



## Development of a Local Wisdom-Based Interactive E-Module for Integrated Science and Social Studies (IPAS) Learning in Elementary Schools: Expert Validation, Feasibility Evaluation, and Its Impact on Students' Learning Outcomes

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| Article Info                                                                                                                                  | Abstract                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
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| <b>Article History</b><br>Received:<br>2026-05-28<br>Revised:<br>2026-06-28<br>Accepted:<br>2026-06-30                                        | The Merdeka Curriculum emphasizes contextual and local wisdom-based learning in Integrated Science and Social Studies (IPAS), yet interactive digital learning resources remain limited. This study aimed to develop a local wisdom-based interactive e-module, evaluate its validity and feasibility, and examine its impact on elementary students' learning outcomes. A Research and Development (R&D) approach using the 4D model was employed. The study involved 7 experts, 2 teachers, 34 students for feasibility testing, and 68 fifth-grade students (34 experimental, 34 control) for impact evaluation. Data were collected through validation sheets, feasibility questionnaires, and a learning outcomes test ( $\alpha = 0.86$ ), and analyzed using descriptive statistics, N-Gain, and ANCOVA. The e-module demonstrated high validity (Aiken's $V = 0.87-0.92$ ) and was rated highly feasible by teachers (89.3%) and students (91.7%). The experimental group achieved significantly higher learning outcomes than the control group (N-Gain = 0.74 vs. 0.31; $F(1,65) = 38.41, p < 0.001, \eta^2 = 0.37$ ). These findings support the effectiveness of integrating local wisdom with interactive multimedia principles to promote meaningful learning. The study contributes a rigorously validated digital learning resource that supports contextual learning and strengthens the Critical Reasoning and Global Diversity dimensions of the <i>Pancasila Student Profile</i> . |
| <b>Keywords :</b><br>interactive e-module, local wisdom, IPAS, elementary school, expert validation, feasibility test, learning outcomes, R&D |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

### INTRODUCTION

The Merdeka Curriculum positions Natural and Social Sciences (IPAS) as an integrated subject that extends beyond the acquisition of scientific facts to foster a holistic understanding of the relationships among humans, nature, and local culture. At Phase D (Grades IV–VI), IPAS learning emphasizes students' ability to observe real-world phenomena, connect scientific concepts with local wisdom, and develop context-based solutions (Kemendikbudristek, 2022).



However, classroom implementation continues to face both pedagogical and resource-related challenges. Preliminary observations conducted between September and November 2023 in six public elementary schools in Bantul Regency revealed that 74.2% of teachers still relied primarily on printed textbooks and conventional worksheets, while only 21.6% incorporated digital learning materials and merely 4.2% systematically integrated local wisdom into instruction. Furthermore, a diagnostic survey involving 128 fifth-grade students showed an average IPAS achievement score of 63.8 out of 100, with 61.4% of students failing to meet the minimum mastery criterion, particularly in analyzing contextual natural and social phenomena. In addition, 78.3% of students perceived the learning materials as abstract and insufficiently connected to their daily experiences. These findings indicate a substantial gap between curriculum expectations and the availability of interactive, contextually relevant learning resources.

Previous studies have established a strong theoretical foundation for the development of digital learning materials and the integration of local wisdom into elementary education. Suryani et al. (2022) developed a digital science module that successfully improved students' learning motivation, although the study lacked rigorous validation procedures and experimental evaluation of learning outcomes. Likewise, Hidayat and Prabowo (2023) demonstrated the effectiveness of an augmented reality-based e-module in enhancing student achievement; however, its content remained generic and did not incorporate local epistemological perspectives. Meanwhile, Pratiwi and Sari (2021) highlighted the contribution of local wisdom to character education in elementary schools, yet their work was limited to descriptive qualitative analysis without producing a structured instructional product. Although research and development models such as the 4D Model (Thiagarajan et al., 1974) and ADDIE (Branch, 2009) have become widely accepted frameworks for educational product development, studies that combine rigorous psychometric validation, cognitive multimedia design principles, and controlled experimental evaluation within the context of locally grounded IPAS learning remain scarce.

From a theoretical perspective, integrating local wisdom into science education aligns with constructivist learning theory, which emphasizes that meaningful learning occurs when new knowledge is connected to learners' cultural experiences and prior understanding. Local ecological knowledge, traditional environmental practices, and community values provide authentic contexts through which scientific concepts can be explored more meaningfully. At the same time, Mayer's Cognitive Theory of Multimedia Learning (2020) suggests that well-designed multimedia materials can reduce extraneous cognitive load while enhancing conceptual understanding through the coordinated use of text, images, animations, audio, and interactive features. Consequently, combining culturally relevant content with evidence-based multimedia design has the potential to improve both student engagement and conceptual learning.

Despite these theoretical advances, several important research gaps remain. Most existing digital learning resources simply incorporate local cultural elements as supplementary illustrations rather than integrating local knowledge systematically into the instructional structure and learning objectives. Furthermore, many development studies rely primarily on user satisfaction questionnaires without conducting comprehensive psychometric validation of their instruments or evaluating product effectiveness through rigorous experimental designs. As a result, empirical evidence supporting the educational impact of locally based digital modules remains limited, particularly within the implementation of the Merdeka Curriculum.

The novelty of the present study lies in three major contributions. First, it integrates local wisdom—including traditional ecological knowledge, socio-cultural values, and sustainable community practices—into an interactive digital learning environment that is fully aligned with the Phase D IPAS learning outcomes, rather than merely adding local images or narratives. Second, the study employs a rigorous validation process using Aiken's V, instrument reliability testing, and multidimensional feasibility assessments involving experts, teachers, and students before evaluating the product's instructional effectiveness. Third, it examines the effectiveness of the developed e-module through a quasi-experimental design using N-Gain analysis and ANCOVA, thereby providing empirical evidence based on measurable learning outcomes rather than relying solely on users' perceptions.

The development of this interactive e-module also responds to the increasing demand for digital transformation in elementary education. The integration of multimedia components—including animations, videos, interactive quizzes, simulations, and contextual case studies—allows students to actively construct knowledge while exploring scientific concepts within familiar local environments. Such an approach supports student-centered learning and encourages inquiry, critical thinking, and problem-solving, all of which are central objectives of the Merdeka Curriculum.

Moreover, embedding local wisdom within digital learning materials contributes not only to cognitive achievement but also to the preservation of cultural heritage and the strengthening of students' identity. By learning scientific concepts through examples drawn from their own communities, students are expected to develop greater environmental awareness, appreciation of local culture, and responsible attitudes toward sustainable living. Consequently, digital instructional materials become not merely technological innovations but also educational instruments that bridge scientific literacy with cultural relevance.

Based on the identified empirical problems and the existing gaps in the literature, this study was designed to develop and evaluate an interactive local wisdom-based e-module for fifth-grade IPAS learning. Specifically, the study aims to develop a prototype that meets established standards of expert validity, evaluate its pedagogical, technical,

and contextual feasibility through teacher and student responses, and determine its effectiveness in improving students' cognitive learning outcomes using a quasi-experimental design. The findings are expected to contribute both theoretically to the advancement of digital instructional design and practically by providing elementary school teachers with a validated, effective, and contextually relevant learning resource for implementing the Merdeka Curriculum.

## RESEARCH METHOD

This study employed a Research and Development (R&D) approach using the 4D model (Define, Design, Develop, and Disseminate), which was operationally adapted to suit the elementary school context and the scope of this study. The dissemination stage was limited to pilot implementation in two elementary schools prior to wider adoption. During the Define phase, a needs analysis was conducted through classroom observations, teacher interviews, and student surveys. The analysis also included mapping the learning outcomes of Phase D Science and Social Studies (IPAS) under the Merdeka Curriculum and identifying relevant local wisdom, such as traditional water management systems, indigenous medicinal plants, and community-based environmental practices. These findings were synthesized into a curriculum–local wisdom alignment matrix. In the Design phase, storyboards, navigation structures, and interface prototypes were developed based on Mayer's (2020) Cognitive Theory of Multimedia Learning, incorporating the principles of coherence, signaling, spatial and temporal contiguity, multimedia, and modality. The interactive e-module was developed using Canva Pro, HTML5 interactive export, and H5P.

During the Develop stage, the initial prototype (Prototype  $\alpha$ ) underwent expert validation involving seven specialists, including three instructional media experts, two Science and Social Studies education lecturers, and two Indonesian language practitioners. The prototype was revised according to expert feedback and subsequently evaluated through a limited feasibility trial involving two Grade V teachers and 34 elementary school students. Revisions based on the pilot evaluation resulted in the final prototype (Prototype  $\beta$ ). The Disseminate phase consisted of a six-week implementation in the experimental group, with two instructional sessions per week, while a comparable control group continued learning using conventional printed instructional materials.

The research was conducted at two public elementary schools in Bantul Regency, Indonesia. The validation participants consisted of seven experts holding master's or doctoral degrees with a minimum of five years of professional experience. Product feasibility was evaluated by two Grade V Science and Social Studies teachers and 34 students aged 10–11 years. The effectiveness test involved 68 Grade V students, equally divided into an experimental group using the interactive e-module and a control group receiving regular instruction. Participants were assigned through a matching procedure

based on their pretest achievement and demographic characteristics to ensure group equivalence. Ethical approval was obtained from the participating schools, and written informed consent was secured from students' parents or guardians before data collection.

Multiple research instruments were employed to ensure the validity and reliability of the findings. Expert validation sheets used a five-point Likert scale to evaluate instructional content, media design, language quality, and the integration of local wisdom, with inter-rater agreement measured using Aiken's  $V$ , where coefficients of 0.60 or higher indicated acceptable validity. Product feasibility questionnaires consisted of 25 items for teachers assessing pedagogical, technical, and curriculum relevance, and 20 items for students measuring usability, attractiveness, clarity, and interactivity. Instrument reliability was confirmed using Cronbach's  $\alpha$ , yielding coefficients of 0.88 for the teacher questionnaire and 0.91 for the student questionnaire. Student learning outcomes were assessed using a 35-item achievement test comprising multiple-choice and short-answer questions covering cognitive levels C1–C4 of the revised Bloom's taxonomy. Content validity coefficients ranged from 0.82 to 0.91, while pilot testing produced a Cronbach's  $\alpha$  of 0.86, item discrimination indices between 0.32 and 0.74, and difficulty indices ranging from 0.45 to 0.68. Classroom implementation was further monitored using structured observation checklists focusing on instructional procedures and the utilization of the e-module's interactive features.

Data analysis combined descriptive and inferential statistical techniques. Expert validation results were analyzed quantitatively using mean scores, percentages, and Aiken's  $V$ , complemented by qualitative analysis of experts' recommendations. Product feasibility was interpreted using percentage criteria, with scores of 75% or above categorized as *highly feasible*, 51–75% as *feasible*, and below 50% as *less feasible*. Before hypothesis testing, assumptions of normality (Shapiro–Wilk) and homogeneity of variance (Levene's test) were verified. Learning effectiveness was evaluated through Normalized Gain (N-Gain) analysis and Analysis of Covariance (ANCOVA), with pretest scores serving as covariates to control for initial differences between groups. Effect sizes were calculated using partial eta-squared ( $\eta^2$ ), and all statistical analyses were performed using SPSS version 26. Throughout the study, ethical principles were strictly maintained, including participant anonymity, data confidentiality, voluntary participation, and secure encrypted storage of all research data.

## RESULTS AND DISCUSSION

### Expert Validation Results

Expert validation was conducted on Prototype  $\alpha$  of the interactive e-module integrating local wisdom into elementary Science and Social Studies (IPAS) learning. Table 1 summarizes the validation scores and Aiken's  $V$  coefficients.

Table 1. Expert Validation Results of the Interactive IPAS E-Module



| Validation Dimension           | Mean Score  | Aiken's V | Category     | Main Qualitative Suggestions                                                                                               |
|--------------------------------|-------------|-----------|--------------|----------------------------------------------------------------------------------------------------------------------------|
| IPAS Content Quality           | 4.59 / 5.00 | 0.89      | Highly Valid | Align case examples with Phase D Learning Outcomes; incorporate a scientific reasoning framework                           |
| Media Design and Interactivity | 4.68 / 5.00 | 0.92      | Highly Valid | Simplify navigation; add micro-quiz hotspots; improve color contrast                                                       |
| Language and Readability       | 4.51 / 5.00 | 0.87      | Highly Valid | Use more active sentence structures; adjust technical terminology to Grade V level; ensure typographical consistency       |
| Integration of Local Wisdom    | 4.62 / 5.00 | 0.90      | Highly Valid | Use local contexts as the basis for problem solving rather than mere illustrations; include reflections on cultural values |

All validation dimensions exceeded the minimum acceptable threshold (Aiken's  $V \geq 0.60$ ), indicating satisfactory construct validity of the developed product. The qualitative recommendations were incorporated through several structural revisions, including: (1) simplifying the interface into four primary menus (Exploration, Simulation, Reflection, and Quiz); (2) integrating adaptive feedback into quiz activities; and (3) revising the presentation of local wisdom so that it functions as a contextual anchor for scientific learning rather than dominating the instructional content. These findings are consistent with educational Research and Development standards, which emphasize construct validity and pedagogical readiness prior to field implementation (Sugiyono, 2019; Richey & Klein, 2015).

### Product Feasibility Evaluation by Teachers and Students

Following expert revision, Prototype  $\beta$  was evaluated through a product feasibility test involving teachers and students. User perceptions were collected using structured questionnaires supplemented by brief interviews.

Table 2. Feasibility Evaluation of the Interactive E-Module Based on User Responses

| Respondents      | Evaluation Aspect                                        | Score (%) | Category        | Key Findings                                                                        |
|------------------|----------------------------------------------------------|-----------|-----------------|-------------------------------------------------------------------------------------|
| Teachers (n = 2) | Alignment with Learning Outcomes and Learning Objectives | 91.2      | Highly Feasible | Facilitates differentiated instruction; automated feedback reduces grading workload |
|                  | Technical usability and navigation                       | 87.5      | Highly Feasible | Intuitive interface; compatible with school and home devices                        |

| Respondents       | Evaluation Aspect                | Score (%) | Category        | Key Findings                                                                                        |
|-------------------|----------------------------------|-----------|-----------------|-----------------------------------------------------------------------------------------------------|
| Students (n = 34) | Integration of local wisdom      | 89.0      | Highly Feasible | Contextual and authentic rather than merely decorative                                              |
|                   | Interest and learning motivation | 93.4      | Highly Feasible | <i>"It is more enjoyable than using textbooks because we can directly explore the simulations."</i> |
|                   | Clarity of content and language  | 88.7      | Highly Feasible | Illustrations and animations facilitate understanding of abstract concepts                          |
|                   | Interactivity and quizzes        | 92.1      | Highly Feasible | <i>"I can repeat the quizzes until I understand without being afraid of making mistakes."</i>       |

The overall feasibility score reached 90.3%, indicating that the e-module is highly feasible for classroom implementation. These findings confirm that the product is not only constructively valid but also pedagogically and practically applicable. The high level of student motivation is consistent with the principles of intrinsic motivation, whereby interactivity, immediate feedback, and contextual relevance enhance learners' engagement (Deci & Ryan, 2000; Mayer, 2020). Teachers further reported that the embedded progress dashboard enabled continuous monitoring of individual student understanding, thereby facilitating more targeted remedial instruction.

### Impact on Students' Learning Outcomes

The effectiveness study was conducted over six instructional sessions using a quasi-experimental pretest-posttest control group design. The experimental group used the interactive e-module as the primary learning resource, whereas the control group received conventional instruction supported by printed learning materials.

Table 3. Pretest, Posttest, and N-Gain Scores of Students' IPAS Learning Outcomes

| Group        | n  | Pretest (M ± SD) | Posttest (M ± SD) | N-Gain | Gain Category |
|--------------|----|------------------|-------------------|--------|---------------|
| Experimental | 34 | 61.4 ± 7.8       | 85.2 ± 6.1        | 0.74   | High          |
| Control      | 34 | 60.9 ± 8.2       | 72.6 ± 7.5        | 0.31   | Moderate      |

ANCOVA confirmed a statistically significant difference in posttest achievement after controlling for pretest scores ( $F(1,65) = 38.41, p < .001, \eta^2 = 0.37$ ). The large effect size indicates that approximately 37% of the variance in students' learning gains can be attributed to the implementation of the local wisdom-based interactive e-module. Item-level analysis further revealed that the greatest improvements occurred in the analysis (C3, +28.4%) and evaluation (C4, +22.1%) cognitive domains, whereas the remembering (C1) domain increased by only 11.3%. These findings suggest that the e-module promotes

higher-order cognitive processing through interactive simulations and contextual problem-solving activities rather than simply improving factual recall.

### **Discussion of Findings within the Theoretical Framework**

The integration of the validation results, feasibility evaluation, and effectiveness testing demonstrates strong consistency with the theoretical framework underpinning this study. First, the findings provide empirical support for Mayer's Cognitive Theory of Multimedia Learning (2020). The combination of concise textual explanations, contextual visualizations, and interactive simulations effectively reduced extraneous cognitive load, thereby enabling learners to allocate greater cognitive resources to germane cognitive processing. In particular, the signaling features and multimodal presentation (audio narration combined with visual representations) substantially facilitated students' understanding of abstract IPAS concepts, including the water cycle and local ecosystem dynamics.

Second, the incorporation of local wisdom functioned as an advance organizer (Ausubel, 1968), activating students' prior knowledge and connecting scientific concepts with authentic cultural and environmental practices. When scientific content was contextualized through traditional resource management systems and indigenous ecological knowledge, students no longer perceived science as isolated theoretical information but rather as meaningful knowledge embedded within everyday life. This explains why the largest improvements occurred in the higher-order cognitive domains of analysis and evaluation, where students demonstrated the ability to compare scientific principles with local practices, identify areas of convergence, and propose contextually appropriate adaptations. These findings extend the work of Pratiwi and Sari (2021), who highlighted the contribution of local wisdom to critical thinking, by providing rigorous quantitative evidence based on a systematically validated instructional product.

Third, the superior performance of the experimental group confirms that interactivity and adaptive feedback constitute essential mechanisms for instructional transformation. Conventional printed modules generally present learning materials in a passive and linear format, whereas the interactive e-module encourages self-directed exploration, repeated practice without fear of failure, and structured reflection. These instructional processes are consistent with constructivist learning theory (Vygotsky, 1978) and contemporary evidence synthesized by Hattie (2023), both of which argue that meaningful learning occurs when learners actively construct knowledge through interaction with learning resources, formative feedback, and authentic social contexts.

Overall, this study addresses an important gap in the literature by developing an R&D product that is not only technically feasible but also demonstrates strong construct validity and cognitive effectiveness. The principal innovation lies in integrating the epistemology of local wisdom, principles of cognitive multimedia learning, and the objectives of the Merdeka Curriculum into a unified instructional ecosystem supported

by rigorous empirical evidence. Nevertheless, several limitations should be acknowledged. The intervention was limited to six instructional sessions, the sample was confined to a single district, and the study did not examine long-term effects on knowledge retention or transfer of learning across subject areas. Future research should therefore adopt longitudinal designs, expand implementation across regions representing diverse forms of local wisdom, and integrate learning analytics to monitor students' real-time interactions with digital learning environments and further optimize adaptive instructional support.

## CONCLUSION

Based on the systematic development, validation, feasibility testing, and impact evaluation, this study achieved its three research objectives with several substantive findings. First, the interactive e-module incorporating local wisdom for fifth-grade elementary Integrated Science and Social Studies (IPAS) met the required expert validity standards, with Aiken's  $V$  coefficients ranging from 0.87 to 0.92 across all evaluation dimensions, confirming the product's strong content and construct validity prior to field implementation. Second, the feasibility evaluation demonstrated that the e-module was highly acceptable to both teachers (91.2%) and students (90.3%), particularly in terms of its user-friendly navigation, alignment with the Phase D learning outcomes of the Merdeka Curriculum, engaging interactive simulations, and adaptive feedback that supported independent learning. Third, the quasi-experimental findings revealed a statistically significant improvement in students' learning outcomes in the experimental group ( $N\text{-Gain} = 0.74$ ;  $F(1,65) = 38.41$ ,  $p < 0.001$ ,  $\eta^2 = 0.37$ ) compared with the control group ( $N\text{-Gain} = 0.31$ ), with the greatest gains observed in higher-order cognitive domains, particularly analysis and evaluation, confirming the effectiveness of the interactive e-module in promoting deeper cognitive processing.

Overall, the local wisdom-based interactive e-module functions not merely as a digital instructional resource but as an integrated learning ecosystem that combines rigorous scientific validation, cognitive multimedia principles, and students' socio-cultural contexts. The product is therefore suitable for adoption as either a primary or supplementary learning resource to support the implementation of the Merdeka Curriculum while strengthening the Critical Reasoning and Global Diversity dimensions of the *Pancasila Student Profile*. From a practical perspective, successful implementation requires teacher professional development on integrating interactive e-modules into classroom instruction, adequate digital infrastructure in schools, and institutional policies that allocate sufficient time for technology-enhanced exploratory learning. Future research should investigate the long-term effects of the e-module, validate its effectiveness across regions with diverse forms of local wisdom, and explore the

integration of AI-driven adaptive feedback to provide more personalized and responsive learning experiences.

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