MUBTADI: Jurnal Pendidikan Ibtidaiyah
Special Edition: The 1st ICEWISE
International Conference on Elementary Teaching and Wisdom in Education
https://ejournal.uinmadura.ac.id/index.php/ibtida
E-ISSN: 2720-8850 P-ISSN: 2715-7067

DESIGN OF AN INTERACTIVE DIGITAL E-ENCYCLOPEDIA BASED ON MADURESE ETHNOSCIENCE FOR GRADE V IPAS LEARNING IN ELEMENTARY SCHOOLS

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Abstrak
Pembelajaran IPAS kelas V membutuhkan sumber belajar yang menghubungkan konsep sains dengan pengalaman nyata melalui visualisasi kontekstual. Penelitian ini bertujuan merancang e-ensiklopedia digital interaktif berbasis etnosains Madura sebagai sumber belajar IPAS kelas V. Penelitian menggunakan pendekatan perancangan produk pendidikan yang mengadaptasi model 4D (Define, Design, Develop, dan Disseminate) secara terbatas, dengan fokus artikel pada proses desain hingga menghasilkan prototipe. Tahapan perancangan meliputi analisis kebutuhan, pemetaan etnosains dan konsep IPAS, penyusunan arsitektur konten, pengembangan storyboard, perancangan antarmuka, dan realisasi prototipe. Hasil penelitian berupa e-ensiklopedia yang mengintegrasikan empat topik etnosains Madura, yakni batik Madura, terasi, petis, dan rengginang lorjuk. Setiap topik memuat pengenalan budaya, identitas dan latar budaya, alat dan bahan, proses pembuatan, keterkaitan dengan konsep IPAS, serta dampak dan tanggung jawab. Prototipe dilengkapi ilustrasi, audio, video, glosarium, fitur pencarian, dan navigasi interaktif untuk mendukung eksplorasi informasi secara mandiri. Rancangan ini menunjukkan bahwa pengetahuan budaya lokal dapat diorganisasikan menjadi sumber belajar digital melalui keterhubungan antara praktik budaya, proses produksi, fenomena ilmiah, dan konsep IPAS. Prototipe tersebut menjadi landasan bagi validasi ahli, uji kepraktisan, dan implementasi pembelajaran dalam penelitian selanjutnya. Dengan demikian, penelitian ini menawarkan rancangan sumber belajar digital kontekstual yang berpotensi memperkaya pengalaman belajar siswa sekaligus mengenalkan warisan budaya Madura secara sistematis.
Kata Kunci: E-Ensiklopedia Digital, Etnosains Madura, Pembelajaran IPAS, Sekolah Dasar.

Abstract
Grade V Natural and Social Sciences (IPAS) learning requires educational resources that connect scientific concepts with real-life experiences through contextual visualization. This study aims to design an interactive digital encyclopedia based on Madurese ethnoscience as a learning resource for Grade V IPAS. The study employs an educational product design approach, partially adapting the 4D model (Define, Design, Develop, and Disseminate), with a focus on the design process leading to prototype development. The design stages include

needs analysis, mapping ethnoscientific knowledge and IPAS concepts, developing content architecture, creating storyboards, designing the interface, and realizing the prototype. The resulting digital encyclopedia integrates four Madurese ethnoscience topics: Madurese batik, shrimp paste (terasi), fish paste (petis), and lorjuk rice crackers. Each topic covers cultural introduction, cultural identity and background, tools and materials, production processes, connections to IPAS concepts, and environmental impacts and responsibilities. The prototype incorporates illustrations, audio, videos, a glossary, search functions, and interactive navigation to facilitate independent exploration. The findings demonstrate how local cultural knowledge can be systematically organized into digital learning resources by connecting cultural practices, production processes, scientific phenomena, and IPAS concepts. The prototype provides a foundation for expert validation, practicality testing, and classroom implementation in future research. This study offers a contextual digital learning resource design with the potential to enrich students' learning experiences while systematically introducing Madurese cultural heritage.

Keywords: Digital E-Encyclopedia, Madurese Ethnoscience, IPAS Learning, Elementary School

Received: 18-10-2026	Accepted: 09-11-2026	Published: 23-11-2026

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Prodi Pendidikan Guru Madrasah Ibtidaiyah
Universitas Islam Negeri Madura, Indonesia

https://doi.org/10.19105/mubtadi.v1i.26493



INTRODUCTION

Science and Social Studies (IPAS) learning in elementary schools should provide students with opportunities to understand science through experiences closely connected to their everyday lives. The increasing flow of information exposes students to a wide range of knowledge; however, the relevance of learning materials to their immediate surroundings remains important in helping them construct understanding. Concepts presented without connections to everyday experiences tend to seem abstract. Therefore, IPAS learning needs to incorporate contexts that help students recognize the relationships between scientific concepts and the events they encounter in their daily lives (Kervinen et al., 2020; Wedaswari & Tegeh, 2023).

Advances in digital technology have provided teachers with new options for presenting IPAS learning materials. Images, illustrations, audio, and video can be integrated to present information that would otherwise be conveyed through text in a more varied range of formats. These features are consistent with the needs of elementary school students, who still rely heavily on concrete and visual representations when learning concepts(Bayu et al., 2026; Zuhri et al., 2024). Visual presentations and simple interactive features can also help students follow information and gradually develop their understanding (Akbar et al., 2025; García & Fernández, 2025). Digital technology thus becomes part of the learning resources that can enrich students' learning experiences throughout the instructional process (Anastasopoulou et al., 2025).

Empirical evidence indicates that culturally relevant learning resources remain insufficiently integrated into elementary IPAS education. Students have limited experiences with learning activities that incorporate local cultural knowledge, while supplementary materials based on local wisdom remain unavailable or limited in several school contexts (Hanida et al., 2026; Sari HS et al., 2025). Furthermore, IPAS instruction still relies heavily on textbooks and static images, with local cultural resources not yet optimally utilized (Ruliani et al., 2026). These findings highlight the need for learning resources that systematically connect local cultural practices with scientific concepts and curricular content.

Several studies have developed digital learning resources and ethnoscience-based media to support contextual learning. For example, previous studies have explored digital teaching materials and interactive media to improve students' understanding and motivation (Indriani & Sakti, 2022). while other studies have integrated ethnoscience into learning activities by connecting scientific concepts with local cultural practices (Rohman et al., 2023; Yulia et al., 2025). Developed a digital encyclopedia based on local wisdom, focusing on cultural diversity and the Pancasila Student Profile (Mutamima & Yudi Purwoko, 2024). Although these studies demonstrate the potential of digital and culture-based learning resources, they have not specifically addressed the systematic organization of Madurese ethnoscientific knowledge into an interactive digital encyclopedia for Grade V IPAS. This study addresses this gap by integrating four Madurese cultural products batik, terasi, petis, and rengginang lorjuk through a structured presentation connecting cultural backgrounds, production processes, scientific phenomena, and IPAS concepts, supported by multimedia and interactive features. Thus, the novelty of this study lies in the development of an interactive digital e-encyclopedia that systematically integrates Madurese ethnoscientific knowledge with Grade V IPAS concepts through a structured presentation of cultural contexts, production processes, and related scientific phenomena.

This situation is also evident in IPAS learning in elementary schools in Madura. Students grow up surrounded by cultural practices that they can observe firsthand, while teachers need learning resources that connect these practices with scientific concepts. Field observations indicated that digital learning media incorporating Madurese culture were not yet available in a form that could be readily and practically used in IPAS instruction. This situation highlights the need to transform local cultural knowledge into learning resources with content structures and presentation formats appropriate for elementary school students.

Ethnoscience provides a point of connection between cultural knowledge and the scientific concepts taught in schools. Various community activities embody knowledge about materials, processing methods, changes in matter, the use of natural resources, and human–environment relationships. This knowledge can be reconstructed as a learning context without losing the cultural characteristics from which it originates. Students can then explore IPAS concepts through activities with which they are already familiar, rather than relying solely on examples presented in textbooks.

Madurese culture encompasses a range of practices that can be connected to IPAS learning. Batik production, for example, involves the properties of materials and changes in color. Terasi processing illustrates fermentation and the role of microorganisms, while the production of petis and rengginang lorjuk involves heating, changes of state, food processing, and the use of coastal

P – ISSN : 2715 – 7067
E – ISSN : 2720 – 8850

resources. These four cultural products demonstrate how local practices can provide contextual foundations for learning IPAS concepts. Their educational potential underpins the selection of Madurese batik, terasi, petis, and rengginang lorjuk as the main content of the e-encyclopedia. This selection is also informed by previous research exploring the ethnoscientific content of Madurese cultural practices (Lestari et al., 2026).

Transforming local knowledge into a digital format requires more than simply transferring cultural information onto electronic pages. The content needs to be organized so that students can follow the connections between cultural products, their production processes, the phenomena involved, and the corresponding IPAS concepts. An interactive digital e-encyclopedia provides a platform for such a presentation through the integration of text, illustrations, audio, video, a glossary, and navigation features that connect different sections of information. In response to these needs, this study focuses on designing an interactive digital e-encyclopedia based on Madurese ethnoscience as a learning resource for Grade V IPAS. The design process centers on how Madurese cultural knowledge can be organized into structured, easily navigable content that aligns with the learning needs of elementary school IPAS instruction.

METHOD

This study adopted an educational product design approach aimed at developing a prototype of an interactive digital e-encyclopedia based on Madurese ethnoscience. The product development framework referred to the 4D model, which consists of four stages: Define, Design, Develop, and Disseminate (Thiagarajan & Semmel, 1974). The model was developed as a systematic framework for designing instructional materials, from needs analysis to product development and dissemination. Its application was adapted to the focus of the e-encyclopedia design; therefore, the Disseminate stage was limited to product documentation and the preparation of a scholarly report.

The object of this study was ethnoscience content drawn from four Madurese cultural products: Madurese batik, terasi, petis, and rengginang lorjuk. These products were mapped against Grade V IPAS concepts and then organized into e-encyclopedia content. Data sources included an analysis of the Grade V IPAS curriculum, teacher interviews, documentation, and literature related to Madurese culture and ethnoscience. The information served as the basis for selecting content, connecting cultural practices with IPAS concepts, and organizing the presentation structure of the e-encyclopedia.

The Define stage focused on identifying instructional needs and determining the scope of the content. The analysis involved reviewing the Grade V IPAS curriculum, interviewing teachers, examining documentation, and reviewing literature on Madurese culture. The information obtained was used to determine the characteristics of the subject matter, learning resource needs, and cultural products that could be connected to IPAS concepts. This stage was consistent with the function of Define in the 4D model, which includes front-end analysis, learner analysis, task analysis, concept analysis, and the specification of instructional objectives (Thiagarajan & Semmel, 1974).

The Design stage involved mapping ethnoscience content to IPAS concepts, developing the content architecture, preparing the storyboard, and designing the interface and navigation. The mapping process identified cultural information, materials and tools, production stages, phenomena

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arising during the processes, and relevant IPAS concepts. The resulting map was used to determine the sequence in which each topic would be presented. This structure then guided the design of the e-encyclopedia pages so that the connections among cultural information, production processes, and IPAS concepts could be followed step by step.

The Develop stage focused on translating the design into an interactive digital e-encyclopedia prototype. The prototype contains four Madurese ethnoscience topics: Madurese batik, terasi, petis, and rengginang lorjuk. Each topic was developed to include a cultural introduction, cultural identity and background, tools and materials, production processes, IPAS concepts, and impacts and responsibility. Information is presented through text, illustrations, audio, video, a glossary, a search feature, and interactive navigation. In the 4D model, the Develop stage includes product development and refinement based on appraisal and developmental testing (Thiagarajan & Semmel, 1974). The process reported in this study focused on realizing the design and producing the prototype.

The data were analyzed descriptively to illustrate how ethnoscientific knowledge was transformed into IPAS learning content. Information was grouped according to cultural context, production processes, scientific phenomena, and relevant IPAS concepts. The resulting map was used to determine the sequence of information, relationships among content sections, and forms of representation used in each part of the e-encyclopedia. Each design was reviewed for alignment with the learning objectives, the characteristics of Grade V students, and the established information structure before the final prototype was assembled.

Practicality, readability, and effectiveness testing were not included in the analytical focus of this article. Expert validation data, teacher responses, and readability testing obtained during the broader product development process are treated as part of the empirical evaluation in the main study. This distinction maintains consistency among the design objective, the process analyzed, and the output produced: an interactive digital e-encyclopedia prototype based on Madurese ethnoscience.

RESULTS AND DISCUSSION

Results

The design outcomes of the interactive digital e-encyclopedia based on Madurese ethnoscience are presented through five main outputs: needs analysis, mapping ethnoscience content to IPAS concepts, content architecture, interface and navigation design, and realization of the digital prototype. The results focus on the process of transforming Madurese cultural knowledge into a learning resource for Grade V IPAS.

Needs Analysis and Content Selection

The needs analysis involved reviewing Grade V IPAS instruction, interviewing teachers, observing student characteristics, and examining the potential of Madurese cultural practices to be connected with IPAS concepts. Interviews were conducted with two Grade V teachers who teach IPAS. The teachers were purposively selected because of their direct involvement in IPAS instruction and their knowledge of students' learning needs and the local cultural context surrounding the school. The interview findings revealed three main themes. First, both teachers

indicated that students understand learning materials more easily when they are connected to real-life experiences. Second, some students were unfamiliar with certain local ingredients or products, such as lorjuk, highlighting the need for visual support to provide an initial understanding. Third, although teachers had used Smart TVs and videos during instruction and observed students' interest in digital media, learning resources specifically featuring Madurese culture that could be directly used in IPAS instruction remained limited. These findings informed the design and presentation of the e-encyclopedia.

Student characteristics were another consideration in determining the presentation format. Observations and interviews indicated that students could follow the material more easily when it included concrete examples, colorful illustrations, and short videos. In contrast, overly long passages tended to reduce students' attention. These findings informed the design of pages with concise paragraphs, guiding icons, images, and strategically placed multimedia elements.

The analysis of cultural content resulted in the selection of four main products for the e-encyclopedia: Madurese batik, terasi, petis, and rengginang lorjuk. Each product involves observable processing stages that can be linked to Grade V IPAS concepts. Batik production involves heating, mixing, color absorption, and drying. Petis production illustrates evaporation and thickening. Terasi production involves mixing, grinding, sun-drying, and changes in material properties during fermentation. Rengginang lorjuk production involves washing, mixing, steaming, shaping, and sun-drying.

Mapping Ethnoscience and IPAS Concepts

The mapping results showed that each cultural product was organized according to the relationships among cultural context, materials and production processes, observable phenomena, and relevant IPAS concepts. This mapping guided the selection of information to be presented in each topic, ensuring that cultural content went beyond product descriptions and explained phenomena that could be explored through IPAS learning.

Table 1 - Mapping Madurese Ethnoscience Products and IPAS Content

Cultural product	Main processes	IPAS phenomena/content presented
Madurese batik	Heating, mixing, dyeing, drying	Material properties, mixing, color absorption, changes caused by heating
Petis	Boiling, evaporation, thickening	Heating, evaporation, changes in material consistency
Terasi	Mixing, grinding, sun-drying, fermentation	Mixing, changes in material properties, drying, fermentation
Rengginang lorjuk	Washing, mixing, steaming, shaping, sun-drying	Material processing, heating, changes in properties, drying

The mapping then served as the basis for organizing the material on each e-encyclopedia page. Information was sequenced according to the relationship between cultural products and observable scientific processes, enabling students to move from concrete contexts toward IPAS concepts.

E-Encyclopedia Content Architecture

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The design results showed that each cultural topic followed a relatively consistent presentation pattern. The structure began with an introduction to the product, followed by its identity and cultural background, tools and materials, production process, IPAS concepts, and a section on impacts and responsibility. This consistent pattern was intended to help students recognize the flow of information as they moved from one cultural product to another.

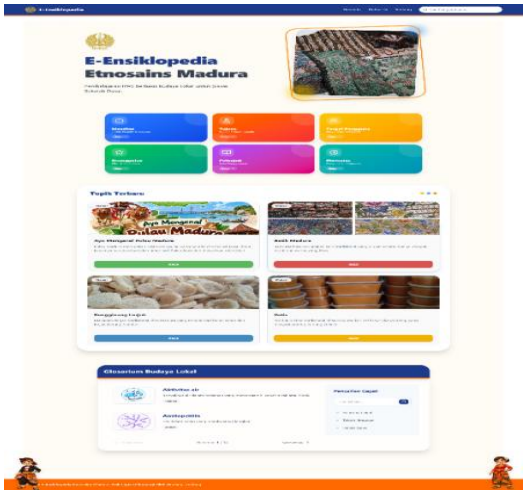


Figure 1 - Homepage and Information Architecture Of The Interactive Digital E-Encyclopedia Based On Madurese Ethnoscience

The homepage serves as the starting point for exploring the e-encyclopedia. It presents the product identity, information about the purpose and intended users, usage instructions, the ethnoscience menu, a list of topics, and a glossary of local culture. This structure provides users with an orientation before they explore individual cultural products in greater detail.

The topic pages follow a more specific structure. Each product has an opening section introducing the cultural product, followed by information on its identity and cultural background, tools and materials, production process, IPAS concepts, and impacts and responsibility. This structure can be seen on the Madurese batik page, which includes product images, an introduction, a prompting question, and navigation menus linking its sections. E-Ensiklopedia-Etnosains-Madura.

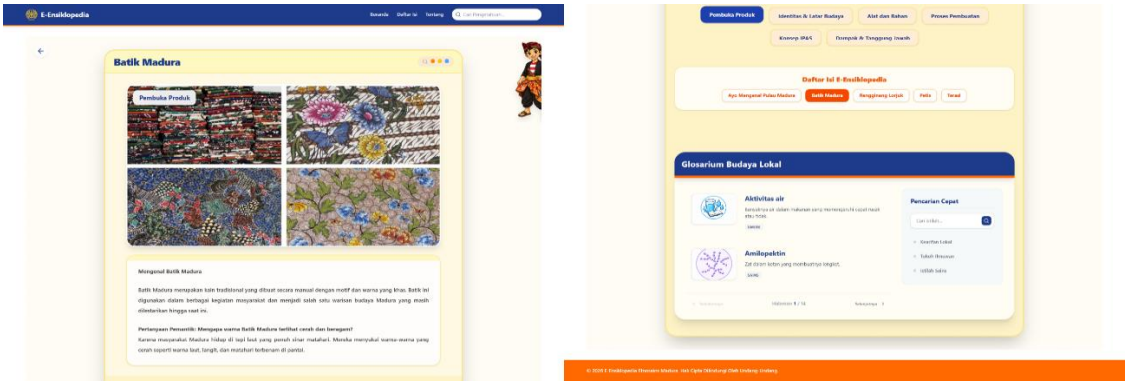


Figure 2 - Presentation Structure Of The Madurese Batik Topic, From Cultural Introduction To IPAS Concepts

Interface, Navigation, and Multimedia Design

The storyboard was developed based on the established content architecture. Each page was designed with attention to information sequence, readability, conceptual clarity, and the relationship between cultural information and IPAS content. The storyboard guided decisions about page layouts, navigation, the placement of visual elements, and the types of interaction incorporated into the product.

The designed components included information about cultural history and processes, explanations connecting these processes with scientific concepts, supporting visuals, exploratory activities, and a glossary. Each topic followed a consistent presentation pattern combining text with photographs, videos, illustrations, or infographics. The glossary was intended to help students understand unfamiliar terms, while the navigation supported movement between sections.

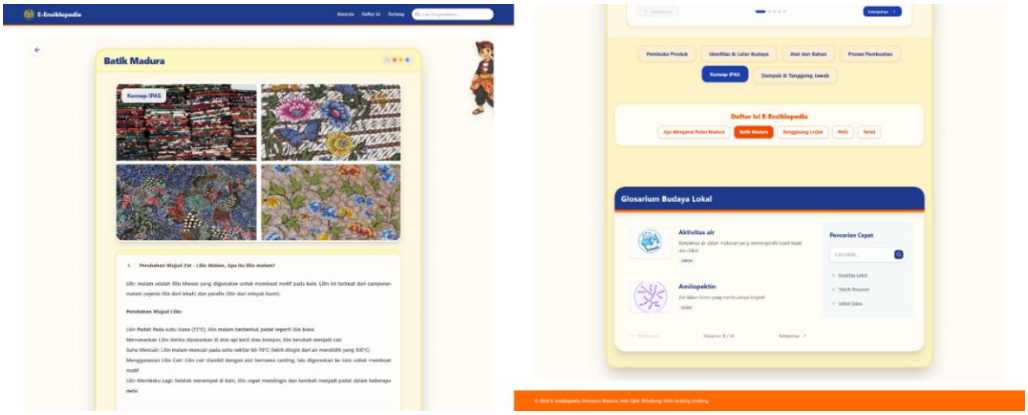


Figure 3 - Presentation of the Relationship Between Ethnoscientific Knowledge And IPAS Concepts In The E-Encyclopedia

Multimedia was incorporated as part of the information structure rather than as a decorative element. Images introduce cultural objects and processes, while audio and video represent information that may be more readily understood through audiovisual formats. The search feature and glossary complement the navigation, allowing students to retrieve information and terms when needed.

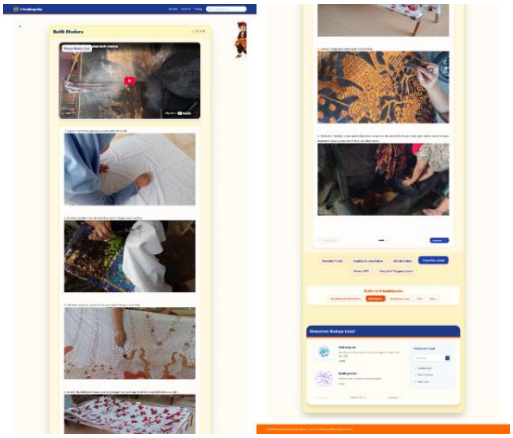


Figure 4 - Integration of Multimedia, Navigation, A Glossary, And A Search Feature In The E-Encyclopedia

Realization of the Interactive Digital E-Encyclopedia Prototype

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The development stage resulted in an interactive digital e-encyclopedia prototype integrating four Madurese ethnoscience topics: Madurese batik, terasi, petis, and rengginang lorjuk. The prototype retained the presentation pattern established during the design stage, giving each topic a consistent information structure while allowing the distinctive characteristics of each cultural product to be represented.

The final product combines text, images, audio, video, a glossary, a search feature, and interactive navigation. The homepage provides access to general information and cultural topics, while each product page offers an exploration pathway from cultural information to production processes and IPAS concepts. This structure produces a digital learning resource in which Madurese cultural knowledge can be explored step by step.

Characteristics of the Design Outcomes

The overall design process resulted in four main characteristics. First, the content draws on Madurese cultural products that are familiar within students' surroundings. Second, cultural information is organized progressively, from product identity and production processes to the related IPAS concepts. Third, the presentation uses multiple forms of representation, including text, images, audio, video, and a glossary. Fourth, navigation and page structures are consistent, allowing students to recognize the pattern of use across topics.

These four characteristics represent the main outcome of the design process: Madurese ethnoscientific knowledge has been organized into a digital learning resource that clearly connects local culture, production processes, scientific phenomena, and IPAS concepts. Unlike digital encyclopedias that primarily present information about specific topics, this e-encyclopedia organizes each cultural product through a consistent sequence, from cultural identity and background to tools and materials, production processes, related IPAS concepts, and impacts and responsibility. This structured integration enables students to explore local cultural knowledge not merely as descriptive information, but as a context for understanding scientific phenomena and their connections to IPAS concepts. The prototype provides a basis for evaluation and implementation in subsequent research.

Discussion

The findings show that the design of an interactive digital e-encyclopedia based on Madurese ethnoscience centers on connecting cultural knowledge with IPAS concepts through a systematic content structure. The four selected cultural products Madurese batik, terasi, petis, and rengginang lorjuk are not presented merely as information about local culture. Each product is examined in terms of its materials, processing stages, and the phenomena arising during production, and is then connected to relevant IPAS concepts. This approach is consistent with research on the relationship between local and scientific knowledge, which suggests that connecting these forms of knowledge can create learning contexts that better reflect students' social and cultural diversity (Sotero et al., 2020).

The main strength of the design lies in how cultural contexts are translated into a learning structure. Madurese batik, for example, involves heating, mixing, color absorption, and drying; petis involves evaporation and thickening; terasi involves mixing, grinding, sun-drying, and

fermentation; and rengginang lorjuk involves washing, mixing, steaming, shaping, and sun-drying. These sequences are mapped to IPAS concepts, providing students with a learning pathway from recognizable objects to scientific phenomena and concepts. This approach is consistent with a systematic review of ethnoscience that positions local knowledge and practices as contexts that can be connected to school science learning (Hikmah et al., 2025).

The findings also indicate that integrating ethnoscience into digital learning resources requires content selection and reconstruction. Cultural knowledge cannot simply be transferred to digital media without considering learning objectives, learner characteristics, and relationships among concepts. Research on ethnoscience-based digital learning resources shows that local knowledge can be integrated into instructional structures so that scientific concepts are learned through contexts closer to students' experiences (Rahmalia et al., 2025).

The resulting e-encyclopedia architecture reinforces this process. Each topic is organized around a product introduction, cultural identity and background, tools and materials, production process, IPAS concepts, and impacts and responsibility. This layered structure moves beyond cultural description toward scientific explanation. The finding is consistent with the development of elementary-level digital learning resources based on local wisdom, which demonstrates that local knowledge can be compiled into structured digital resources while retaining cultural context as part of the learning material (Afandi, 2025).

The design characteristics of the present e-encyclopedia share similarities with the digital encyclopedia based on local wisdom developed by Mutamima and Yudi Purwoko which integrates cultural diversity with the Pancasila Student Profile for elementary school students (Mutamima & Purwoko, 2024). However, the two products differ in their content orientation and organization. While their study focuses on cultural diversity, the present e-encyclopedia specifically organizes four Madurese cultural products according to their production processes, scientific phenomena, and connections to Grade V IPAS concepts. This distinction indicates that local culture is not merely presented as information about cultural identity and diversity but is also used as a context for explaining IPAS concepts. Therefore, the contribution of the present design lies in organizing ethnoscientific knowledge into a digital learning resource structured around the content requirements of elementary IPAS learning.

The need for such a structure is also evident in the needs analysis. Teachers reported that students followed material more easily when examples were connected to real life, while some local cultural materials were unfamiliar to them. These findings informed the use of illustrations, concise paragraphs, icons, and short videos in the e-encyclopedia. This design decision shows how user characteristics were directly translated into forms of information representation. Integrating cultural contexts into IPAS learning can also help connect learning concepts with the social and cultural environments familiar to students (Arifin & Sukarmin, 2026; Zidny et al., 2021).

The multimedia elements in the e-encyclopedia serve representational functions suited to the content. Images introduce cultural products and activities, while audio and video provide alternative representations of information that may not be adequately explained through text alone. The search feature and glossary help students retrieve particular terms or information. By combining these forms of representation, the e-encyclopedia becomes more than an electronic version of a reading

resource; it provides an exploratory structure through which users can navigate information according to their needs.

These findings align with emerging research on ethnoscience-based digital media. Systematic reviews of such media indicate that integrating local culture with digital technology can connect scientific concepts with students' everyday experiences while supporting more contextualized learning (Jufrida et al., 2025; Nelyza et al., 2026).The development of ethnoscience-based e-modules also shows that local content can be combined with text, visuals, and learning activities in a single digital resource (Rahmalia et al., 2025).

Consistency across topics is another defining feature of the design. Madurese batik, terasi, petis, and rengginang lorjuk differ in their cultural characteristics and production processes, but all follow the same presentation pattern. This consistency gives students a recognizable navigation structure as they move between topics. At the same time, the content of each topic retains the distinctive characteristics of its cultural process. These findings suggest that the digitization of ethnoscience should balance consistency in instructional structure with the distinctiveness of local knowledge.

The selection of an interactive digital e-encyclopedia was based on the need to present several cultural products within a single learning resource with interconnected information structures. This format allows students to explore each product progressively through text, images, audio, video, and interconnected navigation menus. Alternative formats, such as digital modules and instructional videos, could also be used to present ethnoscientific knowledge, although they offer different forms of content organization. Digital modules generally organize materials according to instructional sequences, whereas videos emphasize audiovisual presentation. The e-encyclopedia in this study was selected because it provides space for presenting multiple cultural topics through a consistent information structure while allowing users to navigate content according to their needs. Nevertheless, this design choice requires further evaluation to determine its suitability for the characteristics and learning needs of elementary school students.

This approach extends the development of culture-based media, which has often focused on a single type of teaching material or a single form of representation. Research on digital encyclopedias based on local wisdom indicates that local knowledge can be compiled into a structured digital resource for elementary school students (Afandi, 2025). The design in the present study is more specifically directed toward IPAS learning by organizing each cultural product around the relationship between production processes and scientific concepts. This feature distinguishes the e-encyclopedia because its content structure is shaped by the needs of IPAS learning rather than by cultural categories alone.

From a science education perspective, integrating local culture provides a context for making sense of the concepts students learn. Scientific knowledge presented through familiar objects and activities offers a more concrete starting point for understanding school concepts. Research on local and scientific knowledge emphasizes that connecting the two can create learning contexts that value sociocultural diversity while bringing local experiences into dialogue with formal scientific knowledge (Chastenay et al., 2023; Hairida et al., 2026; Sotero et al., 2020). Systematic reviews of

ethnoscience also indicate that local contexts are increasingly used in science learning through approaches such as inquiry, project-based learning, and STEM (Hikmah et al., 2025).

The main contribution of this study lies in the way Madurese ethnoscientific knowledge is organized into a digital IPAS learning resource. The process begins with identifying cultural practices, mapping production processes and phenomena, connecting them with IPAS concepts, developing the content architecture, and translating that structure into a storyboard, interface, multimedia elements, and navigation. This sequence produces a prototype that preserves cultural context while providing a presentation pathway suited to Grade V IPAS learning.

These findings should be interpreted within the scope of the study. The main outcome concerns the design and characteristics of the prototype, rather than a measurement of its effectiveness in improving learning outcomes. Therefore, improvements in critical-thinking skills, responsibility, motivation, or learning outcomes cannot yet be claimed as findings of this study. Testing validity, readability, practicality, and effectiveness constitutes an empirical evaluation stage that can be conducted after the product design has been completed. This distinction maintains consistency among the research objective, development process, and contribution.

Furthermore, the prototype has several limitations. The selection of four Madurese cultural products does not represent the full diversity of ethnoscientific practices that could potentially be integrated into IPAS learning. The use of multimedia and interactive features was also based on design considerations and identified learning needs; therefore, their readability, ease of use, and suitability for all students have not yet been empirically established. In addition, this study did not compare the e-encyclopedia with other digital learning resource formats. Further research is consequently needed to conduct expert validation, readability and practicality testing, and effectiveness evaluation before the product is implemented more widely.

Overall, the resulting e-encyclopedia demonstrates how Madurese cultural knowledge can be transformed into an IPAS learning resource through systematic mapping and organization. Cultural products provide the initial context, production processes offer a pathway for observation, phenomena serve as the link, and IPAS concepts become the focus of scientific interpretation. This integration is reinforced by multimedia, a glossary, a search feature, and interactive navigation, enabling local knowledge to be presented within a structured digital learning environment.

CONCLUSION

This study produced a prototype of an interactive digital e-encyclopedia based on Madurese ethnoscience, designed as a learning resource for Grade V IPAS. The design process involved needs analysis, mapping ethnoscientific knowledge to IPAS concepts, developing the content architecture and storyboard, and realizing the interface and interactive features. Four Madurese cultural products Madurese batik, terasi, petis, and rengginang lorjuk were organized into a learning structure connecting cultural context, production processes, scientific phenomena, and IPAS concepts.

The design outcomes show that the product's main characteristic is a systematic and consistent content structure across topics. Information is organized from the product introduction and cultural identity and background through tools and materials, production processes, IPAS concepts, and impacts and responsibility. This structure is enriched with illustrations, audio, video,

a glossary, a search feature, and interactive navigation, allowing local knowledge to be represented in a more organized digital learning environment.

The study contributes a process for transforming Madurese ethnoscientific knowledge into a digital IPAS learning resource that preserves cultural context while providing a pathway toward understanding scientific concepts. The resulting prototype provides a foundation for subsequent evaluation and implementation. Further testing is needed to obtain empirical evidence of the product's validity, readability, practicality, and effectiveness in IPAS learning.

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