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Analysis of the Need for the Development of E-LKPD Biotechnology for Junior High Schools Based on the Local Wisdom of Subang Pineapple to Improve Understanding of Concepts and Creativity

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ABSTRACT

Biotechnology learning in junior high schools still faces challenges, including limited interactive teaching materials, teacher-centered instruction, and inadequate laboratory facilities, which hinder students' conceptual understanding and creativity. This study aimed to analyze the need to develop an ethnoscience-based biotechnology E-LKPD integrated with Project-Based Learning (PjBL) using the local wisdom of Subang pineapple (Ananas comosus (L.) Merr.). The study employed a convergent mixed-methods design involving 58 ninth-grade students and one science teacher at SMPN 2 Tambakdahan, selected through purposive sampling. Quantitative data were collected via Likert-scale questionnaires measuring understanding of the concept, creativity, and the need for interactive teaching materials, while qualitative data were collected through semi-structured interviews. Data were analyzed using descriptive statistics and thematic analysis through triangulation. The results showed that interactive E-LKPD had never been used (0%), while the need for digital teaching materials reached 95%, local wisdom integration 92%, and PjBL-based creativity features 96%. Students' initial scores of conceptual understanding and creativity were also relatively low. The study highlights the novelty of integrating ethnoscience and local wisdom into biotechnology E-LKPD as a contextual learning innovation and an alternative "virtual laboratory" solution for schools with limited infrastructure.

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1. INTRODUCTION

Natural science (IPA) learning at the junior high school level has an important role in developing high-level thinking skills, including students' creativity. In the context of 21st-century science education, there is a complex challenge to equip students not only with an understanding of concepts but also with higher-order thinking skills, particularly creativity

[1]. Creativity in science learning is closely related to students' ability to generate ideas, solve problems, and produce innovative solutions through scientific processes. These skills are essential for supporting students in meeting the demands of technological and scientific development in modern society. However, the implementation of science learning still shows a teacher-centered tendency and has not fully encouraged students to develop creative thinking skills [2]. This condition indicates a gap between the expected competencies in 21st-century learning and the actual learning practices in schools.

One of the science subjects that requires conceptual and practical understanding is biotechnology. Biotechnology materials include concepts that use living organisms and biological processes to produce products beneficial to humans. However, the characteristics of biotechnology materials, which tend to be abstract and disconnected from daily life, make it difficult for students to understand the material in depth [3], [4]. The abstract nature of biotechnology concepts often limits students' ability to relate scientific knowledge to real-world situations, leading to low engagement during learning activities. This condition affects students' low involvement and creativity. Therefore, biotechnology learning requires contextual, student-centered teaching materials that bridge theoretical concepts with students' real-life experiences.

The results of observations at SMPN 2 Tambakdahan showed that, during the learning process, LKPD was not available in either the conventional (print) or digital form. In addition, several learning facilities that support science practicum activities remained limited, hindering optimal implementation of the practicum activities. The absence of these teaching materials makes the learning process depend heavily on teachers' explanations and textbooks, limiting students' activities and failing to encourage active involvement and creativity. Meanwhile, on the other hand, the teaching materials used in science learning, if there is an LKPD that is still dominated by a conventional format that is only limited to a series of questions without an introduction to the material, which is less interactive and has not been able to facilitate the development of students' creativity. The available LKPD generally only contains a summary of material and routine practice questions, so it does not provide space for students to explore ideas and develop creative thinking [5]. This situation shows that the existing learning resources have not fully supported students' independent, interactive, and meaningful learning experiences.

The development of digital technology opens up opportunities to develop more innovative teaching materials, one of which is E-LKPD (electronic worksheets for students). E-LKPD integrates various media, such as images, videos, animations, and interactive activities, to increase student involvement in learning [6], [7]. The integration of multimedia features into E-LKPD can support visual and contextual learning, making abstract biotechnology concepts easier to understand. In addition, E-LKPD can be designed with a student-centered learning approach, potentially improving creative thinking skills [8]. One learning approach considered relevant for integration into E-LKPD is Project-Based Learning (PjBL), because it emphasizes problem-solving, collaboration, investigation, and product creation, which can stimulate students' creativity and conceptual understanding.

Previous research has shown that integrating E-LKPD into biotechnology topics improves students' conceptual understanding and changes their attitudes towards applicable biotechnology issues [9], [10]. Other studies also confirm that the use of interactive E-LKPD not only improves learning outcomes but also fosters students' creativity [11], [12]. Research on ethnoscience-based learning also revealed that integrating local culture and scientific concepts can improve students' scientific literacy and the relevance of their learning. However, these studies generally still focus on aspects of using digital media without integrating local wisdom as an authentic learning resource. On the other hand, research on local wisdom in science learning has shown that an environment-based, contextually oriented approach can improve understanding of concepts and the relevance of learning [13], [14]. However, the integration of local wisdom into interactive digital teaching materials, especially in biotechnology, remains limited. In addition, most research on biotechnology materials emphasizes cognitive aspects, while the development of students' creativity has not been a main focus. These conditions indicate that there is still a limited integration between E-LKPD, ethnoscience approaches, biotechnology learning, and creativity development in junior high school science learning.

To make learning more meaningful, it is necessary to integrate the development of e-LKPD into students' real-life context, one of which is through the local wisdom approach. Local wisdom is a value, knowledge, and practice that develops within society and can serve as a source of contextual learning [15]. The ethnoscience approach positions local wisdom as part of scientific knowledge that can be scientifically explained and integrated into classroom learning. In the context of this study, the local wisdom raised is the potential of the Subang pineapple (Ananas comosus (L.) Merr), which is one of the leading commodities in the Subang region. The use of Subang pineapple in biotechnology learning, such as in fermentation processes and food product processing, can help students understand concepts more concretely while fostering an appreciation for local potential [16]. The integration of Subang pineapple as ethnoscience-based local wisdom also provides authentic learning experiences that connect scientific concepts with students' social and cultural environments.

Thus, a gap exists between the ideal conditions for science learning and practice in the field and the limitations of previous research in integrating teaching materials, local wisdom, and the simultaneous development of creativity. Therefore, this research offers novelty in the form of the development of biotechnology E-LKPD based on the local wisdom of Subang pineapple (Ananas comosus (L.) Merr), integrated with a student-centered, project-oriented learning approach, designed to facilitate contextual, interactive, and student-centered learning. To ensure that the products developed are tested for relevance, this research begins with a needs analysis that is comprehensively measured using empirical data from schools. The results of this study are expected to provide theoretical and practical contributions in the development of innovative science teaching materials that support concept understanding and students' creativity in biotechnology learning. Based on this description, this study aims to analyze the needs for developing an ethnoscience-based biotechnology E-LKPD integrated with contextual learning approaches to improve junior high school students' conceptual understanding and creativity, using quantitative questionnaires and qualitative interviews with teachers. The analysis results will later serve as a strong empirical foundation for the development of E-LKPD, which is not only innovative but also effective and measurable in achieving the expected learning goals.

2. METHOD

This study uses a mixed-methods research design that combines qualitative and quantitative approaches to obtain a comprehensive picture of the needs for E-LKPD development. The mixed-methods design applied in this study is a convergent mixed-methods design, in which quantitative and qualitative data are collected in parallel, analyzed separately, and then integrated to strengthen the interpretation of the findings. The approach applied focuses on needs assessment design, where quantitative data is used to measure the scale of needs and field conditions, while qualitative data is used to explore in depth the learning context and the potential for integrating the local wisdom of Subang pineapples. The combination of these two methods aims to validate each other (triangulation) to produce more comprehensive, objective, and reliable findings as an empirical basis for the development of teaching materials [17]. This design was selected because it allows researchers to obtain measurable data regarding the level of need for E-LKPD while simultaneously understanding contextual problems experienced by teachers and students in biotechnology learning.

The subjects in this study are educators and students, and the sampling technique is purposive sampling (purposeful sampling). The main selection criteria are based on the subject's direct involvement and relevance to the learning process of biotechnology materials at the school. The chosen teacher subject is 1 junior high school science teacher, who serves as the main practitioner of the subject and an expert resource person on classroom pedagogical conditions. Meanwhile, the sample consisted of 58 students from two classes: 30 from class IX-E and 28 from class IX-D. The selection of these classes was carried out with the consideration that they are representative target users (who have or are studying biotechnology) to map the score of concept understanding, creativity, and the level of need for interactive teaching materials [18]. The indicators of concept understanding measured in this study include students' abilities to explain biotechnology concepts, identify biotechnology applications, and relate concepts to daily life contexts. Meanwhile, creativity indicators include fluency, flexibility, originality, and elaboration in solving biotechnology-related problems. Although the sample was limited to one school context, it was considered adequate to provide an initial empirical overview for the E-LKPD development needs analysis stage.

The main data source (primary) was obtained directly from the research subjects through two complementary data collection techniques, namely questionnaires and interviews. A closed-ended Likert-scale questionnaire was distributed to students and teachers to collect quantitative data on the current availability of teaching materials, the level of initial concept understanding, and the percentage of perceived need for E-LKPD based on local wisdom (Ananas comosus (L.) Merr.). The questionnaire instrument was developed based on indicators of conceptual understanding, creativity, interactive learning needs, and integration of local wisdom. Prior to use, the instrument was validated by experts in science education and in the development of teaching materials to ensure content validity. Reliability testing was conducted using internal consistency analysis to determine the stability of questionnaire responses. As a complement, a semi-structured interview technique was conducted with science teachers to gather deeper qualitative data on specific obstacles in the field, curriculum analysis, and the justification for why the local wisdom of Subang pineapple is relevant and prospective for raising students' creativity. The interview guidelines were systematically organized to explore learning conditions, constraints in biotechnology teaching, students' development of creativity, and teachers' perspectives on implementing an ethnoscience-based E-LKPD.

The data analysis procedure is carried out simultaneously and integrated according to the type of data. The questionnaire data were analyzed using quantitative descriptive statistics, with scores categorized into levels of E-LKPD need. Meanwhile, the qualitative data from the interviews were analyzed using an interactive model that included data condensation (sorting important information), narrative presentation of the data, and conclusion. The interview analysis process was conducted through coding procedures consisting of data categorization, identification of recurring themes, interpretation of findings, and synthesis of relevant patterns related to biotechnology learning needs and creativity development. The results of the analysis of the two types of data are then synthesized to formulate the most appropriate specifications and characteristics of E-LKPD to facilitate improvements in students' understanding of concepts and creativity [19]. The integration of quantitative and qualitative findings was carried out through triangulation to ensure consistency, strengthen validity, and provide a more comprehensive interpretation of the research results.

Ethical considerations were also applied in this study by obtaining permission from the school and ensuring that all participants voluntarily agreed to participate. The confidentiality of participants' identities and responses was maintained throughout the research process and data reporting.

Table 1. Research flow (needs analysis stage)

Research Stages	Activity/Procedure	Instruments / Outputs
1. Preparation Stage	Literature review, formulation of research instruments, and determination of research subjects (Science Teachers & Class IX Students).	Draft Needs Questionnaire, Interview Guidelines, Instrument Grid.
2. Stages of Data Collection	Distribution of questionnaires to 58 students (Classes IX-E & IX-D) and in-depth interviews with 1 junior high school science teacher.	Quantitative Data (Questionnaire Scores) and Qualitative Data (Interview Transcripts).
3. Data Analysis Stage	Processing of the percentage of questionnaire data (Descriptive Statistics) and reduction/presentation of interview data (Interactive Model). Conclusion	E-LKPD Needs Profile, Mapping Concept & Creativity Constraints.
4. Synthesis Stage & Conclusion	Triangulation of quantitative and qualitative data to determine the specification of E-LKPD biotechnology of the local wisdom of Subang pineapples.	The Empirical Foundation and Initial Design (Characteristics) of the E-LKPD are to be developed.

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3. RESULTS AND DISCUSSION

3.1. Results

a. Profile of Learning Conditions, Availability of Teaching Materials, and Initial Score

The main findings show a gap between the availability of infrastructure and the demands of a curriculum that expects innovative learning. Science learning in the classroom is still dominated by packaged books, PowerPoint, and, occasionally, conventional printed LKPD. Although schools have started to utilize smart televisions and *Interactive Flat Panels* (IFPs), the media used is not yet fully interactive and participatory. This condition indicates that technology facilities available in schools have not been optimally utilized to support student-centered and creativity-oriented learning.

More crucially, practicum activities are significantly constrained by the condition of the laboratory, which is destroyed and cannot be used, as well as by limitations on tools and materials. This limits biotechnology learning to simple concept discussions or poorly structured projects (such as conventional tape-making). The absence of laboratory facilities limits students' opportunities to gain direct scientific experience, even though biotechnology learning ideally emphasizes observation, experimentation, and problem-solving.

Table 1 and Table 2 below outline the quantitative profile of the availability of teaching materials and the projection of students' initial scores compiled based on confirmation of field conditions:

Table 1. Profile of teaching material availability and learning conditions

Assessment Indicators	Quantitative Conditions (Survey Projections)	Qualitative Confirmation (Teacher Interview)
Use of LKS/Printed Books	Very High (>90%)	Teachers use packaged books and printed LKPD from companion books.
Use of Interactive E-LKPD	0%	The teacher stated that he had never used interactive E-LKPD.
Integration of Local Wisdom	Low (<15%)	Biotechnology learning has not been specifically linked to local potential, such as Subang pineapple processing.
Practicum Implementation	Very Low	Laboratories were destroyed; The practicum is limited only to very simple experiments with independent materials.

Table 2. Initial score of students' concept understanding and creativity

Measured Aspects	Average Initial Score	Criteria	Supporting Qualitative Findings
Concept Understanding	61,50	Less	Students are less active when they use only printed books/LKPDs. Current technology is quite helpful for visualization, but it is not optimal.
Creativity	55,20	Very Less	Students are active during practicum, but still need direction in developing creative ideas.

The results in Table 2 indicate that students' conceptual understanding and creativity scores remain relatively low. The low creativity score reflects that learning activities have not fully facilitated fluency, flexibility, originality, and elaboration in generating ideas. In addition, the dominance of teacher-centered learning and limited project activities contributes to students' dependence on teacher instructions rather than encouraging independent exploration.

b. The Level of Need for E-LKPD Development Based on Local Wisdom

Research shows a high urgency for developing new media. Science teachers emphasized that development-based learning media and local wisdom are essential. The findings also reveal that both teachers and students expect digital learning media to present biotechnology concepts visually, interactively, and systematically.

Most of the students at SMPN 2 Tambakdahan already have *smartphones* (Android cellphones), which is an excellent basic infrastructure capital for the implementation of E-LKPD. The availability of personal digital devices strengthens the feasibility of implementing E-LKPD as an alternative learning solution despite laboratory limitations.

Table 3. The need for e-LKPD based on local wisdom

Needs Indicators	Percentage of Needs (Teachers & Students)	Field Findings Analysis
Digital Teaching Materials (E-LKPD)	95% (Highly Needed)	Can solve the problem of destroyed laboratories because E-LKPD guides digital-based independent experiments/projects.
Integration of Local Wisdom (Pineapple Subang)	92% (Required)	It is expected to foster environmental awareness and provide an alternative to conventional media such as tempeh/tape.
Project-Based Features (PjBL) & Creativity	96% (Highly Needed)	Teachers hope that E-LKPD can guide students in carrying out projects systematically, step by step.

The high percentages across all indicators confirm that interactive digital teaching materials integrated with local wisdom and project-based learning are urgently needed in biotechnology education. The findings also indicate that contextual learning resources based on local potential are considered more meaningful and relevant to students' daily experiences.

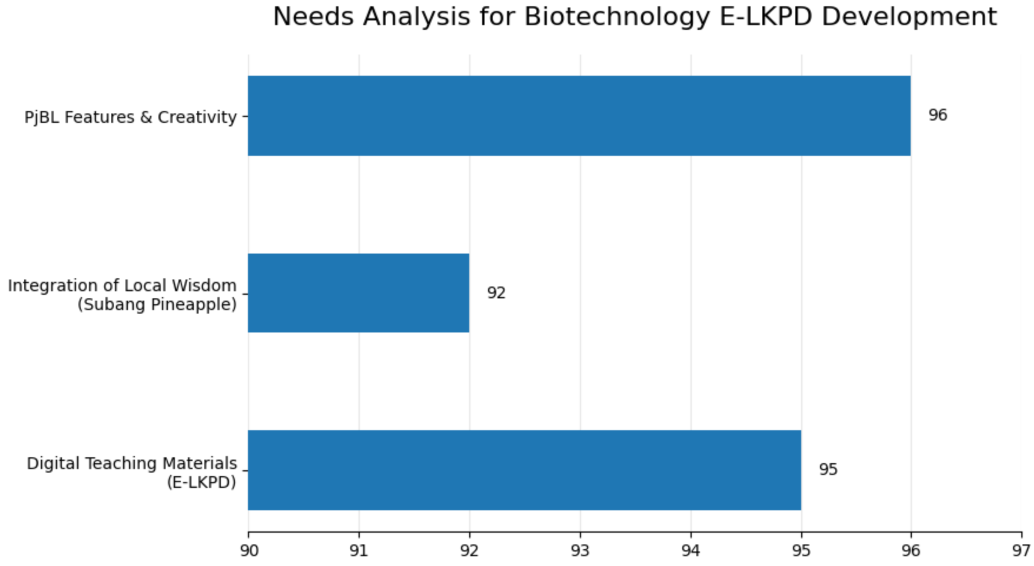

Figure 1. The need for E-LKPD based on local wisdom

The visualization of needs analysis further demonstrates the dominance of positive responses toward the development of ethnoscience-based E-LKPD. Figure formatting and graphical consistency are important for improving readability and strengthening data presentation quality.

c. Comparative Analysis with Previous Research

The findings of this preliminary study strengthen and provide significant *novelty* compared to previous research trends. While previous research has generally focused on the development of conventional project-based LKPD that relies on the availability of physical facilities and laboratories in schools, this research presents an innovative solution to infrastructure limitations. In line with Sari's [20] recommendation to shift reliance away from passive print media, this study proposes an interactive E-LKPD based on Project-Based Learning (PjBL) that guides students to conduct experiments flexibly and independently outside the classroom. Furthermore, instead of simply presenting biotechnology in general, the E-LKPD was explicitly engineered using an ethnoscientific approach that raises the endemic commodity of Subang Pineapple (*Ananas comosus* (L.) Merr). As evidenced by the study by Junita and Yuliani [21], the integration of local wisdom through the E-LKPD instrument has proven crucial for simplifying abstract scientific phenomena into contextual realities that are easy to understand, as well as for honing students' literacy skills.

Compared with previous studies, the novelty of this research lies not only in the use of digital teaching materials but also in the integration of ethnoscience, contextual biotechnology projects, and creativity-oriented learning within a single instructional design. This study also positions E-LKPD as an adaptive learning medium capable of functioning despite infrastructure limitations, a feature that has rarely been emphasized in previous biotechnology learning studies.

This integrative approach proactively positions creativity not only as a response to the limitations of physical facilities but also as a key cognitive variable that is digitally guided, enabling students to actively solve and gather, rather than simply being passive learners.

3.2. Discussion

The results of a preliminary study at SMPN 2 Tambakdahan revealed a fundamental gap between the reality of Natural Sciences (IPA) learning and 21st-century competency standards. Interviews with teachers confirmed that learning is still dominated by conventional means such as packaged books and printed worksheets, which directly contribute to the lack of active student involvement. This problem is further exacerbated by the destruction of the science laboratory infrastructure, preventing biotechnology practicum activities. The absence of these physical facilities can reduce students' understanding by depriving them of empirical experience in science. Therefore, a digital media intervention is urgently needed. This aligns with Astuti's research [22], which shows that the use of Electronic Learner Worksheets (E-LKPD) is highly feasible and effective as a substitute for guiding virtual experiments and for training students' science process skills when physical laboratories are unavailable. These findings indicate that digital teaching materials are no longer merely complementary learning tools but have become strategic learning solutions in schools with limited infrastructure.

As a tactical step to address the limitations of these facilities, the development of an interactive E-LKPD integrated with the Project-*Based Learning* (PjBL) model was proposed as the main solution. Although teachers at the school have tried to implement project-based learning sporadically, the implementation is acknowledged as poorly systematized and limited to simple, conventional experiments. Through E-LKPD, the PjBL syntax (stages) can be digitally engineered so that students can follow the project guidelines in a sequential, structured, and independent manner outside the classroom. The level of effectiveness of this approach is confirmed by an empirical study by Annifah [23], who found that the development of PjBL-based E-LKPD as a whole can facilitate and guide students to design and execute learning projects independently, which ultimately controls analytical and problem-solving skills. The integration of PjBL into E-LKPD also theoretically supports the development of creativity, as students are encouraged to investigate problems, generate alternative ideas, and create contextual biotechnological products.

More than just the transformation of media from printed sheets to digital screens, the essence of E-LKPD's novelty lies in the infusion of local wisdom about the Subang pineapple (*Ananas comosus* (L.) Merr) through an ethnoscience approach. So far, the biotechnology material taught at the institution tends to be *textbooks and fails* to leverage the region's very rich local potential. An ethnoscience approach is necessary to demystify the concept of science, which can seem abstract, and make it a daily phenomenon relevant to students' cultural realities. The urgency of this approach is strengthened by the findings of Dewi [24], who in her research concluded that the reconstruction of regional cultural knowledge (ethnoscience) has proven to be effective in being used as an essential supplement to the junior high school science curriculum because it can change the perception of science to be much more concrete, meaningful, and easy to assimilate. From a theoretical perspective, integrating ethnoscience strengthens contextual STEM learning by reconstructing it through local cultural practices familiar to students. This process helps students connect abstract biotechnology theories with authentic experiences in their social environment.

Intervention on creativity variables and concept understanding is the primary target, addressed simultaneously through the design of this E-LKPD. Field data show that although students often show enthusiasm during stagnation, they often struggle to generate original ideas without intensive teacher guidance. This is where the PjBL syntax in E-LKPD forces students not only to read theories, but also to create innovations. This is emphasized by Wahab [25], who concludes that project-based E-LKPD that raises environmental awareness/local potential not only sharpens critical thinking skills but also directly stimulates students to implement environmental solutions. Through this Subang pineapple exploration project, students' creativity is honed as they are challenged to differentiate biotechnology-derived products [26]. Creativity development in this study is reflected through students' abilities to elaborate ideas, develop product innovations, and solve contextual problems related to biotechnology and local resources.

From a comprehensive pedagogical perspective, the design of this learning instrument offers a strategic contribution to improving the quality of science education in regions with limited infrastructure [27]. In practice, this innovation leads educators to exploit the ownership of smart devices (smartphones) among students to function as "portable laboratories", while optimizing the smart televisions (*Interactive Flat* Panels) available in schools. Theoretically, the design of the E-LKPD represents an innovative architecture that successfully marries technological advancements (interactive software), pedagogical maturity (Project-*Based Learning*), and sociocultural depth (ethnoscience). The triangulation of these three elements gives rise to a holistic science-learning ecosystem aligned with 21st-century literacy without uprooting students from their local roots of wisdom [28]. This finding strengthens international discussions on contextual STEM education, which emphasize integrating technology, culture, and authentic problem-solving into science learning environments.

Apart from the advantages offered, the E-LKPD implementation design still needs to anticipate various technical challenges during deployment [29]. Basic supporting factors, such as the availability of gadgets, are indeed adequate, but the main obstacles identified in the interviews are fluctuations and inconsistencies in the quality of the internet network in the school environment and students' domiciles. Absolute dependence on high-risk online access leads to distractions and extraneous cognitive load, with students' concentration sucked up by network buffering constraints rather than focusing on the essence of biotechnology [30]. This condition indicates that digital learning implementation requires not only technological readiness but also infrastructure adaptation and flexible accessibility design. As an absolute recommendation for the development stage, the E-LKPD Pineapple Subang platform must be equipped with an offline cache storage feature or the ability to convert downloads into secondary interactive formats, so that students' scientific experience can be maintained despite weak regional telecommunications infrastructure. The study is also limited by its relatively small sample size and focus on a single school context, so further research involving broader participants and experimental implementation is needed to examine the effectiveness of E-LKPD more comprehensively.

4. CONCLUSION

This study confirms that biotechnology learning at SMPN 2 Tambakdahan still faces challenges, including limited interactive teaching materials, inadequate laboratory facilities, and limited integration of contextual learning approaches that support students' creativity and conceptual understanding. The findings indicate that the development of an ethnoscience-based biotechnology E-LKPD integrated with Project-Based Learning (PjBL) is highly needed to create more meaningful, interactive, and student-centered learning while connecting biotechnology concepts with students' cultural and environmental contexts through the local wisdom of Subang pineapple (Ananas comosus (L.) Merr). The study contributes theoretically by strengthening the concept of contextual science learning through the integration of technology, pedagogy, and ethnoscience, while practically providing implications for curriculum development and teacher professional development in designing adaptive digital learning environments for schools with limited infrastructure. The use of smartphones and interactive digital platforms as "portable laboratories" also offers an alternative to support science practicum activities in resource-constrained schools. However, this study is limited to a needs analysis conducted in one school with a relatively small number of participants and has not yet reached the product implementation and effectiveness testing stage. Therefore, future research is recommended to develop and experimentally test the effectiveness of the ethnoscience-based biotechnology E-LKPD in improving students' creativity, conceptual understanding, scientific literacy, and problem-solving skills across broader educational contexts, while exploring offline-access digital features to enhance learning accessibility and flexibility.

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