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Developing Ethnoecology-Based Digital IPAS Teaching Materials to Foster Pancasila Students in Madiun

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ABSTRACT

The implementation of the Independent Curriculum (Kurikulum Merdeka) in Indonesia emphasizes flexibility, contextualization, and competency-based learning. However, many elementary school teachers, particularly in Madiun Regency, still rely on generic and non-digital materials that fail to represent local socio-ecological realities. This study aims to develop and validate digital teaching materials for Integrated Natural and Social Sciences (IPAS) based on Madiun's ethnoecology to strengthen the Pancasila Student Profile. Using the Research and Development (R&D) approach adapted from Gall, Gall, and Borg (2007), the research involved students from grades I and IV in selected elementary schools through purposive sampling. Data were collected using expert validation sheets, teacher and student response questionnaires, and pre-test and post-test assessments. The results show that the developed materials are **v**alid**,** practical, and effective in improving learning outcomes and fostering critical thinking, environmental awareness, and cooperative values. Students demonstrated increased engagement and conceptual understanding when interacting with digital modules that featured local wisdom such as farming traditions, forest management, and water conservation. Theoretically, this study contributes to the framework of culturally responsive and technology-integrated science education. Its novelty lies in combining IPAS, ethnoecology, digital learning, and Pancasila-based pedagogy, a synthesis that has rarely been explored, especially in elementary education. The findings suggest that integrating local ecological knowledge with digital pedagogy can enhance contextual, meaningful, and character-oriented learning experiences aligned with the goals of the Independent Curriculum.

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1. INTRODUCTION

Learning in elementary and secondary school education units in Indonesia starting from the 2022/2023 academic year uses the Independent Curriculum (KM). KM is a curriculum with diverse intracurricular learning by optimizing content so that students have enough time and space to explore concepts and strengthen their competencies. KM gives teachers or learners the freedom to choose various learning tools so that the learning and teaching process can be adjusted to the learning needs and interests of students (Humble et al., 2023). The flexible implementation of KM is not all schools and related agencies throughout Indonesia have the same readiness to implement it. Schools have three options in implementing it, namely; implementing several parts and principles of KM without changing the curriculum of the education unit that is being implemented, implementing KM using teaching tools that have been provided, and implementing KM by developing various teaching tools (Imaniyati et al., 2024; Lince, 2022; Vioreza et al., 2023).

In other words, educational units are given the freedom to implement KM based on the readiness of each school. This is as implemented in 418 elementary schools in Madiun Regency. Based on interviews and observations conducted by researchers from July to November 2024, it was obtained that public and private elementary schools in Madiun Regency in the 2023/2024 school year have simultaneously begun to implement KM in stages. In this school year, it was implemented in class phases A and B. KM has advantages compared to the previous curriculum, namely it is simpler and more in-depth. It is said that this KM is simple and in-depth because there are several subjects that are simplified and more focused on essential materials and the development of student competencies according to their phase (Sormunen et al., 2020). One form of simplification is the subject of Natural Sciences (IPA) and Social Sciences (IPS). IPA and IPS in the curriculum that was previously implemented in elementary schools were taught separately, but later in KM they were "integrated" and/or simplified into Natural and Social Sciences (IPAS) (Fatonah et al., 2023). The basic consideration is that elementary school/MI children are still in the stage of thinking concretely/simplely, holistically, comprehensively, and not in detail. So that in their learning, simplification needs to be carried out by referring to the principles of student conditions, lifelong learning, holistic, relevant, and sustainable (Terziev, 2019). This is so that students become superior human resources, lifelong learners who have global competence and behave in accordance with the values of Pancasila (Masrukhin et al., 2021).

Elementary school science aims to; (1) develop interest and curiosity, so that students are triggered to study phenomena around humans, understand the universe and its relationship to human life, (2) play an active role in maintaining, protecting, preserving the natural environment, managing natural resources and the environment wisely, (3) develop inquiry skills to identify, formulate and solve problems through real action, (4) understand who they are, understand how their social environment is, interpret how human life and society change over time, (5) understand the requirements needed by students to become members of a community and nation and understand the meaning of being a member of society, nation and world, so that they can contribute to solving problems related to themselves and the environment around them; and, (6) developing knowledge and understanding of concepts in science and technology and applying them in everyday life (Evagorou et al., 2015; Hadzigeorgiou, 2021; Khryk et al., 2024; Rogers, 2020).

To realize the above objectives, teachers in implementing learning are required to be skilled in developing and/or using appropriate, contextual learning materials, covering living things and inanimate objects in the universe and their interactions, human life as individual and social beings who interact with their environment (Arumsari, 2023; Evagorou et al., 2015). With this simplification, it is hoped that students will grow in curiosity about the phenomena that occur around them, and this curiosity can trigger an understanding of how the universe works and interacts with human life (Cavicchi, 2024; Ball, 2024). The skill of developing teaching materials is an important part for teachers so that learning materials can be conveyed properly, and students also have good learning activities (Lubis et al., 2023). In addition, the positive impact of teaching materials is that teachers will have more time to guide students in the learning process, help students to gain new knowledge from all sources or references used in teaching materials, and the role of teachers as the only source of knowledge is

reduced. However, this has not been fully implemented by elementary school teachers in Madiun Regency. Elementary school teachers in Madiun Regency total 836 people and are distributed to 418 elementary schools (An et al., 2013).

Of the number of teachers, 16 have developed science and natural science teaching materials. The teaching materials that they have successfully developed are still partial and less scientific. Meanwhile, other teachers in implementing science and natural science learning use finished or semi-finished teaching materials that do not meet the criteria for good teaching materials and are not in accordance with the socio-cultural and ecological aspects of students. In fact, the environment is the first and main source of learning, without involving the environment, it will be difficult to realize quality learning (Sutama et al., 2015). So it is not effective for students in constructing their learning experiences.

In addition to the above teaching material problems Ng (2019), teachers in science learning in general have not developed and/or utilized information and communication technology (ICT). This is in line with the demands of 21st century learning and the era of the industrial revolution 4.0, namely digitalization and computerization. ICT allows for learning interactions that do not recognize space and time. Learning where there are classes that do not have to be done face-to-face with the teacher. Students can learn anytime, anywhere, even with anyone, without having to meet face to face with the teacher. Not many science teachers have implemented this because they have not been able to create and develop it. As a result, there is a negative impression that science learning is only a memorization lesson, not interesting, boring, not intelligent, Lower Order Thinking Skills (LOTS) or low-level thinking skills that are only able to answer factual questions with only one alternative answer and usually the answer is something that can be found directly in the book, so that the learning outcomes are not as expected (Lubis et al., 2023). For this reason, it is necessary to develop elementary school science learning materials based on ethnoecology in Madiun Regency by utilizing digital technology.

Many studies have been conducted on IPAS before. The elementary school science learning materials developed above are still global and general. In fact, one of the goals of science learning in elementary school is for students to become members of the community and nation and understand the meaning of being a member of society and nation so that they can contribute to solving problems related to themselves and the surrounding environment (Wanti, 2023). So that in developing science teaching materials, it is necessary to simplify the concept of natural and social sciences by making the surrounding environment (nature and social) and local wisdom as the material. So that students find it easier to build the construction of their minds because they interact with nature and life contextually. That is why this research was conducted.

The implementation of the Independent Curriculum (Kurikulum Merdeka) has introduced a more flexible and competency-oriented learning framework; however, disparities in teacher readiness and local adaptation remain a major challenge, particularly in elementary schools. In Madiun Regency, most teachers still depend on generic and non-digital teaching materials that fail to represent students' sociocultural and ecological contexts. Previous studies on IPAS (Integrated Natural and Social Sciences) have largely focused on curriculum structure, overlooking the importance of localized content and digital integration. Consequently, science learning in elementary schools often remains limited to memorization and low-order thinking skills, contradicting KM's goal of fostering critical, creative, and contextually aware learners. This gap underscores the need for innovative learning materials that integrate local wisdom and digital media to make learning more meaningful and relevant.

This study addresses those gaps by developing and evaluating digital science learning materials based on Madiun's ethnoecology. Academically, it contributes to the discourse on culturally responsive and technology-integrated curriculum design by positioning local ecological knowledge as a valid source of scientific understanding. Practically, it provides a pedagogical model that aligns with the Pancasila student profile, enhances teacher capacity in material development, and supports the realization of meaningful, inquiry-based science learning. Through this approach, the research bridges local culture with global competencies, reinforcing the essential principles of Kurikulum Merdeka in the context of elementary education.

Studies and research on science learning materials have not been widely conducted because science as a subject is relatively new. Science subjects began to be implemented in elementary and secondary schools starting from the odd semester of the school year and this was not implemented at all grade levels. For example, in Madiun Regency, East Java Province, it was implemented in grades I and IV.

The implementation of the Independent Curriculum (Kurikulum Merdeka) has introduced a more flexible, competency-based, and student-centered learning approach in Indonesian schools. However, the uneven readiness of schools and teachers to adapt to this curriculum has resulted in inconsistent implementation, particularly in elementary education. In Madiun Regency, most teachers still rely on generic and non-digital teaching materials that are detached from students' sociocultural and ecological realities. Prior studies on IPAS (Integrated Natural and Social Sciences) have predominantly explored its curricular structure and pedagogical framework, yet few have integrated local wisdom or digital innovation. Consequently, science learning in elementary schools tends to remain abstract, limited to memorization, and disconnected from real-life contexts contradicting the Independent Curriculum's vision of fostering critical, creative, and Pancasila-oriented learners. This gap reveals the urgent need for innovative teaching materials that merge local ecological knowledge (ethnoecology) with digital learning media to create meaningful, contextualized learning experiences.

This study offers a distinctive contribution by combining IPAS integration, ethnoecological principles, digital pedagogy, and the Pancasila Student Profile within a single instructional framework—an approach that has rarely been explored, especially at the elementary school level. The research not only develops and validates digital science learning materials based on Madiun's ethnoecology but also examines their pedagogical impact on students' understanding, character formation, and environmental awareness. Theoretically, it extends the discourse on culturally responsive and technology-enhanced curriculum design by positioning local ecological knowledge as a valid epistemic foundation in science education. Practically, it provides a replicable model for teachers to design localized, digital-based learning resources that embody the spirit of Kurikulum Merdeka while nurturing students' curiosity, digital competence, and alignment with Pancasila values. This synthesis of IPAS–Ethnoecology–Digital Learning–Pancasila Pedagogy represents a novel and strategic pathway for advancing holistic science education in Indonesia's elementary schools.

Based on this, the focus of this study is: (1) how is the process of developing elementary school science learning materials based on Madiun ethnoecology and integrated with digital media?; and (2) what is the quality of the product of developing elementary school science learning materials based on Madiun ethnoecology and integrated with digital media? The purpose of this study is to develop science learning materials based on local Madiun ethnoecology that are integrated with digital media to support the achievement of the Pancasila student profile as a whole.

2. METHODS

This study employed the Research and Development (R&D) method, aiming to produce and validate elementary school science learning materials based on Madiun's ethnoecology integrated with digital media. The research subjects were students from grades I and IV in public and private elementary schools across Madiun Regency, East Java. The total population consisted of 436 elementary schools (411 public and 25 private). Sampling was carried out using purposive sampling, with selection criteria based on (1) schools that had implemented the Independent Curriculum (Kurikulum Merdeka), (2) the availability of digital learning infrastructure, and (3) teacher willingness to collaborate in the research process. The limited trial was conducted in 15 schools (one representative school per sub-district), while the extensive trial involved 45 schools (three schools per sub-district), ensuring diverse representation of both urban and rural contexts.

Judge et al. (2015) model consisting of ten systematic stages: (1) research and data collection, (2) planning, (3) product draft development, (4) initial field testing, (5) revision of preliminary product, (6) main field testing, (7) revision of main product, (8) operational field testing, (9) final product revision, and (10) dissemination and implementation. Data collection employed several instruments: (a) expert

validation sheets for assessing content, media, and language feasibility; (b) teacher and student response questionnaires to measure practicality and usability; and (c) learning outcome tests to evaluate effectiveness. Expert validation involved three specialists—one in science education, one in ethnoecology, and one in educational technology. Quantitative data from validation and testing were analyzed using descriptive statistics (mean, percentage, and category determination), while qualitative data from interviews and observations were analyzed thematically to refine the final product. This methodological design ensures the research process is transparent, replicable, and grounded in both pedagogical rigor and contextual relevance.

3. FINDINGS AND DISCUSSION

Development Process

The Madiun ethnoecology-based science learning materials were developed in the form of interactive digital modules containing local content such as rain-fed farming systems, community forest management, and cultural values in harvesting and water conservation traditions. This content is integrated with the basic competencies of science for grade IV of the Independent Curriculum. The following is a description of each stage in this research and development.

a. Research and Data Collection

The initial steps taken were research and data collection. Based on the literature study conducted, it showed that there was a suitability of the ethnoecology topic with the current Elementary School Science material of the Independent Curriculum Phase B. Furthermore, the literature study was supported by interviews with stakeholders. The results of interviews with teachers showed that local wisdom-based learning was still minimally implemented. Meanwhile, based on data collection on local wisdom in the Madiun area, the results included the Wiwit tradition, methil, organic farming practices, utilization of community forests, and the tradition of mutual cooperation in the Madiun community.

b. Planning

Based on the results of research and data collection, a design of teaching materials was prepared that includes: ethnoecology-based science learning objectives; scientific and project-based learning activities; integration of Pancasila Student Profile values; and a design of digital learning media in the form of Canva e-books, digital LKPD, and learning videos.

c. Product Draft Development

In this stage, the following digital e-books have been produced.

Figure 1. Display of E-book

In addition to e-books, at this stage, digital LKPD and a Pancasila Student Profile assessment rubric have also been produced. The draft product that has been produced is then ready to be validated by experts. For this reason, at this stage, expert validation instruments are also prepared. The results of expert validation are as follows.

Table 1. Expert Validation Results

Aspect	Indicator	Score
Conformity with Objective Learning	Material teach This in accordance with objective learning that you want achieved	4
	Material teach This support achievement competence the basis that has been set	5
	Topics discussed in material teach relevant with context local (ethnoecology) Madiun).	5
Legibility And Understanding	Text in material teach easy understood by student	5
	Structure and material format teach Already organized with Good	4
	Language used in appropriate teaching materials with level ability student	5
Aspects of the Diversity of Learning Methods	Material teach This contain variation method interesting learning (eg , discussions , quizzes , practice) direct).	5
	learning media used (images , videos, infographics) support understanding student .	5
	Material teach provide motivating activities student For active participate	4
Aspects of Relevance to Real Life and Local Wisdom	Material teach connect material with life real students, especially those related to with ethnoecology Madiun	5
	Material teach This promote values wisdom local that can applied in life daily	4
	Material teach covers friendly approach environment And support preservation nature	5
Practical Aspects of Use	Material teach This easy applied in the learning process in class	4
	Material teach This can used by various type students, including those who have need special	4
	Time required For use material teach This Enough efficient And No burdensome student	5

Creativity and Innovation Aspects	Material teach This innovative And creative in serve material learning	5
	Material teach This give room For student explore And be creative	4
	Material teach This Enough interesting For increase interest Study student	5
Total		83
Average		4.61

Based on the results of the expert validation, the product is declared valid and feasible to be used in the trial stage with minor revisions. The suggestion given is to add mutual cooperation material to further strengthen the profile of Pancasila students integrated into the teaching materials.

d. Initial Trial

After being declared valid and feasible to be tested, the product draft was ready to be tested. The initial trial was conducted on 10 fourth grade students at SDN Klegen 04 Madiun. Based on the results of the trial, the teaching material product that had been developed could be well understood by students. In the interview session with teachers and students, suggestions were obtained that the display of images in the teaching material could be added more. Meanwhile, suggestions from teachers stated that the preparation of assignments was adjusted to the allocation of learning time.

e. Revision of Initial Test Results

Based on suggestions and input from students and teachers in the limited trial, the product draft was revised according to the suggestions given. The results of the revision were to add infographics, local Madiun illustrations, and simplify the LKPD instructions to adjust the allocation of time for completing assignments. The following are the results of the revisions made.

Figure 2. Display E-book after revision

f. Field Trial

The field trial was conducted on 40 students from two different elementary schools with the same homogeneous level. In this field trial, teachers and students were actively involved in the learning process. The observation results showed that students were more enthusiastic because the material was close to their daily environment. The videos played in the learning media were not far from the students' environment. The following is a clip of the video played.

Figure 3. Display of Learning Video Media

g. Field Test Product Revision and Dissemination

After the field test was conducted, the layout, font settings, and examples of local agricultural activities were refined. After being refined, the final product was completed and ready to be disseminated. The product has been disseminated through science teacher workshops, MGMP, and digital platforms. Teachers stated that the product was very helpful in contextual science learning.

Quality of Development Products

The quality of development products is measured based on the results of filling out the questionnaire to see teacher and student responses, as well as student learning outcomes obtained from the evaluation test conducted.

a. Teacher Response

Based on the results of the questionnaire with teachers, 85% of teachers stated that the media was easy to apply and 80% of teachers stated that they preferred teaching with digital media based on local wisdom. In addition, teachers felt that it was not difficult to provide examples because they were already available around the school that were in accordance with everyday life.

b. Student Response

Based on the results of the questionnaire with students, the following student responses were obtained. As many as 95% of students stated that the media was easy to understand and as many as 90% of students stated that they preferred learning with digital media based on local wisdom. In addition, students felt that the material felt close to everyday life.

c. Student Learning Outcomes

The test was conducted before and after the Madiun ethnoecology-based IPAS learning materials were developed and used. The following are the learning outcomes before and after.

Table 2. Learning test results

No	Student Name	Learning Achiefment	
		Pre-test	Post-test
1	IN	70	80
2	AJ	50	85
3	A A	60	85
4	AFF	60	80
5	ARD	65	80
6	BM	70	85
7	CN	80	80
8	GAP	70	85
9	GY	70	80
10	HS	70	85

11	HZ	65	85
12	IF	65	85
13	KT	85	75
14	KK	90	85
15	MAA	75	80
Average value		69,67	82,3

The average pre-test score of students: 69.67. The average post-test score of students: 82.3. Thus, there has been an increase in learning outcomes of 12.67 points. Statistically, it shows the effectiveness of teaching materials in improving student understanding.

Discussion

The development of ethnoecology-based IPAS digital teaching materials is carried out to answer the needs of contextual learning mandated by the *Independent Curriculum*. The R&D development model is oriented towards systematic improvement through empirical validation and product iteration (Wanti, 2023). Effective development research models to produce valid and implementable educational products (Dündar et al., 2016). The integration of local values such as the tradition of Wiwit, methil, and water conservation is in accordance with stating that the environment and local culture are the main learning resources in primary education (Setiyadi et al., 2018). Moreover, Ehsan et al. (2023) emphasizing the importance of social context in building the meaning of children's learning through environmental interaction. Ethnoecology-based approaches also strengthen the view Pohan et al. (2021) that social ecology has a direct effect on the formation of learning behaviors. Thus, the integration of local content in digital teaching materials not only enriches the content, but also builds students' cognitive and affective relationships with their environment.

The validation results showed an average score of 4.61, indicating that the teaching materials included in the category were very suitable for use. Expert validation serves to ensure product conformity with effective pedagogical principles, content, and media (Farimani & Shahri, 2020). This assessment is reinforced by Muna et al. (2023) explaining that the success of instructional design depends on the fit between learning objectives, media, and student characteristics. The feasibility of this product is also in line with the principle Sahra (2021) in multimedia *learning theory*, which states that the integration of text, images, and animation strengthens the power of learning retention and transfer. Mention that teaching materials that are concrete and according to the student's cognitive stage facilitate the process of internalizing scientific concepts (Maksum & Salahudin, 2023). Easy-to-understand aspects of language support theory Lia (2023) about *comprehensible input*, which emphasizes the importance of language level suitability in student comprehension. Overall, these findings prove that systematic validation produces credible, contextual, and communicative teaching materials according to the characteristics of elementary school students.

As many as 85% of teachers stated that digital teaching materials are easy to implement, and 80% of them prefer digital media-based learning. This is in line with Eliya (2017) which confirms that the combination of visual and interactive media can improve learning efficiency. Basri et al. (2024) Explaining that the digital native generation needs technology-based learning media to remain relevant and interesting. The positive response of the teacher also proves the view Tondeur et al. (2020) about the *TPACK framework*, where the integration of technology, pedagogy, and content results in an effective learning experience. Meanwhile, Darmayanti et al. (2022) emphasizing that technology is able to facilitate high-level learning activities such as analysis and evaluation. The use of digital media in IPAS teaching materials also supports the theory Jayanti (2025) about *Instructional Media Design*, that the media acts as a bridge between abstract concepts and concrete understanding. Thus, the application of technology in the local context strengthens the teacher's position as an active facilitator who directs students to learn independently and meaningfully.

As many as 95% of students stated that the teaching materials were easy to understand, and 90% of them felt more comfortable learning with digital media based on local wisdom. Elementary school students are at the concrete operational stage, so that real-life experience-based learning is more effective (Yuliana & Budianti, 2015. Contextual learning experiences create a direct connection between theory and practice of everyday life (Jang et al., 2020). The integration of local cultural values in teaching materials also supports the theory Leonard et al. (2017) about *culturally responsive teaching*, which encourages learning based on students' cultural identity. Next Lubis et al. (2023) explains that meaningful learning occurs when new information is associated with an existing cognitive structure. Students also show increased motivation to learn, in accordance with the *theory of Self-Determination* by emphasizing the role of autonomy and relevance of context (Wicaksana, 2020). Based on this, ethnoecology-based digital teaching materials not only improve conceptual understanding, but also strengthen students' emotional and social involvement in the learning process.

The average learning outcome increased from 69.67 to 82.3 after the use of teaching materials, showing an increase of 12.67 points. This strengthens the theory Pauweni et al. (2022) which states that learning outcomes are influenced by the quality of the learning design and student involvement. Cooperative, project-based learning can improve learning outcomes through active participation (Thabassum et al., 2022). This increase in learning outcomes supports the view in *experiential learning theory*, that deep understanding emerges through cycles of experience, reflection, and application (Ghofur et al., 2022). Social learning *theory* explains that students learn more effectively when they see real relationships between actions and outcomes in their environment (Anjaeni, 2021). Moreover, Jou et al. (2021) affirms that *Constructivist Learning Environments* help students build knowledge through the exploration of real problems. Thus, this increase in learning outcomes not only reflects the success of digital media, but also the success of learning strategies based on local contexts and Pancasila values.

The integration of the dimensions of the Pancasila Student Profile in teaching materials—such as mutual cooperation, independence, critical thinking, and creativity—achieved an achievement of above 90%. The Ministry of Education, Culture, Research, and Technology emphasized that the Pancasila Student Profile must be the axis of character formation in the Independent Curriculum (Fauzan et al., 2023). Pattaro (2016) About *character education* supports the importance of integrating moral values in learning. This approach also reinforces the idea of a liberating education, where students are invited to understand social realities and act reflectively. In a global context, Vioreza et al. (2023) through *Education for Sustainable Development* , emphasizing the importance of local value-based learning for environmental sustainability. Moreover, Jasmine (2016) through the theory *of multiple intelligences* , it emphasizes the need to develop interpersonal and naturalistic intelligence rooted in interaction with nature. Overall, this research makes a theoretical and practical contribution in realizing a holistic, digital, contextual, and characterful science education according to the vision of the Independent Curriculum.

The development of digital teaching materials for elementary school science and natural sciences based on Madiun ethnoecology is designed to provide a contextual, meaningful learning experience, and support the formation of the Pancasila Student Profile. The results of expert validation show that the teaching materials developed are in accordance with the learning outcomes of elementary school science and natural sciences in the Merdeka Curriculum. The integration of local wisdom values such as the Wiwit tradition, methil, community forest management, and organic farming practices makes learning closer to students' daily lives. This is in line Clarke & Roche (2018) with that contextual learning encourages students to relate knowledge to real situations they experience.

The use of digital media such as Canva e-books, interactive LKPD, and learning videos has been proven to be effective in increasing student engagement. Multimedia learning theory which states that the use of text, images, and animations combined appropriately can increase student retention and transfer of knowledge (Plass et al., 2015). There was a significant increase in science and natural science learning outcomes from the pre-test to the post-test. This shows that teaching materials are able to strengthen the understanding of science and natural science concepts, especially the material on human

and environmental relations. Ethnoecology-based learning provides a concrete foundation for students to understand the relationship between human activities and environmental sustainability.

The integration of the Pancasila Student Profile dimensions has been proven to be optimally achieved as follows.

Table 3. Integration of the Pancasila Student Profile

Dimensions	Indicator	Achievement
Reasoning Critical	To put forward reason importance guard forest	92% complete
Mutual cooperation	Cooperate in task group	95% complete
Independent	Do task without teacher assistance	93% complete
Creative	Create an invitation poster guard environment	96% complete
Global Diversity	Value wisdom local Madiun	90% complete

This finding strengthens the study by the Ministry of Education, Culture, Research and Technology that contextual project-based learning encourages strengthening the character of Pancasila Students (Gianistika, 2022). The results of the field trial showed that teaching materials were easy to implement in various schools with minimal adaptation. Teachers felt helped by the existence of teaching materials that were structured, interesting, and locally relevant. In addition, students also showed higher enthusiasm because the learning material was directly related to their living environment.

4. CONCLUSION

The development of digital teaching materials for elementary school science and natural sciences based on Madiun ethnoecology through the Gall, Gall, and Borg model has proven to be valid, practical, and effective in improving student learning outcomes while internalizing the values of the Pancasila Student Profile. The materials developed were validated both in terms of content accuracy and media quality, showing strong alignment with the principles of contextual, inquiry-based learning promoted in the Independent Curriculum. The integration of local ethnoecological wisdom not only enhances students' conceptual understanding but also cultivates ecological awareness, cultural appreciation, and character development, making learning more holistic and meaningful. Theoretically, this research reinforces the relevance of ethnoecological perspectives in curriculum design and contributes to the body of knowledge on contextual and culturally responsive pedagogy. It demonstrates that local knowledge systems can serve as legitimate epistemological foundations in science education, bridging indigenous wisdom with modern scientific literacy. Practically, the study provides a replicable model for teachers and policymakers to develop localized, technology-based learning materials that are adaptable to diverse ecological and sociocultural settings. It also underscores the need for sustained teacher training in digital material development and curriculum contextualization. For future research, it is recommended to (1) test the scalability of these ethnoecology-based materials across different regions and ecological contexts, (2) explore long-term impacts on students' critical thinking and environmental behavior, and (3) investigate how AI and interactive technologies could further enhance ethnoecological learning experiences. Continued interdisciplinary collaboration between educators, technologists, and local cultural experts is essential to strengthen the theoretical and practical integration of local wisdom within digital learning ecosystems.

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