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# Development of E-Modules Based on Local Wisdom as an Innovation in Contextual Learning for the Science Education Study Program.

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**Abstract**

Science education in higher education needs learning resources that connect scientific concepts, students' everyday experiences, and the cultural-environmental characteristics of their communities. This article presents a development framework for an electronic module (e-module) based on local wisdom as an innovation in contextual learning for a Science Education Study Program. The proposed development uses a research-and-development orientation organized through the ADDIE stages: analysis, design, development, implementation, and evaluation. Local practices and knowledge are treated as entry points for scientific inquiry rather than substitutes for scientific explanations. The proposed module structure combines contextual phenomena, concept explanations, inquiry activities, multimedia, formative assessment, reflection, and references to community knowledge. Its quality-assurance plan covers content accuracy, cultural appropriateness, instructional design, language, media usability, accessibility, and learning outcomes. Since no field-trial dataset or expert-validation results were provided for this manuscript, the results are presented as a design specification and analytical development framework, not as empirical claims of validity or effectiveness. The article offers a practical model for lecturers and developers seeking to strengthen scientific literacy, critical thinking, environmental awareness, and cultural appreciation through locally grounded digital learning.

**Keywords**

contextual learning; e-module; ethnoscience; local wisdom; science education

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## INTRODUCTION

Science education in higher education is expected to develop more than the ability to recall scientific facts. Students in a Science Education Study Program need to understand how scientific ideas are produced, tested, communicated, and applied to issues in everyday life. Nevertheless, abstract explanations, fragmented learning resources, and limited connections between classroom concepts and students' social and ecological environments can make science appear distant from lived experience.

Contextual learning responds to this challenge by situating concepts in meaningful situations and inviting learners to connect prior knowledge with new explanations (Johnson, 2002; Crawford, 2001).

Local wisdom offers a rich and authentic context for this connection. It includes community knowledge, practices, technologies, values, and environmental-management traditions that have developed through long interaction with particular places. In science education, local wisdom can be examined through ethnoscience: the systematic exploration of how community practices relate to concepts and methods in the natural sciences. The aim is not to romanticize every traditional practice or to assume that all inherited explanations are scientifically verified. Instead, students can document a practice, identify the phenomenon involved, formulate questions, collect evidence, and compare community explanations with scientific models. This approach supports dialogue between knowledge systems while maintaining scientific reasoning and respect for cultural ownership (Aikenhead, 2001; Snively & Corsiglia, 2001; Ogawa, 1995).

Research in Indonesia has increasingly explored local-wisdom-based science modules and e-modules. Studies have reported promising feasibility, practicality, and learning outcomes in school contexts, including modules on pressure, ecosystems, and broader science topics (Adeningsih et al., 2024; Hidayat et al., 2024; Nurhayati et al., 2025). Other work has linked local wisdom and ethnoscience with scientific literacy, environmental education, and contextual science instruction (Verawati & Wahyudi, 2024; Sihombing et al., 2025). These developments provide a basis for extending the approach to undergraduate science teacher education, where students must not only learn science but also learn how to design culturally responsive learning experiences for future pupils.

Electronic modules can combine text, diagrams, photographs, short videos, simulations, hyperlinks, interactive tasks, and self-assessment in a single navigable resource. Properly designed multimedia can support learning when verbal and visual information is coordinated and unnecessary cognitive load is reduced (Mayer, 2021; Sweller et al., 2011). However, digitizing a conventional textbook does not automatically create meaningful learning. An e-module should be structured around clear learning outcomes, coherent learning sequences, active inquiry, feedback, and accessible navigation (Clark & Mayer, 2016; Branch, 2009).

The central problem addressed in this article is how to design an e-module that integrates local wisdom with scientific concepts and contextual learning in a systematic, academically responsible, and digitally engaging way for a Science Education Study Program. The article aims to formulate a development framework, identify the module's core components, and propose a quality-assurance strategy. Its contribution lies in positioning local wisdom as an inquiry-rich learning context for prospective science educators, rather than merely as decorative cultural content.

## METHODS

This article adopts a developmental and conceptual design approach to formulate an e-module framework for a Science Education Study Program. It is written as a development-oriented design manuscript informed by established instructional-design principles and relevant research on contextual learning, multimedia learning, ethnoscience, and local-wisdom-based instructional materials. It does not report a completed field experiment, participant sample, expert-validation score, or learning-gain result. Such empirical information must be generated through subsequent implementation and evaluation.

The proposed development is organized using the ADDIE framework: Analysis, Design, Development, Implementation, and Evaluation (Branch, 2009). During Analysis, the development team identifies course learning outcomes, students' prior knowledge, digital-learning conditions, and locally relevant practices that can be examined through scientific concepts. Potential contexts may include traditional food processing, local building materials, water management, agriculture, fisheries, medicinal-plant knowledge, household energy use, and community conservation practices. The selection must be verified with community members and relevant literature, and must consider cultural sensitivity, safety, environmental sustainability, and the availability of evidence.

During Design, the team maps course outcomes to scientific concepts, local phenomena, learning activities, assessment indicators, and digital media. A learning sequence is developed from an observable local phenomenon toward scientific questioning, investigation, interpretation, application, and reflection. During Development, the content is written, multimedia is produced or curated with permission, interactive activities are assembled, and assessment instruments are prepared. Content experts, instructional-design experts, media experts, language reviewers, and cultural informants should review the draft before it is used with students.

During Implementation, the e-module is introduced in a course or selected learning unit. Students work individually and collaboratively, complete inquiry tasks, discuss the relationship between community knowledge and scientific explanations, and submit evidence-based outputs. During Evaluation, formative feedback is collected throughout development, while summative evaluation examines content validity, usability, accessibility, student engagement, conceptual understanding, scientific literacy, critical thinking, and cultural appreciation. Recommended data-collection techniques include document analysis, interviews, expert-review questionnaires, usability observations, student response questionnaires, and pretest–posttest assessments. Quantitative results may be summarized using descriptive statistics and normalized gain where an appropriate comparison design is used; qualitative data may be coded thematically and triangulated across sources.

Ethical safeguards are integral to the method. Local knowledge should be represented accurately, community contributors should be acknowledged where

appropriate, sensitive or restricted knowledge should not be published without consent, and photographs, recordings, and other media should be used with permission. Scientific claims must be distinguished from cultural descriptions, and uncertain claims should be presented as questions for investigation rather than established facts.

The proposed development logic can be summarized as follows: Course outcomes and learner needs + verified local knowledge → contextual phenomenon selection → scientific concept mapping → inquiry-based module design → multimedia and assessment development → expert and cultural review → classroom implementation → evaluation and revision.

## RESULTS AND DISCUSSION

### Results

The principal output of this design process is a proposed e-module architecture that links local phenomena to core science concepts and to the pedagogical competencies expected of prospective science educators. The e-module is intended to function as a structured learning environment rather than a digital repository of reading materials. Each unit begins with a locally recognizable phenomenon and guides students toward scientific explanation through observation, questioning, evidence gathering, analysis, and reflection.

The proposed module contains seven integrated components: (1) an orientation page presenting course outcomes and learning pathways; (2) a local-wisdom context presenting a documented practice or phenomenon; (3) a scientific-concept section explaining the relevant principles; (4) inquiry activities that ask students to investigate or model the phenomenon; (5) multimedia resources that clarify processes or structures; (6) formative assessment with feedback; and (7) reflection and references. The structure is designed to make the transition from everyday experience to scientific reasoning explicit.

**Table 1. Proposed E-Module Units and Contextual Science Connections**

| Unit / Local Context | Relevant Science Concepts | Learning Activity | Expected Learning Evidence |
|---|---|---|---|
| Traditional food fermentation | Microorganisms, metabolism, temperature, pH, food safety | Compare process conditions; interpret a simple observation log | Concept map and evidence-based explanation |
| Local water management | Water cycle, fluid pressure, filtration, watershed ecology | Map water use; investigate filtration variables | Annotated system diagram and short report |
| Traditional building materials | Material properties, heat transfer, forces, sustainability | Compare insulation or strength using safe models | Data table and design reflection |
| Agricultural and soil practices | Soil composition, nutrient cycling, biodiversity, ecosystems | Observe soil characteristics and relate practices to soil health | Field observation sheet and ecological analysis |

| | | | |
|---|---|---|---|
| Medicinal-plant knowledge | Plant structure, biodiversity, chemical substances, evidence and safety | Document non-prescriptive plant knowledge and evaluate sources | Ethnoscience profile with evidence appraisal |
| Coastal or river conservation | Ecosystems, food webs, pollution, environmental change | Analyze a local environmental case and propose action | Problem analysis and community-oriented proposal |

*Source: Proposed by the authors based on the development framework.*

Table 1 illustrates that local contexts can support learning across several science domains. The examples are adaptable rather than prescriptive: lecturers should select phenomena that are genuinely present in the students' communities and suitable for the course. For instance, fermentation can introduce microbiology and biochemical change, while local water-management practices can support the study of hydrology, fluid behavior, filtration, and environmental systems. Each context should be accompanied by scientific sources and clear guidance on the limits of the analogy between everyday practice and formal scientific models.

The learning activities are designed to develop multiple forms of evidence. Students may submit observation records, annotated diagrams, concept maps, data tables, short explanatory videos, reflective essays, or lesson-design prototypes. Assessment should value the quality of scientific reasoning, the appropriateness of evidence, the ability to connect concepts with context, and the ethical treatment of community knowledge. Cultural appreciation should not be measured by students' agreement with every traditional claim; rather, it should be reflected in respectful inquiry, accurate representation, and an ability to distinguish empirical evidence from belief, interpretation, or customary practice.

**Discussion**

The proposed framework responds to a recurring challenge in science education: students may encounter scientific concepts as abstract content disconnected from the places and practices they know. Contextual learning can make concepts more meaningful by activating prior experience and asking learners to apply new knowledge to authentic situations (Johnson, 2002; Crawford, 2001). In a Science Education Study Program, this approach has a dual purpose. Students learn scientific content while also experiencing a pedagogical process that they can adapt when teaching science in culturally diverse classrooms.

The integration of local wisdom should be epistemically careful. Aikenhead (2001) and Snively and Corsiglia (2001) emphasize the importance of understanding the relationship between Indigenous knowledge and Western science without assuming that one can simply replace the other. Ogawa (1995) similarly broadens the understanding of science as a human activity across cultural settings. Accordingly, the e-module should invite comparison, documentation, and evidence-based interpretation. It should avoid presenting community knowledge as a set of curiosities

or treating scientific validation as the only measure of cultural value.

Recent Indonesian studies provide practical support for developing digital materials around local contexts. Adeningsih et al. (2024) developed a local-wisdom-based e-module for science learning, while Hidayat et al. (2024) reported positive validation and learning outcomes for a contextual science e-module integrating local wisdom on pressure. Nurhayati et al. (2025) applied the ADDIE model to an ecosystem e-module, and other studies have explored local-wisdom integration for scientific literacy and environmental learning (Verawati & Wahyudi, 2024; Sihombing et al., 2025). These studies indicate that local context can be integrated into structured learning materials, but they do not eliminate the need to test the proposed framework with undergraduate learners and the specific curriculum of the target program.

The proposed design extends this work in three ways. First, it targets undergraduate science teacher education rather than assuming that a school-level module can be transferred without adaptation. Prospective teachers need opportunities to analyze both the scientific content and the pedagogical choices involved in representing local knowledge. Second, the framework connects local phenomena with explicit inquiry processes and assessment evidence. Third, it places cultural review and ethical permission alongside content and media validation. This is important because an attractive digital product may still misrepresent a community practice, simplify complex knowledge, or include content that should not be made public.

The multimedia design should follow principles of coherence, signaling, segmenting, and alignment between words and visuals. Mayer (2021) explains that multimedia learning is more effective when learners can select, organize, and integrate relevant verbal and visual information. Cognitive load theory also warns that poorly structured information can overload working memory (Sweller et al., 2011). Therefore, the e-module should use concise explanations, purposeful images, captions, short videos, navigable sections, and feedback that directly supports learning objectives. Interactive elements should serve a learning purpose rather than merely decorate the interface.

Accessibility and usability must be treated as core design criteria. The module should work on commonly used devices, provide readable typography and sufficient contrast, avoid unnecessarily large files, include text alternatives for meaningful images, and allow students to download materials for low-connectivity settings where feasible. The interface should use consistent navigation and provide clear instructions. These decisions align with broader principles of inclusive digital learning and help ensure that technological innovation does not create new barriers to participation.

The proposed evaluation strategy should distinguish validity, practicality, and effectiveness. Content validity concerns scientific accuracy, curriculum alignment, and cultural appropriateness. Media and instructional-design validity concern navigation, layout, accessibility, and the alignment of activities with learning outcomes.

Practicality concerns whether lecturers and students can use the module efficiently in real course conditions. Effectiveness concerns demonstrable changes in conceptual understanding, scientific literacy, critical thinking, or other specified outcomes. A future study should report the number and expertise of validators, instrument indicators, participant characteristics, implementation duration, descriptive statistics, and the analysis used. Until these data are collected, no numerical claim about the product's quality or impact is warranted.

Potential limitations include the diversity of local knowledge across regions, uneven access to digital devices and internet connectivity, and the time required to verify community practices. The same local phenomenon may also have different meanings or forms across communities. The module should therefore be designed as a flexible framework with replaceable local case studies, not as a fixed catalogue that claims to represent all Indonesian communities. Collaboration with local knowledge holders, science lecturers, and education specialists is essential to maintaining accuracy, relevance, and respect.

## CONCLUSION

This article proposes an e-module development framework that integrates local wisdom into contextual learning for a Science Education Study Program. Organized through the ADDIE stages, the framework connects locally recognizable phenomena with scientific concepts, inquiry activities, multimedia explanations, formative assessment, and reflection. Its distinctive emphasis is the simultaneous development of scientific understanding, pedagogical competence, cultural appreciation, and ethical engagement with community knowledge.

The framework is a design proposal and should not be interpreted as evidence that a completed e-module has already been validated or proven effective. The next stage is to select and verify local contexts, produce a prototype, conduct expert and community review, test usability with students, and evaluate learning outcomes through an appropriate research design. Future research may compare different local contexts, investigate the effect of the module on scientific literacy and critical thinking, and examine how prospective teachers adapt local-wisdom-based materials for school science instruction.

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