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Development of the "Pangkatani" Scratch-Assisted Interactive Multimedia for Learning Exponents

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ABSTRACT

Interactive multimedia has become a strategic need in mathematics teaching in the digital era, particularly for exponents, a topic still taught in conventional and abstract ways. This study developed and tested the feasibility of "Pangkatani," a Scratch-assisted interactive multimedia that integrates the local wisdom of cassava farming to give the concept of exponents a concrete context for ninth-grade students at SMPN 3 Sukahening. What makes Pangkatani distinctive is the way it combines visualization, interactive simulation, and culturally grounded gamification, which together are expected to raise student engagement, motivation, and conceptual understanding. The study used a Research and Development (R&D) approach with the ADDIE model and involved 19 students in a limited trial. The instruments were validation questionnaires for a media expert and a material expert, together with a student response questionnaire, analyzed through descriptive quantitative methods and supported by qualitative narrative. Media expert validation (90.77%) and material expert validation (95.38%) both fell in the "highly feasible" category, while the overall student response of 81.58% reflected gains in motivation, understanding, and willingness to learn. The findings suggest that embedding local wisdom in Scratch-based digital multimedia can strengthen contextual, constructivist, and meaningful mathematics learning. The Pangkatani model is recommended as a reference for developing similar media in other schools and as a contribution to the literature on culturally based educational multimedia. Further research with a wider scope and a longitudinal design is advised to test long-term effectiveness and replication.

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Introduction

The digital era has transformed education and pushed schools worldwide to adopt innovative technology to improve the quality of learning (Panferova & Nabiulina, 2025). Yet

the 2022 Programme for International Student Assessment (PISA) shows that the mathematics literacy of Indonesian students remains below the OECD average, especially in problem solving and in grasping abstract concepts such as exponents (OECD, 2023). Limited digital literacy among students and teachers (Kementerian Komunikasi dan Digital, 2023) is another real obstacle to putting technology-based mathematics learning into practice across schools.

Integrating interactive multimedia has grown urgent amid globalization, the diversity of student learning styles, and the demands of twenty-first century learning for digital literacy, critical thinking, and collaboration (Almeida, 2025; Mendonça, 2025). In Indonesia, the case for using technology in the classroom has become stronger as the government and the education sector push to build numeracy and to break the stagnation of innovation in mathematics teaching, particularly for abstract topics like exponents (Enstein et al., 2022; R. Nisa & Fryda Mawardah, 2023; Qumillaila et al., 2017). The potential of multimedia is large, but its use in schools, including SMPN 3 Sukahening, is still far from optimal. Early observation at this school revealed that lessons on exponents were dominated by conventional, text-based, and verbal approaches. As a result, many students struggled to understand the concept, to transfer knowledge to contextual situations, and to solve problems involving exponents. Low motivation and recurring misconceptions made the situation worse.

Recent studies point to the low quality and limited variety of classroom media, the thin adaptation of teachers to digital tools, and the scarcity of media that can bridge abstract concepts to students' concrete experience (Manihuruk & Sutabri, 2024; Saputra & Tegeh, 2024; Sari et al., 2023). Several studies also highlight exponents as one of the most challenging topics for junior high school students, because its basic ideas are often learned procedurally, without meaning (Anggraini et al., 2025; Qumillaila et al., 2017).

In response, innovative multimedia matters not only for lifting the quality of instruction but also for meeting varied learning styles, activating learning experiences, and supporting meaningful transfer of knowledge (Bilynska et al., 2024; Hafizd et al., 2023; Priadko et al., 2022). A body of research shows that contextually designed interactive multimedia can raise conceptual understanding, motivation, and retention well beyond conventional methods (Anggraini et al., 2025; Elfira et al., 2025; Ma'rufah et al., 2023; Sabilla et al., 2025). Within this journal, Fitriya and Faizah (2021) and Jelita et al. (2025) reported that mathematics media developed with the ADDIE model reached feasible to highly feasible ratings. Expert validation and student responses consistently sit between 80% and 95% for feasibility, practicality, and effectiveness, which affirms the transformative promise of this approach (Saputra & Tegeh, 2024; Sari et al., 2023; Wikimalzis & Zuardi, 2024).

Despite these gains, clear research gaps remain. Earlier work has rarely examined the long-term effect of interactive multimedia on the retention and transfer of mathematical concepts (Hafizd et al., 2023; Manihuruk & Sutabri, 2024; Sabilla et al., 2025), has done little to explore how media adapt to different learning styles (Anggraini et al., 2025; Bilynska et al., 2024), and has seldom compared media against traditional methods or other digital platforms (Hanifah et al., 2025; Saputra & Tegeh, 2024). Research on weaving local wisdom into multimedia for mathematics is also very limited, even though contextual, culture-based approaches are known to raise relevance, engagement, and motivation (Hamidah et al., 2024; Hariastuti et al., 2022; Pradnyawati & Rati, 2023).

The novelty of this study lies in developing and validating "Pangkatani," a Scratch-assisted interactive multimedia that draws on local wisdom in an original way, using the practice of cassava farming as a concrete context for understanding exponents. Beyond offering visualization and simulation that ease conceptual understanding, Pangkatani adopts a constructivist, game-based pedagogy shown to raise engagement, motivation, and higher order thinking skills (HOTS) (Ali et al., 2024; Hamidah et al., 2024; Maola & Irianto, 2023; Yulianisa

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& Sudihartinih, 2022). Scratch was chosen as the main platform because it is flexible, easy to access, and has proven effective for building interactive educational games in mathematics and other fields (Sabilla et al., 2025; Satria et al., 2024; Sekarsari & Karimah, 2025; Yulianisa & Sudihartinih, 2022).

The media was built with the ADDIE model, a reliable and systematic framework used in many multimedia development studies at home and abroad (Gamal, 2022; Mesra et al., 2023; U. K. Nisa, 2023; Slamet, 2022). The feasibility, practicality, and effectiveness of Pangkatani were validated in layers, involving a media expert, a material expert, and a limited student trial, with a media validation score of 90.77%, a material validation score of 95.38%, and a student response of 81.58%. These figures align with recent findings that interactive multimedia rich in cultural grounding and visualization improves not only cognitive outcomes but also students' affective and conative dimensions (Manihuruk & Sutabri, 2024; Pradnyawati & Rati, 2023; Sari et al., 2023).

This study makes three main contributions. First, it offers a model for developing local-wisdom-based interactive multimedia that is adaptive and relevant for abstract mathematics, with empirical evidence of its effectiveness among secondary students. Second, it broadens the theoretical understanding of contextual, constructivist, and digital learning in Indonesian education and provides a reference for more inclusive and innovative teaching policy and practice (Almeida, 2025; Gaddi et al., 2024; Mendonça, 2025; Priadko et al., 2022). Third, it strengthens the literature on Scratch as a platform for building educational mathematics multimedia, with an authentic cultural context that is easy to replicate (Ali et al., 2024; Satria et al., 2024; Sekarsari & Karimah, 2025).

This study focuses on the development, validation, and implementation of the Scratch-assisted "Pangkatani" multimedia for learning exponents in grade IX at SMPN 3 Sukahening, Tasikmalaya. The media is expected to improve conceptual understanding, motivation, and engagement, and to serve as a reference for developing relevant, meaningful contextual multimedia in the digital era. Specifically, the study asks how the development and feasibility of "Pangkatani" unfold for the topic of exponents, and how students respond to using the media in mathematics learning.

The Problem of Exponents

Exponents are consistently reported as a topic that students find hard to master. Ulusoy (2018) found that students tend to overgeneralize, applying the rules for positive integer powers to zero and negative powers, so errors often appear in forms such as a^0 and a^{-n}. This misconception grows out of treating a power merely as "repeated multiplication," without grasping the underlying multiplicative structure. Sevgi et al. (2026) report similar patterns, including students' inability to distinguish $-a^b$ from $(-a)^b$ and their confusion over the condition for a zero exponent. In the Indonesian context, Suarka et al. (2024) show that learning obstacles in exponents are largely epistemological: students misdefine an exponent when the power is zero, when it is a negative integer, and when the base carries a negative sign. Azmi et al. (2024) add that the type of misconception varies with students' mathematical ability and covers errors of rule, sign, and symbol, driven by faulty intuitive reasoning and low interest. Taken together, these findings show that difficulty with exponents is not simply a matter of calculation. It is a matter of deep conceptual understanding, which calls for media that can make the meaning of repeated multiplication concrete and contextual. That is the need Pangkatani sets out to meet..

Method

Research Design

This study used a Research and Development (R&D) approach with the ADDIE model (Analyze, Design, Develop, Implement, Evaluate) as set out by Slamet (2022). ADDIE was chosen for its strength in guiding the development of educational products in a systematic, staged, and structured way, and for ensuring product quality through rigorous validation and revision (Mesra et al., 2023). The model suits the goal of producing Scratch-assisted interactive multimedia that weaves local wisdom into mathematics, specifically the topic of exponents. In practice, the Design and Develop stages were carried out twice, with a second round of revision after the first Develop stage, so the actual research flow ran as Analyze, Design, Develop, Design (revision), Develop (revision), Implement, and Evaluate. Figure 1 shows this flow.

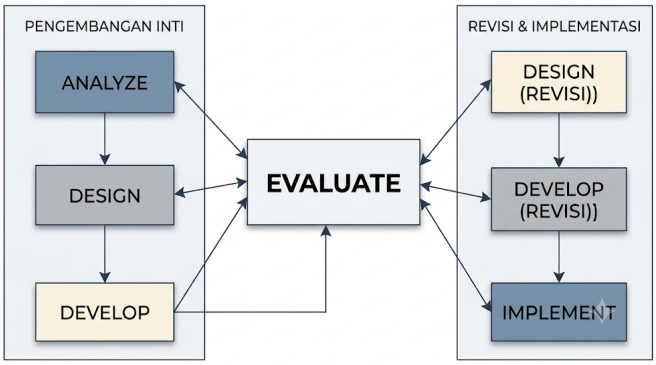

Figure 1. Research flow for developing Pangkatani with the ADDIE model.

Subjects

The subjects were all ninth-grade students in one class at SMP Negeri 3 Sukahening who had studied exponents. Nineteen students took part in the limited trial. Subjects were selected purposively, choosing a class that had already covered the topic so that it fit the aim of development and feasibility testing. Demographic characteristics such as a rural background and access to digital devices were identified to make sure the media matched students' needs and potential.

Instruments

The study used non-test questionnaires for media expert validation, material expert validation, and student response. The media expert instrument covered instructional design and technical aspects, such as clarity of content, layout, appeal, color, and ease of use. The material expert instrument covered content suitability, completeness, language, and motivation. The student response instrument measured cognitive (understanding of the material), affective (motivation and interest), and conative aspects (the wish to keep learning). The media expert (13 items) and material expert (13 items) questionnaires used a 1 to 5 scale, while the student response questionnaire (25 items) used a four-point scale: Strongly Agree (4), Agree (3), Disagree (2), Strongly Disagree (1). The blueprint and sample items for each instrument appear in Table 1.

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Table 1. Blueprint and sample items of the instruments

Instrument	Aspect (number of items)	Sample item
Media expert	Design (5); Instructional (3); Technical (5)	"Clarity of content"; "Instructions for using the media"; "Ease of use"
Material expert	Content (9); Language (2); Motivation (1); Feedback (1)	"Alignment of content with the Basic Competency"; "Simple, easy-to-understand language"; "Ability to motivate students"
Student response	Cognitive (12); Affective (9); Conative (4)	Cognitive: "The Scratch media helps broaden my knowledge"; Affective: "The Scratch media motivates me to study exponents"; Conative: "The Scratch media makes me ask questions when I do not understand the material"

Validity and reliability of the instruments.

Content validity of all three instruments was secured through expert judgment by the media and material validators. The reliability of the student response questionnaire was tested with Cronbach's Alpha on the 25 items from 19 respondents and reached **α = 0,94** (highly reliable), with component-level reliability of 0.86 for the cognitive scale and 0.89 for the affective scale.

Interactive Media

"Pangkatani" was designed as a Scratch-based educational game that runs in a browser or on a smartphone. The design was laid out as a flowchart (navigation flow) and a storyboard (layout of each screen). The media has six scenes: (1) an Opening scene with the title "PANGKATANI," a Start button, and Instructions; (2) a Menu with navigation to Material, Quiz, Profile, and Exit; (3) a Material scene with an introduction, an orientation, a cassava-farming game, and the concept of exponents; (4) a Quiz with four questions set in a traditional market, with automatic scoring and an answer key; (5) a Profile; and (6) a Closing scene. The concept of exponents is presented through a simulation of cassava seedling propagation by cuttings that follows the pattern 2^n, which yields the general form $a^n = a \times a \times \ldots \times a$ (with n factors).

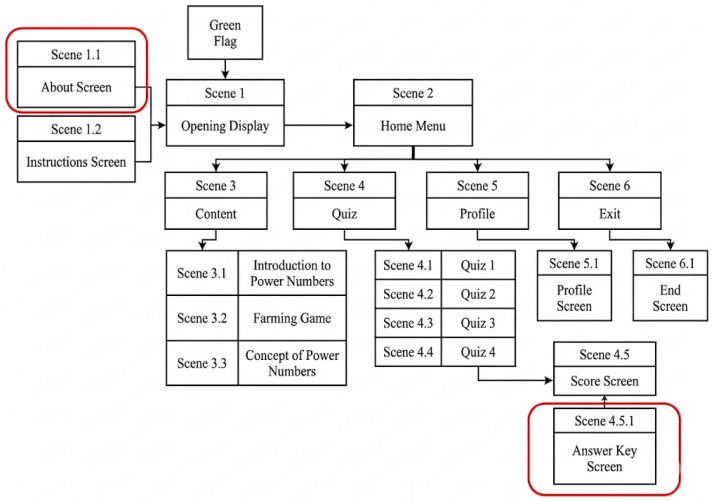

Figure 2. Flowchart of the Pangkatani multimedia (final version after revision)

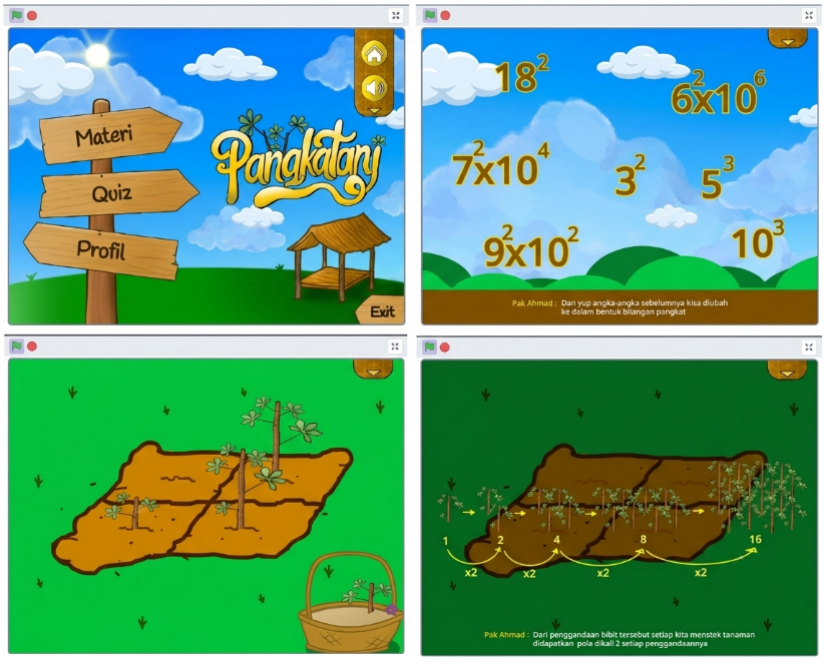

Figure 3. Main screens of Pangkatani

Data Collection

Data collection ran in several main stages. The first stage analyzed the needs of students and the school through a literature review, field observation, and informal interviews to surface learning obstacles and the potential for integrating local wisdom. The next stage was media design, in which the researcher built the flowchart and storyboard and gathered the visual and audio materials that support tying mathematical concepts to the local context of cassava farming. In the development stage, the multimedia was built on the Scratch platform and validated by the media and material experts. Once the product was judged feasible (validation above 90%), it was implemented in a limited trial with 19 students. Data were collected through questionnaires administered after students used the media, along with documentation of student discussion and written responses. The final stage was formative and summative evaluation of the media's effectiveness and improvement.

Data Analysis

Validation and response data were analyzed both quantitatively and qualitatively. The quantitative analysis computed the percentage of validation and response scores using the formula:

$$P = \frac{\Sigma x}{\Sigma x_i} \times 100\%$$

where **P** is the percentage, $\sum \mathbf{x}$ is the total score obtained, and $\sum \mathbf{x_i}$ is the ideal maximum score. The feasibility and response categories follow Table 2 and Table 3. The qualitative analysis drew on the technique of Miles et al. (2014), moving through data reduction, data display as narrative or diagram, and drawing and verifying conclusions. This allowed triangulation across expert validation, student response, and documentation of the development process, which produced a full picture of the media's effectiveness, practicality, and strengths.

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Table 2. Category for expert ratings

Score (x)	Category
80% < x ≤ 100%	Highly feasible
60% < x ≤ 80%	Feasible
40% < x ≤ 60%	Fairly feasible
20% < x ≤ 40%	Less feasible
0% < x ≤ 20%	Not feasible

Table 3. Category for student responses

Score (x)	Category
82% ≤ x ≤ 100%	Very good
63% ≤ x < 82%	Good
44% ≤ x < 63%	Fair
25% ≤ x < 44%	Poor

Research Findings

The study took place at SMP Negeri 3 Sukahening, Tasikmalaya Regency, with 19 ninth-grade students who had studied exponents. Most subjects came from a rural background with relatively limited access to technology, though smartphones were available as a digital learning tool. The media was implemented in mathematics lessons on exponents, with attention to the local wisdom of cassava farming woven into the multimedia design.

Analyze (Needs Analysis)

The needs analysis ran through observation, informal interviews, and documentation. The findings showed that (1) most students struggled to understand exponents, especially in solving contextual problems and applying the concept; (2) the media available at the time were textual and verbal and could not meet students' need for visual, interactive learning; (3) the school's facilities were adequate for smartphone-based digital media, though their use required the teacher's permission; and (4) the local wisdom of cassava farming was identified as a fitting context for illustrating repeated multiplication in exponents. An informant, S1, put it this way: "I often struggle when exponents are only explained on the board, and when the questions are stories about trees or harvests, I get confused trying to picture them." The content analysis found that propagating cassava seedlings by cuttings (harvest roughly every 6 months, height about 250 cm, cuttings up to 40 cm long into 2 to 5 pieces) matches the pattern of exponents.

Design

The design stage produced (1) content design that aligned exponents with the pattern of cassava farming, for example one cassava stem cut into two, then two into four, following the pattern 2^n; (2) a flowchart and storyboard that mapped the sequence of screens, from the opening page and main menu to material, quiz, profile, and closing; and (3) the collection of visual and audio materials to support contextual delivery of the content.

Develop

The design was built on Scratch and produced the main screens: (1) an Opening page with the title, instructions, and a description of the media; (2) a Main Menu with navigation to material, quiz, researcher profile, and exit; (3) Material presented with the visual illustration of cassava farming, an explanation of exponents, and an interactive simulation; (4) a Quiz with

four practice questions and automatic scoring; (5) a Profile with researcher information and words of encouragement; and (6) a Closing scene with a farewell and credits. The media was then validated by two experts, a lecturer in Informatics Engineering and a lecturer in Mathematics Education at Universitas Siliwangi, using the instruments in Table 4 and Table 5.

Table 4. Media expert validation (before revision)

Aspect	Percentage	Category
Design	76.00%	Feasible
Instructional	66.67%	Feasible
Technical	72.00%	Feasible
Total	**73.21%**	**Feasible**

Table 5. Material expert validation

Aspect	Percentage	Category
Content	95.56%	Highly feasible
Language	100%	Highly feasible
Motivation	80.00%	Feasible
Feedback	100%	Highly feasible
Total	**95.38%**	**Highly feasible**

The media expert concluded that the media was "usable with revision," while the material expert judged it "usable without revision." The Design and Develop stages were therefore repeated to act on seven points raised by the media expert: a responsive effect on buttons, the addition of an "About" menu, simpler buttons, less use of Sundanese, thousands separators for large numbers, and an answer key for the quiz. After revision, a second media validation gave the results in Table 6.

Table 6. Media expert validation (after revision)

Aspect	Percentage	Category
Design	96.00%	Highly feasible
Instructional	80.00%	Feasible
Technical	92.00%	Highly feasible
Total	**90.77%**	**Highly feasible**

After revision, both validators judged the media highly feasible and usable without further changes.

Implementation (Limited Trial)

The limited trial ran with 19 ninth-grade students at SMPN 3 Sukahening on Saturday, 3 April 2025, once the media had been judged feasible. Each student used the media independently under the researcher's supervision and then completed the 25-item questionnaire. Student responses appear in Table 7.

Table 7. Student responses

Aspect	Percentage	Category
Cognitive	82.24%	Very good
Affective	83.19%	Very good
Conative	75.99%	Good
Total	**81.58%**	**Good**

The cognitive aspect covers understanding of the material, the affective aspect covers interest and motivation, and the conative aspect covers the wish to keep learning with similar media. One student, S2, said: "The display is appealing and it helped me understand how

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exponents work through the cassava-farming example." Another, S3, said: "I feel more eager to work on the problems because there is a game and I can see my score right away." In all, students left 11 very positive, 15 positive, and 5 neutral comments, with "appealing," "good," and "easy to understand" the most common. Figure 4 records this feedback.

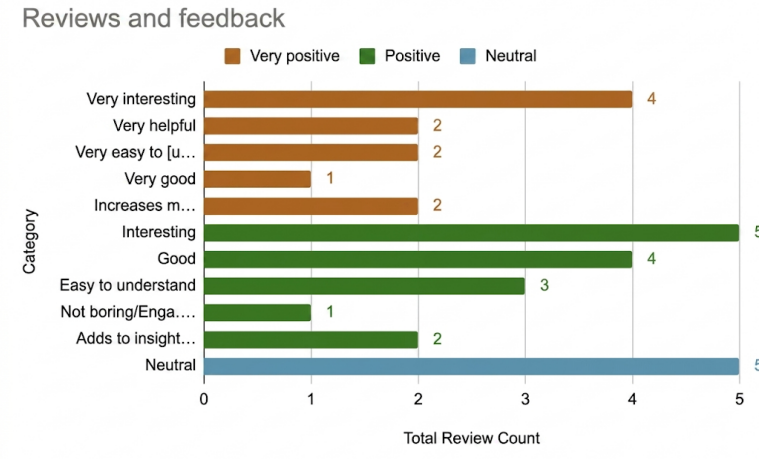

Figure 4. Student reviews and feedback

The classroom use of the media can be read as follows. Students opened Pangkatani on their smartphones, worked through the cassava-farming material on their own, ran the 2^n simulation, and then took the quiz with its automatic scoring. They looked eager and stayed involved, especially during the farming game and the quiz, and most were able to connect the pattern of cassava propagation to repeated multiplication in exponents. The technical constraints were the limited Scratch display on a smartphone screen and the reliance on a network connection, so a projector is advisable as an alternative for showing the media. Documentation of the classroom session appears in Figure 5.

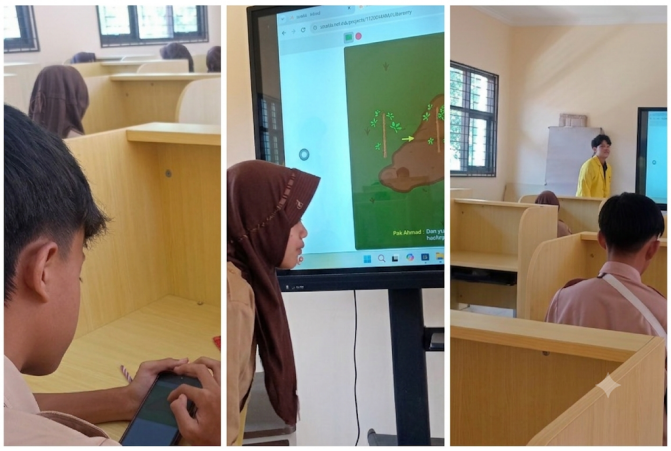

Figure 5. Documentation of Pangkatani implementation in grade IX at SMPN 3 Sukahening.

Evaluate (Formative and Summative)

Evaluation ran at every stage. In Analyze, the needs were met and no serious problem surfaced. In Design, the media was improved on the validators' advice, such as adding the "About" menu and the answer key. In Develop, the display and instructions were refined per

the validators' input. In Implement, student responses were dominated by good to very good categories. The main findings can be summarized as follows. First, the "Pangkatani" multimedia was judged highly feasible by the media expert (90.77%) and the material expert (95.38%). Second, overall student response fell in the good category (81.58%), with the cognitive and affective aspects very good. Third, the media successfully wove the local wisdom of cassava farming into the learning of exponents, backed by empirical evidence from validation and trial.

Discussion

This study reinforces and extends the consensus in the literature that developing interactive multimedia, especially with local wisdom and the Scratch platform, has a clear effect on the quality of mathematics learning in the digital era. High expert validation (media 90.77%, material 95.38%) and positive student response (81.58%) confirm that the ADDIE-based strategy met the quality standard emphasized by Slamet (2022) and Mesra et al. (2023). The two Design and Develop cycles show the value of layered validation: the media expert score rose from 73.21% (feasible) to 90.77% (highly feasible) after revision. This matches Maola and Irianto (2023) and Sabilla et al. (2025), who stress that the quality of Scratch-based media depends heavily on a rigorous cycle of improvement. Set against the most relevant prior study, the results are both consistent and distinctive. Arista et al. (2026) developed Scratch-based media for exponents with the ADDIE model and reported media validity of 0.90 and material validity of 0.95, a User Acceptance Test of 82.9%, and an N-Gain of 0.84 (high). Pangkatani's validation scores (media 90.77%, material 95.38%) sit in a comparable range. The key difference is that Pangkatani adds the local-wisdom dimension of cassava farming, which enriches how the concept is contextualized.

On the theoretical side, the findings agree with Qumillaila et al. (2017) and Mundir (2022), who stress the urgency of digitalizing learning in response to globalization and the demands of twenty-first century learning. "Pangkatani" is more than a visual aid. It carries interactivity, gamification, and personalized features that recent multimedia research identifies as leading strengths (Anggraini et al., 2025; Manihuruk & Sutabri, 2024). Embedding local culture in "Pangkatani" underscores the relevance of ethnomathematics and Contextual Teaching and Learning as described by Hariastuti et al. (2022) and Hamidah et al. (2024). The study shows empirically that framing exponents through the cassava-farming narrative not only deepened conceptual understanding but also nurtured intrinsic motivation, in line with Hamidah et al. (2024) and with findings on other contextual media such as PMRI (Ma'rufah et al., 2023). More broadly, the findings strengthen the meta-analysis by Hartoyo et al. (2025), which reports a large effect of ethnomathematics-based learning on Indonesian students' mathematics achievement (d = 1.15), while Sunzuma et al. (2025) note that culturally based digital media still center on geometry and rarely touch number topics, a gap this study helps fill. The effectiveness of Scratch as a digital educational platform is reinforced here, in keeping with Yulianisa and Sudihartinih (2022) and Maola and Irianto (2023), who highlight Scratch's flexibility and visual appeal for learning mathematics and science. The "highly feasible" and "practical" ratings across validation aspects also echo other Scratch-based educational game studies (Ali et al., 2024; Sekarsari & Karimah, 2025), which signals that the findings replicate across different contexts and topics.

The main novelty of this study, set against the whole body of prior work, rests on three points. First is the integral pairing of the ADDIE model with local wisdom: earlier work usually focused on interactivity or feasibility alone, whereas this study combines the ADDIE structure, the use of Scratch, and the internalization of local wisdom. Second is the multidimensional

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measurement of student response: where other studies tend to stay within a single domain, this study measured the cognitive, affective, and conative domains at once, giving a holistic picture of the media's effectiveness. Third is the contribution to digital and cultural literacy: bringing a local narrative into abstract mathematics widens the digital literacy dimension with local values, as suggested by Mendonça (2025) and Priadko et al. (2022).

In practical terms, "Pangkatani" shows wide potential for replication and adaptation, as seen in the success of other ADDIE-based interactive media across different fields and levels (Elfira et al., 2025; Sabilla et al., 2025). As those same studies note, there are limits: testing was confined to a single school, there was no longitudinal study, and the effect of the media on varied learning styles or more advanced topics was not explored in depth (Hafizd et al., 2023; Sari et al., 2023). A further limit was the absence of an ethnomathematics expert as a validator, so judgment of the local-wisdom elements fell to the media and material experts, along with technical constraints during implementation (restricted smartphone use, an unstable network, and a Scratch display that was less than optimal on small screens). The important implication is the need for sustained teacher policy and training to integrate local-based multimedia into the curriculum, and for further research with a wider scope and a mixed-method design to assess retention and transfer over the long term. In this way, the study not only supports and strengthens prior findings but also offers a new conceptual and methodological model relevant to innovation in Indonesian mathematics education.

Conclusion

This study successfully developed "Pangkatani," a Scratch-assisted interactive multimedia for learning exponents in grade IX at SMPN 3 Sukahening, built around the local wisdom of cassava farming. The development followed the ADDIE model with a repeated Design and Develop stage, and each step, from needs analysis and content design through media development to the limited trial, ran in a systematic way that adapted to the students and the school setting. Validation by the media and material experts confirmed that the media was highly feasible, while student responses showed strong acceptance across the cognitive, affective, and conative aspects. These findings confirm that embedding local wisdom in interactive digital media can improve conceptual understanding in mathematics along with students' motivation and engagement. The main contribution lies in a development model that stresses not only technological innovation through Scratch but also the relevance of local culture. The study has limits, including a trial confined to one school with a relatively small number of subjects, the absence of an ethnomathematics validator, and a short-term evaluation that did not cover retention or transfer. Future work is advised to widen the trial to more schools, to develop richer interactive features and local-wisdom narratives, to run longitudinal studies, and to compare the media against other learning tools.

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Conflict of Interest

The authors declare no conflict of interest related to the research, authorship, and publication of this article.

Auhor Contributions

All authors confirm that they have read and approved the final version of this manuscript. A.A. conceived the study, designed and developed the Scratch-assisted Pangkatani interactive multimedia, developed and administered the instruments, collected the data, and prepared the initial draft. S.S. supervised the study, co-designed the methodology, validated the instruments, led the analysis and interpretation of results, and made substantial contributions to reviewing and editing the manuscript. M.N.P. supervised the study, validated the methodology and analysis, and contributed to reviewing and editing the manuscript. The contribution percentages for conceptualization, drafting, and revision of this paper are as follows: A.A.: 40%, S.S.: 40%, and M.N.P.: 20%.

Data Availability Statement

The authors declare that the data supporting the results of this study are available from the corresponding author, S.S., upon reasonable request.

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