



Supporting sustainable development goals 4 through ethnoscience: Development of a scientific magazine on madurese shrimp paste



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ABSTRACT

Education that integrates local wisdom with scientific concepts is essential to create meaningful and contextual learning experiences. This study was aimed at developing and evaluating the feasibility of a scientific magazine based on the ethnoscience of Madurese shrimp paste as a biology learning medium for class X at Islamic Senior High School (MA). The method employed was the Research and Development (R&D) 4-D model (Define, Design, Develop, Disseminate). The validation process showed a very high level of feasibility, with an average score of 92.5% from two subject matter experts, 93% from two media experts, and 95% from a biology teacher. In addition, the limited trial involving 30 students resulted in an average feasibility score of 93.4%. The results indicated that the scientific magazine based on the ethnoscience of Madurese shrimp paste was highly feasible as an alternative teaching material, contextual, engaging, and supportive of biology learning within the Merdeka Curriculum. Furthermore, the product was considered to have strong potential to enhance scientific literacy and promote the preservation of local wisdom in education, especially in support of SDG 4.

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INTRODUCTION

Indonesia's rich cultural diversity can be utilized as a learning resource to foster students' awareness of their communities and make learning more meaningful (Hadi et al., 2019). The quality of a nation's life is determined by the quality of its education. Education plays a crucial role in shaping an intelligent, peaceful, open, and democratic society. Therefore, educational reform is necessary to improve the quality of national education. National progress can be achieved through the structuring of education that elevates the dignity and worth of the Indonesian people (Manaban, 2020).



In alignment with the Sustainable Development Goals (SDGs), particularly Goal 4 on Quality Education, learning innovation is crucial to ensure inclusive, equitable, and high-quality education for all learners. Integrating ethnoscience into the curriculum supports this global agenda by contextualizing learning, preserving local wisdom, and promoting lifelong learning skills (Widiatmoko et al., 2024).

Twenty-first-century education demands mastery of skills like critical thinking, creativity, collaboration, and communication. Effective learning should not only transfer knowledge but also develop essential competencies. Scientific proficiency requires not just theory, but the ability to link science with culture and local wisdom. Ethnoscience integrates traditional and modern knowledge to deepen students' understanding (Wahyudin & Permatasari, 2020). Ethnoscience refers to the knowledge possessed by a particular ethnic group or social community. In the field of education, ethnoscience integrates culture into the learning process through the design of learning environments and experiences (Lidi et al., 2022).

A survey at MA Al-Djufri Blumbungan on October 25–26, 2024, revealed that students were passive and less interactive due to limited instructional materials. The only available module was a text-heavy narrative without visuals, making learning dull and hard to understand. It also lacked integration with Madurese ethnoscience. As a result, 80% of students felt bored and sleepy. These findings highlight the urgent need for engaging, culturally relevant learning materials to enhance student enthusiasm.

Madura Island, rich in culture and tradition, holds great potential as a source for ethnoscience-based learning. Madura possesses a wealth of cultural heritage and local knowledge that can be utilized to enhance the quality of student learning. One of its distinctive traditional products is shrimp paste, a fermented product made from small shrimp (*Schizopodes* or *Mytis* sp.) commonly used as a food seasoning. Shrimp paste is a typical product created by the local community to utilize marine resources. The production process of shrimp paste involves the concept of fermentation biotechnology, in which the breakdown of shrimp tissue by enzymes results in a beneficial product. Fermentation is similar to decomposition; however, fermentation produces unique aromas and flavors that are widely appreciated (Hadi et al., 2019). High-quality shrimp paste is typically dark brown in color, has a distinctive shrimp paste aroma, is free from rancid odors, and contains no impurities such as sand, fish residues, or shrimp remnants. As a well-known flagship product of Madura, shrimp paste holds great potential to be utilized as an engaging and relevant instructional material in an educational context (Alawiyah et al., 2022).

Instructional materials integrating the ethnoscience of Madurese shrimp paste are still lacking. Existing resources often use modern science approaches that feel disconnected from students' local context. To improve understanding, alternative materials are needed to link lessons with students' environments and promote independent learning. A scientific magazine can be an effective solution (Meiningsih et al., 2019). A scientific magazine is a communication medium used to disseminate research findings within the academic community, particularly in higher education institutions (Irianti, 2017).

Developing a scientific magazine based on the ethnoscience of Madurese shrimp paste is essential to connect local knowledge with modern science. It serves as an engaging learning resource, fosters appreciation of local culture, and boosts students' motivation in learning science. Thus, this magazine functions both as an instructional medium and a tool for preserving and promoting local culture among the younger generation.

The integration of Madurese shrimp paste ethnoscience in this research represents a novel contribution to educational development. Unlike previous studies that have generally explored ethnoscience in broader cultural contexts, this study specifically focuses on local biotechnology processes derived from shrimp paste fermentation. This approach not only enhances students'

understanding of biological concepts but also promotes the preservation of regional identity and supports the implementation of sustainable education in line with SDG 4 (Quality Education) (Hadi et al., 2019).

RESEARCH METHODS

Research Design

This study employed a research and development method known as Research and Development (R&D). The model applied was the 4-D model developed by Shivasailam Thiagarajan, Dorothy S. Semmel, and Melvyn I. Semmel in 1974 that consists of four stages: define, design, develop, and disseminate. The 4-D model was selected because it is considered to be clear, comprehensive, well-directed, structured, and systematic, and it effectively guides developers from the initial stages to the final product.

Population and Samples

The population of this study comprised all 30 class X students at MA Al-Djufri, all of whom were included as the sample using a census sampling technique. This approach was chosen due to the small population size, ensuring that the data collected fully represented students' perspectives for a comprehensive evaluation of the learning media's feasibility and effectiveness. In addition to student data, expert validation was conducted to ensure the product's quality and accuracy. The validation process involved five validators, consisting of two material experts, two media experts, and one biology teacher. The material experts were university lecturers specializing in biology education and curriculum development, while the media experts were lecturers with expertise in educational technology and instructional media design. The biology teacher acted as a field practitioner, assessing the practicality and relevance of the developed scientific magazine for classroom implementation. This combination of academic and practitioner validators ensured that the product met theoretical, technical, and practical standards of educational media development.

Instruments

The research instruments in this study included validation sheets, student and teacher response questionnaires, interviews, and documentation. Validation sheets were used by media experts, subject matter experts, and biology teachers to assess the product's validity based on indicators such as content feasibility, visual design, and illustrations. Student and teacher questionnaires measured the feasibility and responses to the developed learning media. Interviews provided in-depth data on participants' perceptions during the trial phase. Documentation was used to collect supporting evidence throughout the research process, including photographs, observation notes, and records of validation and trial activities. This instrument helped strengthen the credibility and traceability of the research findings. All instruments were developed according to appropriate assessment standards and validated, ensuring their reliability in generating accurate and relevant data.

Procedures

The research procedure followed a systematic process, starting with a needs analysis and literature review on developing ethnoscience-based learning media using Madurese shrimp paste through observation, interviews, and document analysis. In the define stage, data on student characteristics, curriculum, and teaching materials were collected via questionnaires and interviews. The design stage produced an initial prototype of the scientific magazine based on analysis results and expert input. During the development stage, the product was validated by media experts, subject matter experts, and biology teachers, then revised and tested in a limited classroom setting

to evaluate effectiveness and feasibility. Validation and trial data were analyzed descriptively and statistically. The final stage involved limited dissemination to gather final feedback and make necessary revisions, although broader implementation was constrained by time.

Data Analysis

The data analysis combined qualitative and quantitative descriptive methods to evaluate the product's feasibility, relevance, and effectiveness, while identifying its strengths and weaknesses. Data from experts, teachers, and students were analyzed statistically and through comment interpretation, guiding revisions to achieve the research objectives systematically.

RESULTS

The research produced a scientific magazine based on Madurese shrimp paste ethnoscience for class X students at MA Al-Djufri Blumbungan, Pamekasan. Content was aligned with the Merdeka Curriculum's learning objectives. Formative evaluation involved two subject matter experts, two media experts, one biology teacher, and 30 students in a small group trial. The results guided revisions and refinement of the material.

I. Define

The definition stage involved a needs analysis, curriculum review, analysis of student characteristics, evaluation of existing teaching materials and subject matter, as well as the formulation of learning objectives (Gustiawati *et al.*, 2020). All data were collected through observations and interviews with teachers, students, and local shrimp paste producers. The results of the analysis of instructional material needs are presented in Table I.

Table I. Results of Instructional Material Needs Analysis According to Biology Teachers and Students

No.	Teacher Perspectives on Material Needs	Students Perspectives on Material Needs
1.	Biology learning has not yet fully captured students' interest	75% of students reported feeling easily bored and uninterested in attending lessons due to the lack of variety and contextual relevance in the instructional media used.
2.	The teaching media used tends to be monotonous in the form of black and white text modules without adequate illustrations, and does not link biological concepts to real life in the students' environment.	Students showed high interest in learning media presented with images, colors, and topics relevant to everyday life.
3.	Teachers stated the need for innovation in teaching media that is visual, fun, and contains elements of local wisdom so that students are more active and can easily understand the material.	75% of students also stated that they wanted to learn biology through something close to the culture and customs of the Madurese people.

To strengthen the local context, an interview was conducted on September 28, 2024, with a traditional shrimp paste producer in Pasean, Pamekasan. The findings, shown in Table 2, support the integration of ethnoscience into instructional media. Insights into fermentation, raw materials, and production challenges connect with biological concepts like microorganisms, enzymes, metabolism, and environmental factors, helping students see science as part of everyday culture and life.

Table 2. Results of the Shrimp Paste Production Interview

No.	Shrimp Paste Production Interview
1.	The shrimp paste-making business has been running for approximately 40 years
2.	It started from a personal initiative to utilize the marine wealth around his residence. "Because my place is close to the sea and there is no one producing shrimp paste around me, finally I tried to mix it myself," he explained. After trying and getting a satisfactory taste, production was increased
3.	And now it generates a turnover of around 2 to 3 million rupiah per week
4.	The shrimp paste produced has a distinctive savory taste and aroma because it uses pure rebon shrimp as the raw material, not mixed fish. This product is marketed through local markets, food business owners, and also on social media
5.	The main challenges faced are the availability of raw materials for small shrimp and weather conditions during the rainy season, which hamper the drying process

Analysis results indicated the need to develop a scientific magazine based on Madurese shrimp paste ethnoscience. The magazine integrated structured biology content with local wisdom, making learning more contextual, engaging, and meaningful.

2. Design

This stage produced an initial draft based on the define phase, which included a cover, foreword, table of contents, main article, contextual story, quiz, traditional Madurese recipe, opinion column, and references. Developed using Canva and Microsoft Word, the magazine was designed to be both informative and visually appealing. Activities in this stage involved outlining content, aligning learning objectives with the Merdeka Curriculum, and ensuring content relevance. The layout emphasized aesthetics and structure to support contextual, engaging, and meaningful learning. The magazine is intended as an effective alternative for teaching biology—particularly fermentation biotechnology—while integrating elements of Madurese culture.

3. Development

In the development stage, the ethnoscience-based scientific magazine on Shrimp paste Madura was validated by two subject matter experts, two media experts, and a biology teacher to assess its content, language, presentation, and visuals. This ensured the magazine met quality standards and was suitable for classroom biology learning.

a) Validation by Material Experts

The completed initial product was then validated using a validation questionnaire for material experts. The assessment of the material experts on the initial product is presented in Table 3.

Table 3. Results of Material Expert Tests on Products

No.	Eligibility Components	Material Expert	
		1	2
1	Content Eligibility	49	48
2	Presentation Eligibility	16	18
3	Language Eligibility	28	26
	Total score (Σx)	93	92
	$P = (\Sigma \chi / \Sigma \chi_i) \times 100\%$	93%	92%
	Average	92,5%	

Based on Table 3, material experts gave scores of 93 and 92, with an average P value of 92.5%, indicating the magazine was very suitable for use (Sugiyono, 2016). Qualitative comments provided further input for improvement, as shown in Table 4.

Table 4. Comments of Material Experts

Material Expert Comments	
I	2
This scientific magazine based on Madura Shrimp paste ethnoscience is overall good, but some sentences need to be clarified and there are some images that are not quite right.	Scientific Magazine is suitable for use as a source of teaching materials for Biology subjects in schools.

b) Validation by Media Experts

In addition to validation by material experts, validation was also conducted by media experts. The media expert's assessment of scientific magazine products is presented in Table 5.

Table 5. Results of Media Expert Tests on Products

No	Component	Media Expert	
		I	2
1	Layout Design View	23	21
2	Ease of Use	15	14
3	Consistency	11	11
4	Expediency	23	21
5	Graphics	20	19
Total score (Σx)		92	86
$P = (\Sigma \chi / \Sigma \chi_i) \times 100\%$		96%	90%
Average		93%	

Media experts gave scores of 96 and 90, with an average P value of 93%, indicating the magazine is very suitable for use (Sugiyono, 2016). General comments and suggestions are presented in Table 6.

Table 6. Comments from Two Media Experts

Media Expert	
I	2
This scientific magazine based on Madura Shrimp paste ethnoscience is very good and creative, but the title on the cover should be improved by removing the word "Berbasis"	This scientific magazine based on Madura Shrimp paste ethnoscience is suitable for use as additional teaching material in schools.

c) Validation by Biology Teacher

This assessment aimed to gauge biology teachers' perceptions of the magazine's quality and eligibility to determine the need for revision. Questionnaire results are shown in Table 7.

Table 7. Teacher Response Test on Products

No	Assessment Aspects	Score
1	Scientific magazines can be used easily	3
2	The font size can be read clearly	4
3	The sentence structure is clear and easy to understand	4
4	The explanations in the magazine are easy to understand	4
5	The design is visually comfortable and pleasing to the eye	4
6	The images displayed are clear and easy to understand	4
7	Quizzes and crosswords are clear and easy to understand	4
8	The language used is easy to understand	4
9	The instructions in scientific journals are quite clear	4
10	The objective (CP) is clear and easy to understand	3
	Total Score (Σx)	38
–	$P = (\Sigma \chi / \Sigma \chi t) \times 100\%$	95%

Biology teachers gave a total score of 38 with a P value of 95%, indicating the magazine was highly suitable for use, with some comments and suggestions. These are summarized in Table 8.

Table 8. Biology Teacher Comments**Comments from Biology Teacher**

In the shrimp paste creation section, it would be better to add a typical Madurese menu/ recipe, so that the name of the region and typical Madurese dishes are better known among outsiders.

d) Student Trial

This assessment evaluated students' perceptions of the scientific magazine on Madurese shrimp paste ethnoscience to determine its feasibility. As shown in Table 9, 30 students gave scores ranging from 85–100, with an average P value of 93.4%, indicating the magazine was considered highly feasible. Student comments (Table 10) guided revisions, with changes summarized in Table 11 and Figure 1.

Table 9. Results of Student Response Scores on Products

Std	Total	Pres.	Category	Std	Total	Pres	Category
1	100	100%	HS	16	90	90%	HS
2	95	95%	HS	17	92	92%	HS
3	100	100%	HS	18	85	85%	HS
4	92	92%	HS	19	90	90%	HS
5	97	97%	HS	20	90	90%	HS
6	100	100%	HS	21	92	92%	HS
7	100	100%	HS	22	92	92%	HS
8	90	90%	HS	23	92	92%	HS
9	92	92%	HS	24	100	100%	HS
10	100	100%	HS	25	90	90%	HS
11	95	95%	HS	26	92	92%	HS
12	92	92%	HS	27	85	85%	HS
13	92	92%	HS	28	100	100%	HS
14	95	95%	HS	29	92	92%	HS
15	90	90%	HS	30	90	90%	HS

Average = 93,4% (Highly Feasible)

Std = Student; Pres = Presentation; HS = Highly Feasible



Table 10. Student Comments

No	Comments from Class X Students of MA Al-Djufri
1.	This scientific magazine is good, there are lots of pictures and the appearance is attractive.
2.	This scientific magazine makes it easier for us to learn about Biology.
3.	Very good, suitable for additional teaching materials.
4.	This magazine is great, very easy to understand.

Table 11. Differences between the Initial Design and the Revised Design of the Scientific Magazine







No.	Before Revision	After Revision	Information
1.			The nutritional content of shrimp paste must be included with the amount of measurement used.
2.			The content of the questions is not suitable. It is better not to use many colors which can cause students to be less focused on answering the content of the questions.
3.			The initial appearance is not neat. The content is not an interpretation of the verses of the Qur'an, so readers will have difficulty understanding.



Figure 1. Scientific Magazine Cover

4. Disseminate

The distribution was carried out in a limited manner due to time constraints and research scale. The scientific magazine was printed in limited quantities and distributed to teachers and students of class X IPA at MA Al-Djufri Blumbungan, Pamekasan, as trial subjects. The distribution of the product was also accompanied by documentation of teacher and student responses in the form of questionnaires and interviews, which strengthened the findings that this magazine can be used as an innovative contextual teaching material and supports the implementation of the Merdeka Curriculum. Furthermore, this magazine is recommended to be distributed more widely in the next research stage, both in print and digital formats, as well as through the MGMP forum or ethnoscience-based teacher training.

DISCUSSION

Scientific magazines are underutilized in classrooms, presenting an opportunity to develop contextual, locally-rooted learning media. Appropriate media can make learning more engaging and boost student interest (Muzdhalifah et al., 2024). In fact, teaching materials, including scientific magazines, play an important role in the learning process as they can save time during teaching and learning activities and enhance students' independence in learning (Putri et al., 2023). The scientific magazine developed in this study not only serves as a medium for contextually delivering biology content but also functions as a varied, engaging, and interactive learning resource. The structure of the magazine's content is designed to integrate science, local culture, Islamic values, and literacy creativity. The main sections of the magazine include: Bio Info, Short Stories, Shrimp Paste Creations, Legendary Shrimp Paste Figures, BioThink, and Interpretations of Quranic Verses.

Bio Info presents a featured article discussing biological concepts related to the process of making shrimp paste, such as fermentation biotechnology, the role of microorganisms, and metabolic processes. The article was written in a communicative yet scientifically nuanced language, making it accessible and easy for students to understand. It helped deepen their understanding of biological concepts in a real, locally relevant context—bridging theory and practice while strengthening scientific literacy. This literacy extended beyond reading and writing to include critical thinking skills, enabling students to become scientifically literate, especially in the field of science (Thahir et al., 2021).

The next section of the scientific magazine is the Short Story section. This section presents contextual stories about the lives of the Madurese community, especially in shrimp paste production. These stories entertained while conveying educational and character-building messages, making learning more enjoyable. Story-based learning proved effective in enhancing information retention. Through short stories, students were also encouraged to develop multiliteracy skills—searching, selecting, managing, and using various forms of information critically and logically (Sugiarti et al., n.d.)

The Shrimp Paste Creations section featured traditional Madurese recipes using shrimp paste, such as sambal, and corn rice with urap. It introduced local culinary diversity while connecting it to biological concepts like nutrition, heating processes, and digestive enzymes—reinforcing contextual learning and integrating science with culture (Hadi et al., 2019).

In addition to scientific content, the magazine featured a Figure column highlighting local figures like Prince Cakrabuana (Walangsungsang), a 15th-century leader and Islamic missionary in Cirebon. His efforts in spreading Islam and promoting social order based on local wisdom were the focus of this section. He was also known as the first to introduce shrimp paste into Cirebon's coastal culinary tradition, which later became a valuable local commodity. The aim of this column is to inspire students to appreciate local history and figures, and to understand the significant role of knowledge and cultural values in real life. Through the true story of Prince Cakrabuana, students were encouraged to emulate values such as the spirit of *da'wah*, wise leadership, and cultural preservation. Incorporating local history and figures into learning served as a strategic way to connect students with their environment. In Cirebon, introducing the history of the Cirebon Sultanate, especially Prince Cakrabuana, highlighted his key role in the spread of Islam in the archipelago during 1445–1479 AD (Hotimah, 2023).

One of the contents that empowers students' thinking skills in this scientific magazine is Bio Think. This column featured interactive content such as questions, quizzes, or crossword puzzles related to the magazine, such as fermentation or microorganisms in shrimp paste production. It strengthened students' critical and creative thinking while making learning more engaging and promoting collaboration through cooperative activities (Anwar & Hujjatusnaini, 2024).

Furthermore, given that schools in Madura—particularly MA Al-Djufri—are deeply rooted in religious values, a special column entitled Qur'anic Verses is included. This column links biological concepts and natural phenomena with relevant verses from the Qur'an, such as those concerning halal food, the creations of Allah in the sea, and the encouragement to reflect on His creations. The strength of this feature lies in its integration of spiritual values into science education, aligning with the holistic nature of Islamic education. Through this integration, students not only grasp scientific concepts but also develop religious awareness that the pursuit of knowledge is part of worship and an expression of awe toward the greatness of Allah. Additionally, the inclusion of Qur'anic verses reinforces moral and ethical values in understanding science, as reflected in the Pancasila Student Profile. This integration also serves as a reminder of Islam's significant contributions to the advancement of science, which have profoundly influenced the history of world civilization. (Alkadafi et al., 2024).

The development of the ethnoscience-based scientific magazine on Madurese shrimp paste is a strategic effort to introduce local culture while enhancing students' scientific literacy. As contextual learning material, it integrates scientific literacy elements to support holistic student competency development (Afrida et al, 2025). Integrating ethnoscience in learning effectively enhanced students' practical skills and provided meaningful, contextual experiences. Local knowledge, like Madurese shrimp paste processing, proved to have strong potential as an innovative and relevant science learning medium (Khery et al., 2025).

Ethnoscience-based learning not only contextually introduces scientific concepts, but also strengthens students' local cultural identity through the integration of traditional knowledge that has been passed down from generation to generation (Herlinawati & Suhartini, 2025). The learning approach that utilizes ethnoscience methods holds significant potential to enhance students' scientific literacy, critical thinking skills, and awareness of the surrounding culture (Ali, 2025). Ethnoscience is an interesting subject of study as it has a positive impact on critical thinking and creativity, strengthens cultural character and conservation, and promotes scientific literacy (Widarti et al., 2025).

Studies conducted from 2020 to 2025 highlighted the growing importance of integrating local wisdom into science education to enhance environmental awareness and promote sustainability. This approach supported cultural preservation, fostered environmental consciousness, and enriched the curriculum with meaningful, contextual learning rooted in scientific inquiry and cultural heritage (Sihombing et al., 2025).

Ethnoscience-based learning is a culturally relevant tool for enhancing critical thinking skills in biology (Adam et al., 2024). The integration of ethnoscience into biology education is essential, as it connects scientific concepts with local wisdom, thereby enhancing students' understanding of biological material while also fostering environmental awareness, cultural appreciation, and promoting contextual learning that is relevant to everyday life (Sihombing et al., 2025). Contextual material assists teachers in linking concepts with relevant and applicable real-life examples, thereby enriching students' knowledge and understanding (Afriani, 2018).

The development of a scientific magazine based on Madurese shrimp paste ethnoscience is essential as an innovative, contextual learning medium aligned with the Merdeka Curriculum, which emphasizes meaningful learning. It helps students understand biological concepts through real-life contexts while preserving a local culture rich in traditional wisdom. By integrating local knowledge like shrimp paste production, students can improve scientific literacy, critical thinking, and cultural awareness. This ethnoscience-based media also offers a more engaging and relevant learning experience, potentially boosting motivation and academic performance.

CONCLUSION

The scientific magazine based on the ethnoscience of Madurese shrimp paste was found to be highly feasible as a biology learning medium for Grade X students at MA Al-Djufri. This was supported by validation scores from two subject matter experts (92.5%), two media experts (93%), one biology teacher (95%), and positive responses from 30 students (93.4%), all of which fall into the "highly feasible" category. The magazine contextualizes biology concepts through the local wisdom of Madura, making learning more engaging, meaningful, and relevant to students' lives. In addition to strengthening conceptual understanding, it also promotes cultural appreciation and supports the implementation of the Merdeka Curriculum. Furthermore, this product contributes to the achievement of Sustainable Development Goal/ SDG 4 (Quality Education) by providing inclusive, culturally relevant, and high-quality learning materials.

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