstruction skills is dominant in the OSK category by a p-value of $0.026 < 0.05$. Students feel unfamiliar with the culture being studied, although students' science knowledge increases. The results showed that the MANOVA Test obtained the results of Wilk lambda KE = 0.674 and KK = 0.878, and the Calculation of Experimental Class (KE) = 17,974, Control Class (KK) = 6.877 showed that the SSI strategy with ethnoscience proximity was very effective in empowering students' science reconstruction skills simultaneously (SMA A, B, and C) with significant influence.

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