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Research Artikel

DEVELOPMENT OF ETHNOSCIENCE INTEGRATED E-WORKSHEET IN ACID BASE MATERIALS TO IMPROVE CRITICAL THINKING SKILL

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Abstract

Critical thinking skills are one of the skills needed in the current era of education. The ability to think critically is an important key for students in successful problem solving. This research aims to develop an ethnoscience-integrated Electronic Student Worksheets (E-LKPD) for acid-base learning to enhance students' critical thinking skills. The Research & Development (R&D) 4-D model, developed by Thiagarajan, was utilized. The research subjects were 11th-grade students of Science at SMAN 1 Cigugur, in the academic year 2022/2023. The E-LKPD was designed in HTML 5 format, accessible online through smartphones and laptops. The material presentation in the introductory activities was contextual, incorporating ethnoscience content related to local phenomena, enabling students to understand and explore the connection between these phenomena and acid-base concepts. The validation results by expert validators showed a high validity rate of 92%. The assessment of student responses through questionnaires yielded scores of 87.2% in the small-scale trial and 89.4% in the large-scale trial, indicating that the E-LKPD was highly practical. To evaluate the effectiveness of the ethnoscience-integrated E-LKPD in enhancing critical thinking skills, pre-tests and post-tests were conducted. The N-gain value of 0.71 indicated a high improvement in students' critical thinking skills. The findings demonstrate that the developed E-LKPD integrated with ethnoscience effectively enhances students' critical thinking abilities. This is because the Ethnoscience Integrated E-LKPD media can connect learning in the classroom with the real experiences of students in everyday life, so that it can help students to develop critical thinking skills in the process.

Keywords: Acid-base; critical thinking; electronic student worksheets; ethnoscience.

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INTRODUCTION

Education in the 21st century is essential for preparing the younger generation of Indonesia to embrace the advancements in information and communication technology within society (Maylitha *et al.*, 2022). Every student in the 21st century is required to possess a range of abilities and skills (Zubaidah, 2016). Critical thinking is one of the essential competencies and skills that must be acquired (Indraswati *et al.*, 2020). In other research, the abilities and skills referred to are known as "The 4C's," which include: Communication, Collaboration, Critical Thinking, and Creativity (Sakinah & Widodo, 2019). In essence, education aims to support students in developing optimally, rapidly, and in alignment with their potential and the value system of their society (Agus, 2020). The ethnoscience-based educational approach refers to science learning that incorporates local wisdom derived from the objects being studied. This approach is relatively straightforward and engaging for students (Pujiastuti & Sudarmin, 2013).

Chemistry is one of the sciences that needs to be studied due to its strong relevance to the development of 21st-century science. Learning through an ethnoscience-based approach is relatively easy for students to comprehend (Pujiastuti & Sudarmin, 2013). The Ethnoscience-Based Chemistry Learning Model (MPKBE) connects classroom learning with aspects of students' everyday lives. This learning model enhances students' cognitive abilities and critical thinking skills (Arfianawati *et al.*, 2016). The ethnoscience approach is expected to help students perceive science as a reflection of culture and local wisdom (Shidiq *et al.*, 2013). The ethnoscience approach also positively impacts science learning, particularly in enhancing student participation and learning activities (Khoiriyah *et al.*, 2021). Ethnoscience fosters the development of critical thinking and literacy skills (Sanova *et al.*, 2021). Students are expected to develop their character through the ethnoscience approach in chemistry learning (Ariyatun, 2021).

Traditional beverages (jamu) are beneficial for treating various ailments without side effects (Isnawati & Sumarno, 2021). Jamu exhibits a

variety of acidity levels; for example, turmeric acid jamu possesses acidic properties, while bitter jamu exhibits basic properties due to its alkaloid content. The acid-base characteristics of jamu are one of the subjects studied in chemistry (Yulfriansyah & Novitriani, 2016).

Student worksheets (LKS) are educational tools utilized by teachers to enhance understanding, motivation, and interest among students in materials integrated with ethnoscience (Nurdin *et al.*, 2019). LKS, now referred to as LKPD (Student Worksheets), can aid in learning by integrating the local cultural perspectives of Indonesian society, which is accustomed to consuming traditional jamu, with science, particularly in the context of acid-base materials (Laksana *et al.*, 2020). The materials, summaries, tasks, and questions included in the LKPD, presented through supporting images or videos, must align with the basic competencies (Kholifahtus *et al.*, 2022). Research related to the development of ethnoscience-integrated E-LKPD on acid-base materials is expected to provide valuable benefits by enhancing students' critical thinking skills.

The development of ethnoscience-integrated E-LKPD on acid-base materials, using jamu as a representation of local cultural wisdom, is crucial for enhancing the quality of learning, preserving culture, and developing 21st-century competencies. E-LKPD offers improved interactivity and accessibility, thereby increasing students' interest and understanding of the subject matter. Jamu, as a part of Indonesia's local wisdom, provides a tangible practical context that helps students appreciate and understand their cultural heritage while developing critical, creative, collaborative, and communication skills. Additionally, this approach supports the implementation of the 2013 Curriculum, which emphasizes contextual and activity-based learning (Kemendikbud, 2013). Thus, the integration of technology and local culture in science education through E-LKPD not only enriches students' learning experiences but also contributes to the preservation of culture and the development of knowledge based on local resources (Lestari, 2020).

METHOD

The research was conducted at SMAN 1 Cigugur during the second semester of the 2023/2024 academic year. The Research and Development (R&D) process follows the 4-D model developed by Thiagarajan, which includes the stages of Define, Design, Develop, and Disseminate (Sugiyono, 2011). In the Define stage, a needs analysis was conducted to formulate learning objectives by identifying student characteristics, analyzing chemistry materials relevant to the context of ethnoscience, and collecting qualitative data through interviews with chemistry teachers to understand the needs and challenges in learning. Next, in the Design process, the initial design of the ethnoscience-integrated E-LKPD was developed, encompassing content design, learning structure, and interactive components, including the creation of instruments to measure students' critical thinking abilities. In the Develop stage, the E-LKPD was finalized and validated by two chemistry experts from Universitas Negeri Semarang, who served as content and media specialists, along with the chemistry teacher from SMAN 1 Cigugur, to ensure its feasibility and validity. Finally, in the Disseminate stage, the validated ethnoscience-integrated E-LKPD was distributed to chemistry teachers in the school and other schools through workshops, seminars, or publications in educational journals.

The feasibility and validity of the E-LKPD Integrated Ethnoscience product were assessed based on the scores provided by experts, which classified it as "feasible." After revisions were made according to the received feedback, the E-LKPD was tested on a small scale involving 10 students from class XII MIPA 1 to evaluate its practicality as well as the validity and reliability of the instrument. Subsequently, a large-scale trial was conducted with 29 students from class XI MIPA 1 to determine the effectiveness of the E-LKPD in enhancing critical thinking skills. Practicality was measured by assessing the extent to which the product could be easily utilized, accepted, and applied by both students and teachers in daily learning activities. In the final stage, Dissemination, the validated E-LKPD

Integrated Ethnoscience was disseminated to chemistry teachers within the school and at other institutions through workshops, seminars, or publications in educational journals. The data from the validation of the feasibility of the E-LKPD Integrated Ethnoscience by subject matter experts and chemistry teachers included constructive feedback and suggestions for the improvement of the E-LKPD.

Data collection was conducted using questionnaires to capture responses from students and teachers after utilizing the E-LKPD. The evaluation scale used was a Likert scale, and the data analysis was performed using the average score of responses from students and teachers. This approach aimed to assess the effectiveness of the E-LKPD Integrated Ethnoscience in supporting the improvement of students' critical thinking skills, as observed in 29 students from class XI MIPA 1 at SMAN 1 Cigugur. This research also employed qualitative data obtained from interviews with chemistry subject teachers at SMAN 1 Cigugur and quantitative data from student questionnaires to analyze the practicality of the E-LKPD Integrated Ethnoscience, as well as test score data following the use of the E-LKPD to evaluate students' critical thinking abilities.

Students' critical thinking abilities were measured using a test instrument based on indicators which include Elementary Clarification, Basic Support, Inference, Advanced Clarification, and Strategies and Tactics (Ennis, 1985). The reliability (consistency) of this instrument was determined using Cronbach's alpha. The calculation formula for Cronbach's alpha is as follows:

$$\alpha = \frac{N}{N-1} \left(1 - \frac{\sum s_i^2}{s_t^2} \right)$$

Expert evaluation utilized a scale ranging from 1 to 4, with the following details: Scale 1 = Not Suitable, as the content or media does not align with the learning objectives or is not supportive of the learning process. Scale 2 = less suitable, as the content or media requires modifications to be relevant to the learning objectives. Scale 3 = Suitable, as the content or

media is adequately relevant and effective in supporting learning. Scale 4 = Highly Suitable, as the content or media is highly relevant and effective, and no further improvements are necessary. To analyze the practicality of the E-LKPD, student response questionnaires were used. The measurement of students' critical thinking skills was conducted using the N-gain score. The N-gain score is calculated using the following formula:

$$N - gain = \frac{Posttest\ Score - Pretest\ Score}{Max\ Score - Pretest\ Score}$$

The N-gain categories are classified as follows: high if N-gain > 0.7, medium if $0.3 \leq N\text{-gain} \leq 0.7$, and low if N-gain < 0.3 (Hake, 1999).

RESULT AND DISCUSSIONS

The research was conducted during the even semester of the 2023/2024 academic year at SMAN 1 Cigugur to develop an Ethnoscience-Integrated E-LKPD on Acid-Base Material to Enhance Students' Critical Thinking Skills. The implementation of the 4-D model in this study can be described as follows:

Define

In this phase, there are four steps that need to be carried out: front-end analysis, conceptual analysis, task analysis, and formulation of learning objectives. The purpose of this stage is to establish and define the necessary requirements for the development of the Ethnoscience-Integrated E-LKPD, specifically for the acid-base material for class XI students.

The first step is front-end analysis, which aims to address existing gaps with reality in order to resolve the identified issues. This stage is conducted through interviews with chemistry teachers to determine the availability of student worksheets (LKPD) and through observations regarding the integration of cultural values (ethno) in the chemistry learning process for class XI at SMAN 1 Cigugur. The interview results indicated that class XI students at SMAN 1 Cigugur have never used LKPD in their chemistry learning process due to the unavailability of such worksheets at the school. Teachers solely rely on one learning resource, the thematic textbook from

the 2013 curriculum owned by the students, to deliver the material.

To determine the content of the ethnoscience-based E-LKPD being developed, a conceptual analysis was carried out (Junta & Yuliani, 2022). This step is crucial in building an understanding of the material used as a tool to achieve students' core competencies and basic competencies, as well as identifying the prior knowledge and skills needed in the learning process. In the development of this E-LKPD, the structure includes a concept map, literacy components, material summaries, multiple-choice questions, essay questions, and case studies that align with the competency achievement indicators and learning objectives for the Acid-Base material for class XI. Information regarding the basic competencies (KD) that students are expected to achieve for this material can be found in Table 1.

Table 1. Basic Competencies and Learning Achievement Indicators for Acid-Base Material

Basic Competencies	Learning Achievement Indicators
3.10 Explaining the concepts of acids and bases, their strengths, and the ionization equilibrium in solution.	3.10.1 Identifying substances that are acidic or basic in everyday life. 3.10.2 Differentiating the concepts of acids and bases according to Arrhenius, Brønsted-Lowry, and Lewis theories. 3.10.3 Measuring the pH of several acid/base solutions using a universal indicator. 3.10.4 Calculating the pH of an acid or base solution based on concentration data.
4.10 Analyzing the pH change pathway of several indicators extracted from natural materials through experiments.	4.10.1 Conducting experiments to create acid-base indicators from natural materials. 4.10.2 Analyzing the pH change pathway of acid/base solutions using natural indicators. 4.10.3 Summarizing the results of the acid-base pH test experiment.

In the analysis of formulating learning objectives, the aim is to establish the learning goals that will be articulated in the E-LKPD, as presented in Table 2.

Table 2. Learning Objectives and Critical Thinking Indicators

Component	Description
Basic Competencies	3.7 Analyzing the properties of acid, base, and salt solutions based on acid-base theory.
Learning Indicators	<ol style="list-style-type: none"> 1. Students can identify the properties of acid, base, and salt solutions using examples from traditional herbal medicine (jamu). 2. Students can connect acid-base theory with the chemical properties found in local materials such as herbal medicine. 3. Students can evaluate the chemical effects of using herbal medicine based on acid-base theory.
Critical Thinking Indicators	<ol style="list-style-type: none"> 1. Interpretation: Students can understand and explain the properties of acids and bases in various types of traditional herbal medicine (jamu) solutions. 2. Analysis: Students can compare and analyze the chemical effects of acid and base solutions on local materials. 3. Evaluation: Students can evaluate the effectiveness of using traditional herbal medicine as substances that possess acidic or basic properties in everyday life. 4. Inference: Students can draw conclusions about the relationship between the use of herbal medicine and the resulting chemical effects. 5. Explanation: Students can present clear and logical arguments to support the use of herbal medicine based on its chemical properties.

Learning objectives are formulated based on the learning achievement indicators for the acid-base material. The results from all stages of analysis that have been conducted, including front-end analysis, conceptual analysis, and formulation of learning objectives, will serve as the foundation for proceeding to the next stage, which is the product design phase.

In addition to conducting observations at school to gain a deeper understanding of the raw materials and the process of making herbal medicine (jamu), observations were also carried out to identify natural substances with chemical properties related to traditional herbal medicine in Kampong Jamu, Semarang. This observation aimed to further understand the raw materials and the traditional herbal medicine-making process (Almasi et al., 2019). The results of the observation indicated that many raw materials for herbal medicine possess acidic and basic properties, which are relevant to the chemistry concepts taught in school. Incorporating culturally related materials into science learning can enhance students' ability to connect theory with real-world practice, while also encouraging them to be more critical in evaluating scientific information (Adam et al., 2024). For example, some ingredients like turmeric and temulawak contain compounds that are acidic, while others like lime (kapur sirih) are basic. Based on these findings, the Integrated Ethnoscience E-LKPD was developed, utilizing herbal medicine raw materials as contextual examples used to explain acids and bases in chemistry learning.

These findings support the idea that local materials can be effectively used to explain complex chemical concepts, such as the properties of acids and bases, to students. Integrating traditional knowledge into the science curriculum not only facilitates student understanding but also enhances their appreciation of local cultural richness (Lee et al., 2022). By utilizing herbal medicine ingredients as examples in this E-LKPD, the relevance of learning becomes stronger, as students can directly observe the application of acid and base theory in the context of their lives (Sutapa & Novita, 2022.).

The E-LKPD integrates local wisdom from traditional herbal medicine with the material on acids and bases. This integration not only makes learning more contextual and engaging for students but also assists them in understanding the concepts of acids and bases. Additionally, it enhances their ability to apply these concepts to everyday life, particularly using local materials such as traditional herbal medicine. Indicates that

contextualizing scientific concepts with local phenomena can enhance student motivation and engagement in learning, as well as strengthen their critical thinking skills (Kim & Tan, 2021). This is also reflected in improvements in criteria such as making further explanations and drawing conclusions, while helping to preserve local cultural knowledge through science education. This E-LKPD is designed to provide an interactive and relevant learning experience by utilizing technology to facilitate more effective and enjoyable learning. Through this approach, students are expected to better understand the concepts of acids and bases while also recognizing and appreciating the rich traditional culture of Indonesia.

Design

The design phase is a step toward developing a product based on research findings. In the planning stage, the objective is to design a learning material in the form of an Electronic Student Worksheet (E-LKPD) that is integrated with an ethnosience approach on the topic of acids and bases. This design phase consists of the following components: Constructing Criterion-Referenced Tests, Media Selection, Format Selection, and Initial Design.

The Criterion-Referenced Test is developed based on the achievement of fundamental competencies, presenting questions in multiple-choice and essay formats derived from the acid-base material featured in the E-LKPD. Media Selection is conducted by considering students' accessibility to the necessary learning materials. To prevent student boredom during the learning process and to assist in remote learning, the E-LKPD is packaged in an electronic format that can be accessed using laptops and smartphones. In practice, the developed E-LKPD is accessed through students' smartphones, as this aligns with the availability of media possessed by the students. When combined with culturally relevant content, this approach can enhance student engagement and create a more flexible learning environment. Thus, the use of technology enables students to access materials anytime and anywhere, significantly increasing their

participation and interest in the learning process (Ginting, 2021).

Format Selection in this research includes the design of learning content, the organization of the learning material in a logical flow that is easy for students to understand, the learning resources, and the content of the E-LKPD. Additionally, the creation of the E-LKPD design encompasses the layout, the use of images, and the arrangement of the text presented within it.

The typeface used in the Integrated Ethnosience E-LKPD is Bree Serif, size 36 pt. The layout design of the Integrated Ethnosience E-LKPD features a sea blue background, combined with text in yellow, white, and black. The images presented are related to the acid-based material with a focus on local wisdom, and there are also educational videos included as part of the apperception.

The Initial Design of this E-LKPD refers to the format which includes: (1) a cover featuring a sea blue background with black text, incorporating the identity of ethnosience (turmeric, kencur, herbal medicine) alongside chemical identities such as laboratory tools and chemical structure formulas that relate to the ethnosience realm in the context of acids and bases; (2) learning instructions that provide information on how to use the Integrated Ethnosience E-LKPD; (3) competencies to be achieved, including Basic Competencies (KD), Competency Achievement Indicators (IPK), and learning objectives related to the acid-base material; (4) supporting information that includes additional information to assist students in using the E-LKPD, such as a table of contents; (5) tasks and work steps that involve apperception, presentation of phenomena related to the material, educational videos, and practice questions; (6) assessments containing questions related to acid-base material to measure students' critical thinking skills (Prastowo, 2013).

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 Dosen Pembimbing: Prof. Dr. Wawa Sumardi, M. Si

LEMBAR KERJA PESERTA DIDIK ELEKTRONIK (E-LKPD)
TERINTEGRASI ETNOSAINS
LARUTAN ASAM BASA

Nama :
 Kelas :
 No. Absen :

JURUSAN KIMIA
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2022

KOMPETENSI DASAR (KD)

3.10 Menjelaskan konsep asam dan basa serta kekuatannya dan kesetimbangannya penguasaannya dalam larutan.
 4.10 Menganalisis tingkat perubahan pH beberapa indikator yang diekstrak dari bahan alam melalui percobaan.

INDIKATOR PENCAPAIAN KOMPETENSI (IPK)

3.10.1 Memahami hubungan sifat asam dan basa yang ada dalam Jamu tradisional, dan bahan pembuat Jamu Tradisional.
 3.10.2 Membedakan teori asam basa menurut Arrhenius, Bronsted-Lowry, dan Lewis.
 3.10.3 Menentukan pH larutan jama dari data yang telah disediakan.

Tujuan Pembelajaran

Siswa dapat mengidentifikasi sifat larutan asam basa dalam kehidupan sehari-hari, menentukan, mengidentifikasi pH larutan jama dari data yang telah disediakan yang terintegrasi dengan penemuan etnosains pada jama tradisional.

LKPD ASAM BASA 2

Figure 1. The Integrated Ethnoscience E-LKPD

Petunjuk Pengerjaan

1. Baca tujuan pembelajaran dan indikator pencapaian kompetensi yang tercantum dalam LKPD!
2. Dengan bimbingan guru, bacalah informasi yang terdapat dalam LKPD!
3. Setiap peserta didik mengeksplorasi tentang model yang diberikan dalam LKPD, dengan guru bertindak sebagai fasilitator!
4. Berdasarkan pemahaman terhadap model dan informasi, maka jawablah pertanyaan-pertanyaan yang diberikan!
5. Untuk memunculkan soal pada LKPD, klik link gambar yang terdapat pada LKPD!
6. Peserta didik bertanggung jawab terhadap jawaban pertanyaan yang ditanyakan.
7. Untuk memperkain konsep atau materi yang didapat, peserta didik berhak untuk memperkainnya dalam mengerjakan sejumlah latihan yang diberikan.
8. Pada saat diskusi guru akan memandu jalannya diskusi serta melakukan pengawalan sesuai dengan tujuan pembelajaran.

Kompetensi Inti

KI-3: Menemukan, menerapkan, dan menggunakan pengetahuan faktual, konseptual, prosedural, dan metodologis berdasarkan rasa ingin tahunya tentang ilmu pengetahuan, teknologi, seni, budaya, dan kemanusiaan dengan wawasan kemanusiaan, kebangsaan, kenegaraan, dan peradaban terkait penyebab fenomena dan kejadian, serta menerapkan pengetahuan prosedural pada bidang kajian yang spesifik sesuai dengan bakat dan minatnya untuk memecahkan masalah.
 KI-4: Mengetahui, menalar, dan menguji dalam rangka keadilan dan hasil objektif terkait dengan pengembangan diri yang diprioritaskan di sekolah secara mandiri, bertindak secara efektif dan kreatif, serta mampu menggunakan metode sesuai kebidanan keilmuan.

LKPD ASAM BASA 1

Develop

The development stages in this research consist of an initial stage (validation) and a final stage (product testing). In the initial stage, validation of the research instruments, specifically the E-LKPD, is conducted by media and subject matter expert validators. This is followed by the final stage (product testing), which includes small-scale trials and large-scale trials involving questionnaires. Validation of the Integrated ethnoscience E-LKPD is performed by two expert lecturers in the fields of subject matter and media. A recap of the validation results for the Integrated ethnoscience E-LKPD is presented in Table 2.

Tabel 2. Validation Results of E-LKPD by Experts

No	Evaluator	Validity Score (%)	Caterogy
1	Subject Matter Experts	93.33	Valid
2	Media Expert	100	Valid
3	Teacher	93.48	Valid

The validation results of the Integrated Ethnoscience E-LKPD presented in Table 2 indicate that the developed product falls into the "very valid" category. This validation was conducted by subject matter experts, media experts, and education practitioners, who provided valuable feedback for the refinement of the product. The feedback, along with critiques and suggestions from the validators, served as the basis for improvements to the E-LKPD, which included the addition of content, incorporation of links to interactive quiz platforms such as Quizizz, and modifications to the cover design, including the addition of the Merdeka Campus logo to reinforce the identity of the sustainable education program.

The small-scale trial was conducted on January 24, 2023, involving 10 students from class XII MIPA 1. The purpose was to assess the reliability of the instruments and evaluate the critical thinking skills of the students, as well as the practicality of the developed Integrated Ethnoscience E-LKPD. The results of the trial indicated that the practicality of the Integrated Ethnoscience E-LKPD reached 87.2%, categorizing it as "very practical." This high level of practicality suggests that the E-LKPD is easy for students to use and understand and can be effectively implemented in the learning activities.

The reliability of the instrument was measured using Cronbach's alpha, resulting in a score of 0.917. This value indicates that the test or questionnaire instrument possesses very good internal reliability. The items within the instrument are positively correlated and consistently measure the critical thinking skills of students regarding the topic of acids and bases

from an ethnoscience approach. With such high reliability, the measurement results can be considered valid and effective for research and evaluation purposes.

The large-scale trial was conducted from January 30 to February 24, 2023, involving 29 students from class XI MIPA 1 at SMAN 1 Cigugur. This trial aimed to assess the effectiveness of the Integrated Ethnoscience E-LKPD after its implementation in the learning process. Students accessed the E-LKPD using smartphones, which were directly linked to the provided materials. The practicality of the E-LKPD in the large-scale trial yielded a score of 89.4%, which also falls within the "very practical" category. This reinforces that the E-LKPD is not only effective in an educational context but also easily accessible and user-friendly for students on a larger scale.

With highly positive results from the validation and trials, the development of the Integrated Ethnoscience E-LKPD can proceed to a broader implementation stage, with the hope of enhancing the quality of contextual and relevant science education while preserving local wisdom, such as traditional herbal medicine (jamu).

The effectiveness of the Integrated Ethnoscience E-LKPD was tested by comparing the scores of students before and after using the Integrated Ethnoscience E-LKPD. The test instrument consisted of 10 essay questions that integrated ethnoscience. The pre-test was conducted on February 1, 2023, while the post-test took place on February 23, 2023. The results of the test scores before and after learning with the Integrated Ethnoscience E-LKPD are outlined in Figure 2.

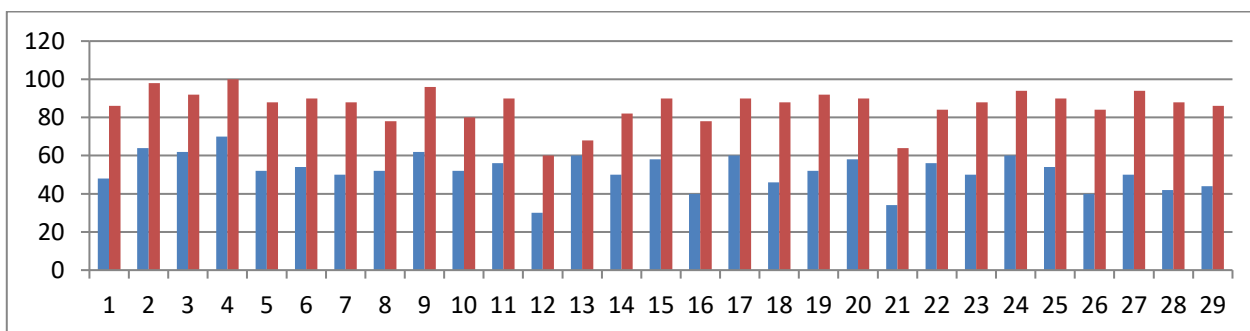


Figure 2. Pre-test and Post-test Score

Data in Figure 2 shows that the average pre-test score of students was 51.93, with the lowest score being 30 and the highest score being 70. After the use of the Integrated Ethnoscience E-LKPD, the average post-test scores significantly increased to 86.07, with the lowest score being 60 and the highest score being 100. This increase demonstrates the effectiveness of the Integrated Ethnoscience E-LKPD in enhancing students' critical thinking skills. The improvement in the average pre-test score from 51.93 to a post-test score of 86.07 indicates that this learning approach aids students in understanding chemical concepts through contextualization with local culture. This aligns with research that shows that the integration of local content in technology-based learning can enhance student engagement and facilitate a better understanding of the material (Maričić & Lavicza, 2024).

The effectiveness of this product can be seen in more detail in Table 3, which illustrates the comparison between the pre-test and post-test results. This table shows a significant improvement in critical thinking skills after the implementation of the Integrated Ethnoscience E-LKPD. Students demonstrated a deeper understanding of acid-base material and were able to apply these concepts in contexts related to local wisdom, such as the use of traditional herbal medicine (jamu).

The effectiveness of the Integrated Ethnoscience E-LKPD is also reflected in the improvement of various aspects of critical thinking skills, such as analysis, evaluation, and interpretation. Before using the E-LKPD, many students struggled to connect theory with real-life practice. However, after using the E-LKPD, they were able to better identify the properties of acids and bases in various herbal ingredients and understand the scientific implications of their use in everyday life. These difficulties often arise when learning is not contextualized, leading students to feel disconnected from the material (Alezeni, 2023).

However, after using the E-LKPD, significant changes occurred. Students were able to better identify the acidic and basic properties of various herbal ingredients, such as turmeric and

temulawak. They not only understood the theory of acids and bases but also applied it to the local context that was familiar to them, namely the use of herbal medicine in everyday life. This indicates that the ethnoscience-based approach is very helpful in bridging the gap between theory and practice, emphasizing the importance of integrating local cultural aspects into science education to enhance understanding and relevance of the material (Isa et al., 2022).

Students' analytical skills improved along with their ability to distinguish the acidic and basic properties of natural materials and evaluate the chemical effects produced by those substances. Moreover, their evaluation skills also increased as they were able to connect the concepts of acids and bases with the effects generated in everyday use. A problem-based approach that integrates local context can strengthen students' abilities to evaluate and apply scientific concepts in a more relevant manner (Aidoo et al., 2016).

In addition, feedback from students regarding the use of E-LKPD was also very positive. They felt that the learning process became more engaging and interactive. The integration of technology and local culture not only made the material easier to understand but also enriched their knowledge about Indonesia's cultural wealth. Students also stated that the use of interactive quiz links, such as Quizizz, helped them test their understanding in real-time, which was identified as an effective method for enhancing students' critical thinking and collaborative skills in a digital learning environment (Onyenma et al., 2024). The use of interactive technology allows students to test their understanding directly, providing quick feedback and supporting their learning process.

Thus, the measurement results in Figure 2 and the analysis in Table 3 affirm that the Integrated Ethnoscience E-LKPD is highly effective in enhancing students' critical thinking skills. This supports efforts to create more contextual, interactive, and relevant learning experiences related to daily life while preserving local wisdom. The average score of students on the acid-base material before treatment was 51.93,

while after treatment, it increased to 86.07. This improvement resulted in an N-gain value of 0.71, which falls into the high category. These results indicate that the Integrated Ethnoscience E-LKPD developed is effective in enhancing the critical thinking skills of students in class XI MIPA 1. This indicates that the Integrated Ethnoscience E-LKPD developed is effective in improving students' critical thinking skills. The criteria for critical thinking used in the test consist of several stages, namely Elementary Clarification, Basic Support, Inference, Advanced Clarification, and Strategies and Tactics, which can be linked to the use of E-LKPD. A recap of the assessment of critical thinking criteria is presented in Table 3.

Table 3. shows a significant improvement in each criterion of students' critical thinking skills after using the Integrated Ethnoscience E-LKPD. The application of teaching strategies that are responsive to culture can help develop students' critical thinking skills by providing real-world applications of scientific concepts.

Table 3. Summary of the Assessment of Critical Thinking Skill Criteria

No	Criteria	Post-test	Pre-test	Enhancement (%)
1	<i>elementary clarification</i>	354	410	15.82
2	<i>basic support</i>	208	280	34.62
3	<i>inference</i>	124	185	49.20
4	<i>advance clarification</i>	97	212	118.6
5	<i>strategies and tactics</i>	43	117	172.1
Total Score		826	1204	45.77

This indicates that ethnoscience-based approaches, such as those implemented in this E-LKPD, encourage students to connect theoretical knowledge with practical applications, thereby strengthening their critical thinking skills. Below are the details of the improvements in each aspect of critical thinking skill:

1. Elementary Clarification

A notable increase of 15.82% is observed in the evaluation results of students. This indicates progress in their ability to focus on questions, analyze them, and formulate and respond to inquiries related to explanations or statements. Students have become more adept at

understanding and articulating simple questions, which are foundational to critical thinking. Culturally relevant science education not only enhances critical thinking skills but also aids students in establishing deeper connections between the material taught and their daily lives.

This underscores the importance of linking scientific concepts with local phenomena, thereby strengthening students' capabilities in critical thinking and problem-solving. Through the implementation of the Integrated Ethnoscience E-LKPD, students not only acquire scientific concepts but also contextualize them within their cultural practices, making the learning experience more meaningful and relevant (Trevino, n.d.).

2. Basic Support

This criterion exhibits an increase of 34.62%, indicating that students possess the ability to critically consider accurate explanations regarding the arguments they present. They are capable of assessing the reliability of sources, as well as interpreting observations derived from the learning materials, specifically the videos presented in the ethnoscience-based E-LKPD. This reflects an improvement in students' abilities to evaluate information and construct solid arguments. The 34.62% enhancement in this criterion suggests that the ethnoscience-based E-LKPD assists students in developing a more critical approach to evaluating information and arguments. This aligns with findings that indicate integrated assessments within local contexts can strengthen students' capabilities to consider source reliability and build well-founded arguments (Santos, 2017).

3. Inference

An increase of 49.20% in this criterion indicates that the use of the E-LKPD enhances students' abilities to summarize information by presenting diverse and engaging learning materials, as well as providing relevant and easily comprehensible examples. Students become more proficient in identifying relationships among concepts and drawing logical conclusions from the information provided. The 49.20% improvement suggests that the diverse and engaging nature of the E-LKPD is effective in

assisting students in summarizing information and making conclusions. Research supports that the presentation of interesting and relevant materials facilitates students' abilities to identify connections among concepts and make logical inferences (Pinneo, 1992.).

4. Advanced Clarification

An increase of 118.6% in this aspect indicates that students can describe and apply examples of problems explained by the teacher into exercises. The developed E-LKPD includes several questions regarding the application of acid-base material related to ethnoscience concepts. Students are able to respond well to the questions presented in the E-LKPD integrated with ethnoscience, demonstrating an improvement in their ability to provide deeper and more applicable explanations. The 118.6% increase suggests that students can effectively apply the examples and exercises provided. The ethnoscience-based approach within the E-LKPD reinforces students' understanding by connecting the subject matter with local contexts, as seen in the acid-base examples related to ethnoscience (Sarkingobir & Bello, 2024).

5. Strategies and Tactics

An increase of 172.1%, which is the highest among the other aspects, indicates that the use of E-LKPD is highly beneficial in assisting students in developing efficient learning strategies and tactics. The presentation of diverse learning materials tailored to students' learning styles helps them to be more effective in absorbing and applying the information learned.

The earlier improvement mentioned of 118.6% signifies that students are capable of applying the provided examples and exercises. The ethnoscience-based approach within the E-LKPD reinforces students' understanding by linking the subject matter with local contexts, as exemplified in the acid-base questions related to ethnoscience (Darmaji et al., 2022).

In summary, the data presented in Table 4 indicate that the Integrated Ethnoscience E-LKPD is highly effective in enhancing various aspects of students' critical thinking skills. The significant improvement observed in each criterion

demonstrates that this teaching method not only reinforces understanding of acid-base concepts but also fosters essential critical thinking skills, enabling students to evaluate and apply their knowledge in real-world contexts, particularly related to local wisdom such as the use of traditional herbal medicine (jamu).

Furthermore, it highlights the effectiveness of the E-LKPD in aiding students to develop learning strategies and tactics. The presentation of material tailored to students' learning styles can enhance their learning efficiency, thereby supporting the findings of this research.

CONCLUSION

Based on the evaluation results and analysis, it can be concluded that the Integrated Ethnoscience E-LKPD demonstrates a highly positive performance in the context of learning. This E-LKPD has been declared very valid, indicating that the presented materials and structure meet the established learning standards. From a practicality perspective, students reported that this E-LKPD is easy to use and implement in their learning activities, demonstrating that this tool effectively meets practical needs in the educational process. Moreover, the Integrated Ethnoscience E-LKPD has proven effective in enhancing students' critical thinking skills. This indicates that the E-LKPD not only facilitates the learning process but also successfully promotes the development of students' critical thinking abilities. Overall, the Integrated Ethnoscience E-LKPD is an excellent tool that significantly contributes to students' learning experiences in a valid, practical, and effective manner.

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