



Validity and practicality of a *Pancaniti* ethnoscience-based UA-EVAA digital science module

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ABSTRACT

Science education needs learning resources that connect scientific knowledge with contextual problem-solving, environmental responsibility, and learners' cultural experiences. UA-EVAA is an instructional framework derived from the operationalization of the five Sundanese *Pancaniti* values: Niti Harti–Understanding, Niti Surti–Awareness, Niti Bukti–Evidence-Based Reasoning, Niti Bakti–Value-Based Action, and Niti Sajati–Authentic Truth. This study developed and formatively evaluated a web-based UA-EVAA Digital Science Module for junior secondary science. Using the ADDIE model, the article reports the Design and Develop stages, including expert assessment and a small-scale trial, and the Implement stage through a large-scale user trial, with formative evaluation embedded throughout. Six validators assessed 44 sub-indicators using Aiken's V. Practicality was examined with 15 students and three teachers in the small-scale trial and 100 students and 10 teachers in the large-scale trial. The overall Aiken's V was 0.861, while item-level coefficients ranged from 0.708 to 1.000 and identified targeted revisions to content breadth, phase transitions, multimedia use, visual contrast, navigation, and cross-device access. Small-scale practicality reached 86.30% for students and 87.67% for teachers; large-scale scores were 83.44% and 86.60%, respectively. The study contributes an empirically refined model for translating culturally grounded *Pancaniti* values into an explicit digital learning sequence that integrates scientific reasoning, problem-solving processes, and environmental responsibility. The findings establish developmental readiness for subsequent effectiveness testing rather than evidence of learning-outcome effects.

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INTRODUCTION

Science education in the twenty-first century faces increasingly complex demands as environmental challenges intensify alongside rapid developments in educational technology (Priadi et al., 2026; Ramdani et al., 2025). Environmental challenges have expanded science learning beyond conceptual knowledge, requiring learners to critically examine issues, evaluate evidence, develop solutions, make reasoned decisions, and apply scientific knowledge toward responsible action (Apriansyah et al., 2024; Badriah et al., 2023; Nurlia et al., 2026). Such competencies emphasize the role of scientific knowledge beyond the reproduction of disciplinary content, enabling learners to interpret complex environmental problems and develop appropriate responses to them (Colucci-Gray et al., 2013). This issue is especially relevant in the Indonesian context, as the PISA 2022 findings suggest that students continue to face difficulties in scientific literacy, particularly when applying their scientific understanding to problems and situations beyond familiar contexts (OECD, 2023). The gap between expected science competencies and learners' ability to apply scientific knowledge highlights the need for problem-based and contextually relevant learning environments (Supriatna et al., 2025).

A preliminary needs analysis in Tasikmalaya showed strong digital readiness, with 98% internet access, 89% computer-laboratory access, and 93% projector availability. However, 94% reported inadequate support for problem-solving skills and 70% indicated a need for greater environmental awareness. Support was also high for integrating local wisdom into the topic Effect of the Environment on an Organism (93%) and *Pancaniti* values into science learning (95%) (Supriatna et al., 2026). The implications of these findings are that the central development challenge is not only to allow access to technology but also to make certain digital science learning experiences pedagogically meaningful and relevant in context (Bidarra & Rusman, 2017).

The topic Effect of the Environment on an Organism provides an appropriate setting for addressing that gap because it requires learners to connect biotic and abiotic interactions, ecosystem change, pollution, human activity, and organism survival (Kep Ka BSKAP, 2025; Nelsen et al., 2021; Odum & Barrett, 1971). Such relationships are difficult to understand when environmental concepts are presented as decontextualized information (Bowers, 2001; Chaidir et al., 2024). Contextual science learning can instead position observable local phenomena as evidence for identifying problems, explaining causal relationships, and evaluating possible responses (Aikenhead, 1996; Hernawati et al., 2019). Ethnoscience research shows that local knowledge can enhance the cultural relevance of scientific concepts while supporting environmental stewardship and sustainability (Dumaili & Mary, 2026; Sihombing et al., 2025). A recent systematic review also shows that local-wisdom integration is increasingly used to connect science content with students' lived cultural and environmental experiences (Lestari et al., 2024). The needs-analysis evidence therefore provides an empirical rationale for a digital resource that is not only accessible but also structured around local environmental problems and culturally situated reasoning (Supriatna et al., 2025).

UA-EVAA operationalizes the five *Pancaniti* stages as a digital instructional sequence: *Niti Harti* as Understanding, *Niti Surti* as Awareness, *Niti Bukti* as Evidence-Based Reasoning, *Niti Bakti* as Value-Based Action, and *Niti Sajati* as Authentic Truth (Rachman et al., 2022; Supriatna et al., 2026). The mapping therefore translates cultural values into observable learning functions rather than using local culture only as contextual decoration (Nurhafidah et al., 2026; Rusmana et al., 2024). Operationally, *Niti Harti* and *Niti Surti* jointly support Polya's understanding of the problem and early planning; *Niti Bukti* strengthens the planning process through evidence evaluation; *Niti Bakti* corresponds to carrying out the plan; and *Niti Sajati* corresponds to looking back through evaluation and reflection (Polya, 1957). Environmental awareness is distributed across the sequence through cognitive understanding, affective concern, and responsible action (Navia et al., 2024). Accordingly, the proposed contribution lies in a culturally grounded pedagogical framework that meaningfully integrates ethnoscience with problem-solving processes and environmental awareness.

Previous studies show that ethnoscience-based digital resources can contextualize science learning and support environmental literacy, critical thinking, science-process skills, and engagement through interactive multimedia (Abdillah & Susilo, 2026; Geopany et al., 2021; Ristanto et al., 2018). The key gap is the limited evidence on operationalizing the five *Pancaniti* stages as a digital sequence integrating problem-solving and environmental awareness and evaluating it through expert assessment and user trials (Anggini et al., 2026; Azqia et al., 2026; Errabo & Ongoco, 2024; Nurlia et al., 2026). The novelty of UA-EVAA therefore lies not simply in including Sundanese local wisdom, but in pedagogically operationalizing *Pancaniti* as a testable learning architecture (Supriatna et al., 2026). Before

instructional effectiveness can be examined, this architecture requires evidence that its scientific, pedagogical, linguistic, graphical, and digital components are sufficiently suitable and practical for intended users (BSNP, 2014; Helda & Syahrani, 2022; Merino-Soto, 2023; Siregar et al., 2018).

Accordingly, this study aimed to develop and formatively evaluate the *Pancaniti* ethnoscience-based UA-EVAA Digital Science Module by: (1) examining product suitability through expert assessment of content, presentation, language, and graphics; (2) identifying and implementing formative revisions from item-level expert feedback; and (3) examining user practicality through small- and large-scale trials. (BSNP, 2014; Siregar et al., 2018). The study addresses developmental readiness rather than instructional effectiveness; it does not test causal effects on students' problem-solving skills or environmental awareness (Weldami & Yogica, 2023; Yulia et al., 2023).

METAHODS

Research Design

This study was conducted within a Research and Development orientation, with ADDIE (Analyze, Design, Develop, Implement, and Evaluate) used as the procedural development model (Branch, 2009). The preceding needs analysis informed the Analyze stage by identifying digital readiness, priority competencies, preferred learning resources, and the need for *Pancaniti*-based local contextualization (Supriatna et al., 2026). The present article reports the Design stage; the Develop stage, comprising prototype development, expert assessment, revision, and a small-scale user trial; and the Implement stage, represented by the large-scale user trial (Branch, 2009; Ranuharja et al., 2021; Weldami & Yogica, 2023; Yulia et al., 2023). Evaluation functioned formatively across transitions among these stages. No causal effectiveness test of problem-solving skills or environmental awareness was conducted.

The web-based UA-EVAA Digital Science Module addressed Effect of the Environment on an Organism through five *Pancaniti*-based phases: Understanding, Awareness, Evidence-Based Reasoning, Value-Based Action, and Authentic Truth. It integrated Sundanese environmental knowledge with scientific concepts, problem-solving, environmental action, and reflection, supported by student learning pages and a teacher monitoring interface (Supriatna et al., 2026).

Instrument

The study used an expert-assessment instrument and a user-practicality questionnaire (Ranuharja et al., 2021; Yulia et al., 2023). Expert assessment comprised 44 sub-indicators across content (16), presentation (8), language (8), and graphics (12) (BSNP, 2014). The BSNP (2014) criteria were retained to assess content, presentation, language, and graphics, and complemented by contemporary digital-usability and software-quality frameworks, including ISO 9241-11:2018, ISO/IEC 25010:2023, UEQ, SUS, and TAM. Six experts—two each in science education, digital learning technology, and Indonesian language—independently rated 44 sub-indicators on a five-point scale. The analysis was therefore interpreted as expert-assessed product suitability rather than content validity alone (Anggini et al., 2026; Apriansyah et al., 2024).

User practicality was assessed using a 40-item, five-point questionnaire informed by usability, software quality, user experience, and technology acceptance frameworks (Brooke, 1995; Davis, 1989; ISO/IEC, 2018, 2023). Four negatively worded items were reverse scored across nine practicality dimensions. Student and teacher responses were analyzed separately due to differences in instructional roles, module interactions, and user-specific features (Branch, 2009; Dwitianti et al., 2020). Table 1: Summary of data collection procedures and instruments used in the study.

Table 1.
Data Collection Techniques and Instruments

Stage	Technique	Instrument	Data Sources
Develop	Expert validation	44-sub-indicator, 5-point validation instrument	6 validators: 2 science education, 2 digital media/IT, 2 language experts
	Small-scale user trial	40-item, 5-point practicality questionnaire	15 students and 3 teachers
Implement	Large-scale user trial	40-item, 5-point practicality questionnaire	100 students and 10 teachers

Adapted from Dzulqarnain et al. (2025)

Procedure

The development procedure followed the formal ADDIE components (Branch, 2009; Weldami & Yogica, 2023). The Analyze stage identified requirements for digital accessibility, local contextualization, problem-solving, and environmental awareness, which informed the Design of the UA-EVAA-*Pancaniti* framework. During Develop, six experts evaluated the prototype, followed by revision and a small-scale trial with 15 students and 3 teachers. The revised module was then implemented with 100 students and 10 teachers. Formative evaluation guided refinement throughout the process before effectiveness testing (Ranuharja et al., 2021).

Data Analysis Techniques

Two main sources of formative data were used to inform the analysis: an expert validation, and written responses received from the user trials. Analyses performed for each dataset were in accordance with the purpose of that dataset (see the following sections).

Expert-Assessed Product Feasibility

Expert agreement on the relevance and adequacy of the 44 product components was quantified using Aiken's V (Aiken, 1985). Each sub-indicator was rated by six validators ($n = 6$) on a five-point scale ($c = 5$; lowest score $l_0 = 1$). Aiken's V assessed expert-rated product suitability. Sub-indicators with $V \geq 0.800$ were retained, while lower values guided revision with expert feedback. The 0.800 threshold served as a formative criterion for decision-making (Aiken, 1980). Table 2 summarizes the operational decision criteria adopted in this study.

Table 2.

Operational Decision Criteria Based on Aiken's V

Aiken's V	Operational Interpretation	Decision
$V \geq 0.800$	Adequate expert agreement	Retain
$V < 0.800$	Further review required	Review and revise

Adapted from Apsari (2021).

User-Trial Data Analysis

User feedback was analyzed descriptively for both small- and large-scale trials. Negatively phrased items (9, 19, 24, and 36) were reverse-scored to ensure that all questionnaire items were scored in the same direction (Artino et al., 2014). Mean practicality scores were calculated for each indicator and the overall instrument, then converted into percentages of the maximum possible score. The corresponding categories and formative interpretations are presented in Table 3.

Table 3.

Descriptive Criteria for Interpreting User Practicality Scores

Mean Range	Category	Operational Interpretation
4.210–5.000	Very High	Highly positive user evaluation
3.410–4.200	High	Positive user evaluation
2.610–3.400	Moderate	Adequate; improvement advisable
1.810–2.600	Low	Substantial revision recommended
1.000–1.800	Very Low	Major revision required

Adapted from Musawi et al. (2024).

RESULTS AND DISCUSSION

The final prototype was developed directly from the needs-analysis requirements rather than from a technology-first design (Annisa & Darussyamsu, 2023). The earlier analysis indicated that schools already had substantial digital access, while respondents identified a stronger need for problem-solving support, environmental awareness, local-wisdom contextualization, and *Pancaniti* integration (Supriatna et al., 2026). The module used digital functionality to deliver a culturally contextualized problem-solving sequence. Student pages integrated learning content, *Pancaniti*-based activities, evaluation, and reflection, while the teacher interface supported monitoring and instructional management (Anggini et al., 2026). The student-facing interface was designed to provide structured access to these learning components within an integrated and intuitive digital environment, as illustrated in Figure 1.

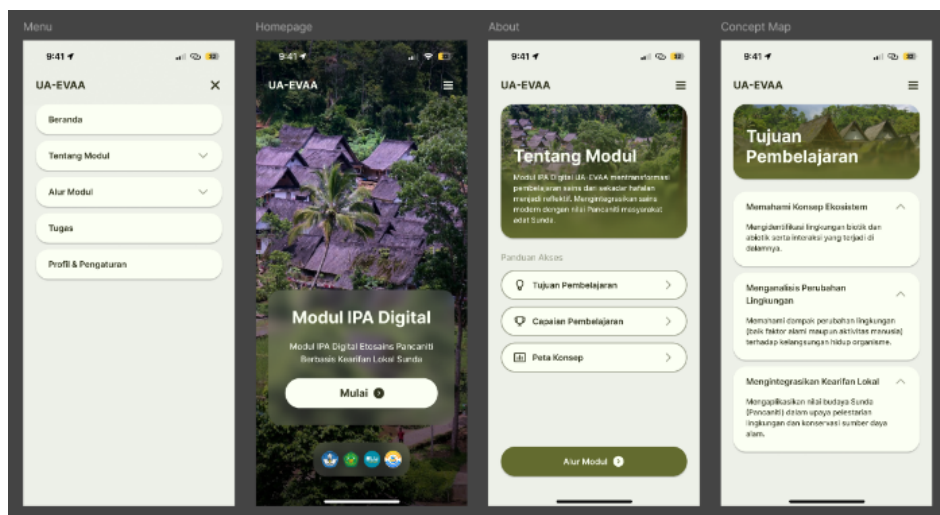


Figure 1. Student User Interface Design of the *Pancaniti* Ethnoscience-Based UA-EVAA Digital Science Module

The student interface combined modern-ethnic design with sequence-based navigation, integrating Sundanese practices and local environmental phenomena to contextualize scientific concepts through ethnoscience (Aikenhead, 1996; Sihombing et al., 2025). The UA-EVAA module operationalized *Pancaniti* as a sequential pathway: *Niti Harti* (Understanding) identified environmental problems; *Niti Surti* (Awareness) examined conditions and causes; *Niti Bukti* (Evidence-Based Reasoning) evaluated evidence; *Niti Bakti* (Value-Based Action) formulated responsible actions; and *Niti Sajati* (Authentic Truth) evaluated outcomes and promoted reflection (Rachman et al., 2022; Supriatna et al., 2026).

This structure was designed to preserve the philosophical progression of *Pancaniti* while translating each stage into an explicit pedagogical function. Problem-solving and environmental awareness were embedded across all five phases, progressing from problem identification and causal analysis to responsible action and reflection, while aligning *Pancaniti* with Polya's problem-solving stages and the cognitive, affective, and behavioral dimensions of environmental awareness (Navia et al., 2024; Polya, 1957). Table 4 summarizes the UA-EVAA framework and its assessable indicators for *Pancaniti* integration, learning-pathway consistency, problem-solving, and environmental awareness.

Table 4.
Operational Alignment of *Pancaniti* in the UA-EVAA Digital Science Module

Panca-niti	UA-EVAA	Learner activity	Cognitive process	Environmental awareness	Problem-solving	Product
<i>Niti Harti</i>	Understand-ing (U)	Identify an environmental phenomenon and articulate what is known/unknown.	Concept recognition and interpretation	Cognitive awareness	Understand the problem	Problem statement and initial concept explanation
<i>Niti Surti</i>	Awareness (A)	Observe local conditions, identify causes, and recognize consequences.	Observation, causal analysis, perspective taking	Cognitive and affective awareness	Understand the problem and begin devising a plan	Observation record and cause-effect map
<i>Niti Bukti</i>	Evidence-Based Reasoning (E)	Gather, compare, and evaluate evidence; select a defensible alternative.	Evidence evaluation and analytical reasoning	Cognitive awareness	Devise the plan	Evidence matrix and proposed solution

Panca-niti	UA-EVAA	Learner activity	Cognitive process	Environmental awareness	Problem-solving	Product
<i>Niti Bakti</i>	Value-Based Action (V A)	Implement the selected solution or environmental action responsibly.	Application, decision enactment, self-regulation	Behavioral awareness	Carry out the plan	Action/ project product and implementati on record
<i>Niti Sajati</i>	Authentic Truth (A)	Evaluate outcomes, reflect on consequences, and formulate improvements.	Evaluation, metacognition, reflective judgment	Affective and behavioral awareness	Look back	Reflection, evaluation, and improvement plan

Adapted from Supriatna et al. (2026), Rachman et al. (2022), Navia et al. (2024), and Polya (1957).

The teacher interface supported attendance, activity monitoring, assignments, projects, portfolios, assessment, and progress tracking across the five phases (Figure 2). Separate student and teacher functions supported independent learning and instructional oversight, with practicality evaluated through user trials.

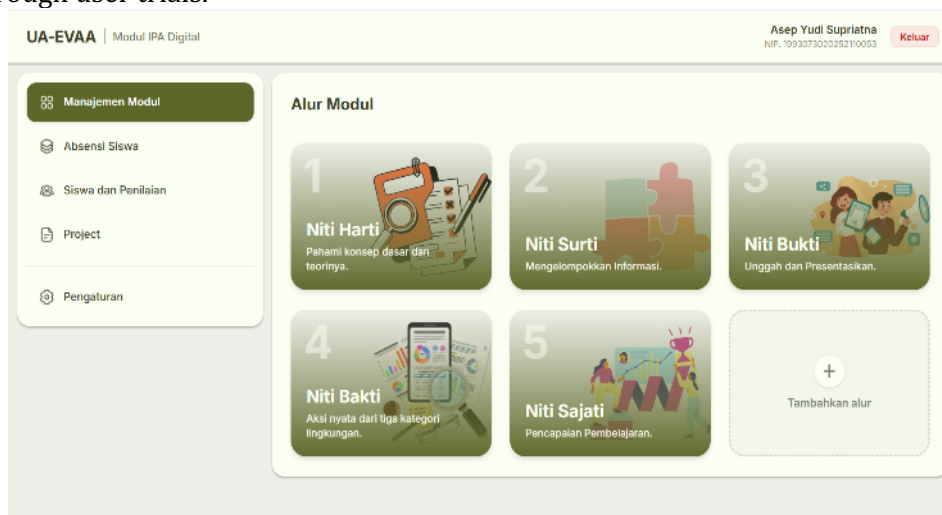


Figure 2. Teacher-Facing Interface of the UA-EVAA Digital Science Module

The teacher interface supported progress monitoring across the UA-EVAA phases and management of learning activities, assignments, projects, portfolios, and assessments, integrating self-directed learning with teacher-guided feedback (Supriatna et al., 2026). Module practicality encompassed student-interface usability and teacher-system efficiency, reliability, and integration, assessed through nine indicators of functionality, user experience, and continued-use intention (Anggini et al., 2026; Apriansyah et al., 2024; Azqia et al., 2026).

Product Architecture and Formative Evaluation

Results are organized according to the developmental logic of the study: product architecture, expert-assessed feasibility, formative revisions, small-scale practicality, large-scale practicality, and implications for *Pancaniti*-based science pedagogy. This organization distinguishes evidence of product readiness from evidence of instructional effectiveness.

Expert-Assessed Product Feasibility

Six validators evaluated 44 sub-indicators across four feasibility dimensions (BSNP, 2014). The overall Aiken's V was 0.861, with dimension means of 0.891 (content), 0.847 (graphics), 0.844 (presentation), and 0.839 (language). Despite adequate dimension-level agreement, item-level values ranged from 0.708 to 1.000, identifying lower-scoring components as targets for formative revision. At the aggregate level, expert agreement was sufficient across all four feasibility dimensions, but individual sub-indicators showed more variation in Aiken's V coefficients. In response, an item-level analysis was performed to identify what could be kept and what needed to be further improved. Table 5 shows the outcomes for each of the 44 sub-indicators.

Table 5.

Expert Validation Results for the Feasibility of the UA-EVAA Digital Science Module

Feasibility Criteria	Indicator	Sub-indicator	Mean Aiken's V	Category	Decision
Content	1. Curricular Alignment	1.1, 1.2	0.958	Adequate	Retain
	2. Scientific Accuracy	2.1, 2.2	0.959	Adequate	Retain
	3. Depth and Breadth of Content	3.1, 3.2	0.813	Adequate	Retain
	4. Currency and Contextual Relevance	4.1, 4.2	0.813	Adequate	Retain
	5. Integration of Sundanese Local-Wisdom Ethnoscience	5.1, 5.2	0.896	Adequate	Retain
	6. Integration of <i>Pancaniti</i> Philosophical Values	6.1, 6.2	0.792	Review Required	Minor Revision
	7. Facilitation of Problem-Solving Skills	7.1, 7.2	0.938	Adequate	Retain
	8. Facilitation of Environmental Awareness	8.1, 8.2	0.958	Adequate	Retain
Total		16	0.891	Adequate	Retain
Presentation	9. Systematic Presentation	9.1, 9.2	0.875	Adequate	Retain
	10. Consistency of the UA-EVAA- <i>Pancaniti</i> Learning Flow	10.1, 10.2	0.771	Review Required	Minor Revision
	11. Active and Interactive Learning Presentation	11.1, 11.2	0.813	Adequate	Retain
	12. Assessment and Feedback Alignment	12.1, 12.2	0.917	Adequate	Retain
Total		8	0.844	Adequate	Retain
Language	13. Language Appropriateness for Learners	13.1, 13.2	0.792	Review Required	Minor Revision
	14. Accuracy and Clarity of Language	14.1, 14.2	0.875	Adequate	Retain
	15. Accuracy and Consistency of Terminology	15.1, 15.2	0.896	Adequate	Retain
	16. Communicativeness, Coherence, and Cohesion	16.1, 16.2	0.792	Review Required	Minor Revision
Total		8	0.839	Adequate	Retain
Graphic	17. Interface Design and Layout	17.1, 17.2	0.834	Adequate	Retain
	18. Typography and Visual Readability	18.1, 18.2	0.792	Review Required	Minor Revision
	19. Illustration Quality and Cultural Representation	19.1, 19.2	0.959	Adequate	Retain
	20. Navigation and Usability	20.1, 20.2	0.854	Adequate	Retain
	21. Multimedia Quality and Digital Interactivity	21.1, 21.2	0.875	Adequate	Retain
	22. Compatibility and Display Consistency	22.1, 22.2	0.771	Review Required	Minor Revision
Total		12	0.847	Adequate	Retain

Expert agreement was strongest for scientific accuracy, environmental-problem understanding, and authentic Sundanese representation ($V = 1.000$), followed by curricular alignment ($V = 0.958$), environmental awareness ($V = 0.958$), and problem-solving ($V = 0.938$). These findings support the module's core scientific and pedagogical suitability while identifying scope for targeted refinement (Asiyah et al., 2021; Sihombing et al., 2025). The distribution of Aiken's V coefficients across the validated indicators, including the relative strengths and areas requiring further refinement, is illustrated in Figure 3.

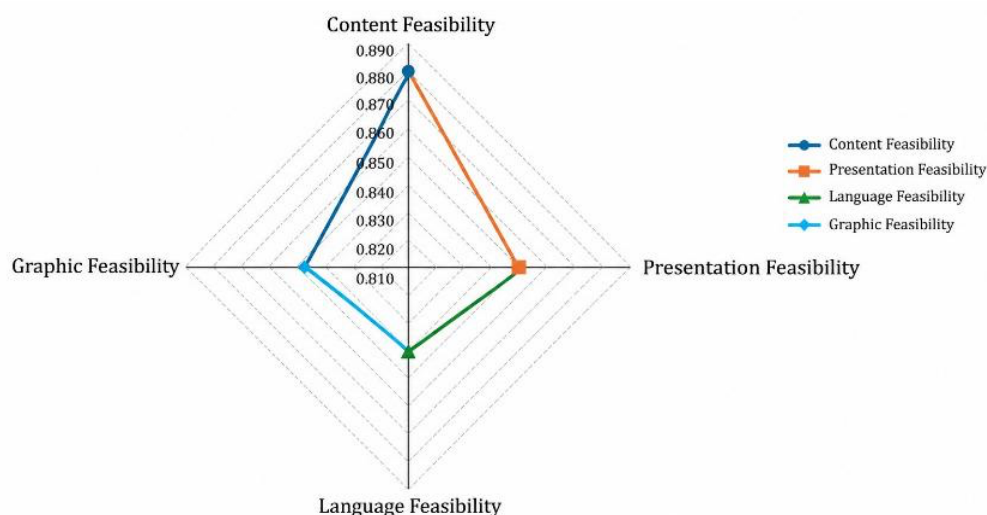


Figure 3. Aiken's V Coefficients across the Four Feasibility Dimensions of the UA-EVAA Digital Science Module

Priorities Formative Revisions from Expert Assessment

Item-level analysis identified concrete revision priorities. *Pancaniti* philosophical integration averaged $V = 0.792$, largely because the instructional functions of the five stages required clearer operational explanation. UA-EVAA-*Pancaniti* flow consistency also required stronger transition cues. Other lower-scoring components concerned content breadth, functional multimedia use, visual contrast, navigation between activities, and cross-device access. These findings identified specific opportunities for interface and instructional improvement rather than indicating failure of the overall product architecture. The key indicator-level results highlighting these strengths and revision priorities are summarized in Table 6.

Table 6.
Selected Indicator-Level Validation Results

Indicator	Mean V	Validity	Formative implication
Curricular Alignment	0.958	Highly	Retain
Scientific Accuracy	0.958	Highly	Retain
<i>Pancaniti</i> Philosophical Integration	0.792	Moderately	Clarify functional mapping of the five stages
Problem-Solving Skills	0.938	Highly	Retain
Environmental Awareness	0.958	Highly	Retain
UA-EVAA- <i>Pancaniti</i> Flow Consistency	0.771	Moderately	Strengthen transitions and sequence cues
Language Appropriateness	0.792	Moderately	Simplify/scaffold learner-facing language
Typography & Visual Readability	0.792	Moderately	Improve contrast and readability
Navigation & Usability	0.854	Valid	Refine movement between activities
Compatibility & Display Consistency	0.771	Moderately	Improve responsive consistency across devices

Language and graphic assessment identified further refinements, including simpler learner-facing language, clearer typography and contrast, explicit navigation, and instructionally relevant multimedia. These revisions show that cultural and scientific adequacy alone did not ensure pedagogical clarity or digital usability. The main lower-scoring sub-indicators and their corresponding revision priorities are summarized in Table 7.

Table 7.
Lower-Scoring Sub-indicators and Revision Priorities

Lower-Scoring Sub-indicator	V	Revision Priority
Breadth of content (3.2)	0.708	Reduce conceptual load and rebalance breadth
<i>Pancaniti</i> stages linked to instructional functions (6.2)	0.708	Make phase functions explicit
Logical UA-EVAA- <i>Pancaniti</i> sequence (10.2)	0.708	Add clearer transitions and progression cues
Multimedia used functionally (11.2)	0.750	Strengthen instructional purpose of media

Lower-Scoring Sub-indicator	V	Revision Priority
Visual contrast (18.2)	0.750	Improve text/background/icon contrast
Movement between activities (20.2)	0.750	Clarify navigation paths
Target-device access (22.1)	0.708	Improve cross-device compatibility

Lower-scoring items (Table 7) guided targeted revisions to content breadth, *Pancaniti* functions, phase transitions, multimedia integration, visual contrast, navigation, and cross-device compatibility. These revisions demonstrate the formative value of item-level expert assessment by identifying and refining weaknesses before effectiveness testing (Nurmasitoh et al., 2025). Table 8 summarizes the validation findings and their implications for subsequent product development.

Table 8.
Overall Interpretation of Expert Validation Results

Validation Indicator	Result	Interpretation
Item-level Aiken's V range	0.708–1.000	Individual items showed an acceptable to maximum level of expert agreement, highlighting the specific components that needed focused on adjustments.
Dimension-level decision	All four dimensions were feasible	Compared with the identified ideal target for content, language, presentation, and graphic dimensions feasibility was moderate.
Use of validation results	Focus polishing before or instead of usability testing	The specific components were iteratively refined with expert feedback while not requiring changes to any high-level facets of the module.

Table 8 summarizes the formative use of expert validation, supporting overall product suitability while identifying targeted revisions before practicality testing rather than providing evidence of instructional effectiveness.

Small-Scale User Trial

Small-scale practicality was Very High for students ($n = 15$; $M = 4.315$, 86.30%) and teachers ($n = 3$; $M = 4.383$, 87.67%). Student indicator means ranged from 4.173 to 4.417, while teacher means ranged from 4.200 to 4.600. Internal consistency was $\alpha = 0.896$ and 0.774, respectively; the latter was interpreted cautiously given the small teacher sample. Overall, the findings supported product refinement and progression to the large-scale trial. Table 9 Comparison of student and teacher responses across the nine practicality indicators, overall scores and internal consistency estimates.

Table 9.
Small-Scale User-Trial Results

Respondent	N	Overall Mean	Percentage	Category	Cronbach's α
Students	15	4.315	86.30%	Very High	0.896
Teachers	3	4.383	87.67%	Very High	0.774

Large-Scale User Trial

Large-scale practicality remained High for students ($n = 100$; $M = 4.172$, 83.44%) and Very High for teachers ($n = 10$; $M = 4.330$, 86.60%). Student ratings ranged from 4.117 for Behavioral Intention/Continued Use to 4.242 for Ease of Use/Perspicuity, while teacher ratings ranged from 4.220 for Ease of Use/Perspicuity to 4.475 for Satisfaction. All teacher-rated indicators remained Very High (Tavakol & Dennick, 2011). Internal consistency was excellent for student responses on the practicality instrument ($\alpha = 0.908$) and adequate for teacher responses ($\alpha = 0.820$) (Cronbach, 1951). Table 10 summarizes the indicator-level results and overall practicality profile from the large-scale trial.

Table 10.
Large-Scale User-Trial Results

Respondent	N	Overall Mean	Percentage	Category	Cronbach's α
Students	100	4.172	83.44%	High	0.908
Teachers	10	4.330	86.60%	Very High	0.820

Lower student ratings in the large-scale trial may reflect greater user diversity, particularly in Attractiveness/User Experience and Continued Use, consistent with expert feedback on visual contrast,

navigation, and cross-device consistency. Teacher ratings remained Very High. Overall, expert and user feedback supported developmental readiness and identified usability issues for further refinement (Nurmasitoh et al., 2025; Sihombing et al., 2025).

Implications for *Pancaniti*-Based Science Pedagogy

The UA-EVAA module demonstrated adequate expert-assessed suitability and positive practicality while identifying areas for refinement. Its main contribution lies in operationalizing *Pancaniti* as an evaluable and revisable digital instructional sequence. Content achieved the highest feasibility score ($V = 0.891$), with strong agreement for curricular alignment ($V = 0.958$), problem-solving facilitation ($V = 0.938$), and environmental-awareness facilitation ($V = 0.958$); selected sub-indicators reached $V = 1.000$. These findings highlight the module's substantive pedagogical foundation. Rather than simply digitizing existing science materials, UA-EVAA integrates local contexts with environmental science, problem-solving, and responsible action. This orientation mirrors Aikenhead (1996), a view of culturally relevant science education focused on learners constructing relations between scientific knowledge and which are within their own contexts. Likewise, ethnoscience research finds that indigenous knowledge has more pedagogical usefulness when it is systematically recast into new terms and made explicit connection with scientific understandings than if it were simply presented as mere ancillary cultural information (Nisa' et al., 2024; Sihombing et al., 2025; Telussa & Tamaela, 2023).

Expert assessment supported the substantive integration of Sundanese culture, with authentic cultural representation reaching $V = 1.000$ and local knowledge–science integration $V = 0.917$. These findings indicate that ethnoscience functioned as a contextual bridge between local knowledge and scientific reasoning rather than as supplementary cultural content. Supriatna et al. (2025) Earlier studies demonstrate that local wisdom can support environmental education by strengthening contextual relevance between scientific learning and learners' cultural and ecological context. Hikmawati et al. (2021) also previously appear local wisdom as something that can be utilized as a source of ethnoscience-oriented science learning, while Verawati & Wahyudi (2024) previous research, which has also shown a role for local wisdom in scientific literacy. It can be viewed as a formalized way of building self-directed digital learning, one that promotes cultural knowledge in an integrated modular format as opposed to local wisdom understood simply in terms of optional content. Validation distinguished cultural authenticity from pedagogical operationalization: Sundanese culture was authentically represented, but the instructional links among *Pancaniti* phases required further clarification. This difference supports the principle that cultural authenticity is necessary but not sufficient: culturally grounded knowledge must also be translated into explicit learner actions, cognitive processes, evidence requirements, and reflective tasks if it is to function as pedagogy rather than as contextual ornament (Rachman et al., 2022; Rusmana et al., 2024).

The revisions strengthened UA-EVAA–*Pancaniti* alignment: *Niti Harti* (Understanding) supports problem identification; *Niti Surti* (Awareness), observation and causal analysis; *Niti Bukti* (Evidence-Based Reasoning), evidence evaluation; *Niti Bakti* (Value-Based Action), responsible action; and *Niti Sajati* (Authentic Truth), evaluation and reflection. (Nurhafidah et al., 2026). This sequence shows conceptual compatibility with Polya (1957) problem-solving structure of understanding the problem, devising a plan, carrying out the plan, and looking back. The relationship is not intended to suggest that *Pancaniti* is equivalent to Polya's framework. Rather, UA-EVAA provides an instructional translation through which the cultural-philosophical sequence can interact with established problem-solving processes. *Niti Surti* and *Niti Bukti*, for example, broaden problem analysis by requiring contextual awareness and evidence-based judgment, whereas *Niti Bakti* gives the solution process an explicit value-oriented and action-oriented dimension (Supriatna et al., 2026).

Environmental awareness further differentiates this architecture from a conventional problem-solving sequence. The module distributes cognitive, emotional, and behavioral awareness across the learning phases instead of positioning environmental awareness as a separate attitudinal outcome. This structure corresponds with the multidimensional conception of environmental awareness represented by cognitive understanding, affective concern, and behavioral responsibility (Navia et al., 2024). *Niti Harti* and *Niti Surti* emphasize recognition and interpretation of environmental conditions; *Niti Bukti* requires evidence-informed evaluation; *Niti Bakti* translates knowledge and concern into responsible behavior; and *Niti Sajati* creates space for reflection on the consequences and meaning of environmental action (Hidayat, E. S. 2023; Hidayat, R. et al., 2025).

The design integrates knowing, reasoning, valuing, acting, and reflecting into a unified

instructional progression, recognizing that environmental problem-solving requires not only conceptual understanding but also awareness, value judgment, and responsible action (Prastiwi et al., 2019; Winarto et al., 2022). Item-level validation confirms why an acceptable overall coefficient should not be interpreted as a finished product. Content breadth, *Pancaniti* instructional functions, UA-EVAA-*Pancaniti* sequencing, functional multimedia integration, visual contrast, navigation, and cross-device access produced coefficients between 0.708 and 0.750 and were therefore revised. The diagnostic value of Aiken's V in this study lies in locating components that need refinement; relying only on the overall value of 0.861 would have masked these weaknesses. This interpretation is consistent with the iterative logic of ADDIE, in which evaluation informs revisions throughout development (Branch, 2009; Ranuharja et al., 2021; Weldami & Yogica, 2023).

Practicality remained positive across both trials. Small-scale scores were 4.315 (86.30%) for students and 4.383 (87.67%) for teachers, compared with 4.172 (83.44%) and 4.330 (86.60%), respectively, in the large-scale trial. The slightly lower student score may reflect greater user and usage variability rather than reduced product quality. Large-scale internal consistency was high for students ($\alpha = 0.908$) and teachers ($\alpha = 0.820$), supporting the consistency of the practicality instrument (Errabo & Ongoco, 2024; Siregar et al., 2018). Large-scale student ratings were highest for Ease of Use/Perspicuity ($M = 4.242$; 84.84%) and Satisfaction ($M = 4.210$; 84.20%), but lower for Attractiveness/User Experience ($M = 4.118$; 82.36%) and Continued Use ($M = 4.117$; 82.33%). This pattern aligns with expert-identified needs for improved visual contrast, navigation, and cross-device accessibility. This convergence indicates that interface quality extends beyond technical functionality and may contribute to users' willingness to maintain engagement with digital learning resources.

Previous research on interactive digital modules similarly suggests that multimedia features are most educationally meaningful when their usability is aligned with clear instructional purposes (Errabo & Ongoco, 2024; Ismail et al., 2024). Digital interactivity should therefore be evaluated not according to the quantity of multimedia features but according to how effectively those features support the intended learning process. Teachers also rated the module positively, with Satisfaction reaching $M = 4.475$ (89.50%) and overall practicality $M = 4.330$ (86.60%). These ratings may reflect the module's integration of student learning with teacher functions for monitoring activities, assignments, projects, portfolios, assessments, and progress across the five UA-EVAA phases (Apriansyah et al., 2024; Azqia et al., 2026; Juliarti et al., 2026). The difference between student and teacher ratings further supports analyzing the two user groups separately because they interact with different functions and judge the module from different instructional roles.

The findings highlight three interdependent dimensions of ethnoscience-based digital-module design: cultural authenticity, pedagogical operationalization, and digital usability. Cultural authenticity preserves local knowledge and values, while pedagogical operationalization translates them into explicit activities, cognitive processes, evidence, and competency-based tasks (Badriah et al., 2024; Haromain et al., 2024). The design and usability of the digital resource affects to how easily learners and teachers navigate these processes in a technological learning environment (Aulia Najiyah et al., 2021; Chaidir et al., 2024; Hernawati et al., 2019). Strength in one layer does not guarantee strength in the others. UA-EVAA therefore functions as the operational bridge that translates *Pancaniti* into observable processes of understanding, awareness, evidence-based reasoning, responsible action, and reflective authentic understanding (Supriatna et al., 2025, 2026). These findings establish formative readiness rather than instructional effectiveness. Without pre-post or control-group comparisons, gains in problem-solving skills and environmental awareness cannot be inferred. Instead, the study establishes a culturally grounded and empirically refined digital framework suitable for subsequent effectiveness testing. Future studies should examine learning outcomes and how students navigate the five phases to connect cultural knowledge, scientific reasoning, and environmental action.

CONCLUSION

The tangible contribution of this study is an empirically refined instructional architecture that translates the five Sundanese *Pancaniti* values into the UA-EVAA sequence—Understanding, Awareness, Evidence-Based Reasoning, Value-Based Action, and Authentic Truth—and embeds that sequence in a usable digital science module. Expert assessment produced an overall Aiken's V of 0.861, while item-level analysis exposed and guided revisions to content breadth, phase transitions, multimedia use, visual contrast, navigation, and cross-device access. Practicality remained positive from the small-scale trial (students 86.30%; teachers 87.67%) to the large-scale trial (students 83.44%; teachers 86.60%). These

findings demonstrate developmental readiness and provide a replicable approach to translating culturally authentic knowledge into explicit pedagogical functions that connect scientific reasoning, problem-solving processes, and environmental responsibility. They do not constitute evidence that the module improves learning outcomes; that question requires subsequent research on effectiveness.

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