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Unveiling the needs for ethnoscience-based e-worksheets to enhance the nature of science and environmental awareness of elementary school students

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ABSTRACT

The growing emphasis on culturally based education highlights the need for ethnoscience-based e-worksheets to improve students' understanding of scientific concepts. This study explores the development needs of such e-worksheets using the 4D Research and Development model, specifically focusing on the define stage through descriptive data analysis. Research instruments included interviews with natural and social sciences teachers and questionnaires assessing the needs of teachers and students. The preliminary study involved 136 students and five teachers from five elementary schools in Bandar Lampung. Findings from the teachers' needs questionnaire revealed that none (100%) had integrated natural and social sciences with local Lampung culture. Likewise, 89% of students reported never experiencing such integrated learning. Furthermore, 84% of students and all (100%) teachers strongly supported the development of ethnoscience-based e-worksheets. These findings underscore the importance of integrating local wisdom into education to enhance scientific literacy, enrich learning experiences, and foster environmental awareness.

Mengeksplorasi kebutuhan lembar kerja peserta didik elektronik berbasis etnosains untuk meningkatkan pemahaman hakikat sains dan kesadaran lingkungan siswa sekolah dasar

Kata Kunci:

lembar kerja peserta didik elektronik, kesadaran lingkungan, Etnosains, hakikat sains

ABSTRAK

Peningkatan perhatian terhadap pendidikan berbasis budaya memerlukan pengembangan e-worksheet berbasis etnosains untuk meningkatkan pemahaman siswa terhadap konsep-konsep ilmiah. Penelitian ini bertujuan untuk menggambarkan analisis kebutuhan pengembangan e-worksheet berbasis etnosains menggunakan model 4D Research and Development, dengan fokus khusus pada tahap definisi yang menerapkan teknik analisis data deskriptif. Instrumen penelitian terdiri dari wawancara dengan guru sains alam dan sosial serta kuesioner yang mengevaluasi kebutuhan guru dan siswa. Studi awal melibatkan 136 siswa dan 5 guru dari 5 Sekolah Dasar di Bandar Lampung. Hasil dari kuesioner kebutuhan guru menunjukkan bahwa 100% guru belum mengintegrasikan pembelajaran sains alam dan sosial dengan budaya lokal Lampung. Demikian pula, 89% siswa melaporkan belum mengalami pembelajaran yang terintegrasi. Selain itu, 84% siswa dan 100% guru menyatakan setuju secara kuat mengenai potensi pengembangan e-worksheet berbasis etnosains. Penelitian ini berimplikasi dalam mengintegrasikan kearifan lokal untuk memperkaya proses belajar, mendukung

literasi ilmiah, dan meningkatkan kesadaran lingkungan.

Contribution to the literature

This research contributes to:

- Identifying and addressing gaps in existing literature by exploring the utilization of local cultural contexts in science education, offering new perspectives on the application of ethnosciences in education.
- Providing practical recommendations for developing more relevant and meaningful teaching materials for students by integrating cultural and local environmental aspects into the learning process.

1. INTRODUCTION

The Nature of Science (NoS) concept has regained prominence in science education and is recognized as a fundamental component of scientific literacy [1]. Comprehending the NoS constitutes a vital aspect of scientific literacy [2]-[3]. Various science education frameworks, including those from the American Association for the Advancement of Science and the National Research Council, emphasize the importance of NoS in enriching students' learning experiences [4]. Understanding NoS is essential for creating, managing, and processing scientific and technological advancements. It informs decision-making on socio-scientific matters and fosters an appreciation for science as an integral part of contemporary culture. Additionally, NoS helps individuals develop an awareness of the norms within the scientific community, enabling them to uphold moral commitments that hold universal values in society. Furthermore, it facilitates the learning of scientific subjects [5]. Given its significance, it is crucial to investigate how NoS is taught and evaluated [6], [7].

A strong understanding of NoS plays a pivotal role in scientific literacy. It enhances students' comprehension of scientific concepts and equips them to make well-informed decisions on personal and social science-related issues [8], [9]. Research suggests that for students to grasp NoS effectively, it must be deliberately integrated into lesson planning and assessment. This involves setting instructional goals focused on science and engineering practices, core disciplinary concepts, and overarching themes [7]. NoS is a vital conduit for fostering the growth and development of students' attitudes, skills, and knowledge [10]. It enables students to refine their reasoning, critical thinking, and application of scientific knowledge. Moreover, it fosters positive attitudes, making NoS a crucial foundation for navigating and thriving in a challenging society. This importance extends beyond material aspects, especially in today's rapidly evolving world shaped by globalization and advancements in Science and Technology [11], [12].

In the present era of globalization and technological advancement, addressing environmental issues and ensuring food security are as critical as improving student literacy [13]. The escalation of these challenges stems from the expanding human population, which increases the demand for a clean environment and adequate food resources [14]. Environmental concerns include waste management difficulties, as the growing population and rising consumption levels contribute to waste accumulation, posing a substantial threat of pollution [15]. Environmental challenges extend to climate change, biodiversity loss, financial crises, and economic downturns, necessitating global readiness and cooperation [16]. As consumers of Earth's natural resources, humans are responsible for conserving them for future generations. Consequently, present-day

society must be prepared to enhance the quality of life and confront the myriad challenges that await humanity globally [17].

The endeavor to improve the quality of life for all individuals worldwide, both now and in the future, is achieved through implementing sustainable development practices [18]. Schools play a crucial role as the primary cornerstone for instilling the values inherent in Education for Sustainable Development (ESD) [19]-[21]. ESD is a collective effort to equip individuals with the knowledge, skills, values, and attitudes necessary to shift perspectives and collaborate in building a sustainable future while preserving the Earth's environment [22]. Environmental issues and degradation are attributed to human negligence, often stemming from a lack of accountability and insufficient environmental consciousness [3], [22]. Previous research indicates that environmental awareness behavior is influenced by three key factors: external conditions (environmental factors), individual personality traits, and one's relationship with nature [23]. A person's level of environmental awareness may not always be high, as various factors, including environmental knowledge, values, and behaviors, influence it.

Environmental awareness also entails assisting social groups and individuals in developing sensitivity to the environmental issues they encounter [11], [24], [25]. Education is crucial in enhancing students' environmental awareness and fostering a sense of responsibility toward environmental preservation [26], [27]. Due to a deficiency in environmental awareness, students exhibit minimal behaviors reflecting a sense of responsibility for protecting the environment [28], [29]. Cultivating environmental awareness is essential to address escalating environmental issues [30]. A lack of responsibility among students toward the environment can have detrimental consequences, as disregard for nature can lead to ecosystem degradation. Urgent preventive measures, primarily through education, are imperative to mitigate these risks [31], [32]. Amidst the educational revolution of Industry 4.0, the education system requires innovative approaches to address emerging challenges. This era has ushered in a paradigm shift, incorporating internet-based technologies tailored to meet students' diverse needs [15]. Previous studies highlight that while the rapid development of science and technology eases human life, it also generates numerous challenges. Without proper constraints, these advancements can encroach upon various aspects of humanity, inevitably leading to problems [17]. Ethnoscience, also known as indigenous science, represents a cultural element that can be seamlessly integrated into science education [33]. It is a strategic approach for designing learning environments and educational experiences incorporating cultural elements into elementary school science education [15], [34].

Ethnoscience-based learning bridges indigenous knowledge with scientific learning by utilizing elements of local culture or the surrounding environment [17], [35]. Implementing an ethnoscience approach empowers teachers and educational practitioners to impart science education grounded in culture, local wisdom, and community issues. This approach enables students to comprehend and apply natural science concepts in real-life contexts, equipping them with the skills to address everyday challenges effectively [22], [36].

Ethnoscience learning represents a novel educational breakthrough, seamlessly blending culture with science. By incorporating local culture and wisdom into learning, ethnoscience enhances the significance of education and boosts students' scientific literacy. Additionally, it introduces students to culture-oriented learning, fostering a deeper appreciation for their heritage. Ethnoscience-based learning highlights regional diversity, igniting students' interest in exploring and embracing their cultural heritage

[37]. Consequently, researchers have developed e-worksheets on "Why Do We Need to Eat and Drink?" to enhance NoS and environmental awareness among fifth-grade elementary school students using ethnoscience principles. This approach simplifies and contextualizes learning, allowing students to engage deeply with their cultural, social, and environmental surroundings. By doing so, students acquire practical abilities, skills, and knowledge beneficial to themselves and society. Moreover, this approach instills attitudes and behaviors aligned with regional values and norms, fostering cultural preservation and character development.

Research on ethnoscience-based e-worksheets has been conducted, including STEM-based chemistry e-worksheets with ethnoscience content [38], the development of ethnoscience-based e-worksheets in science subjects [39], the development of ethnoscience-based e-worksheets to enhance science literacy [40], and analysis of the need for higher-order thinking skills-based e-worksheets [41]. However, no research has specifically examined the need for ethnoscience-based e-worksheets to enhance NoS and environmental awareness.

This study aims to investigate the need for ethnoscience-based e-worksheets to enhance NoS and environmental awareness among elementary school students. While previous research has analyzed the need for e-worksheets, none have been based on ethnoscience. Therefore, this research fills an existing gap by considering cultural aspects in the learning process, making it an interesting and valuable topic for scholarly study.

2. METHOD

The research employed the Research and Development (R&D) methodology. Within R&D methodologies, various models exist, and this study utilizes the 4D development model, as depicted in Figure 1. The 4D model is a framework for creating diverse learning media and instructional materials. It comprises four primary stages: Define, Design, Develop, and Disseminate [42], [43]. The chosen method and model were specifically selected to produce an ethnoscience-based E-Worksheet. As this study is in the early stages of development, a development research design was necessary. The scope of this research is limited to a needs assessment aimed at conducting an initial analysis for developing a science learning model based on local wisdom through an ethnoscience learning approach.

The research and development process resulted in E-Worksheet teaching materials that are theoretically and empirically feasible within the ethnoscience framework. Following ethics approval, the research was conducted. The adapted procedure for E-Worksheet development is illustrated in Figure 1.

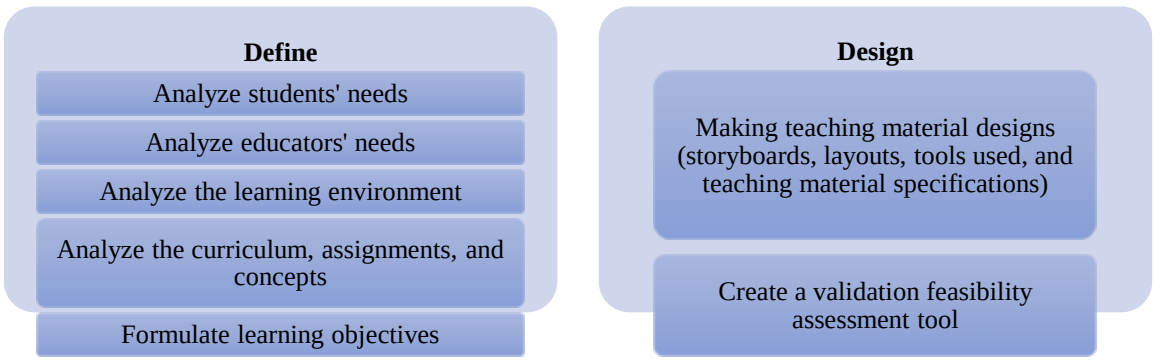


Figure 1. Research Stages

The research encompasses five elementary schools in Bandar Lampung, selected for their heterogeneity and diverse learning environments. A preliminary study involved 136 students and five teachers from these schools. After obtaining consent from parents and students, the research was conducted. The research instruments included interviews with natural and social sciences teachers and questionnaires assessing the needs of both teachers and students. The data analysis technique used was descriptive, focusing on calculating percentages and averages to illustrate key findings.

3. RESULTS AND DISCUSSION

The initial stage (Define) in the 4D model involves defining development requirements, essentially serving as the needs analysis stage. This phase is crucial for identifying what is necessary for learning and gathering information pertinent to the product under development. In the context of the schools targeted in this research, the school environment already supports the learning process. Thus, the definition stage determines the school's needs and gathers information relevant to the products developed in the learning process.

Observations conducted at these schools to gather information regarding necessary products revealed a lack of teaching material facilities related to science learning based on local wisdom and community culture. This led researchers to determine that the product developed in this research would be an E-Worksheet based on ethnoscience. Ethnoscience-based E-Worksheets are particularly suitable as research material because ethnoscience serves as a strategy for creating a learning environment and designing learning experiences that integrate culture into the elementary school learning process. Integrating ethnoscience into learning highlights the uniqueness of teaching materials, classrooms, learning environments, methods, and approaches.

Incorporating ethnoscience into learning themes can significantly enhance the effectiveness of the learning process. For example, cultural knowledge about traditional rituals, medicinal plants, houses, and other relevant cultural aspects can be primary learning themes. This aligns with research findings indicating that ethnoscience integration enhances learning outcomes. Research by Davison & Miller on American Indian students revealed that integrating ethnoscience into learning enabled students to derive meaning from mathematics and science concepts. Students exhibit better comprehension of material when it is connected to cultural knowledge. This is consistent with Vygotsky's theory, which underscores the importance of interpersonal (social), cultural-historical, and individual factors in human development. Cognitive advancements occur within the Zone of Proximal Development (ZPD) when teachers and students utilize cultural tools and engage in cultural mediation, leading to cognitive changes as students internalize these interactions [21].

Furthermore, research findings from Gallagher in the domain of Environmental Education & Science Culture among Americans revealed that ethnoscience aims to enrich knowledge in science program planning, teacher education, research, and school curricula. As a result, various culturally rooted ideas for learning were incorporated within schools [2]. The research findings highlight five key points. Firstly, collaborative learning—integrating culture, cognition, and the science of learning—emerges as a powerful tool for improving student learning outcomes. Secondly, ethnoscience-based teaching strategies, emphasizing observation, problem-solving, and student-led discovery, prove effective in achieving educational objectives. Thirdly, ethnoscience integration extends beyond elementary science to encompass subjects like ecology, marine fisheries, and general science education. Fourthly, teachers benefit from

ethnoscience integration by gaining insights into their students' diverse cultural backgrounds. Finally, students are given opportunities for individual and group projects, fostering holistic learning experiences.

These findings underscore the importance of integrating ethnoscience into elementary education, especially considering that elementary students undergo significant cognitive development. During this period, they transition from perception-dominated thinking to utilizing experiences as cognitive references, thus enhancing comprehension and reducing confusion.

3.1 Define

The defined needs analysis stage can be conducted by analyzing previous research and literature studies. Thiagarajan identified five activities that can be undertaken during this defining stage [42], which include:

3.1.1 Initial Analysis

The initial analysis step was conducted to identify fundamental issues in product development. This stage focuses on recognizing and outlining the basic problems encountered in the learning process, emphasizing the necessity for further development [42]. At this stage, researchers conducted preliminary and final analyses to identify teachers' fundamental challenges in enhancing their performance during the learning process. This involved analyzing the teaching materials used by students and the learning strategies typically employed by teachers. Through this initial analysis, researchers gained insights into the facts and potential solutions, aiding in the selection and determination of learning tools to be developed.

Data for the initial and final analyses were obtained by distributing needs analysis questionnaires to students and teachers across five elementary schools in Bandar Lampung. The results of this initial analysis were further explored through questionnaires distributed to 17 science teachers in these schools. Field studies were conducted to ascertain the needs of both teachers and students regarding the utilization of teaching materials in the form of an ethnoscience-based E-Worksheet.

The findings from the needs analysis for ethnoscience-based interactive multimedia served as the foundation for developing products that aligned with the identified needs in the field. The needs analysis for the ethnoscience-based E-Worksheet by teachers is presented in Table 1. These findings provide valuable insights into the specific requirements and expectations of educators in integrating ethnoscience into their teaching materials.

Table 1. Analysis of Teachers' Needs for Ethnoscience-Based E-Worksheet

No	Statement	Response	Percentage (%)
1	Teaching materials commonly used in teaching	Module	95%
		Worksheet	95%
2	Teachers who have employed digital teaching resources	Once	25%
3	Varieties of digital teaching resources that have been utilized	E-Books	50%
		PPT	25%
		Videos	50%
4	How teachers obtain electronic teaching materials	Self-creation	5%
		School-provided	10%
		Download	85%
5	Teachers who have participated in workshops or training sessions focused on creating digital teaching resources.	Once	25%
6	Teachers' perspectives on the significance of developing electronic teaching materials (e-worksheets) grounded in	Yes	100%

	ethnoscience		
7	Educators express interest in the development of e-worksheets based on ethnoscience.	Yes	100%
8	The essential requirement to incorporate ethnoscience-based e-worksheets into the learning process	Yes	95%

According to the findings from the needs analysis of ethnoscience-based e-worksheets by teachers, as outlined in Table 1, a wide range of teaching materials had been utilized, including textbooks, student worksheets, blackboards, charts, environmental media, internet resources, and PowerPoint presentations. Many teachers have incorporated electronic teaching materials into their instructional practices, with PowerPoint presentations and instructional videos being the most commonly used. The widespread use of e-worksheets in the learning process suggested their potential to facilitate students' rapid and efficient absorption of information, aiding in acquiring knowledge that might have been challenging to obtain through direct experience [44]. Most teachers utilized e-worksheets in diverse ways, including accessing them from school resources, downloading them from the internet, and creating their own. However, the majority preferred to download e-worksheets due to this approach's convenience and time-saving benefits. The creation of e-worksheets by teachers had been notably limited, primarily due to the lack of training opportunities in developing interactive multimedia, as well as constraints related to age and time availability. Most teachers had not attended workshops or training sessions on creating interactive multimedia, and factors such as age and time constraints further hindered their ability to develop customized materials aligned with their teaching methods.

Nevertheless, integrating e-worksheets into classroom learning processes has significantly enhanced student learning outcomes [45]. However, relying solely on interactive multimedia might not have fully optimized the learning process. Many online teaching materials fail to connect the content to everyday life, leaving students feeling disconnected and perceiving the learning as irrelevant. Science education, closely intertwined with students' daily experiences, could have benefited greatly from integrating local and national cultural aspects. Incorporating ethnoscience into the curriculum was essential, as it bridged the gap between academic content and real-life experiences. However, it was uncommon for teachers to integrate students' cultural traditions into their subjects effectively.

Based on the teacher needs questionnaire analysis, it was found that 50% of teachers had utilized e-worksheets focused on "why we need to eat and drink," with half indicating that they had created these materials themselves. Only 20% of teachers reported involving students in every aspect of the learning process, highlighting a significant portion of educators who had not actively engaged students in science learning. Additionally, 25% of teachers stated that the e-worksheets they had used did not effectively enhance students' knowledge literacy or increase environmental awareness. Interestingly, a quarter of teachers had relied on e-worksheets from social media platforms, attributing this to a lack of motivation and innovation in supporting the learning process. Notably, 100% of teachers had never encountered the term "ethnoscience." Similarly, none knew that science learning could be interconnected with cultural customs, particularly concerning why we need to eat and drink. Based on these findings, it was evident that 85% of teachers expressed a need for ethnoscience-based e-worksheet teaching materials related to the significance of why we need to eat and drink, aiming to enhance students' understanding of science and increase environmental awareness.

3.1.2 Student Analysis

Student analysis involved identifying the characteristics of the target students to develop appropriate learning tools. It provided insights into students' challenges regarding the material, teaching resources, and strategies used in the learning process. This analysis was conducted through the distribution of needs questionnaires to uncover the issues students encountered during science learning. Educators comprehensively understood student needs by examining their responses to science lessons, interactions with learning materials, and preferred learning styles, interests, and motivations. Additionally, interviews with educators were conducted to assess students' levels of environmental awareness.

The findings revealed a lack of environmental consciousness among students, as evidenced by behaviors such as littering, vandalizing school property, neglecting plant care, relying on instant food, and disregarding hand hygiene. Moreover, a disconnect was observed between indigenous science and formal education, as teachers failed to integrate local wisdom from Lampung into the curriculum.

Table 2. Analysis of Students' Needs for Ethnoscience-Based E-Worksheet

No	Statement	Response	Percentage (%)
1	Instructional resources typically employed by teachers during lessons	Modules	90%
		Worksheet	50%
		Whiteboards	70%
2	Teachers use electronic teaching resources	Once	50%
3	The equipment utilized for presenting digital teaching materials	PPT	75%
		Flash Media	5%
		Videos	80%
		E-Module	25%
		E-Worksheet	5%
4	Digital teaching resources are engaging for educational purposes	Very interesting	85%
		Interesting	10%
		Quite interesting	5%
		Not attractive	0%
5	Students have been instructed with content grounded in local wisdom	Once	65%
		Never	35%
6	The necessity of incorporating electronic teaching materials (e-worksheets) infused with local wisdom into the learning process	Yes	98%

According to Table 2, analyzing students' needs for ethnoscience-based e-worksheets revealed that teachers employed diverse teaching materials, including books, student worksheets, and blackboards. Nearly all students had been exposed to electronic teaching materials provided by their teachers. The utilization of electronic media in teaching, such as e-modules and e-books, was prevalent among many educators. Incorporating electronic teaching materials infused with local wisdom was essential in learning, as it facilitated students' comprehension of abstract concepts. Furthermore, e-worksheets were regarded as superior to other materials due to their interactive nature and effectiveness in enhancing learning outcomes. This aligned with previous research, which indicated that integrating interactive multimedia into classroom learning could significantly enhance student learning outcomes compared to relying solely on PowerPoint presentations [46].

The analysis of the student needs questionnaire revealed that 30% of students had utilized e-worksheets, with only 25% specifically mentioning the use of e-worksheets related to why we need to eat and drink. Moreover, 80% of students reported that the e-

worksheets used in learning did not incorporate Lampung cultural traditions. In comparison, 90% felt these materials did not effectively enhance scientific literacy and environmental awareness. Consequently, students expressed a need for teaching materials that were more innovative, versatile, culturally relevant, and capable of promoting scientific literacy. In light of this, 90% of students agreed that developing ethnoscience-based e-worksheets focusing on why we need to eat and drink was crucial for enhancing the NoS and environmental awareness.

Science learning encompassed both tangible concepts related to everyday life and abstract principles. E-worksheets served as effective tools to elucidate these abstract concepts by illustrating them vividly, simulating real-world processes, and aiding teachers in guiding students to grasp these concepts more effectively [47], [48] in addition to employing interactive multimedia, educational materials needed to be intertwined with everyday experiences to aid students in better retention. Most educators had incorporated teaching materials intricately connected to the local cultural context. Local culture was deeply embedded in everyday life, and the learning process rooted in local culture extended beyond the mere transmission of cultural knowledge. It involved leveraging local culture to empower students in crafting significance, pushing the boundaries of imagination and creativity, and facilitating a profound understanding of the subject [49], [50]. This underscored the significance of integrating e-worksheets infused with local culture, as it captured students' interest and warranted further development for integration into the learning process.

The analysis of the student needs questionnaire reaffirmed that 30% of students had utilized e-worksheets, with only 25% specifically mentioning the use of e-worksheets related to why we need to eat and drink. Additionally, 80% of students expressed that the e-worksheets used in learning did not showcase Lampung cultural traditions, while 90% felt these materials did not effectively enhance scientific literacy and environmental awareness. Consequently, students called for teaching materials that were more innovative, versatile, culturally relevant, and capable of promoting scientific literacy. In light of this, 90% of students agreed that developing ethnoscience-based e-worksheets focused on why we need to eat and drink was essential for improving the NoS and environmental awareness.

3.1.3 Task Analysis

Task analysis was conducted to identify the content incorporated into the teaching materials. Its objective was to pinpoint the skills investigated by researchers and subsequently break them down into a series of supplementary skills that might be required [42]. In this context, researchers analyzed students' primary tasks to master to attain the specified minimum competencies. This ensured that students could effectively receive and comprehend the material. Task analysis was carried out to outline the tasks that students had to accomplish and categorize them based on the learning implementation. In this E-Worksheet, the assigned tasks were formulated according to the competency achievement indicators outlined in the teaching module.

3.1.4 Concept Analysis

Concept analysis was conducted to determine the content of the ethnoscience-based E-Worksheet material under development. This process involved identifying the primary concepts to be imparted, organizing them hierarchically, and distinguishing between critical and non-essential concepts [42]. Concept analysis played a crucial role in adhering to the principles of constructing concepts within educational materials. It serves

as a vehicle to achieve learning objectives and assess students' knowledge and skills as foundational competencies for their learning journey. The scientific material under consideration is outlined in the following table.

Table 3. Topic B Learning Outcomes

Teaching Topic B: Why Do We Need to Eat and Drink?			
Learning Outcomes	**Meaningful Understanding**	**Indicator NoS**	**Indicators Environmental Awareness**
Students engage in simulations utilizing simple pictures, charts, tools, and media to explore the human body's organ systems, including the respiratory, digestive, and circulatory systems. These simulations are intertwined with instructions on effectively maintaining the body's organs' health.	1. Students are acquainted with the terminology and sequential process of human digestion. 2. Students grasp the functions of each organ involved in food processing until its eventual excretion in feces. 3. Students are aware of the food substances ingested by the body. 4. Students are familiar with nutritious foods suitable for consumption to uphold a healthy body. 5. Students are capable of implementing a balanced diet in their everyday lives.	1. Students can interpret scientific data and evidence. 2. Students are capable of providing explanations of scientific phenomena. 3. Students can design scientific inquiry. 4. Students can evaluate scientific inquiry.	1. Participants are instructed to understand how food and beverages contribute to our vitality and activity levels. 2. Participants are instructed to understand the workings of the digestive system in processing the food and beverages they consume. 3. Students are familiar with healthy eating patterns and the characteristics of nutritious food and beverages. 4. Participants are taught how to maintain a healthy digestive system 5. Participants are taught to know medicinal plants to treat diseases in the digestive system 6. Students understand the significance of preserving local wisdom to demonstrate respect and empathy.

3.1.5 Specifying Instructional Objectives

Based on the analytical tasks and concept analysis, the previous stage involved determining indicators aligned with the learning achievements outlined in the independent curriculum. The formulation of learning objectives consolidated the outcomes of concept analysis and task analysis, aiming to specify the expected behaviors of the research subjects [42]. This summary served as the fundamental groundwork for crafting assessments and designing future learning tools beyond merely delineating the learning material to be employed. The specification of learning objectives, derived from material analysis, entailed envisioning the anticipated student outcomes following the learning process.

Table 4. Learning Objectives for Topic B

Teaching Topic B: Why Do We Need to Eat and Drink?	
Topic B Learning Objectives	**Essential Questions**
1. Students can describe the digestive process in humans. 2. Students can apply a balanced diet in their daily lives.	1. How do food and drink help us stay alive and active? 2. How does the digestive system process the food and drinks we consume? 3. What constitutes a nutritious diet, and what are the characteristics of healthy food and beverages?

3.2 Design

The second phase of the 4D model was the design stage. This phase involved four essential steps: establishing test criteria, selecting appropriate media, choosing formats, and initiating design, as outlined by Thiagarajan. During this stage, the design process began with selecting media and formats, followed by the actual design of the chosen media. In this research, the developed media was an ethnoscience-based e-worksheet. The designed e-worksheet encompassed natural and social sciences content, integrated with local cultural knowledge, particularly ethnoscience from the Lampung region.

3.2.1 Creating Criterion-Referenced Tests (Preparation of Test Standards)

Preparing test standards was crucial in bridging the definition and design stages. It involved creating test instruments based on the specifications of learning objectives and student analysis. Starting with a question grid, scripts for pretest and posttest questions were prepared to assess students' abilities. The posttest results indicated students' understanding of the NoS and environmental awareness. Before assessing students, the test instrument underwent testing to ensure the validity and reliability of the questions.

3.2.2 Media Selection

Media selection was essential in identifying learning tools suitable for the material's characteristics. It was based on the outcomes of concept and task analyses, student characteristics, and distribution plans across various media. The selection process prioritized optimizing the use of teaching materials during development. In this study, researchers focused on crafting e-worksheets to enhance students' NoS and environmental awareness.

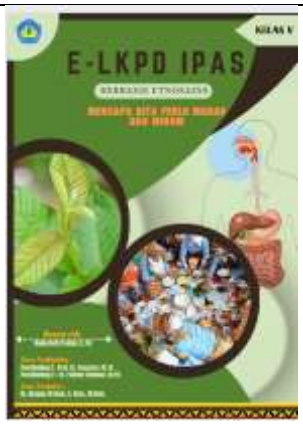
3.2.3 Format Selection

The format outlined learning media design and the selection of strategies, approaches, methods, and learning resources in crafting learning tools. In this study, an ethnoscience approach was employed to develop teaching materials in the form of e-worksheets. The process commenced with researchers conceptualizing and constructing the e-worksheet for natural and social sciences and designing its visual layout. Researchers generated learning content, including pretests, materials on the importance of eating and drinking, learning videos, and posttests for each learning activity. These components were systematically integrated to ensure a coherent and engaging learning experience for students.

3.3.3 Initial Design

Thiagarajan emphasized that the initial design represents the comprehensive blueprint of the learning tool that must be finalized before testing is initiated [42]. At this stage, various structured learning activities were incorporated, along with diverse learning skills through teaching practices, such as microteaching. This encompassed preparing evaluation tools for teaching materials, including expert validation and student response questionnaires. These tools helped ascertain the suitability of the e-worksheet teaching materials developed by researchers. Researchers generated an initial product or prototype during the design phase—an ethnoscience-based e-worksheet designed to enhance students' NoS and environmental awareness, as outlined in the storyboard. This prototype served as the foundation for subsequent refinements and iterative improvements based on expert reviews and field trials.

Table 5. Storyboard Prototype of the E-Worksheet

No	Section	Description
1		Cover
2		Concept Map
3		Learning Activity Part 1
4		Ethnoscience of Lampung Typical Food

5		Learning Activity Part 2
6		Learning Activity Part 3
7		Ethnoscience of Lampung Typical Medicinal Plants
8		Competency Test

In developing the e-worksheet, the cover image served as the initial visual introduction, featuring essential details such as the title, a depiction of the digestive system, and insights into Lampung's traditional medicines and foods. Additionally, it included acknowledgments to the developer, supervisors, and discussants involved in the project. The Concept Map presented a graphical representation elucidating the interconnectedness between healthy foods and the human digestive system, aiding conceptual understanding.

Subsequent sections, such as Learning Activities 1, 2, and 3, provided engaging content on the importance of proper nutrition, digestive system functions, and strategies for preventing disorders. Each activity incorporated informative videos to enhance comprehension. The Ethnoscience segments on Lampung's typical food and medicinal plants offered insights into indigenous knowledge and its applications in health and wellness. Finally, the Competency Test evaluated students' learning outcomes by integrating questions aligned with scientific indicators and practical assignments to assess environmental awareness. Through this comprehensive approach, the e-worksheet aimed to foster holistic learning experiences for students.

Building upon the insights gathered from preliminary studies and relevant research, this study aimed to create educational resources in the format of an ethnoscience-based e-worksheet focusing on the significance of consuming food and beverages. This educational material was designed to incorporate the cultural heritage of the Lampung region, integrating indigenous knowledge into the learning process. Specifically, the content explored dietary habits through the lens of ethnoscience, incorporating learning activities centered around traditional Lampung cuisine and medicinal plants used to address digestive ailments. By intertwining scientific concepts with Lampung's local wisdom, the study sought to enhance students' comprehension of scientific principles while fostering an appreciation for their cultural heritage.

The findings of this study aligned with prior research conducted by Rahma Sahara *et al.*, which analyzed the requirements for developing an ethnoscience-based module on temperature and heat for the ninth grade of SMAN (Senior High School) Kota Bengkulu [37]. Additionally, research by Kurniawan indicated that integrating ethnoscience into instructional media could meet students' needs and conditions while supporting independent and scientific learning [51]. Moreover, ethnoscience served as a strategic approach to creating a learning environment that incorporated cultural elements into the educational process at elementary schools. Integrating ethnoscience into education effectively illustrated various aspects of teaching resources, classrooms, learning environments, instructional strategies, and culturally based learning approaches. The educational process became more effective when ethnoscience was embedded in the primary learning themes.

Furthermore, leveraging community knowledge as a learning asset for students [52] enhanced learning outcomes across all dimensions of science, encompassing attitudes and scientific skills [53]. This approach also fostered critical thinking among students, as evidenced by previous research demonstrating its role in character development, particularly regarding local culture [54]. Additionally, learning with an ethnoscience approach instilled values of local wisdom [55], and incorporating local cultural elements served as an effective learning resource in elementary schools [56].

Students' learning requirements underscored the need for developing e-worksheets. Given that students' cultural backgrounds could influence their learning styles, such materials created a learning environment that resonated with their lived experiences, thereby fostering the development of local cultural character. Further research

corroborated the impact of using learning kits and worksheets with an ethnoscience approach in enhancing student learning outcomes [57].

A limitation of this research was that the ethnoscience-based e-worksheet focused solely on topic B, phase C, addressing why we need to eat and drink. However, this study is expected to be a valuable resource for teachers and students in developing and utilizing ethnoscience-based e-worksheets for other material content in the elementary school curriculum. Future studies could expand the development of e-worksheets to include themes such as health, the environment, and different local cultures, thereby broadening students' understanding of the NoS and enhancing environmental awareness. Additionally, future research could assess the effectiveness of ethnoscience-based e-worksheets in classroom learning by involving more schools and diverse cultural contexts to obtain more comprehensive results.

4. CONCLUSION

Based on the findings derived from the analysis and discussion of data collected from five elementary schools in Bandar Lampung, it was evident that 85% of teachers expressed a need for ethnoscience-based e-worksheet teaching materials focused on the importance of eating and drinking aimed at enhancing students' understanding of the NoS and environmental awareness. Moreover, the results of the student analysis, as indicated by the student needs questionnaire, revealed that 95% of students agreed that developing an ethnoscience-based e-worksheet would enhance their understanding of NoS and environmental awareness regarding the topic of why we need to eat and drink. Given the limitation of this study, which focused solely on the topic "Why We Need to Eat and Drink" in developing ethnoscience-based e-worksheets, future research is recommended to explore their application across various other topics in the elementary school curriculum. This research has significant implications for integrating local wisdom to enrich learning, support scientific literacy, and foster environmental awareness.

AUTHOR CONTRIBUTION STATEMENT

WOP contributed to designing and conducting experiments, analyzing and interpreting data, and writing the manuscript. SS, FR, and RF contributed to improving and providing feedback on the research manuscript.

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