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How does ethnoscience-students' worksheet (ESW) influence in science learning?

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ABSTRACT

Incorporating ethnoscience into lessons through the ethnoscience-students' worksheet (ESW) is one method to improve student interest in science learning while introducing them to the local culture. However, no research was reported the effects of ESW on students' responses and the factors that influence ESW implementation in science learning. In order to better understand how students learn through ESW, this study investigated the relationship between ethnoscience context, science learning, and the implementation of students' worksheets. Seventy-two students participated in the survey after they studied ethnoscience learning through ESW. Students' responses are more influenced by science learning. In addition, the ethnoscience-integrated students' worksheets (SW) variable indirectly affects students' responses. Additionally, ESW affects students' responses more significantly than science learning and ethnoscience. This research provides insightful implications for educators on planning, designing, and practicing ESW to enhance students' problem-solving motivation and academic achievement. Furthermore, to contribute significantly to future researchers, further research employed the structural equation model through covariance analysis, also known as confirmatory factor analysis (CFA).

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1. INTRODUCTION

In the era of globalization, problem-solving skills (PSS) have to deal with various challenging issues daily [1], [2]. Students apply their knowledge to comprehend the issue, create a workable solution, and accomplish the learning objective. Implement innovative science learning tools and models into curriculum can develop students' soft skills, such as communication, leadership, problem-solving, and scientific skills [3]–[7]. Science learning tools especially students' worksheets (SW) convey information about knowledge, skills, and attitudes through students' activities to improve their academic achievement [8]–[10].

Kurikulum Merdeka, announced by Indonesia's Ministry of Education, Cultures, Research, and Technology (MOECRT), describes the pedagogical approach to teaching science focusing on cultural student-centered learning (CSCL) techniques. Applying CSCL to establish a constructivist-based learning environment has great promise [11]. This local potential can be incorporated into contextual learning for students to construct their knowledge based on their discoveries [12]. Indonesia's indigenous knowledge, norms, and rituals are particularly distinctive and exist in every region [13]–[17]. It consists of local knowledge and conventions that serve as a life guide to resolving common challenges. A dogmatic perspective of science can be transformed into science for everyone, for the future, and for everyday life by combining science and indigenous knowledge [18], [19]. The transformation of indigenous science and scientific knowledge is ethnoscience [20]–[22].

There are three aspects of the philosophical review found in ethnoscience: i) ontology discusses the fundamental theoretical characteristics of a fact or source of knowledge; ii) epistemology focuses on the search for truth in knowledge; and iii) axiology focuses on the practical benefits of knowledge gained by humans in the form of expression, social life, and moral (ethical) actions [23]–[25]. Ethnoscience describes the relationship between the implementation of ethnoscience learning and social life. Additionally, it is essential to preserve local knowledge in the age of globalization by balancing the influence of globalization with local wealth or the localization of the community [26]–[28]. As a result, it is crucial to make an effort to preserve ethnoscience content in science learning. In addition, SW integrated ethnoscience can be used as a learning resource to help students advance their knowledge and skills [29]. SW can increase students' roles and decrease teachers' roles while assisting students in coming up with ideas [30]. Providing students access directly to science teaching resources is the most crucial thing teachers can do to help them develop life skills [31].

This study looked at how students' thought about importance ethnoscience students' worksheets (ESW) could affect science learning. Authors do bibliometric analysis to view the research map and how far previous science learning research based on Scopus database (June 2023). Based on Figure 1, there are three main points: i) the biggest science learning in previous research were low qualities of problem solving; ii) applying ethnoscience in science learning is important because science learning also linked to cultural awareness; and iii) to evaluate the learning process through students needed the survey to recap students' thoughts. So, this study focuses on students' thoughts after they study science with ESW.

The biggest problem is the need for more information about students' thoughts after they studied with ESW. There is also limited information about their variables and their effects on implementing ESW in science learning. On the other hand, ethnoscience have been a priority research area in fields of science, technology, and education [18]. This research was conducted to answer the following questions:

- How is the validity and reliability of the questionnaire instrument?
- How does the model fit for ethnoscience on students' responses through SW and science learning?

Therefore, this research aim is to analyse the incidence of ethnoscience in the students' thoughts. Our specific objective is to determine whether ethnoscience, science learning, and SW variables are significant, and to determine these variable's direct and indirect effects in implementing ESW in classroom.

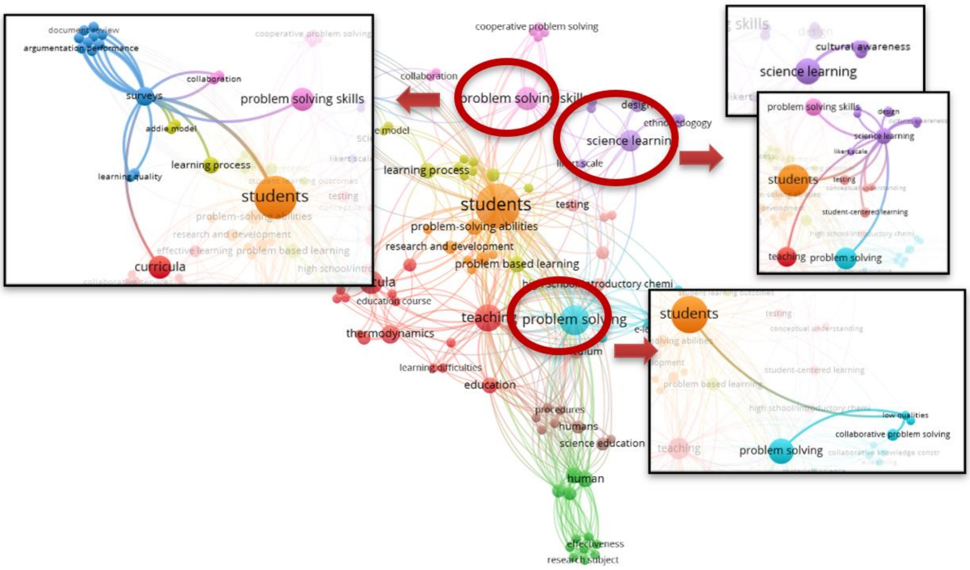

Figure 1. Research trends of science learning

2. METHOD

2.1. Research design

This research aims to investigate the importance of ESW on science learning based on students' thoughts through questionnaire survey. The widespread use of survey design stems from the strength of the

Indonesian demographic [32]. Before the survey, the teacher used ESW and guided the students to discuss and solve ethnoscience-contextual problems. When the learning activity finished, these students had to respond to a survey to show their perceived thoughts toward ethnoscience learning with ESW.

2.2. Sample and data collection

The samples used to depend on the number of indicators and latent variables in the questionnaire uses multiplied by five to ten [33], [34]. The sample involved 72 Madurese students. The samples are senior high school students who live in Madura and know the culture of *kerapan sapi* Madura. Purposive sampling was used in this study; the sample was selected immediately after fulfilling the criteria [35]. The questionnaire was distributed in February 2023. Table 1 summarizes the sample's demographic characteristics.

Table 1. Demographics characteristics of respondents

No	Demographic Characteristics	Students	
		Total	%
1	Gender		
	Male	30	41.67
	Female	42	58.33
2	Domicile		
	City	50	69.44
	Village	22	30.56

2.3. The instrument

The questionnaire established four variables: ethnoscience (ES), science learning (SL), students' worksheet (SW), and students' responses (SR). Every variable consists of three statements, so there are twelve agreement statements. It uses a four-point Likert scale: 1 for strongly disagree, 2 for disagree, 3 for agree, and 4 for strongly agree. So, respondents are not being neutral or not arguing. The Likert scale measures students' thoughts and perceptions [36]. Table 2 represents the detailed agreement statement that was used in this research. The instrument was distributed through a Google Form. This study assessed the students' responses through three variables. The research results have shown that students' responses after they learning science throught students' worksheet with ethnoscience content. In sum, the research model can be seen in Figure 2. Research model represented how variable affect others. Variable science learning and SW are mediate variable between ethnoscience and students' responses.

Table 2. Instrument

Category	Measure	Indicator	Value
ES	Students' thoughts about ethnoscience content	*Kerapan sapi* content is suitable for use as interesting content or a stimulus for science learning.	ES1
		ES is object that makes learning more meaningful.	ES2
		The *kerapan sapi* content can motivate students to learn science.	ES3
SL	Students' thoughts about implement ES in science learning	ESW is the best SW for science learning.	SL1
		ESW is easy and interesting to use in science learning.	SL2
		ESW can improve understanding of science and PSS.	SL3
SW	Students' thoughts about SW as learning media	SW is easy to read and understand while pictures on ESW are clear and in good resolution.	SW1
		The ethnoscience content in SW is clear and easy to understand.	SW2
		There is a clear correlation between culture and science.	SW3
SR	Students' fell when they learn with ESW	The students were motivated to learn and solve the problem when working on the ESW.	SR1
		The students tried their best to solve the problem on the ESW.	SR2
		The students do not feel bored when they solve the problem in ESW.	SR3

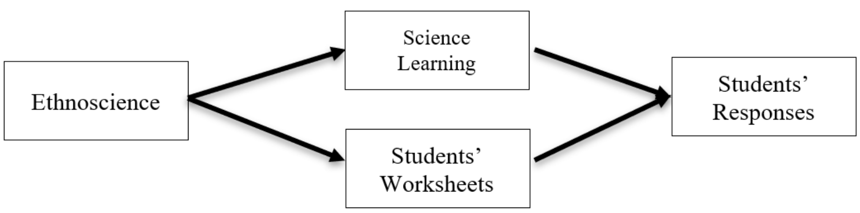

Figure 2. The research models

2.4. Analysing of data

Descriptive statistics and multiple regression-structural equation model (SEM) analysis was used to analyse the data [1]. Partial least squares structural equation model (PLS-SEM) analysis was a modern and powerful analytical technique in educational research [37]. It is not predicated on numerous assumptions [38]. It can analyse data with a small sample size and combine ordinal, interval, and ratio indicators on the same model [39], [40]. The metadata was inserted into Microsoft Excel to gather descriptive data and SmartPLS 4 software to conduct PLS-SEM analysis [41], [42]. A PLS-SEM consists factor analysis and multiple regression. So, the results contain two main elements, such as a structural model (correlation between latent variables) and a measurement model (correlation between latent variables and their indicator) [43]–[46]. This method was used to analyse the structural relationship among the variables [47]–[49]. In PLS-SEM, there are several requirements for the outer model, including:

- Convergent validity (loading factor) between latent variables and their indicators. A latent variable and its indicators are declared valid if the value is more significant than 0.7 [50].
- Cronbach alpha and composite reliability, which represent reliability values, have a minimum alpha coefficient value of 0.6 or a minimum composite reliability value of 0.7 [51].
- Average variance extracted (AVE) or an average variance value of at least 0.5 to be categorized as good and a determinant of convergent validity [50].
- F square (effect size) to determine the good-fit model with a minimum value of 0.35 [52], [53].
- Cross-loading is used to fulfil the discriminant validity test.

Table 3 describes the indicators that are accepted and the indicators that show the goodness of fit model.

Table 3. Fit model criteria [48], [54]

Parameter	Acceptable fit indicates	Goodness of fit indicates
Standardized root mean square residual (SRMR)	0.05 < RMR < 0.08	RMR ≤ 0.05
Normed fit index (NFI)	0.80 < NFI < 0.90	NFI > 0.90

In PLS-SEM, several indicators for the inner model and hypothesis testing have the following conditions: a t-statistic value > 1.96 and a p value < 0.05 [33]. If the p-value and t-statistics for each inner model indicator comply with these requirements, the hypothesis is accepted, and there is a correlation between the two latent variables [50].

3. RESULTS AND DISCUSSION

3.1. Results

The PLS-SEM analysis of the measurement and structural models and the relationship among variable in research models demonstrates that they are measured by variables consistent with actual data. Sub-section 3.1.1 represents the construct's validity and reliability and 3.1.2 for relationship among variables.

3.1.1. Evaluation of measurement model

The results of the convergent validity and reliability are presented in Table 4. All of the constructs have Cronbach's Alpha (CA) values higher than 0.6. Except for the ethnoscience construct (0.695), all constructs had CR values of 0.7, showing strong internal consistency due to CR_C and its CA [34]. Additionally, all of the indicators' factor loadings are high (> 0.7), except for the construct of ES2 (Loadings = 0.659). The indicators' AVE values range from 0.617 to 0.688, above 0.5. As a result, the four variables provided have done a decent job of validly and consistently explaining the latent variables. Furthermore, the measurement model's discriminant validity was assessed to see if the latent variables under investigation in this research could be distinguished. The value numbers in bold words in Table 5 show that the outer-loadings of each indicator in its construct are higher than the cross-loadings in other constructs. According to the PLS-SEM analysis's results for reliability, convergent validity, and discriminant validity, each indicator was found to be valid and reliable for measuring senior high school students' responses and experiences, particularly in the context of ethnoscience education using ESW.

3.1.2. Evaluation of structural model

PLS-SEM analysis using 5000 bootstrap subsamples was used to test the structural relationships among the latent variables investigated in this study [55]. A nonparametric method, the bootstrap, replaces the original data set with a random sample. It is to estimate the statistical significance of a PLS path model. Five significant predictive associations were discovered in the model, with path coefficients (PC) ranging from 0.333 to 0.511. The relationships between SL and SR had the highest PC (0.511; p 0.05; t > 1,167). These findings indicate that students were motivated to learn and solve the problem when working on the ESW.

According to Figure 3, the variables related to ethnoscience learning explained 56.9% of the variance in SL and 20.9% of the variance in SW. In contrast, learning significantly impacted on students' responses (motivation and PSS) more than SW. In other words, students' responses as a result of the ethnoscience learning environment may be crucial for their future learning of science and their ability to solve problems independently.

Table 4. Convergent validity and reliability

Indicator	Loadings	CA	CR_A	CR_C	AVE
ES1	0.842				
ES2	0.659	0.682	0.695	0.827	0.617
ES3	0.841				
SL1	0.793				
SL2	0.888	0.758	0.761	0.862	0.676
SL3	0.782				
SW1	0.805				
SW2	0.832	0.768	0.776	0.864	0.678
SW3	0.834				
SR1	0.861				
SR2	0.759	0.777	0.813	0.868	0.688
SR3	0.865				

Table 5. Cross loadings

Indicator	EF	SW	SL	SS
ES1	0.842	0.367	0.546	0.533
ES2	0.659	0.335	0.433	0.355
ES2	0.841	0.373	0.485	0.447
SL1	0.564	0.497	0.793	0.686
SL2	0.499	0.617	0.888	0.563
SL3	0.469	0.517	0.782	0.540
SW1	0.389	0.805	0.388	0.496
SW2	0.387	0.832	0.599	0.671
SW3	0.354	0.834	0.622	0.468
SR1	0.389	0.561	0.525	0.861
SR2	0.412	0.437	0.484	0.759
SR3	0.588	0.640	0.757	0.865

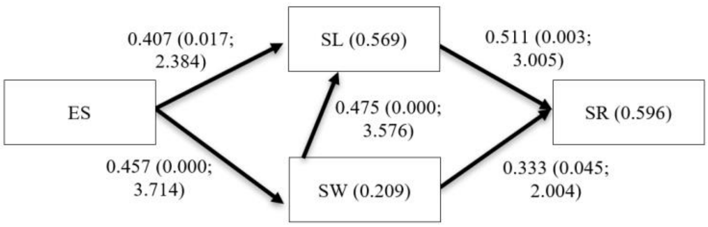

Figure 3. The research models

3.1.3. The direct and indirect effects

This research further investigated the indirect effects among the latent variables of the structural model to understand better the mediating students' responses on the relationship between ethnoscience learning and SW. Three significant mediated paths were discovered, as shown in Table 6. The positive indirect effects for all three paths show a considerable positive mediating influence of the students' responses on the link between ES, SW, and SL. Similar findings suggested that SW was a mediator in the relationship between the inclusion of ethnoscience content and students' attitudes toward science education. Additionally, there were critical mediated paths, including ES→SW→SR and ES→SL→SR.

Table 6. Specific indirect effects

Path	O	Mean	STDEV	T-stat	P-values
ES→SW→SL→SR (significant)	0.111	0.105	0.046	2.434	0.015
ES→SW→SR (significant)	0.217	0.231	0.095	2.292	0.022
SW→SL→SR (significant)	0.243	0.225	0.081	2.986	0.003
ES→SW→SR	0.152	0.178	0.105	1.451	0.147
ES→SL→SR	0.208	0.211	0.131	1.583	0.113

In addition, PLS-SEM can also measure the goodness of fit of the measurement model. The goodness of fit is based on SRMR, NFI, and F square values. The NFI and SRMR values of the model are unfit (NFI = 0.612; SRMR = 0.107). Table 7 shows the F-square values of each variable are fit, so that the model can be accepted.

Table 7. F-square

Variable	ES	SW	SL	SR
ES	-	0.264	0.305	-
SW	-	-	0.415	0.154
SL	-	-	-	0.363
SR	-	-	-	-

3.2. Discussion

The results of this research contributed toward a structural framework for comprehending how SW and ethnoscience play a part in student's learning of science. The PLS-SEM findings showed that the research model was accurate and valid. According to the structural model, there were several correlations between student responses and ethnoscience. SW and science learning serve as good mediators or predictors. Furthermore, the SW and SL mediated the relationship between ethnoscience and students' responses. The PLS-SEM method used in this research discovered a number of indirect effects of ethnoscience, students' worksheets, and students' responses. SW and SL were discovered to be significant mediators when participating in science learning. If we compare the magnitude of the direct effect of science learning on students' responses, it is 0.511 × 0.511, equal to 0.261121 or 26.1121%. In contrast, the magnitude of the indirect effect of ethnoscience on students' responses through SW is 0.457 × 0.576 = 0.263232 or 26.3232%. It suggests that while the effects of science learning are felt directly by students, the ethnoscience-integrated SW as an intervening variable significantly impacts how well students' responses.

The research results demonstrate a significant total effect of ethnoscience on SW, science learning, and students' responses, as well as a significant total effect of SW on science learning and students' responses and a significant total effect of science learning on students' responses. According to statistical analysis findings, all hypotheses are significant at p-values < 0.05. The total effect of students' worksheets on students' responses can be calculated when we compare the total effect across factors, and it is equal to 0.576 × 0.576 = 0.331776. The magnitude of the total effect of science learning on students' responses is 0.511 × 0.511, or 26.1121%. Then, the total effect of ethnoscience is 0.47 × 0.47 = 0.221841 or 22.14% on students' responses. It indicates that the worksheets students complete have a greater impact on their responses than science learning or ethnoscience.

In general, it would be thought that adding more ethnoscience content to other science subjects like physics, mathematics, biology, and chemistry would result in a more noticeable change in students' answers, especially in their motivation to solve the problems. The reason for this is that more SW and science education utilize ethnoscience elements. Learning institutions and surroundings that can promote intelligence and student abilities exhibited via cooperation in discipline, responsibility, and learning motivation can create learning cultures that mirror the standards of academic life [38]. Ethnoscience in learning activities helps us understand how scientific information emerges in society and is converted to scientific knowledge through a science learning process. It is made possible by studying ethnoscience [56]–[58]. The indigenous-scientific knowledge of how science and technology are used in society to address issues was investigated. The learning strategy through ethnoscience aims to enhance communication, PSS, students' motivation, and creative thinking abilities [59]–[62].

After implementing ESW, Sudarmin *et al*. [63] received positive feedback from students and raised the students' achievement in terms of religion, social and mental growth, and morals. In addition, the experimental class's average responses, acquired from 92% of the students, demonstrate that they responded well to learning with an ethnoscience-based direct instruction model [64]. Educators must use local knowledge or ethnoscience that can give students direct experience [65].

Because socio-cultural issues in ethnoscience are more directly related to students' daily lives, students ought to investigate, implement, and evaluate the solutions [66]. The learning process based on ethnoscience is not just transferring or conveying culture or cultural manifestations but also using culture to make students create meaning, penetrate the boundaries of imagination, and achieve a profound understanding of the subject matter and concepts being studied by students [67]–[70]. Due to the students prefer for an enjoyable learning experience over conventional methods, they are more engaged and excited about their studies [71]. Science can be easy to learn and understand using ethnoscience materials packaged in the SW as learning resources [72]–[74].

4. CONCLUSION

The PLS-SEM results show that there was a significant direct-indirect effect among variables. The result confirms that science learning has more effect on students' responses. Besides, the ethnoscience-integrated SW variable indirectly contributes to students' responses. In addition, SW has a total effect on students' responses than on science learning and ethnoscience. Therefore, implementing ESW in science learning can increase students' motivation and responses because all indicators and variables have positive correlations and influences on other variables. In other words, ethnoscience, students' worksheets, and science learning contribute to students' responses, especially their problem-solving and motivation.

This research theoretically contributed to literature that examines the role of ESW in science learning and its relevance to the use ethnoscience approach to studying science. Further, study methodologically used the SEM via covariance analysis or CFA analysis to contribute significantly to future researchers. This research practically provided educators insights, primarily designing, planning, and practicing ethnoscience-contextual learning strategies to enhance students' motivation and PSS in studying science. In this regard, there are implications for educators or education practitioners to pay attention to adding ethnoscience content when implementing science learning. The current study suggests that ethnoscience learning with ESW affects students' academic achievement and PSS in studying science.

There were some limitations to this research. First, the sample size of this research was small. Future research could increase the sample size and enlarge the target sample to other school levels and other institutions. Second, the time allocation of the learning process in this research was approximately 90 minutes. Examining the validity of the proposed model with long-term instructional intervention could be considered in future research. Third, future research could include learning outcomes, learning motivation, and other variables to examine with the proposed structural model. Despite the limitations, the findings of this research contribute to identifying the determinant factors of students' responses to science learning.

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