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Implementation of the Guided Inquiry Learning Model Based on Ethno-STEM Terasi Udang to Improve Students' Science Process Skills

Fadhillah Khoirunisah[1], Beni Setiawan[1]*, Mohammad Romadhoni[2]
[1]Faculty of Mathematics and Natural Sciences, Universitas Negeri Surabaya, Surabaya, Indonesia
[2]Asia-Pacific Regional Studies, College of Humanities and Social Sciences, National Dong Hwa University, Hualien, Taiwan

ABSTRACT

This study aims to describe improvements in students' science process skills and the implementation of guided inquiry-based learning using Terasi Udang as a medium in the context of Ethno-STEM. The research design is a one-group pretest-posttest design. The subjects in this study were 33 students in class IX-E at SMP Negeri 1 Prambon. The instruments used in this study were pretests and posttests of science process skills and an observation sheet for the implementation of teacher activities. The improvement in science process skills was analyzed using N-Gain analysis and the Wilcoxon test, while the implementation of teacher activities was analyzed using the Guttman scale. Students' science process skills improved after implementing the Guided Inquiry learning model based on Ethno-STEM. The research results regarding science process skills were evidenced by an average N-Gain score of 0.73, categorized as High, and by a p-value of 0.000 (< 0.05) from the Wilcoxon test. Since the p-value was < 0.05, H0 was rejected, and H1 was accepted. The implementation of the learning process achieved a 100%. This study contributes to science education by demonstrating that the Etno-STEM approach is an effective strategy for enhancing learning quality.

ARTICLE INFORMATION

Keywords:
guided inquiry, science process skills, ethno-stem

Correspondent Author:
Beni Setiawan

Email:
benisetiawan@unesa.ac.id

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INTRODUCTION

The era of globalization is evidence of human development, and education plays a role in creating a generation ready to face the times' changes (Panjaitan, 2023). In the era of globalization, the science learning process emphasizes providing direct experiences to develop competencies for understanding and responding to the world scientifically (Wayan et al., 2021). Science learning is closely related to direct learning through experiences, such as investigations and experiments (Latukau, 2022). The current era of globalization requires a STEM (Science, Technology, Engineering, and Mathematics) approach that can increase the relevance and contextuality of science learning (Hiğde & Aktamış, 2022; Bybee, 2018). This approach integrates science, technology, engineering, and mathematics into problem-solving, thereby encouraging students to learn across disciplines and in context. The STEM approach can help students master science process skills (Hasan et al., 2024; Angelia et al., 2022). Science process skills are ideal for science learning because they support the implementation of the scientific method (Aliyah & Erman, 2021; Alia et al., 2025). However, previous studies mostly discuss STEM and science process skills separately, and limited studies integrate STEM with local wisdom and guided inquiry simultaneously. This condition indicates a research gap in

integrating guided inquiry, ethnoscience, and STEM approaches to enhance students' science-process skills. Science process skills are developed from students' scientific experiences and are defined as the ability to investigate phenomena in their environment and to construct scientific concepts (Santiawati et al., 2022). The reality is that students' abilities in science learning in Indonesia are still low. Based on the 2022 PISA results, the PISA score decreased by 13 points from 2018 to 2022. The 2018 PISA result was 396 points, while the 2022 PISA result was 383 points (OECD, 2023). These results show that Indonesian students lag behind the global literacy mean by 117 points (Rini et al., 2024). These results also show that many students are still unable to connect the knowledge they learn with real life (Azizah et al., 2023). Interviews with science teachers also show that the learning process lacks exploration activities, case studies, and problem-based learning. In addition, science process skills are still not given enough attention or training to students. This shows that students' science process skills are a significant problem that needs attention and solutions. Therefore, instructional innovation that integrates contextual learning, local wisdom, and scientific investigation is needed to address this problem.

Based on the results of preliminary research conducted on Tuesday, September 16, 2025, in class IX-F of SMP Negeri 1 Prambon by testing six indicators of science process skills, the percentage data shows that 1) Observing 62.83%; 2) Questioning and Predicting 43.17%; 3) Planning and Conducting Investigations 56.7%; 4) Processing, Analyzing Data and Information 40.00%; 5) Evaluating and Reflecting 52.50%; and 6) Communicating Results 82%. The data show that the students' strengths are evident in the observation indicator, which meets good criteria, and in the communication results indicator, which meets very good criteria. Meanwhile, the students' weaknesses are seen in the four indicators of science process skills: 1) Questioning and Predicting; 2) Planning and Conducting Investigations; 3) Processing, Analyzing Data and Information; and 4) Evaluating and Reflecting, which show low criteria. Based on preliminary research results, the main focus of this study is to improve the four indicators that meet the low criteria.

Based on observations and preliminary research at the school, there is a need for instructional innovations that facilitate active student learning and enhance students' science process skills. Furthermore, classroom instructional models have been shown to positively impact students' science process skills (Angelia et al., 2022). Instruction that directly encourages students to be active in the classroom has been proven to improve science process skills. The learning model used in this study is guided inquiry (Hediana & Nurita, 2022; Moog & Farrell, 2017). This is supported by Jaya et al. (2022), who found that students' science process skills through guided inquiry were rated "good" by 83% of respondents. Similarly, Farida and Fahmi (2024) reported that implementing the guided inquiry learning model improved students' science process skills in Cycle I by 72% and in Cycle II by 95.84%. However, previous studies have mainly focused on guided inquiry without integrating local wisdom and Ethno-STEM approaches. This indicates that the state of the art of this research lies in integrating guided inquiry learning with Ethno-STEM based on local wisdom.

The guided inquiry learning model is a conceptual learning framework that involves investigating problems, formulating hypotheses, designing experimental activities, analyzing data, and drawing conclusions from the problems that arise (Sari & Lahade, 2022). The guided inquiry learning model will be more supportive if it is developed with ethnoscience, enabling students to discover new concepts through direct experiences in everyday life (Orosz et al., 2022). Ethnoscience can encourage teachers to teach science grounded in culture, local wisdom, and societal issues, making science learning more meaningful for students (Ulya et al., 2023). Ethnoscience in this study refers to the local wisdom unique to the city of Sidoarjo, namely Terasi Udang production, which involves conventional biotechnology processes such as fermentation. Integrating Terasi Udang, a local wisdom,

into science learning provides contextual learning experiences while connecting scientific concepts with students' cultural environment.

The Ethno-STEM approach integrates STEM with local culture to make learning more contextually relevant (Idrus, 2022). The Ethno-STEM approach supports the development of students' science process skills because every aspect of STEM guides students through the scientific process. Students can understand and investigate scientific phenomena in their own culture. They can conduct experiments, explore, and investigate scientific phenomena in their surroundings (Illahi et al., 2025). These activities will foster an understanding of local wisdom and develop students' scientific process skills. Therefore, the novelty of this research lies in integrating guided inquiry learning, the Ethno-STEM approach, and the local wisdom of Terasi Udang into biotechnology learning to improve students' science process skills. Based on the problems and facts described above, the researcher will examine the effectiveness of applying the Sidoarjo-style Terasi Udang-guided inquiry learning model based on Ethno-STEM in improving students' scientific process skills in biotechnology. This study is expected to improve students' scientific process skills in junior high school, especially in science learning, by integrating general knowledge, local wisdom, and guided inquiry learning models to achieve the intended learning objectives.

METHOD

The research methodology employed in this study is quantitative, with a pre-experimental design, specifically a one-group pretest-posttest design, to measure improvements in students' science process skills after implementing the Ethno-STEM-based guided inquiry learning model. This study aims to describe the implementation of the learning process and to measure students' improvement in science process skills after treatment. The pre-experimental design results are dependent variables that are not entirely influenced by independent variables due to the absence of a control group and the non-random selection of the sample (Sugiyono, 2021). This study was conducted at SMP Negeri 1 Prambon, specifically with students in class IX-E, totaling 33 research subjects.

The research instruments used included learning implementation observation sheets and science process skills test sheets. The science process skills test is structured around four indicators: questioning and predicting; planning and conducting investigations; processing and analyzing data; and evaluating and reflecting. The test items are multiple-choice and adapted for biotechnology learning materials. Data collection techniques in this study included pretests and posttests to measure improvements in students' science process skills, and observation sheets to assess the implementation of the Ethno-STEM-based guided inquiry learning model during its application. The instrument's validity was assessed through content validity, with assessments conducted by science teachers and science education students. The instrument's reliability was assessed using Cronbach's alpha. An instrument is considered reliable if the Cronbach's Alpha value is greater than 0.70. N-Gain analysis was used to identify improvements in students' science process skills after treatment. N-Gain values were interpreted according to Hake's categories (Hake, 1998) as presented in Table 1.

Table 1. N-Gain Categories

N-gain	Category
N-Gain > 0,70	High
0,30≤ N-Gain ≤ 0,70	Medium
N-Gain < 0,30	Low

An analysis of students' achievement in each aspect of the science process skills was conducted using pretest and posttest data. Students' science process skill scores were calculated using the percentage formula: dividing the student's total score by the maximum score and multiplying by 100%. These percentage results were categorized according to criteria for the achievement of science process skills: very poor, poor, fair, good, and very good (Amalia et al., 2024). This study was conducted over three sessions in Class IX-E at SMP Negeri 1 Prambon. Science instruction was conducted with a time allocation of 2 × 40 minutes for the first and second sessions, and 3 × 40 minutes for the third session. Observations and assessments were carried out by three observers: one science teacher and two science majors from Surabaya State University. Quantitative analysis of the learning process implementation was conducted by calculating a score for each aspect based on the learning process implementation criteria for each session, using the Guttman scale: "Yes" received a score of 1, and "No" received a score of 0. The scores were then calculated as percentages to determine the level of implementation of the learning process.

The pretest and posttest results were analyzed using a paired sample t-test to determine whether there was a significant difference between the pretest and posttest scores. Before conducting the hypothesis testing, the data were tested for normality. If the data were normally distributed (sig. > 0.05), a paired sample t-test was used. However, if the data were not normally distributed (sig. < 0.05), a non-parametric test, the Wilcoxon test, was used. Hypothesis testing in this study was conducted using IBM SPSS Statistics software. Ethical considerations in this study included obtaining permission from the school, informing students about the study's purpose, ensuring student data remained confidential, and using the research results only for academic purposes.

RESULTS AND DISCUSSION

This study applied an Ethno-STEM-based guided inquiry learning model using terasi udang to improve students' science process skills. The research data collected included students' pretest and posttest scores on science process skills and the implementation of the learning process. The analysis of these learning outcomes used N-Gain to measure the magnitude of the increase in pretest and posttest scores. Based on the study results, the achievement of each science process skill indicator increased from pretest to posttest, indicating that the Ethno-STEM-based guided inquiry learning model improved students' science process skills.

Table 2. Percentage of Achievement on the Pretest and Posttest for Each Science Process Skill Indicator

Indicators of Science Process Skills	Percentage of Achievement Pretest	Category	Percentage of Achievement Posttest	Category
Questing and Predicting	47%	Quite Good	85%	Very Good
Planning and Conducting Investigations	52,5%	Quite Good	85%	Very Good
Processing, Analyzing Data and Information	55,5%	Quite Good	90%	Very Good
Evaluating and Reflecting	39,4%	Less	89%	Very Good

Based on Table 2, all indicators of science process skills improved from pretest to posttest. The most significant improvement occurred in the evaluating and reflecting indicator, while the questioning and predicting indicator showed the lowest improvement. This indicates that learning

activities emphasizing reflection and analysis were more effective than activities requiring prediction skills. This finding suggests that students are more accustomed to evaluating results than formulating predictions, which requires higher reasoning skills at the beginning of learning. The detailed N-Gain results for each science process skill indicator are presented in Figure 1.

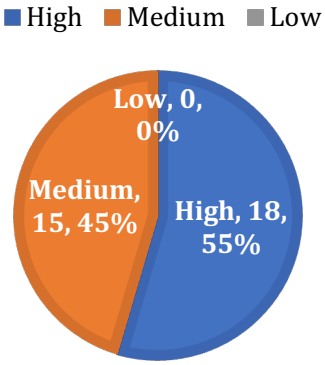

Figure 1. Percentage Distribution of N-Gain Scores

Based on Figure 1, most students achieved moderate to high N-Gain categories, indicating that the Ethno-STEM-based guided inquiry learning model effectively improved students' science process skills. The following is a detailed breakdown of N-Gain scores for each science process skill indicator, presented in Table 3.

Table 3. Recapitulation of N-Gain Scores for Science Process Skills Indicators

Indicators of Science Process Skills	Percentage of Achievement Pretest	Percentage of Achievement Posttest	N-Gain	Category
Questing and Predicting	47%	85%	0,61	**Medium**
Planning and Conducting Investigations	52,5%	85%	0,48	**Medium**
Processing, Analyzing Data and Information	55,5%	90%	0,52	**Medium**
Evaluating and Reflecting	39,4%	89%	0,98	**High**

Based on Table 3, the evaluating and reflecting indicator had the highest N-Gain score, while planning and conducting investigations had the lowest. This indicates that students showed greater improvement in evaluation and reflection skills compared to investigation planning skills. This result may be influenced by the guided inquiry learning stages, in which students were guided more intensively during the reflection and conclusion stages than during the investigation planning stage. The Shapiro-Wilk normality test results are presented in Table 4.

Table 4. Normality Test

Test of Normality			
	Shapiro-Wilk		
	Statistic	Df	Sig
Pretest	0.929	33	**0.032**
Posttest	0.871	33	**0.001**

Based on Table 4, the significance values for both pretest and posttest are less than 0.05, indicating that the data were not normally distributed. Therefore, the Wilcoxon test was used to determine whether there was a significant difference between pretest and posttest scores. The Wilcoxon test showed a p-value of 0.000 < 0.05, indicating a significant difference in students' science process skills before and after the implementation of the Ethno-STEM-based guided inquiry learning model. This result indicates that the learning model significantly improved students' science process skills. The learning process was observed across three meetings, and the results are presented in Table 5.

Table 5. Percentage of Implementation Each Meeting

Learning Meeting	Percentage (%)	Category
1	100%	Very Good
2	100%	Very Good
3	100%	Very Good

Based on Table 5, the implementation of the Ethno-STEM-based guided inquiry learning model was carried out very well in all meetings. The successful implementation of the learning model improved students' science process skills. From a Science perspective, the core of terasi production is the fermentation process. The Technology aspect in the ethno-science of Sidoarjo *terasi udang* is evident in the traditional processing methods that have been refined over generations. This includes shrimp grinding techniques, mixing with salt (salting), fermentation in specific containers (e.g., bamboo baskets, jars, or wooden barrels), and drying methods either naturally under sunlight or with the aid of simple tools. The Mathematics aspect involves ingredient proportions (the ratio of shrimp to salt) and the calculation of fermentation time. The Engineering aspect is evident in the design of the tools used; this study employs a grinding machine powered by an electric motor. The number of blades on this grinding machine will be manipulated to 1, 2, and 3.



Figure 2. Electric Motor-Powered Grinding Tool



Figure 3. Knife Blades

The increase in science process skills was analyzed using N-Gain, showing an average science process skill of 55% in the high category, 45% in the medium category, and 0% in the low category. Students' science process skills were measured through cognitive domain indicators in pretest and posttest questions. The posttest score percentage shows that the indicator of processing, analyzing data and information, C4 (Analyzing), obtained the highest posttest score percentage of 90%. The C5 (Evaluating) indicator of evaluating and reflecting had a posttest score of 89%. The fact that science process skills indicators, analyzing and evaluating, yielded greater gains than lower-order indicators is noteworthy and warrants analytical exploration, as discussed in subsequent sections.

On the questioning and predicting indicators, there was an increase from 47% to 85% on the posttest, with an N-Gain score of 0.61, which is in the moderate category. The increase in the questioning and predicting indicators was influenced by the implementation of learning, which received a 100% rating. In this phase, students were trained to formulate problems based on the local wisdom phenomenon of Terasi Udang. In learning with the guided inquiry model based on Etno-STEM, students were trained to ask further questions to clarify their observations and make predictions about scientific investigations (Babalola & Keku, 2024). While this context successfully motivated student engagement, improvements in predictive skills suggest that additional support strategies, such as hypothesis generation, could further enhance students' initial scientific reasoning. This aligns with the characteristics of the guided inquiry learning model, which places students actively in the process of constructing their own knowledge through scientific investigation, while the teacher acts as a facilitator or mentor (Michalsky, 2021). From a Vygotsky perspective, improvements in this indicator reflect the Zone of Proximal Development (ZPD), where students require more intentional support to bridge existing knowledge and the new scientific reasoning required by inquiry tasks (Khasawneh et al., 2023).

The indicator for planning and conducting investigations increased from 52.5% in the pretest to 85% in the posttest, with an N-Gain score of 0.48, which is in the moderate category. The improvement in this indicator was influenced by the implementation of learning, which received a 100% score. In this phase, students were trained to formulate hypotheses and conduct investigations, namely, Terasi Udang fermentation experiments. Learning with the guided inquiry model based on Etno-STEM provided real-world context, making it easier for students to understand the scientific process and its application in scientific investigation (Aznam et al., 2025). This indicator guides students in building scientific concepts by investigating natural phenomena in their surroundings (Astutik, 2025). In addition, it benefits students by training them in scientific and systematic skills, both in the learning process and in their daily lives (Angelia et al., 2022). This improvement can be further understood through Vygotsky's theory, which is particularly relevant in the structured inquiry phase, serving as a cognitive foundation and progressively guiding experimental planning from teacher to student (Andrini, 2023; Rigopouli et al., 2025). Unlike direct instruction approaches, in which students follow predetermined procedures, the guided inquiry model requires students to negotiate their own investigative strategies within a framework supported by a process that builds not only procedural competence but also metacognitive awareness of scientific methodology (Khasawneh et al., 2023).

The indicator of processing and analyzing data and information increased from 55.5% in the pretest to 90% in the posttest, with an N-Gain score of 0.52, which falls in the moderate category. The improvement in this indicator was also influenced by the implementation of learning, which received a 100% score. In this phase, students were trained to collect data on Terasi Udang fermentation experiments by conducting organoleptic and pH tests. In learning with the guided inquiry model based on Etno-STEM, students were trained to present data in tables and models and to explain their observations. This aligns with the characteristics of guided inquiry learning, in which students not

only collect data but are also guided to analyze it and connect the experimental results through teacher guidance (Wardana & Arvianto, 2026; Hadi et al., 2022). In addition, students' prior knowledge also plays an important role in the data analysis process, as teachers encourage them to relate it to new findings during the investigation. Improvements in indicators for processing and analyzing data and information align with science learning objectives that emphasize logical, data-based thinking skills, thereby strengthening the role of guided inquiry models in building scientific concept understanding (Nasir et al., 2023). The increase in this indicator is due to practical activities that enhance students' memory of knowledge and their thinking skills (Supatmi, 2022). This progression can be theoretically explained through Bruner's discovery learning perspective, which operationalizes the concepts of enactive, iconic, and symbolic representation. Students moved from handling physical materials (enactive) to recording observations in tables (iconic) and finally interpreting data in relation to scientific theory (symbolic) (Andrini, 2023; Boling & Fauziah, 2025).

The indicator of evaluation and reflection increased from 39.4% in the pretest to 89% in the posttest, with an N-Gain score of 0.98, which is in the high category. The increase in this indicator was influenced by the implementation of learning, which received a 100% rating. In this phase, students were trained to test hypotheses or formulate hypotheses. In learning with the guided inquiry model based on Etno-STEM, students were trained to evaluate conclusions by comparing them with scientific theories or concepts. This indicator aligns with the Ethno-STEM context because it encourages students to develop scientific thinking skills by understanding and reflecting on natural phenomena in their surroundings, thereby optimizing the development of students' science process skills (Sumarni, 2023; Utrujjah et al., 2024). The indicators of processing, analyzing data and information, and evaluating and reflecting both have higher posttest scores. The high achievement in both indicators is influenced by learning activities involving practicums (Supatmi, 2022).

The improvement in evaluation and reflection indicators is due to learning activities that train students to better understand the results of scientific investigations than the process of investigation, resulting in a higher percentage of achievement (Putri, 2026; Gizaw & Sota, 2023). This high achievement is theoretically grounded in Bruner's discovery learning theory, which illuminates this process. When students are actively involved in testing their own hypotheses and reconciling findings with theoretical frameworks, they engage in the highest form of intellectual discovery, not merely receiving knowledge but constructing it through reflective evaluation (Andrini, 2023). This represents a fundamental departure from rote-learning approaches, in which reflection is rarely systematically practiced, and constitutes one of the distinguishing contributions of the Ethno-STEM-based guided inquiry model used in this study (Khasawneh et al., 2023).

The pretest and posttest results were then normalized to determine whether the data followed a normal distribution, which helps determine the best method for evaluating the hypothesis. The results showed that the data were not normally distributed. Consequently, the pretest and posttest data were analyzed using the non-parametric Wilcoxon test. Based on the Wilcoxon analysis using IBM SPSS Statistics 25, the results showed a significance level of 0.0000 < 0.05. The results showed that H0 and H1 were rejected. Therefore, there was a significant difference between the Ethno-STEM and the Science-based guided inquiry learning model for grade IX-E students at SMP Negeri 1 Prambon before and after implementation. This shows that implementing the guided inquiry learning model can improve students' process skills.

The Ethno-STEM indicator approach helps students understand local wisdom, particularly Sidoarjo's signature Terasi Udang. The engineering aspect of the STEM approach involves students in using an electric motor-powered grinder with different blades, enabling them to understand the working principles of simple technology in shrimp paste production. This research uses a grinder powered by an electric motor. The blades on this grinder will be manipulated in batches of 1, 2, and 3.

The use of local wisdom in the preparation practice provides a relevant and easily understood context for students, thereby increasing their motivation and desire to learn. In addition, the use of local wisdom can help students develop an appreciation for local customs and culture while increasing awareness of cultural quality (Aulia & Setiawan, 2025; Mutia et al., 2025). This allows them to understand the concept of fermentation, the role of microorganisms, and the chemical changes that occur (Susilowatini & Astriani, 2024). Guided inquiry learning strategies encourage a process of search and discovery. Consequently, students can improve their ability to identify outcomes in everyday life through the learning process (Latukau, 2022). This aligns with Bruner's statement that the inquiry learning model is more responsive to active student participation in the learning process. Inquiry is the process by which students use their own thinking patterns to discover a concept or principle (Andrini, 2023). Through learning activities, students gain new insights from observation and exploration to find the necessary information. This aligns with Bruner's learning theory, which states that the learning process must be discovery-based to help students acquire new knowledge and skills (Boling & Fauziah, 2025; Arsyad et al., 2024).

Ethno-STEM-based guided inquiry learning is grounded in Vygotsky's constructivist theory of knowledge. According to Vygotsky, learning within a constructivist context fosters knowledge development through specific stages, known as scaffolding. Scaffolding is a tool provided at the beginning of learning to assist student development. The learning process can take the form of examples, directions, or reminders, enabling students to solve problems without relying on others (Mulyadi, 2022; Khasawneh et al., 2023). The concept of scaffolding refers to a learning process inseparable from social interaction and plays a crucial role in enhancing individual learning, particularly through group work. Scaffolding is not carried out solely by the teacher; students can also support and assist the learning process (Amrullah, 2025).

The overall pattern of improvement across science process skill indicators can be understood analytically through the integrated application of Vygotsky's sociocultural constructivism and Bruner's discovery learning theory, both of which are, in their own ways, complementary in the context of inquiry-based learning. Vygotsky's theory posits that cognitive development is mediated by social interaction and by scaffolding provided within the learning Zone of Proximal Development (ZPD) (Mulyadi, 2022; Wibowo et al., 2025). In this study, scaffolding was operationalized at various levels: teachers provided structured inquiry phases, peer group collaboration supported the construction of social knowledge, and the Ethno-STEM context in Shrimp Paste production provided a culturally familiar cognitive foundation, thereby reducing cognitive load during the process of mastering new concepts (Nasir et al., 2023). Bruner's discovery learning theory, which states that learning is most lasting and meaningful when students achieve understanding through independent exploration rather than direct instruction, is evident in the consistent improvement observed across indicators (Boling & Fauziah, 2025; Michalsky, 2021). The guided inquiry phase encouraged students to move through Bruner's modes of representation systematically: hands-on fermentation activities (enactive), data recording and tabulation (iconic), and theoretical interpretation and reflection (symbolic)(Andrini, 2023; Angraini et al., 2023).

The results of the study show that science learning through a guided inquiry learning model using the Ethno-STEM approach helps students better understand the material. The practicum or experiment carried out by students involves making Terasi Udang, which relies on the activity of natural microorganisms found in rebon shrimp (Acetes spp.). Making terasi udang through fermentation involves breaking down complex compounds into simpler ones (Safitri et al., 2025; Bachruddin, 2018). Terasi udang fermentation occurs through anaerobic metabolism, but still requires oxygen because it is facultative. Shrimp contain protein (in the shrimp meat), fat (in the head and muscle tissue), and carbohydrates in the form of glycogen (in the muscle tissue) (Sihotang, 2022).

During fermentation, bacteria, such as lactic acid bacteria and Bacillus species, break down the proteins and fats in shrimp into simpler compounds, such as free amino acids and free fatty acids (Thieman et al., 2019). This local wisdom, typical of Sidoarjo City, helps students connect the concept of biotechnology material through the application of the STEM approach. In this context, applying local wisdom not only makes the material more relevant but also increases student engagement in the learning process (Billa et al.,2025). Education based on local wisdom can increase student interest by allowing them to observe how the concepts in the learning material can be applied in everyday life (Aulia & Setiawan, 2025; Alia et al., 2025). According to Gaffar and Achmad (2025), students who engage in local wisdom-based learning can deepen their understanding of scientific concepts by connecting new knowledge to their local customs and culture. According to Saputri and Desstya (2023), science learning grounded in local wisdom can enable students to increase their creativity by utilizing and developing the potential in their surrounding environment.

CONCLUSION

Based on data analysis and discussion, the use of the Ethno-STEM learning model in the terasi udang-making process effectively improves students' scientific process skills. This improvement is demonstrated by students' abilities in science process skills indicators, asking questions and making predictions, planning and carrying out investigations, collecting and analyzing data and information, and evaluating and reflecting on the results, as shown by increases in pretest-to-posttest scores. The integration of local wisdom with STEM makes learning more meaningful by connecting scientific concepts with students' everyday life experiences. The findings indicate that the Ethno-STEM approach can serve as an effective strategy to improve students' science process skills and promote meaningful learning experiences. Practically, the results of this study imply that teachers can use the Ethno-STEM-based guided inquiry learning model as an alternative learning strategy to improve students' scientific skills and learning engagement. In addition, this study provides implications for educational practice and curriculum development, particularly in integrating local wisdom into science learning to make learning more contextual and relevant to students' environments. However, this study still has several limitations. The limitations include limited implementation time, a pre-experimental design without a control group, and a limited scope of research subjects, which may affect the generalizability of the results. Therefore, future research is recommended to use a quasi-experimental or experimental design with a control group, to involve a larger sample, and to implement the learning model over a longer period to obtain more comprehensive results.

DECLARATION OF GENERATIVE AI

The authors declare that no generative AI or AI-assisted technologies were used in the writing process of this manuscript.

CONFLICTING INTEREST STATEMENT

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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REFERENCES

Alia, A., Parlina, I., & Fitri, N. L. M. (2025). Local Culture-Based Multiliteracies Pedagogy with Digital Media to Improve Argumentative Writing Skills. *Jurnal Pemberdayaan Masyarakat, 4*(4), 885–897.

Aliyah, A., & Erman, E. (2021). Analisis Unsur-Unsur Keterampilan Proses Sains dalam Buku IPA SMP. *PENSA: E-Jurnal Pendidikan Sains, 9*(2), 147–153.

Amalia, L., Agustina, A., & Hardianti, R. D. (2024). Peningkatan Keterampilan Proses Sains melalui Model Problem Based Learning (PBL) Murid Kelas VII H SMP Negeri 23 Semarang Tahun 2024. *JPPI (Jurnal Pendidik IPA Indonesia)*, 1021–1027.

Amrullah, M. F. (2025). *Pengaruh Implementasi Model Pembelajaran Inkuiri Terbimbing Berbantuan Aplikasi PHYPHOX terhadap Keterampilan Proses Sains dan Minat Belajar pada Materi Tumbukan*. Fakultas Keguruan dan Ilmu Pendidikan Universitas Lampung.

Andrini, O. (2023). *Penerapan Model Pembelajaran Inkuiri dalam Meningkatkan Aktivitas Belajar Pendidikan Agama Islam Siswa Kelas VII di SMP Negeri 8 Padangsidimpuan* [Doctoral dissertation]. UIN Syekh Ali Hasan Ahmad Addary Padangsidimpuan.

Angelia, Y., Supeno, S., & Suparti, S. (2022). Keterampilan Proses Sains Siswa Sekolah Dasar dalam Pembelajaran IPA Menggunakan Model Pembelajaran Inkuiri. *Jurnal Basicedu, 6*(5), 8296–8303.

Angraini, L. M., Larsari, V. N., Muhammad, I., & Kania, N. (2023). Generalizations and Analogical Reasoning of Junior High School Viewed from Bruner's Learning Theory. *Infinity Journal, 12*(2), 291–306.

Arsyad, S. N., Tangkin, W. P., Sumartono, S., & Astuti, B. (2024). Implications of Bruner's Cognitive Theory on Elementary School Education in the 21st Century. *Klasikal: Journal of Education, Language Teaching and Science, 6*(3), 697–704.

Astutik, F. I. (2025). Pembelajaran STEM dalam Mengembangkan Keterampilan Berpikir Kritis Siswa Sekolah Dasar pada Pelajaran Ilmu Pengetahuan Alam (IPA). *Journal of Early Childhood and Islamic Education, 3*(2), 209–220.

Aulia, R., & Setiawan, B. (2025). Respon Peserta Didik dalam Pembelajaran Inkuiri Terbimbing Berbasis Kearifan Lokal. *PENSA E-JURNAL: Pendidikan Sains, 13*(2).

Azizah, H., Sukarno, S., & Hartoyo, Z. (2023). Korelasi antara Keterampilan Proses Sains dengan Literasi Sains Siswa Madrasah Tsanawiyah Negeri Kota Jambi. *Physics and Science Education Journal (PSEJ)*, 1–9.

Aznam, N., Shiddiqi, M. H. A., & Nurason, F. (2025). Integrated Guided Inquiry Learning Model of Ethnochemistry on High School Students' Critical Thinking Skills and Learning Interest in Reaction Rate Material. *Jurnal Pemberdayaan Masyarakat, 4*, 748–759.

Babalola, E. O., & Keku, E. (2024). Ethno-STEM Integrated Project-Based Learning to Improve Students' Creative Thinking Skills. *International Journal of Ethnoscience and Technology in Education, 1*(2), 116.

Bachruddin, Z. (2018). *Teknologi Fermentasi pada Industri Peternakan*. UGM PRESS.

Billa, A., Setiawan, B., & Romadhoni, M. (2025). Application of Local Wisdom-Based Discovery Learning Model to Improve Students' Critical Thinking Skills. *Jurnal Pemberdayaan Masyarakat, 4*(2), 370–378.

Boling, T. E., & Fauziah, A. N. M. (2025). Model Pembelajaran Inkuiri Terbimbing: Strategi Meningkatkan Keterampilan Proses Sains Siswa SMP. *Prosiding Seminar Nasional Pendidikan IPA, 2*(1).

Bybee, R. W. (2018). *STEM Education Now More Than Ever*. National Science Teachers Association.

Farida, L., & Fahmi, F. (2024). Inkuiri Terbimbing dan Peningkatan Keterampilan Proses Sains Murid SMA pada Materi Asam Basa. *Indonesian Journal of Science Education and Applied Science, 4*(1), 32–48.

Gaffar, M. S., & Achmad, A. N. P. (2025). Peran Pendidikan Berbasis Kearifan Lokal dalam Meningkatkan Kesadaran dan Identitas Budaya Siswa. *Leksikal: Jurnal Pengajaran Bahasa dan Sastra Indonesia, 1*(2), 125–136.

Gizaw, G. G., & Sota, S. S. (2023). Improving Science Process Skills of Students: A Review of Literature. *Science Education International, 34*(3), 216–224.

Hadi, S., Izzati, N., Aulia, R. N. A., Rahmat, S., Trisnawati, & Dinda, Y. A. (2022). Guided Inquiry Learning with Experimental Methods During the Pandemic Period in Improving Physics Learning Outcomes of High School Students. *AMPLITUDO: Journal of Science and Technology Innovation, 1*(1), 18–25.

Hake, R. R. (1998). Interactive-Engagement versus Traditional Methods: A Six-Thousand-Student Survey of Mechanics Test Data for Introductory Physics Courses. *American Journal of Physics, 66*, 64–74.

Hasan, Y., Busyairi, A., & Doyan, A. (2024). Pengaruh Strategi Creative Problem Solving dengan Pendekatan STEM terhadap Keterampilan Proses Sains Peserta Didik. *GeoScienceEd, 5*(1).

Hediana, P. P., & Nurita, T. (2022). Analisis Penggunaan Model Pembelajaran Inkuiri Terbimbing dalam Meningkatkan Keterampilan Proses Sains Siswa SMP. *Pensa: E-Jurnal Pendidikan Sains, 10*(2), 167–171.

Hiğde, E., & Aktamış, H. (2022). The Effects of STEM Activities on Students' STEM Career Interests, Motivation, Science Process Skills, Science Achievement and Views. *Thinking Skills and Creativity, 43*.

Idrus, S. W. A. (2022). Implementasi STEM Terintegrasi Etnosains (Etno-STEM) di Indonesia: Tinjauan Meta Analisis. *Jurnal Ilmiah Profesi Pendidikan, 7*(4), 2370–2376.

Illahi, B. K., Suwarma, I. R., Suhendi, E., & Rusnayati, H. (2025). Exploring Students' STEM Literacy on Global Warming Issues Using the Rasch Model. *Jurnal Pemberdayaan Masyarakat, 4*(1), 55–69.

Jaya, T. D., Tukan, M. B., & Komisia, F. (2022). Penerapan Pendekatan Inkuiri Terbimbing untuk Melatih Keterampilan Proses Sains Murid Materi Larutan Penyangga. *Educativo: Jurnal Pendidikan, 1*(2), 359–366.

Khasawneh, E., Hodge-Zickerman, A., York, C. S., Smith, T. J., & Mayall, H. (2023). Examining the Effect of Inquiry-Based Learning vs. Traditional Lecture-Based Learning on Critical Thinking Skills and Students' Achievement in College Algebra. *International Electronic Journal of Mathematics Education, 18*(1), 159.

Latukau, M. (2022). Pembelajaran IPA dengan Model Inkuiri Terbimbing untuk Meningkatkan Pemahaman Konsep dan Keterampilan Proses Sains Siswa SD. *Jurnal Ilmiah Wahana Pendidikan, 8*(23), 351–362.

Michalsky, T. (2021). When to Scaffold Motivational Self-Regulation Strategies for High School Students' Science Text Comprehension. *Frontiers in Psychology, 12*, 1–16.

Moog, R. S., & Farrell, J. J. (2017). *Chemistry: A Guided Inquiry*. John Wiley & Sons.

Mulyadi, M. (2022). Teori Belajar Konstruktivisme dengan Model Pembelajaran (Inquiry). *Al Yasini: Jurnal Keislaman, Sosial, Hukum dan Pendidikan, 7*(2), 174.

Mutia, C., Oktavinanda, G., & Rahmatillah, R. (2025). Developing Local Wisdom-Based Project Modules to Improve Pancasila Student Profiles. *Jurnal Pemberdayaan Masyarakat, 4*(4), 836–844.

Nasir, M., Fahruddin, F., Haljannah, M., & Nehru, N. (2023). Implementasi Model Pembelajaran Problem Based Learning untuk Meningkatkan Keterampilan Proses Sains Siswa SMAN 5 Kota Bima. *JIIP - Jurnal Ilmiah Ilmu Pendidikan, 6*(2), 289–296.

OECD. (2023). *PISA 2022 Results: The State of Learning and Equity in Education*. OECD Publishing.

Orosz, G., Németh, V., Kovács, L., Somogyi, Z., & Korom, E. (2022). Guided Inquiry-Based Learning in Secondary-School Chemistry Classes: A Case Study. *Chemistry Education Research and Practice, 24*(1), 50–70.

Panjaitan, Z. A., Malau, N., & Setyawan, A. (2023). Analisis Kecakapan Abad 21 untuk Meningkatkan Hasil Belajar IPA di Sekolah Dasar. *Jurnal Inovasi Pendidikan Madrasah Ibtidaiyah (JIPMI), 2*(1), 38–45.

Putri, V. V. K. (2026). Analisis Kemampuan Siswa Kelas V SD dalam Merencanakan dan Mengevaluasi Penyelidikan Ilmiah Materi Organ Pernapasan. *Pendas: Jurnal Ilmiah Pendidikan Dasar, 11*(1), 35–46.

Rigopouli, K., Kotsifakos, D., & Psaromiligkos, Y. (2025). Vygotsky's Creativity Options and Ideas in 21st-Century Technology-Enhanced Learning Design. *Education Sciences, 15*(2).

Rini, N. P., Widodo, W., & Roqobih, F. D. (2024). Pembelajaran Discovery untuk Meningkatkan Keterampilan Proses Sains Murid Materi Interaksi Makhluk Hidup. *BIOCHEPHY: Journal of Science Education, 4*(1), 312–320.

Safitri, T., Rachman, I., & Kurniasih, S. (2025). Enhancing Food Biotechnology Literacy through Informal Science Learning of Mozzarella Cheese-Making Workshop: A Case Study. *Jurnal Pemberdayaan Masyarakat, 4*(3), 606–615.

Santiawati, S., Yasir, M., Hidayati, Y., & Hadi, W. P. (2022). Analisis Keterampilan Proses Sains Siswa SMP Negeri 2 Burneh. *Natural Science Education Research (NSER), 4*(3), 222–230.

Saputri, A. N., & Desstya, A. (2023). Implementasi Pembelajaran IPA Sekolah Dasar Berbasis Kearifan Lokal di Kabupaten Sragen. *ELSE (Elementary School Education Journal): Jurnal Pendidikan dan Pembelajaran Sekolah Dasar, 7*(2), 154–165.

Sari, F. F. K., & Lahade, S. M. (2022). Pengaruh Model Pembelajaran Inkuiri terhadap Sikap Ilmiah Rasa Ingin Tahu Peserta Didik Sekolah Dasar pada Pembelajaran IPA. *Jurnal Basicedu, 6*(1), 797–802.

Sihotang, S., Prasetyo, D., Noer, Z., Setiyabudi, L., Sari, D. N., Munaeni, W., ... & Rohmah, M. K. (2022). *Pengantar Bioteknologi*. Tohar Media.

Sufriyah, L. (2024). *Analisis Keterampilan Proses Sains Siswa pada Model Pembelajaran Inkuiri Terbimbing Materi Bioteknologi* [Bachelor thesis, UIN Syarif Hidayatullah Jakarta].

Sugiyono. (2021). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Penerbit Alfabeta.

Sumarni, W. (2023). PjBL-Etno-STEM: Potensi dan Kontribusinya dalam Peningkatan Keterampilan Abad 21 dan Karakter Konservasi Mahasiswa. *Bookchapter Pendidikan Universitas Negeri Semarang, 6*, 49–80.

Supatmi, S. (2022). Peningkatan Keterampilan Proses Sains melalui Praktikum Kimia Berbasis Skala Mikro Materi Stoikiometri. *Jurnal Riset Pendidikan Kimia (JRPK), 12*(1), 47–58.

Susilowatini, S., & Astriani, D. (2024). Respon Siswa terhadap Pembelajaran Inkuiri Terbimbing untuk Meningkatkan Keterampilan Berpikir Kritis. *Jurnal Intelek dan Cendikiawan Nusantara, 1*(4), 6071–6079.

Thieman, W., Thieman, W. J., & Palladino, M. A. (2019). *Introduction to Biotechnology*. BoD–Books on Demand.

Ulya, K., Pamelasari, S. D., & Hardianti, R. D. (2023). Pembuatan Makanan Khas Moto Belong dalam Pembelajaran IPA Berpendekatan Etnosains untuk Melatih Keterampilan Proses Sains Murid. *Proceeding Seminar Nasional IPA*.

Utrujjah, F., Hartono, & Wahyuni, S. (2024). Analysis of Science Process Skills to Application of Module Practicum Ethno-STEM for Senior High School. *Physics Communication, 8*(2), 55–59.

Wardana, H. A. W. H. A., & Arvianto, S. (2026). Pembelajaran Inkuiri Terbimbing Berbantuan Media Smart TV dalam Meningkatkan Pemahaman Konsep Siswa di Sekolah Dasar. *Jurnal Genta Mulia, 17*(1), 114–120.

Wayan, D. N., Dantes, N., & Gunamantha, I. M. (2021). Pengembangan Instrumen Keterampilan Proses Sains Tema Lingkungan Sahabat Kita KD Menganalisis Siklus Air dan Dampaknya pada Peristiwa di Bumi serta Kelangsungan Makhluk Hidup dan Locus of Control Siswa Kelas V Sekolah Dasar. *PENDASI: Jurnal Pendidikan Dasar Indonesia, 5*(1), 1–11.

Wibowo, S., Wangid, M. N., & Firdaus, F. M. (2025). The Relevance of Vygotsky's Constructivism Learning Theory with the Differentiated Learning Primary Schools. *Journal of Education and Learning, 19*(1), 431–440.