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Effectiveness of CELL Model to Train Student's Ethnoscience Literacy

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ABSTRACT

Objective: This study aims to examine the effectiveness of Collaborative Ethnoscientific Literacy Learning (CELL) model to train student's ethnoscience literacy competencies at Junior High School. **Method:** This research used a experimental method with one group pretest and posttest design. Data collection involved 32 students of VII grade at SMP Muhammadiyah 12 GKB Gresik, East Java, Indonesia. Data was collected throught scientific literacy competency test instrument enriched with Local Wisdom Science Issue (LWSI). The test instrument consists of 15 multiple-choice questions and essays designed based on three dimensions of scientific literacy ability.Data analysis technique using quantitative descritive. **Results:** The results of the data analysis showed that the application of the CELL Model was effective in improving students' ethnoscience literacy ability. This was indicated by a significant increase in ethnoscience literacy scores from pretest to posttest, with an average N-Gain of 0.72 in the high category. The results of the paired t-test showed a significant difference between the pretest and posttest. In addition, all ethnoscience literacy indicators increased with several indicators reaching the high N-Gain category. The highest increase was seen in the indicator of interpreting data and evidence scientifically. **Novelty:** Collaborative investigation activities in the CELL model provide a positive contribution to the achievement of ethnoscience literacy competencies. This shows that learning with a social emotional approach has a positive impact on improving students' understanding of science.

INTRODUCTION

The world is entering the VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) era, where the flow of information moves rapidly and uncertainly through digitalization (Hadar, 2020). The tide of globalization has eroded many of Indonesia's local cultural values. Internalizing local scientific and cultural knowledge through education is one way to restore Indonesia's natural wealth and cultural diversity. The Center for Research on Education and Cultural Policy reports that the average National Reading Activation Index in 34 provinces in Indonesia is in the low category with a score of 37.32 (Solihin, 2019). Four dimensions that influence the national reading activation index include the proficiency dimension index of 75.92; the alternative dimension of 40.49; the cultural dimension of 28.50; and the access dimension of 23.09. This means that data, strategies, media, and various positive habits that stimulate and strengthen students' literacy skills need to be continuously studied and practiced.

Based on the results of the Programme for International Student Assessment (PISA), the numeracy literacy competency of Indonesian students is still low, ranking 68th out of 81 participating countries with scores in mathematics literacy (379/472), science literacy (398/485), and reading (371/476)(OECD, 2023). The data above also illustrates that 40% of students have science skills at level 2. Students at level 2 can recognize correct explanations for scientific phenomena. Meanwhile, Indonesian students who achieve in science at levels 5 and 6 with the proficient category reach 7%. Students with this proficient competency level are able to implement their scientific knowledge

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independently and creatively in various situations. Another finding from the study Aryungga (2021) also stated that only 11 out of 102 students at Banjarmasin Indonesia had scientific literacy skills at level 5 and achieved the minimum completion criteria (75). PISA sets standards and indicators for scientific literacy competencies, encompassing knowledge, competence, context, and attitudes. Ethnoscience provides examples and discourse relevant to students' lives. This can help students apply scientific skills and draw scientific conclusions. Ethnoscience refers to the traditional knowledge of local communities related to science and technology. In Indonesia, scientific literacy scores remain below the global average according to the PISA, so ethnoscience learning can be a solution for developing students' scientific literacy competencies. The scientific literacy skill student of Indonesia still need improve if we look the data obtined from PISA.

Aditomo & Klime (2020) stated that scientific literacy skills can be effectively trained through inquiry-based learning (IBL) models. This is demonstrated by a positive correlation between the use of the Guided Inquiry learning model and scientific literacy achievement, as well as learning quality, in aspects such as classroom management (2.84), teacher support (3.16), and teacher-student relationships (3.42). Meanwhile, Open Inquiry correlated negatively with scientific literacy achievement. This is due to moderating factors in the adaptive teaching system, which still have low scores (<2.5), particularly in the teacher-student relationship aspect (Kang, 2020). Therefore, fostering social interaction to create a collaborative and meaningful learning atmosphere is needed. Other research suggests that one of the barriers to scientific literacy skills is the provision of inadequate and in-depth scientific materials, which impacts understanding (Basam et al., 2018). This situation can be improved by providing learning experiences that integrate various dimensions of local wisdom of the localcommunity (Nalau et al., 2018; Parmin & Fibriana, 2019; Verawati & Wahyudi, 2024).

Ethnoscience is a cross-disciplinary science that connects human culture (anthropology) with science learning (Dewi et al., 2021). Ethnoscience is knowledge gained from the study of local wisdom contained within the culture of a particular community or ethnic group (Lestari et al., 2021). Indigenous knowledge of local communities can encompass material phenomena deemed important and organized by the community, resource use and management, flora and fauna classification systems, social interactions, cultural practices, and even spirituality (Nalau et al., 2018; Kasi et al., 2021). The knowledge produced by these local communities is holistic-integrative, functional, and adaptive to changes in the natural, cultural, social, and economic environments (Zidny et al., 2021;Parmin et al., 2019).

Various learning models that have been studied in training scientific literacy skills based on community wisdom (ethnoscience) include inquiry-based learning models (Hastuti et al., 2022), open inquiry (Parmin et al., 2019), guided inquiry (Alim et al., 2020; Milanto et al., 2023). Learning models using the Contextual Teaching approach are also used to improve scientific literacy skills based on local wisdom that are directly integrated with chemical topics (Alim et al., 2020; Yuliana et al., 2021; Sumarni et al., 2020; Dewi et al., 2021). Furthermore, preliminary research on the initial competencies of ethnoscience literacy of students in Gresik Regency showed that the ability to explain scientific phenomena of local wisdom among junior high school students is still relatively low, only achieved by 37.30% of 65 students in the material on coastal community ecosystems (Shofatun et al., 2021).

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The Collaborative Ethnoscientific Literacy Learning (CELL) model integrates scientific knowledge from diverse sources and real-world problems relevant to students' lives, including the phenomenon of local wisdom or ethnoscience. This is needed for training and equipping students with 21st-century skills, particularly literacy and collaboration skills. The CELL model is learning approach, which facilitates collaborative scientific inquiry activities for students, involving various scientific concepts and local wisdom contextualized to students' lives. These activities, which not only transfer knowledge but also involve socio-emotional interactions and the use of various reading literacy strategies, further train students in ethnoscientific literacy competencies. The CELL learning model has several characteristics, including facilitating learning activities that integrate ethnoscientific content using multiple modalities strategies, training students in collaborative investigations enriched with local wisdom scientific content, and providing opportunities for students to construct their acquired knowledge through the construction and reflection phases. The research question posed in this article is how effective the Collaborative Ethnoscientific Literacy Learning Model (CELL) is in implementing science learning in seventh grade at Muhammadiyah Junior High School 12 GKB Gresik.

RESEARCH METHOD

This research employed a quasi-experimental descriptive quantitative research design. This study aims to examine the influence of the CELL learning model on improving students' ethnoscience literacy competencies. The competence aspect of ethnoscience literacy which includes explaining scientific phenomena from community wisdom knowledge, evaluating and designing ethnoscience-based scientific investigations, interpreting data and evidence scientifically, and applying the science concept of local wisdom scientific in community life.

This research was conducted at SMP Muhammadiyah 12 GKB Gresik, East Java Indonesia. The sample involved in the study was 32 students of VIIC grade consisting of 17 male dan 15 female student. The complete chart of the research procedure is in Figure 1.

This research uses a quasi-experimental method with a one-group pre-test and post-test design with one experimental class without a control class as shown at Table 1.

Table 1. Research Design

Group	Pretest	Treatment	Posttest
Experiment	O1	X	O2

Description
O1 : Pretest given before treatment
X : Treatment in applying the CELL Model for treatment class
O2 : Posttest given after treatment

Data was collected throught ethnoscience literacy test instrument enriched with Local Wisdom Science Issue (LWSI). Ethnoscience literacy test with the topic of interaction in an ecosystem integrated with the Ngudek Srumbung tradition in Gresik. The test instrument consists of 15 multiple-choice questions and essays designed based on three dimensions of scientific literacy ability. The results of the validation of the ethnoscience literacy test instrument by three experts were then analyzed using Aiken's Validity Coefficient (Aiken, 1985) with the following formula.

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$$V = \sum S / [n(C-1)]$$

Description
V : Validity score
S : The score given by the validator minus the lowest score in the category
n : Number of validator
C : Highest score

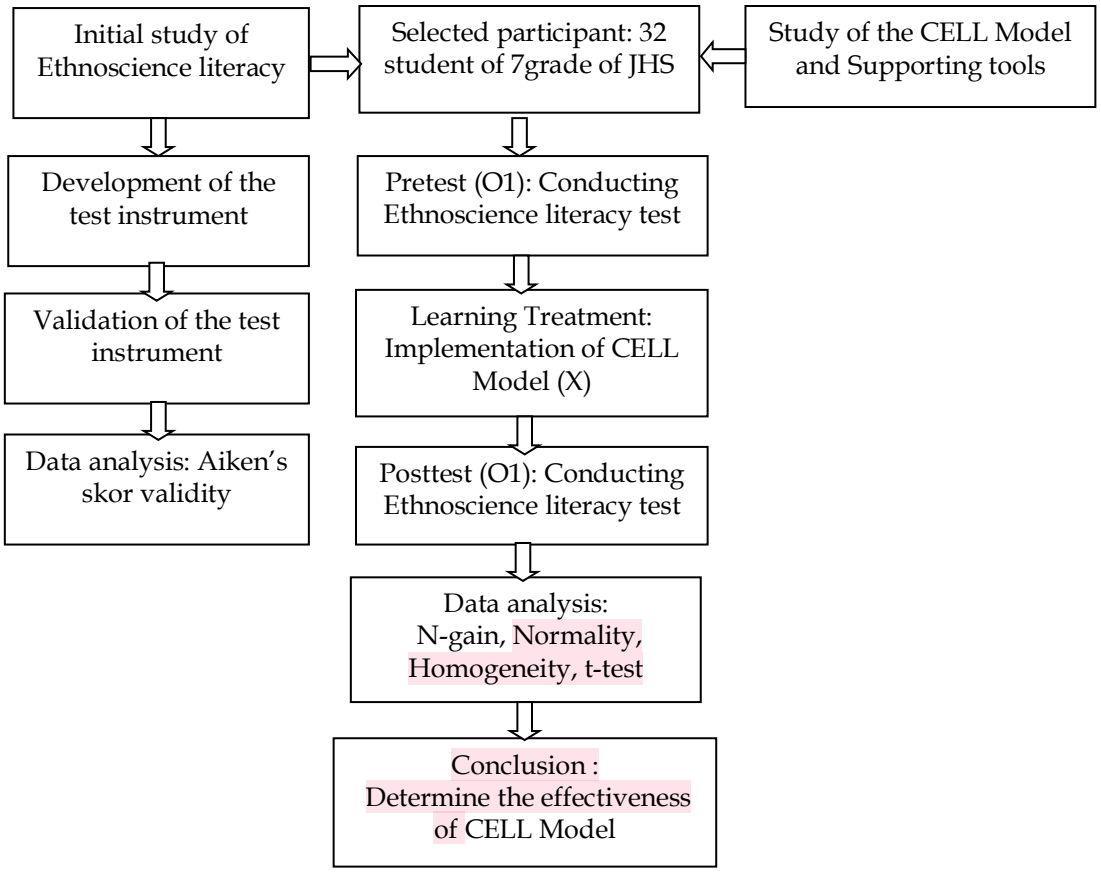

Figure 1. Research Prosedure

Then, the data validatity score obtained is categorized as per Table 2

Table 2. Validation Criteria for the ethnoscience literacy test instrument

Score Interval	Criteria	Meaning
0.75 ≤ V < 1,00	Very valid	Can be used without revision
0.50 ≤ V < 0.75	Valid	Can be used with minor revision
0.25 ≤ V < 0.50	Quite Valid	Can be used with mayor revision
0,00 ≤ V < 0.25	Less Valid	Not yet usable

Validity assessment showed that 6 out of 15 questions obtained an average Aiken's Validity score of 1.00, which categorized it as "very valid". While 8 questions with a score of 0.92 and 2 question with a score of 0.86 were considered "very valid." Reliability assessment using Cronbach's Alpha showed good dependability. Furthermore, the ethnoscience literacy test instrument was used in collecting data of pretest and posttest to measure the effectiveness of the CELL model to train students' scientific literacy competencies. Data analysis techniques were also used, including n-gain, normality test,

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homogeneity test, and t-test. The normalized gain formula (n-gain) used to ascertain difference between pretest and posttest score. The average n-gain was determined by:

$$N - gain = \frac{post\ test\ score - pre\ test\ score}{maximum\ score - pre\ test\ score}$$

Then, the n-gain obtained is categorized based on the following Table 3.

Table 3. The N-gain Criteria

N-gain score	Criteria
0,70 < n-gain	High
0,30 ≤ n-gain ≤ 0,70	Average
n-gain < 0,30	Low

RESULTS AND DISCUSSION

Results

Observation of the results of the ethnoscience literacy competency test showed a significant influence. The results of the limited test were measured using quantitative descriptive from the pretest, posttest and n-gain scores. Ethnoscience literacy competency data were obtained through an ethnoscience literacy competency test instrument consisting of 15 questions in the form of multiple choice and essay. Details of the ethnoscience literacy skills test scores in the limited test can be seen in Appendix 1. Summary of the description of the pretest, posttest and n-gain score of student's ethnoscience literacy competency in the limited trial can be seen in Table 4.

Table 4. Description of the Pretest, Posttest and N-gain Score of Student's Ethnoscience Literacy Competencies.

Initial Student	*Pre-Test*	*Post-Test*	*N-gain*	*Criteria*
SC1	17.00	84.00	0,81	High
SC2	24.00	71.00	0,62	Average
SC3	23.00	78.00	0,71	High
SC4	37.00	82.00	0,72	High
SC5	44.00	96.00	0,92	High
SC6	44.00	79.00	0,62	Average
SC7	23.00	78.00	0,71	High
SC8	48.00	89.00	0,79	High
SC9	34.00	73.00	0,59	Average
SC10	47.00	72.00	0,48	Average
SC11	29.00	96.00	0,94	High
SC12	29.00	80.00	0,72	High
SC13	34.00	70.00	0,54	Average
SC14	36.00	84.00	0,76	High
SC15	24.00	76.00	0,68	Average
SC16	39.00	84.00	0,75	High
SC17	23.00	81.00	0,75	High
SC18	36.00	81.00	0,71	High

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Initial Student	*Pre-Test*	*Post-Test*	*N-gain*	*Criteria*
SC19	24.00	78.00	0,71	High
SC20	44.00	79.00	0,62	Average
SC21	30.00	91.00	0,87	High
SC22	28.00	78.00	0,69	Average
SC23	34.00	80.00	0,69	Average
SC24	40.00	76.00	0,59	Average
SC25	34.00	87.00	0,80	High
SC26	46.00	81.00	0,65	Average
SC27	26.00	72.00	0,63	Average
SC28	37.00	89.00	0,82	High
SC29	37.00	72.00	0,56	Average
SC30	37.00	81.00	0,70	High
SC31	30.00	76.00	0,65	Average
SC32	39.00	87.00	0,78	High
Average N-gain		**0.71**		
Criteria		**High**		

Based on the data in Table 4, it was observed that there was a significant difference in students' ethnoscience literacy scores after implementing the Collaborative Ethnoscientific Literacy Learning (CELL) model. The test results before treatment with the CELL model (pretest) obtained low scores ranging from 17.00 to 48.00 with an average score of 34.00. After implementing the CELL model with four learning meetings, and conducting a posttest, there was a spike in ethnoscience literacy scores in the range of 70.00 to 96.00 with an average score of 81.00.

One important indicator to measure the effectiveness of learning is by calculating n-gain. Analysis with n-gain describes the degree of influence of increasing students' ethnoscience literacy competency before and after learning using the CELL Model. The high average n-gain of 0.71 which is currently included in the criteria shows that the CELL model has succeeded in significantly training students' ethnoscience literacy competency. Another important thing is that each student experiences an increase in their literacy skills for all students to get a minimum score of 70.00 or higher. especially seen in students who get the lowest scores during the pretest. As seen in students with the initials SC1 and SC7. Student SC1 got the lowest pretest score with a score of 17.00 and after taking part in learning with the CELL model and got a score of 81.00 on the posttest results with an n-gain value of 0.81 (high criteria). Likewise, it is seen in student C17 with a pretest score of 23.00 (lowest) and a posttest result of 78.00 (high) and after intervention with an n-gain score of 0.71 (high). This proves that the CELL model can improve students' ethnoscience understanding and skills from a very low level to a medium-high level of understanding.

Table 5. illustrates that the implementation of the CELL model has had an impact on improving ethnoscience literacy competency at the school. This is indicated by the average N-gain of 0.72 for ethnoscience literacy competency, which is categorized as high.

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Table 5. N-gain Score for each Indicators of Ethnoscience Literacy Competence

Indicator of Ethnoscience Literacy	Question Number	Pre-test	Post-test	N-Gain	Criteria
Explaining scientific phenomena from community wisdom knowledge	1,2,3,6,7, 14	40	82	0,70	Average
Evaluating and designing ethnoscience-based scientific investigations	12, 13, 15	27	76	0,67	Average
Interpreting data and evidence scientifically	4, 8	32	85	0,78	High
Applying the science concept of local wisdom scientific in community life	5,8, 10,	34	82	0,73	High
Average N-gain			**0.72**		
Criteria			**High**		

Table 6. Results of the Normality Test of the Pre-test and Post-test of Ethnoscience Literacy Competence

School	Class	Shapiro-wilk			
		Data	Statistic	Sig	Description
Muhammadiyah 12 GKB Junior High School Gresik	VII-C	Pre-test	0.960	0.282	Normal
		Post-test	0.957	0.234	Normal

Table 6. Present the results of the normality test for pre-test and post-test ethnoscience literacy. Data in the limited trial at Muhammadiyah 12 GKB Junior High School Gresik. Normality was tested using the Shapiro-Wilk test for class VII-C using SPSS 25 Sofware Programme. The Shapiro-Wilk statistic obtained was 0.960 with a significance value (Sig) of 0.282 (pretest) and 0.957 with a significance value (Sig) of 0.234 (posttest). Based on the significance value (>0.05), it can be concluded that the data are normally distributed. These results indicate that normality is met; therefore, the data are suitable for further statistical analysis. A paired t-test was run to compare the mean scores of ethnoscience literacy data before and after the intervention in the same group (category VII-C). This test helps us determine whether the intervention made a significant difference in learning outcomes. The t-test results are presented in Table 7.

Table 7. Paired t-Test of Pretest and Posttest data on Etnoscience Literacy

School	Class	*Paired t-Test*		
		N	*Statistic*	*Sig*
Muhammadiyah 12 GKB Junior High School Gresik	VII-C	32	-27,690	0,000

Table 7, shows that there is a difference between the average pre-test and post-test scores of students' ethnoscience literacy competencies during the limited trial in class VIIC. This can be proven by the negative t-value (-27.690), which means the average post-test score is greater than the pre-test score. This condition illustrates that learning with the CELL model has an impact on improving students' ethnoscience literacy competencies before and after participating in learning using the developed CELL model.

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Discussion

The data presented show that the ethnoscience literacy competency of VII-C grade students increased after participating in learning with the CELL model. The average pre-test score for ethnoscience literacy was 34, and the post-test score increased to 81. The effectiveness of this CELL model is determined by the increase in ethnoscience literacy competency which refers to the results of the N-gain calculation and paired t-test. This correlates with the research findings of Dewi (2021) which states that science learning by integrating ethnoscience content can improve students' science literacy skills from various aspects of content, process and attitudes towards science.

Based on table 5, the highest N-gain can be seen in the competency and scientific process aspects, especially in the indicator of interpreting data and evidence scientifically with an N-gain of 0.78, categorized as high. The scientific context aspect, with the indicator for applying local wisdom concepts in community life, also showed an N-gain of 0.73, categorized as very high. This indicates that students have experienced a shift in ethnoscience literacy competency, moving from the low category to the medium and high categories. Based on existing findings, the integration of indigenous knowledge into science (ethnoscience) can facilitate students' understanding of scientific concepts and help them recognize the value of promoting sustainable living (Zidny et al., 2020; Handayani et al., 2018). Meanwhile, the development of students' ethnoscience literacy skills can be easily understood by integrating them with real-life problems (Ridho et al., 2021), culture (Rahmawati, Ridwan, Cahyana, et al., 2020), and life and social issues (Toleubekova & Zhumataeva, 2018).

The average ethnoscience literacy competency score increased from 34 to 81. The results of this study have been supported by Verawati & Wahyudi (2024). The t-test results showed differences in students' ethnoscience literacy competencies before and after participating in learning with the CELL model. Ethnoscience-based collaborative learning is a factor in students' understanding of science concepts. Social interaction between students in groups during learning can enhance distributed cognitive learning and individual constructivism (Slavin, 2018). When students share information including local wisdom knowledge (ethnoscience) and respond to each other's ideas, students will improve their understanding, elaborate on knowledge, be encouraged to clarify and organize ideas, and accept shortcomings in their reasoning(Khalikov et al., 2020). Finally, new perspectives and alternatives will emerge that are appropriate to their cognition. This cognitive knowledge of students is formed by themselves through interactions between students and their environment (Moreno, 2010). This is in line with the research findings of (Rahmawati, et al., 2020), which states that understanding indigenous knowledge related to science learning topics will increase through socio-cultural interactions and collaboration in learning.

Dewi (2021) found that contextual science learning by integrating ethnoscience content can improve scientific literacy skills across content, process, and attitudes. Scientific literacy is one way to know, understand, and answer questions about everything in the world. Currently, learning scientific literacy skills is no longer individual-based but will provide greater benefits when built on a community basis (Snow & Dibner, 2016). Therefore, through learning activities that practice communication and collaboration skills through scientific literacy, students are expected to develop an awareness and concern for science and technology. These ethnoscience

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skills will help students shape their natural, intellectual, and cultural environments, as well as a willingness to engage and care about science-related issues (OECD, 2023a). The results of this study indicate that the Collaborative Ethnoscientific Literacy Learning Model (CELL Model) is effective in training students' ethnoscientific literacy competencies.However, students' skills in evaluating and designing ethnoscience-based investigations still need to be continuously trained, which is a limitation found in this study.

CONCLUSION

Fundamental Findings: The above analysis reveals that the Collaborative Ethnoscientific Literacy Learning (CELL) model can substantially improve the literacy competency of junior high school students. The average n-gain ethnoscientific literacy score resulting from this study is in the "high" category. Significant improvements were observed in the ability to interpret data and evidence scientifically and to apply the scientific concept of local scientific wisdom in community life. **Implication:** The effectiveness of the CELL model in improving students' scientific literacy has been described in this paper. As described in the analysis, this model increased ethnoscience literacy scores with an average n-gain categorized as medium-high. Improvements were recorded across all ethnoscience literacy indicators, including explaining scientific phenomena from indigenous knowledge, evaluating and designing ethnoscience-based scientific investigations, interpreting data and evidence scientifically, and applying local wisdom concepts in community life. **Limitation:** Further extensive trials are needed to determine the consistency of the effectiveness of this CELL model. **Future Research:** Ethnoscience-based science learning and teaching models can be studied at all levels of school, including elementary, secondary, and university. Further research is needed to determine the appropriateness of this model for adoption at various levels of education. Further exploration of various forms of local scientific knowledge can be conducted with regard to other factors related to student skills, such as scientific process and collaboration.

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