Prisma Sains: Jurnal Pengkajian Ilmu dan Pembelajaran Matematika dan IPA IKIP Mataram
https://e-journal.undikma.ac.id/index.php/prismasains/index
e-mail: prismasains.pkpsm@gmail.com

October 2026. Vol. 14, No. 4
p-ISSN: 2338-4530
e-ISSN: 2540-7899
pp. 2831-2846

Mopendigtif: A DDD-E Interactive Digital IPAS Module for Elementary Students' Active Participation and Learning Motivation

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Received: August 2026; Revised: September 2026; Published: October 2026

Abstract

Active and motivated participation is essential in elementary IPAS learning, yet abstract concepts are often presented through static, teacher-controlled media. This developmental study designed and evaluated Mopendigtif, a Grade IV interactive digital IPAS module, through Decide–Design–Develop–Evaluate (DDD-E) in three public elementary schools in Jambi City, Indonesia. One validator assessed each of the material, language, and media domains; three teachers and small groups of six students per school (n = 18) assessed practicality; and classroom teachers observed activity and motivation among 67 students at two time points. Final domain-validation scores were 4.80, 5.00, and 5.00, respectively, while teacher practicality averaged 4.97/5 and large-group student practicality approximately 0.95. Mean activity ratings increased descriptively from 3.80 to 4.24 and motivation from 3.77 to 4.38. Because the outcomes were bounded observational ratings, N-gain analysis was removed; raw differences and between-school variation were used instead. The findings support Mopendigtif as a domain-validated, highly practical resource accompanied by observed classroom improvement, but do not establish causal effectiveness. Its contribution is an explicit learner-action design principle aligning dynamic representations, interactive prompts, feedback, reflection, and gamified progression with activity and motivational support across three technology contexts.

Keywords: Interactive digital module; DDD-E development model; IPAS learning; Active participation; Learning motivation

How to Cite: Risdaliani, R., Sofwan, M., Indryani, I., & Risdalina, R. (2026). Mopendigtif: A DDD-E Interactive Digital IPAS Module for Elementary Students' Active Participation and Learning Motivation. *Prisma Sains: Jurnal Pengkajian Ilmu Dan Pembelajaran Matematika Dan IPA IKIP Mataram*, *14*(4), 2831–2846. https://doi.org/10.33394/j-ps.v14i4.22307

https://doi.org/10.33394/j-ps.v14i4.22307

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INTRODUCTION

The implementation of Indonesia's Merdeka Curriculum has strengthened expectations that elementary learning should move beyond the transmission of facts toward meaningful, active, and contextual knowledge construction (Amiruddin et al., 2023; Harjanti et al., 2026; Silviani et al., 2025). This expectation is particularly relevant to Integrated Natural and Social Sciences (*Ilmu Pengetahuan Alam dan Sosial*/IPAS), where learners are expected to observe phenomena, formulate questions, interpret evidence, and connect scientific ideas with everyday situations (Rahmawati, 2026; Surul & Septiliana, 2023). These expectations align with inquiry-oriented science education, which emphasizes active knowledge construction through scientific investigation, evidence interpretation, and appropriately guided learning activities (Furtak et al., 2012; Lazonder & Harmsen, 2016). In Grade IV, topics such as energy transformation, magnetism, electricity, and technology involve abstract concepts and processes that are difficult to observe directly. When these concepts are presented primarily through lectures, hand-drawn illustrations, or static presentations, learners have fewer opportunities to explore representations, test ideas, and engage in learning activities that sustain interest and motivation (Burde & Wilhelm, 2020; Morris, 2025; Okur & Seyhan, 2025; Staneviciene & Žekienė, 2025).

Consequently, elementary IPAS instruction requires learning resources that make abstract phenomena accessible while providing structured opportunities for active participation and meaningful interaction.

Initial needs analysis conducted at SDN 215/IV, SDN 132/IV, and SDN 97/IV in Jambi City, Indonesia, revealed a similar instructional challenge. Teachers reported difficulties in visualizing complex IPAS content, while classroom practices remained predominantly teacher-centered. Students tended to be passive, asked few questions, participated inconsistently in discussions, and demonstrated limited enthusiasm for completing learning tasks. Nevertheless, the schools possessed digital resources, including Smart TVs, Chromebooks, projectors, and teachers' mobile devices. The problem was therefore not the absence of technology but the lack of systematically designed digital learning resources that transformed available technological facilities into interactive, learner-centered experiences. Research syntheses indicate that the educational benefits of digital technology depend substantially on instructional strategies, technological characteristics, and implementation conditions rather than technological availability alone (Hillmayr et al., 2020; Sung et al., 2016; Tamim et al., 2011). Teaching methods, hardware characteristics, and student-to-device ratios also influence cognitive, affective, and behavioral learning outcomes in primary and secondary education (Wang et al., 2023). Similarly, technology-supported inquiry in elementary science education highlights the importance of aligning technological affordances with intended learning processes (Yun & Crippen, 2024). These findings suggest that addressing the identified instructional challenges requires pedagogically structured technology integration rather than merely increasing access to digital devices.

Interactive digital learning resources offer opportunities to address these challenges by integrating multimodal representations with meaningful learning activities. The Cognitive Theory of Multimedia Learning provides a theoretical foundation for combining verbal and visual information while considering learners' limited cognitive processing capacity. Multimedia instruction is more likely to support meaningful learning when relevant information is coherently organized, unnecessary information is minimized, and learners are encouraged to actively process the presented material (Mayer, 2021). Dynamic representations, particularly animations and instructional videos, are relevant to scientific concepts involving movement, transformation, and processes that are difficult to communicate through static illustrations. Meta-analytic evidence indicates that instructional animations can offer advantages over static graphics, although their benefits depend on representational characteristics and instructional conditions (Berney & Bétrancourt, 2016). Accordingly, multimedia integration in elementary IPAS should extend beyond visual attractiveness to facilitate the observation, interpretation, and discussion of scientific phenomena.

However, multimedia presentation alone does not necessarily generate meaningful learning activity. Learner engagement encompasses behavioral, emotional, and cognitive dimensions that are interrelated but conceptually distinguishable (Fredricks et al., 2004). The Interactive–Constructive–Active–Passive (ICAP) framework further emphasizes that the quality of cognitive engagement depends on the nature of learners' activities and their opportunities to construct knowledge (Chi & Wylie, 2014). From this perspective, viewing instructional videos and navigating digital materials may provide access to information, but deeper engagement requires opportunities to respond to questions, generate explanations, connect ideas, and participate in meaningful interactions. Interactive digital modules should therefore integrate multimedia representations with quizzes, discussion prompts, problem-solving activities, and reflection. Formative feedback can complement these activities by helping learners identify discrepancies in their understanding, reconsider their responses, and monitor their progress. Nevertheless, the instructional value of feedback depends on its informational content and pedagogical function rather than its mere presence (Wisniewski et al., 2020). These theoretical perspectives emphasize the importance of designing digital learning resources around intended learner actions rather than technological features alone.

Learning motivation constitutes another essential consideration in the design of interactive learning environments. Self-Determination Theory emphasizes that learning environments can support motivation by addressing learners' psychological needs for autonomy, competence, and relatedness (Ryan & Deci, 2020). Meta-analytic evidence indicates that intrinsic motivation and personally valued learning activities are associated with favorable educational outcomes, whereas externally regulated motivation does not necessarily provide comparable benefits (Howard et al., 2021). Interactive digital modules can provide motivational support through meaningful choices, attainable learning objectives, informative feedback, and visible opportunities for progress. Gamification represents a complementary instructional strategy for organizing these experiences through narratives, challenges, progression, and achievement recognition. However, different game-design elements can generate different psychological experiences, making their pedagogical alignment particularly important (Sailer et al., 2017). Systematic reviews and meta-analyses have reported favorable cognitive, motivational, and behavioral outcomes associated with educational gamification, while also identifying considerable variation across instructional designs and implementation contexts (Bai et al., 2020; Sailer & Homner, 2020; Zainuddin et al., 2020). More recent evidence suggests that gamification can support intrinsic motivation and perceived autonomy and relatedness, although its contribution to perceived competence may be more limited (Li et al., 2024). Therefore, gamified learning activities in elementary IPAS should serve clearly defined pedagogical and motivational functions rather than merely introduce entertainment or external rewards.

Previous studies have explored the educational potential of interactive digital resources through diverse technological formats and instructional approaches. Interactive digital modules have been developed for game-based English language learning (Husna et al., 2015), electronic instructional support (Saputra & Oktarina, 2023), and the development of students' learning activity and autonomy (Tarigan et al., 2021). Other studies have developed interactive PowerPoint media for Grade IV elementary learners (Fajar & Mayar, 2023), Wordwall-assisted interactive multimedia targeting critical-thinking skills (Fajrin et al., 2025), and Canva-assisted discovery learning media for social sciences education (Habibah et al., 2025). International research further demonstrates that technology-supported learning can address cognitive, affective, and behavioral outcomes, although its educational value remains sensitive to pedagogical design, learner characteristics, and implementation arrangements (Hillmayr et al., 2020; Wang et al., 2023; Yun & Crippen, 2024). Collectively, these studies demonstrate the diversity of interactive learning resources and suggest that further development should focus not merely on incorporating technological features but also on explicitly articulating how those features are intended to support learning activities and motivational experiences within a coherent instructional sequence.

Despite these developments, four interrelated research needs emerge from the reviewed literature. First, from a developmental perspective, further attention is needed to documenting how identified instructional problems, pedagogical requirements, expert judgments, and user feedback inform successive product refinements. Educational design research emphasizes iterative analysis, design, evaluation, and refinement as essential processes for developing contextually appropriate educational interventions and generating transferable design insights (McKenney & Reeves, 2021; Wang & Hannafin, 2005). Second, from a content perspective, although previous studies have investigated interactive resources across various educational domains, further investigation is warranted into curriculum-aligned Grade IV IPAS modules addressing scientific phenomena that require dynamic visualization and guided interaction. Third, from an outcome perspective, the multidimensional nature of learner engagement and motivation highlights the importance of considering observable learning activity and motivational support as complementary design targets rather than evaluating digital media exclusively through academic achievement or technological attractiveness (Chi & Wylie, 2014; Fredricks et al., 2004; Howard et al., 2021). Fourth, from an implementation perspective,

differences in technological infrastructure, device-sharing arrangements, and instructional facilitation justify examining product feasibility across multiple classroom settings (Hillmayr et al., 2020; Wang et al., 2023). Together, these research needs provide a rationale for developing an interactive IPAS module that explicitly connects digital features, intended learner actions, and motivational support through an iterative development process and multi-school feasibility evaluation.

To address these research needs, the present study developed Mopendigtif (*Modul Pembelajaran Digital Interaktif*), an interactive Grade IV IPAS module organized through the Decide–Design–Develop–Evaluate (DDD-E) model. The distinctive contribution of Mopendigtif lies not merely in combining multimedia, quizzes, navigation, reflection, and gamification but in integrating these components through a learner-action design principle. This principle conceptualizes instructional interactivity as the deliberate alignment of technological affordances, intended learner actions, and motivational support. Dynamic representations are designed to make otherwise difficult scientific processes observable; hyperlinks and navigation provide opportunities for learner choice and revisiting content; quizzes and discussion prompts encourage cognitive and social participation; feedback and reflection support progress monitoring; and detective-themed missions and completion recognition provide structured goals, progression, and acknowledgment. These design relationships are conceptually consistent with multimedia learning principles, cognitive engagement frameworks, and motivational perspectives that emphasize the quality of learner interaction rather than the presence of technology itself (Chi & Wylie, 2014; Mayer, 2021; Ryan & Deci, 2020; Sailer et al., 2017). Learning activity and motivation are therefore positioned as explicit pedagogical design requirements that inform product development and evaluation.

The DDD-E model was selected because its evaluation component enables continuous refinement throughout the development process rather than limiting evaluation to the completed product (Juniari & Putra, 2021; Sulistiyarini et al., 2021; Suryasari et al., 2026). This iterative orientation aligns with broader educational design research principles that emphasize evidence-informed design decisions, progressive product refinement, and responsiveness to authentic implementation conditions (McKenney & Reeves, 2021; Wang & Hannafin, 2005). Through this approach, Mopendigtif integrates curricular requirements, multimedia design, intended learner activities, and motivational support within a coherent instructional resource. Its evaluation across three elementary schools provides preliminary evidence concerning product validity, user practicality, and observed classroom participation under different technological arrangements.

Accordingly, this study aimed to (1) describe the DDD-E development process of Mopendigtif for Grade IV IPAS; (2) determine its validity in terms of content, language, and media; (3) examine its practicality from teacher and student perspectives; and (4) evaluate descriptive changes in teacher-observed indicators of students' learning activity and motivation during implementation. The conceptual contribution of this study lies in articulating feature–action–motivation alignment as an explicit pedagogical design principle, while its methodological contribution lies in connecting iterative product refinement with domain-specific expert judgments, user practicality assessments, and preliminary classroom observations across three elementary-school contexts. Rather than treating technological innovation as an end in itself, this study positions digital module quality as an integration of curricular validity, usability, active participation, and motivational support. The resulting evidence is intended to inform the development and feasible implementation of interactive elementary IPAS resources while providing a foundation for subsequent comparative research examining their effectiveness and the mechanisms through which particular design features may support learning activity and motivation.

METHOD

Research design and setting

This study employed a research and development (R&D) design using the Decide–Design–Develop–Evaluate (DDD-E) model, complemented by qualitative and quantitative evidence to examine the developmental process, product validity, user practicality, and preliminary classroom implementation of Mopendigtif. The selection of DDD-E was based on its structured yet iterative approach to instructional multimedia development, in which evaluation informs successive design decisions and product refinement rather than being restricted to the final development stage (Juniari & Putra, 2021; Sulistiyarini et al., 2021; Suryasari et al., 2026). This approach is consistent with educational design research principles that emphasize the integration of contextual analysis, instructional design, empirical evaluation, and iterative refinement in developing educational interventions (McKenney & Reeves, 2021; Wang & Hannafin, 2005).

The research comprised three complementary evaluation components: domain-specific expert review, teacher and student practicality assessment, and descriptive classroom observations of learning activity and motivation. Expert review focused on the appropriateness of the instructional content, language, and media design, whereas practicality assessment examined user perceptions of the developed product. Classroom evaluation involved two observation points during implementation to document descriptive changes in teacher-observed indicators of students' learning activity and motivation. This evaluation was not designed as an experimental or quasi-experimental investigation of causal effectiveness.

The study was conducted during the first half of 2026 in three public elementary schools in Jambi City, Indonesia: SDN 215/IV, SDN 132/IV, and SDN 97/IV. The schools were selected because they exhibited similar instructional challenges identified during the preliminary needs analysis, particularly difficulties in visualizing abstract IPAS concepts and facilitating active student participation. They also provided different technological arrangements for classroom implementation, allowing the practicality and preliminary feasibility of Mopendigtif to be examined across multiple school contexts.

Participants and data sources

Three groups of participants contributed to the development and evaluation of Mopendigtif: expert validators, Grade IV teachers, and elementary school students. The expert evaluation involved three validators purposively selected according to their respective areas of expertise: instructional material and content, Indonesian language, and instructional media. Each validator assessed one specific domain using the corresponding evaluation instrument. Because only one expert evaluated each domain, the resulting scores represent domain-specific professional judgments rather than consensus among multiple experts or evidence of interrater reliability.

The teacher participants comprised three Grade IV classroom teachers, with one teacher representing each participating school. They assessed product practicality before the student trials and subsequently served as classroom observers during the implementation phase. Their involvement provided context-specific information regarding the perceived usability, instructional appropriateness, and classroom application of Mopendigtif.

Student participation involved two successive evaluation phases. The small-group trial included 18 Grade IV students, comprising six students from each school. Students were selected to represent variations in learning attainment and familiarity with digital technology. This phase focused on identifying preliminary usability issues and obtaining student responses before wider implementation. The large-group trial involved 67 Grade IV students, consisting of 29 students from SDN 215/IV, 12 students from SDN 132/IV, and 26 students from SDN 97/IV. These students constituted the classroom cohorts involved in the wider implementation and observational evaluation.

Qualitative evidence was obtained through preliminary teacher and student interviews,

initial classroom observations, expert comments, and implementation notes. These data informed the identification of instructional requirements, interpretation of user difficulties, and refinement of product characteristics. Quantitative evidence consisted of expert validation ratings, teacher and student practicality responses, and classroom observation ratings of learning activity and motivation. The qualitative and quantitative evidence served complementary functions in documenting the development process and examining product feasibility.

Table 1. Development stages and principal evidence

Stage	Main activities	Evidence used
Decide	Needs analysis; learner characteristics; learning objectives; resource analysis	Teacher/student interviews; initial observations
Design	Content mapping; flowchart; storyboard; interface and activity planning	Draft design and prototype
Develop	Multimedia production; e-learning/flipbook integration; quizzes; navigation; gamification	Expert material, language, and media validation
Evaluate	Iterative revision; teacher review; small-group trial; large-group trial; descriptive classroom observations	Practicality scores; activity and motivation ratings

Mopendigtif development

The development of Mopendigtif followed the four interrelated stages of the DDD-E model. Throughout the development process, the identified instructional needs were translated into digital features and learning activities intended to support students' active participation and motivation. The development process emphasized the alignment of technological affordances, intended learner actions, and pedagogical support within a coherent learning sequence.

During the Decide stage, the researcher identified curriculum requirements, challenging Grade IV IPAS topics, learner characteristics, existing instructional practices, and available technological resources in the participating schools. Preliminary interviews and classroom observations informed the identification of instructional problems and the formulation of product requirements. Particular attention was given to concepts that were difficult to visualize through conventional learning media and to the limited opportunities for students to participate actively in classroom learning. These findings provided the basis for determining the instructional objectives, content coverage, multimedia requirements, and interactive characteristics of Mopendigtif.

During the Design stage, the identified requirements were translated into an instructional sequence represented through flowcharts and storyboards. The module was organized around a detective-themed learning journey comprising learning missions, multimedia explanations, interactive quizzes, discussion prompts, reflection activities, and completion recognition. Each component was assigned an intended pedagogical function. Dynamic representations were intended to facilitate the observation of abstract scientific processes, navigation features provided opportunities to revisit instructional content, quizzes and discussion prompts encouraged learner responses, and feedback and reflection supported progress monitoring. The detective-themed missions and completion recognition provided a structured progression through the learning activities. These design relationships are conceptually consistent with multimedia learning principles, cognitive engagement frameworks, and motivational perspectives (Chi & Wylie, 2014; Mayer, 2021; Ryan & Deci, 2020).

During the Develop stage, the instructional design was transformed into a functional digital prototype using Canva Premium and Heyzine Flipbooks. Gemini and Canva AI were used to assist the organization of digital learning content and the generation or refinement of visual-design elements. The researchers reviewed, corrected, and adapted AI-assisted outputs before incorporating them into the module. The resulting learning environment integrated text, images, animations, audio, instructional videos, hyperlinks, interactive quizzes, reflection

activities, and an e-learning component. A completion certificate and the designation "Junior Detective of Mopendigtif" were incorporated as gamified recognition following the completion of learning missions and the final assessment.

During the Evaluate stage, the prototype underwent expert review, teacher practicality assessment, student usability trials, and preliminary classroom evaluation. Expert comments informed revisions concerning curriculum alignment, conceptual content, spelling and punctuation, typography, image placement, cover information, navigation, and operational usability. Teacher and student responses provided additional information regarding the practicality of the module under actual classroom conditions. Evaluation therefore functioned as an iterative mechanism for refining the product rather than solely as a final assessment. Following the initial evaluation and revision processes, Mopendigtif was implemented across the three participating schools to document its practicality and descriptive classroom outcomes.

Instruments

Product validity was assessed with three domain-specific instruments. The material instrument addressed curriculum alignment, conceptual accuracy, sequencing, contextuality, visual support, and support for activity and motivation; the language instrument addressed readability, sentence effectiveness, conventions, terminology, and suitability for Grade IV learners; and the media instrument addressed appearance, typography, image placement, audiovisual quality, interactivity, navigation, reusability, and ease of operation. Teacher practicality was measured with 13 five-point items, whereas student practicality used 13 dichotomous items summarized as the proportion of positive responses. The learning-activity rubric covered visual, oral, listening, writing, motor, mental, and emotional participation. The motivation rubric covered willingness to succeed, learning drive, aspirations, recognition, interest, and environmental support. Instrument indicators were mapped to these operational domains before use. However, the available dataset did not permit estimates of internal consistency, construct validity, or interrater reliability; consequently, the scores are treated as descriptive indicators rather than psychometrically established scales.

Data collection and analysis

Data collection proceeded from preliminary diagnosis to expert validation, usability trials, and classroom implementation. Expert validation was conducted in two rounds where revision was required. Teacher practicality was assessed before the student trials. The large-group trial was conducted on 19 May 2026, followed by classroom observations on 25 May and 15 June 2026. In SDN 215/IV, Mopendigtif was displayed through a projector and speaker; in SDN 132/IV and SDN 97/IV, it was presented through Smart TVs. The researcher facilitated instruction, whereas classroom teachers used the prepared rubrics to observe activity and motivation. Before observation, the indicators and rating anchors were reviewed with the teachers to encourage consistent application. Nevertheless, the teachers had previously rated product practicality and knew the study purpose; expectancy and observer bias therefore remain possible. No independent second observer was available, so interrater agreement could not be estimated.

Quantitative data were summarized descriptively using means and the category thresholds specified in the instruments. Expert and teacher ratings were interpreted on five-point criteria, and student practicality was summarized as the proportion of positive responses. Changes in activity and motivation were evaluated as raw differences between the two observation points. N-gain was removed because these outcomes were teacher-rated, bounded ordinal scores rather than achievement-test scores with an interpretable maximum gain. To provide a measure of dispersion supported by the available aggregate data, between-school sample standard deviations are reported alongside overall means; these values describe variation among the three school means and must not be interpreted as student-level variability. With no control group, randomization, or inferential causal design, the observations are

interpreted as descriptive classroom improvement during implementation. Qualitative comments were used to explain product revisions and classroom functioning.

Ethical considerations

The research was conducted with written permission from the participating elementary schools. Personally identifying student information was removed from the analytic and reporting files, and the research findings were reported in aggregate to protect participant confidentiality. Particular ethical consideration was necessary because the student participants were children.

School-level permission was treated as administrative authorization to conduct research within the participating institutions and was not regarded as a substitute for formal research ethics review, parental or guardian informed consent, or child assent. Documentation confirming institutional ethical approval or exemption, parental or guardian consent, and child assent was not available for verification in the methodological information used to prepare this report. Consequently, no claim was made regarding the completion of these ethical procedures. This limitation requires clarification and appropriate documentation before final publication.

RESULTS AND DISCUSSION

From needs analysis to an interactive IPAS learning environment

The Decide stage confirmed a mismatch between curricular expectations for active, meaningful IPAS learning and the dominant instructional practices observed in the three schools. Students had access to technology and were generally familiar with digital devices, yet the available hardware was used mainly to display static presentations or teacher-controlled material. This finding is important because technology availability alone does not create interactivity. The instructional value of digital media depends on how it structures learners' opportunities to observe, respond, manipulate information, receive feedback, and revisit explanations (Abdulrahaman et al., 2020; Area-Moreira et al., 2023; Maier & Klotz, 2022; Staneviciene & Žekienė, 2025).

The Design stage translated the needs analysis into a learning journey rather than a collection of digital pages. Flowcharts and storyboards were used to sequence content, missions, videos, quizzes, reflection, and navigation. The detective theme provided a narrative frame for progression through the module. Such a structure was intended to make participation visible to learners: students were not only expected to read material but also to complete missions, answer questions, engage with multimedia, and progress toward a final certificate. This design choice is consistent with the broader finding that interactive modules can stimulate learning interest when content presentation and learner actions are deliberately connected (Abdulrahaman et al., 2020; Abramenka-Lachheb & Ozogul, 2025).

In the Develop stage, Mopendigtif became a multi-component learning environment that could be accessed through laptops, smartphones, Smart TVs, and projector-based classroom arrangements. The use of Heyzine supported flipbook presentation, while multimedia and e-learning components extended the module beyond linear reading. Video and animation were used to represent phenomena that are difficult to observe directly; quizzes provided opportunities for immediate responses; and reflection and discussion elements encouraged students to process what they had learned. This multimodality is particularly relevant in IPAS, where conceptual understanding often depends on connecting verbal explanation with visual, dynamic, and contextual representations (Annajmi et al., 2026; Bobek & Tversky, 2016; Jägerskog, 2021; Johnson et al., 2013; Ruilin Zhang & Jiang, 2026).

The Evaluate principle proved central to the development model. The initial product was not treated as final: expert comments led to substantive content adjustments, language corrections, and visual refinements. This supports the use of DDD-E as an iterative development framework. Its value in this study was not merely that it divided production into four named stages, but that evaluation operated across the stages and generated documented changes before classroom use. Suryasari et al. (2026) similarly emphasize DDD-E as a

structured framework for developing technology-supported educational products.

Validity and iterative expert revision

Material validation showed the greatest improvement, from 3.40 in the first round to 4.80 after revision (Table 2). First-round comments indicated that learning outcomes and content emphases required closer alignment with current IPAS guidance, including contextual aspects of community livelihoods and environmental conservation. Revision therefore strengthened curriculum alignment, content completeness, contextual examples, and coherence among objectives, material, practice, and quizzes. The change documents the influence of domain-specific feedback on the product; however, because one validator assessed each domain, the final score should not be interpreted as evidence of expert consensus.

Table 2. Expert validation across two rounds

Aspect	Round 1 mean	Round 1 category	Round 2 mean	Round 2 category
Material/content	3.40	Moderately valid	4.80	Very valid
Language	5.00	Very valid	5.00	Very valid
Media	4.59	Very valid	5.00	Very valid

Language validation remained at 5.00 in both scoring rounds, but the validator still identified details that needed correction, particularly the writing of prefixes and prepositions and the punctuation of commands and invitations. These edits matter in an elementary module because readability is not determined solely by vocabulary difficulty; consistency of spelling, sentence structure, and instructional cues can reduce unnecessary cognitive load and prevent ambiguity. The final language score therefore reflects both high initial readability and targeted editorial refinement.

Media validation increased from 4.59 to 5.00. Revisions addressed small font sizes, image placement, and the inclusion of author and year information on the cover. The final score indicates that visual appeal was balanced with functional readability and navigation. This result complements prior studies showing the usefulness of interactive media in elementary learning (Aryfien et al., 2025; Murthadila et al., 2026), while extending them by demonstrating how iterative expert review can improve not only attractiveness but also the alignment among interface, content, and learning tasks.

Practicality across teacher and student users

Practicality was consistently high across teachers and students. Teacher ratings averaged 4.97 out of 5, indicating that the module was perceived as easy to use, suitable for IPAS, supportive of student attention and activity, and flexible enough to be used at school or at home. The small-group trial produced an overall positive-response score of 0.88, providing an opportunity to identify user difficulties before full implementation. In the large-group trial, school scores ranged from 0.93 to 0.96, with an overall mean of approximately 0.95 (Table 3).

Table 3. Practicality results across the three schools

Evaluator/trial	SDN 215/IV	SDN 132/IV	SDN 97/IV	Overall interpretation
Teacher response (1–5)	4.92	5.00	5.00	4.97; very practical
Small-group student response (0–1)	1.00	0.82	0.82	0.88; very practical
Large-group student response (0–1)	0.96	0.96	0.93	≈0.95; very practical

The small variation in large-group responses is analytically useful. A larger group introduced differences in prior digital experience, independence, attention, and speed of adapting to the module. Some students still needed additional guidance even after the operation of the module had been demonstrated. Thus, high practicality should not be interpreted as identical usability for every learner. It instead indicates that most learners could navigate and benefit from the module under ordinary classroom support. This finding reinforces the need for

teacher facilitation during initial implementation, particularly when devices, display modes, and digital familiarity differ across schools.

Practicality is a critical bridge between validity and classroom effectiveness. A product may be accurate and visually well designed but still fail if teachers cannot implement it efficiently or if students struggle to navigate it. Mopendigtif's high practicality is therefore a key result: it indicates that the multimedia and interactive features did not make the resource operationally burdensome. This is consistent with the role of well-designed digital media in making learning more varied and accessible (Haleem et al., 2022; RuiYao Zhang, 2022).

Learning-activity ratings were higher at the second observation in all three schools. The overall mean rose from 3.80 to 4.24, a raw difference of 0.44 points (Table 4). Between-school variability was small at both observations (SD = 0.09 and 0.07, respectively), although these aggregate SDs do not represent variability among individual students. Observers recorded stronger attention, more questioning and answering, greater discussion participation, more active task completion, and greater willingness to engage with quizzes. The largest descriptive difference occurred in SDN 97/IV (3.75 to 4.31). With only two observations and no comparison group, this pattern indicates observed improvement during implementation, not a stable trend or module-caused effect.

Table 4. Descriptive observation scores for learning activity and motivation

Outcome	School	Observation 1	Observation 2	Change
Learning activity	SDN 215/IV	3.91	4.22	+0.31
	SDN 132/IV	3.75	4.18	+0.43
	SDN 97/IV	3.75	4.31	+0.56
	Overall	3.80	4.24	+0.44; between-school SD: 0.09 → 0.07
Learning motivation	SDN 215/IV	3.78	4.43	+0.65
	SDN 132/IV	3.80	4.31	+0.51
	SDN 97/IV	3.73	4.40	+0.67
	Overall	3.77	4.38	+0.61; between-school SD: 0.04 → 0.06

Motivation displayed a larger overall descriptive increase, from 3.77 to 4.38. Students were observed to show stronger willingness to succeed, more sustained attention, greater enthusiasm in completing missions and quizzes, and higher interest in following the learning sequence. The module combined a detective narrative, multimodal presentation, immediate tasks, and completion recognition; however, the present design did not isolate components and therefore cannot determine which feature, if any, accounted for the observed change. The pattern is compatible with studies associating interactive modules with learning interest and motivation (Ibrahim et al., 2025; Saputra & Oktarina, 2023), but alternative explanations—including repeated exposure, teacher familiarity, and novelty effects—remain plausible.

The activity and motivation patterns may be mutually related, but the study did not test mediation, reciprocity, or component effects. The design rationale was that visualizations and videos would support access to content, quizzes and discussion would make participation observable, and missions and recognition would provide progression cues. This explicit feature–action–motivation mapping distinguishes Mopendigtif from media that primarily digitize content. The classroom data support the feasibility of the integrated design, not a causal claim about any individual feature or pathway.

Descriptive change and interpretive boundaries

Across the three schools, the raw differences were positive for both outcomes, and between-school variability was small: activity increased from M = 3.80 (SD = 0.09 across school means) to M = 4.24 (SD = 0.07), while motivation increased from M = 3.77 (SD = 0.04) to M = 4.38 (SD = 0.06). These descriptive changes are encouraging but cannot establish sustained improvement because only two observation points were available. Repeated

exposure, teacher familiarity, novelty effects, and other classroom influences remain viable explanations.

The three schools used different display technologies, students differed in digital familiarity and independence, and some activities occurred in shared arrangements rather than through one-to-one devices. Activity and motivation were also rated by classroom teachers who knew the study purpose. Together with the absence of a comparison group and the availability of only two observation points, these conditions prevent attribution of the changes to Mopendigtif and do not establish a stable developmental trend. The evidence is therefore limited to feasibility, high reported practicality, and descriptively encouraging classroom change.

Contribution, implications, and limitations

The main contribution is an explicit learner-action design principle implemented through a complete product-development pathway. Conceptually, Mopendigtif treats activity and motivation as design targets: representations support observation, interactive prompts elicit responses, reflection supports monitoring, and missions and recognition provide progression cues. Methodologically, the study connects iterative expert revision, teacher and student practicality, and two descriptive classroom observations across three schools. Contextually, implementation under different display technologies offers preliminary evidence of usability beyond a single classroom. These contributions concern design logic and feasibility; they do not establish causal effectiveness.

For teachers, the findings imply that digital learning resources should be selected or designed according to the actions they invite students to perform. A module is more likely to support participation when it combines explanation with questions, discussion, manipulable or dynamic representations, and feedback. For schools, the findings suggest that existing devices can be used more productively when accompanied by structured digital content and teacher guidance. The high practicality scores also indicate that innovation does not necessarily require a one-device-per-student model; shared Smart TVs, projectors, speakers, and mobile access can still support interactive learning when activities are carefully orchestrated.

The study has limitations that constrain interpretation and generalization. It involved three schools in one city, lacked a comparison group, and included only two observation points. The same classroom teachers who evaluated practicality rated their students while knowing the study purpose; observer subjectivity and expectancy bias are therefore possible, and no interrater reliability estimate was available. The activity and motivation instruments lacked reported construct-validity and reliability evidence, while each validation domain relied on one expert. Device conditions differed, shared quizzes could permit imitation, and prior digital experience varied. Formal ethics approval/exemption, parental consent, and child assent must also be fully documented. Future research should employ psychometrically evaluated instruments, independent multiple observers, student-level variability estimates, broader samples, additional observation waves, randomized quiz options, and experimental or quasi-experimental comparisons to distinguish module-related change from familiarity and novelty effects.

CONCLUSION

Mopendigtif was developed as an interactive Grade IV IPAS module through Decide, Design, Develop, and Evaluate. It integrates curriculum-aligned content, dynamic media, hyperlinks, quizzes, reflection, and a detective-themed progression structure. Final domain-validation scores were 4.80 for material, 5.00 for language, and 5.00 for media, based on one validator per domain. Teacher practicality averaged 4.97/5, and large-group student practicality averaged approximately 0.95. Across two classroom observations, mean activity ratings changed from 3.80 to 4.24 and motivation from 3.77 to 4.38. These are descriptive observed differences rather than estimates of effectiveness.

The findings support Mopendigtif as a domain-validated and highly practical Grade IV IPAS resource that was accompanied by descriptively higher activity and motivation ratings at the second observation across three school contexts. Its principal contribution is the explicit alignment of digital features with learner actions and motivational support within iterative DDD-E development. The study does not demonstrate effectiveness or causality because it lacked a comparison group, used only two observations, relied on teacher ratings, and did not establish the psychometric quality or interrater reliability of the outcome instruments. Multi-site comparative research with independent observers, validated measures, student-level variability estimates, and longer follow-up is required to test whether the observed improvement is robust and sustained.

RECOMMENDATION

Schools and teachers can use Mopendigtif as a supplementary or core digital resource for Grade IV IPAS, particularly for topics that benefit from dynamic visualization and structured learner interaction. Initial implementation should include clear guidance on navigation and quiz procedures, followed by increasing opportunities for students to operate the module independently. Future versions should diversify problem-solving challenges, exploratory tasks, randomized quizzes, and reflection activities, and should be tested with more schools, different regions, and stronger comparative designs.

ACKNOWLEDGMENTS

The authors thank the principals, Grade IV teachers, students, and expert validators from the participating schools and Universitas Jambi who supported the development, review, and classroom implementation of Mopendigtif.

FUNDING INFORMATION

This research received no external funding.

AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Risdaliani	✓	✓	✓	✓	✓	✓		✓	✓	✓			✓	
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Risdalina		✓				✓		✓	✓	✓	✓	✓		

CONFLICT OF INTEREST STATEMENT

The authors declare that they have no known competing financial or personal interests that could have influenced the work reported in this article.

ETHICAL APPROVAL

The study was conducted with written permission from the participating schools. No personally identifying student information is reported, and all results are presented in aggregate. School permission alone is not treated as equivalent to ethics review or participant consent.

DATA AVAILABILITY

De-identified data supporting the findings may be made available by the corresponding author upon reasonable request, subject to school and institutional permissions and applicable ethical restrictions.

AI USE DECLARATION

During product development, Gemini and Canva AI were used to assist the structuring of learning content and the generation or refinement of visual-design elements. Their outputs were reviewed, corrected, and adapted by the researchers before inclusion in Mopendigtif. During preparation of this manuscript, ChatGPT (OpenAI) was used to assist language polishing, structural reorganization, and alignment with the journal template. Generative AI was not used to create or alter research data, perform the reported quantitative calculations, or make final scientific judgments. The authors take full responsibility for the accuracy, integrity, and originality of the final manuscript.

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