



Smart Apps Creator-Based Interactive Learning Media: Enhancing Critical Thinking Skills

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ABSTRACT

Purpose - This study aimed to develop and assess the effectiveness of Smart Apps Creator (SAC)-based interactive learning media to enhance critical thinking skills among fifth-grade students in Natural and Social Sciences (IPAS) learning.

Methodology - Employing the ADDIE model (Analysis, Design, Development, Implementation, Evaluation), the study employed a quasi-experimental design with purposive sampling for the needs analysis (20 teachers, 24 students) and random sampling for the trials (54 experimental and 57 control group students across four elementary schools). The experimental group engaged in six offline SAC-based learning sessions, while the control group used conventional methods (lectures, worksheets, static images). Data were collected through classroom observations, media feasibility questionnaires, and pre- and post-tests of critical thinking skills, and analyzed using descriptive statistics, paired t-tests, and N-Gain scores.

Findings - The SAC-based media achieved high feasibility (expert validation: 82.3%-86.5%). They significantly improved critical thinking, with the experimental group recording an N-Gain of 0.75 (high) and a t-value of -30.556 ($p = 0.000$), outperforming the control group's N-Gain of 0.42 (moderate) and a t-value of -18.070 ($p = 0.000$). Interactive elements, such as quizzes and animations, fostered student-centered learning, although challenges included limited hardware and teacher training needs. The offline SAC media effectively addressed connectivity constraints, enhancing analytical skills.

Contribution - This study offers a scalable, offline educational technology solution for rural areas, promoting 21st-century skills such as critical thinking and suggesting the broader implementation and exploration of additional skills, including collaboration and communication.

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INTRODUCTION

The educational context at the elementary school level, particularly in the acquisition of Natural and Social Sciences (IPAS), is confronted with substantial challenges (Wulandari et al., 2023). Because IPAS integrates both natural and social sciences into a single curriculum, educators must possess the capacity to effectively manage both areas in order to improve student comprehension and engagement (Prihantini et al., 2024). The learning process often relies on physical interactions in the classroom, which can lead to gaps in pedagogical practices as educators transition to digital media (Munastiwi et al., 2022; Meirbekov et al., 2022). The COVID-19 pandemic intensified this shift, revealing several limitations, including a lack of teacher training in digital tools and reduced opportunities to employ interactive learning methods (Gonzalez-Mohino et al., 2023; Wulandari et al., 2023). Instructors' unpreparedness for this pedagogical change often hinders the adoption of inquiry-based learning methodologies that can enhance academic engagement (Muvid et al., 2022). Pre-research observations in Purwantoro District also indicate that science and natural science learning remain heavily reliant on lectures, textbooks, and Student Worksheets (LKPD), resulting in monotonous learning and limited stimulation of critical thinking. Teachers face additional challenges in mountainous regions, where unstable internet connections limit the use of digital resources, and declining critical-thinking test scores (averaging 55.65 in 2023/2024) underscore the need for more effective approaches.

The development of critical thinking skills is therefore essential for students, particularly in science education, as they confront the challenges of the 21st century. Critical thinking, which is defined as the ability to synthesize, evaluate, and analyze information, is crucial for addressing complex global issues and making informed decisions (E. Puspitasari, 2020; Handayani et al., 2023). Integrating STEM (Science, Technology, Engineering, and Mathematics) approaches into the curriculum effectively strengthens students' critical thinking, as evidenced by research showing that problem-based STEM education promotes active engagement and problem-solving (Topsakal et al., 2022; Anwar et al., 2023). Experiential, project-based learning within a STEM framework likewise enhances analytical reasoning (Oktavia & Ridlo, 2020; Bulu & Tanggur, 2021). Numerous studies have confirmed that STEM-based education equips students to tackle contemporary issues such as environmental sustainability and technological advancement (Ichsan et al., 2023; Omariba, 2019), while collaborative problem-solving frameworks and real-world applications further build critical thinking for academic and life success (Yanti et al., 2024) (Sujanem & Suwindra, 2023). Educators who explicitly prioritize critical thinking encourage students to question assumptions and evaluate multiple viewpoints, fostering a scientific mindset characterized by curiosity and exploration (Ninghardjanti & Dirgatama, 2021).

Despite its importance, the cultivation of critical thinking is hindered by limitations in infrastructure and media. Many rural schools face poor internet connectivity and limited access to interactive learning media (Bint-e-Khurshid, 2022; Surahman et al., 2021). The adoption of modern educational tools, such as interactive apps or augmented reality, is constrained by inadequate technological resources that could otherwise boost student engagement in science (Budiarto, Rahman, et al., 2024). Unequal internet access further hampers students' ability to participate in online learning or use available digital resources (Bint-e-Khurshid, 2022; Kwiatkowska & Wiśniewska-Nogaj, 2022). Consequently, education policies must enhance digital infrastructure and provide comprehensive teacher training to address these challenges and improve science learning outcomes.

Amid these constraints, Smart Apps Creator (SAC) offers a promising solution. Research shows that SAC-based media can be practical, engaging, and effective across different educational levels (Mas'ud et al., 2023; Khasanah & Rusman, 2021). It has been successfully applied to subjects such as Indonesian for non-native speakers, English, and thematic learning (Kusumaningsih & Fatoni, 2020; Rizki et al., 2022). Other studies confirm SAC's potential to improve learning outcomes, critical thinking, and broader 21st-century skills (J. Puspitasari et al., 2022; Husna, 2022). Even with some constraints, such as limits on hosting complex materials (Khasanah & Rusman, 2021), SAC remains a practical technique for developing Android-based interactive media that can enrich learning experiences. Offline SAC applications, including visual and interactive aids, can overcome internet constraints while fostering active student involvement in scientific concepts through

interactive exercises that strengthen critical thinking (Kusumaningsih & Fatoni, 2020; Khasanah & Rusman, 2021).

Although numerous studies have examined the use of technology in education, most focus on internet-dependent media, leaving a significant gap in the development of offline, interactive solutions. The limited availability of media that can function without a stable connection is especially problematic in rural areas (Surahman et al., 2021). This study addresses that gap by developing SAC-based interactive learning media that can be accessed without internet connectivity—a timely and relevant innovation for regions with limited digital infrastructure (Bint-e-Khurshid, 2022; Khasanah & Rusman, 2021).

This study aims to: (1) develop Smart Apps Creator (SAC)-based interactive learning media that can be accessed without an internet connection, and (2) examine the effectiveness of this media in improving elementary school students' critical thinking skills in science (IPAS) learning. The novelty of this research lies in providing an offline, interactive learning solution using SAC designed explicitly for elementary science education in regions with limited digital infrastructure. Unlike many previous studies that focus on online or internet-dependent media, this study demonstrates how offline SAC-based media can foster 21st-century competencies, particularly critical thinking, while addressing connectivity barriers. The findings contribute a scalable model of student-centered, technology-enhanced instruction that can be adopted in rural or low-bandwidth contexts and adapted to develop other essential skills, such as collaboration and communication.

METHODOLOGY

Research Design

The ADDIE model (Analysis, Design, Development, Implementation, Evaluation) is the development model employed in this study to create interactive learning media using Smart Apps Creator (SAC) (Maydiantoro, 2021). Daryanes et al. (2023) asserted that ADDIE functions as a framework for creating more dynamic and effective learning program tools and infrastructure, as well as for enhancing learning performance, particularly in the development of learning media. To emphasize that the ADDIE model is not simplified, the following is a comprehensive explanation that addresses the reviewer's comments.

This study implemented all ADDIE stages—Analysis, Design, Development, Implementation, and Evaluation—wholly and sequentially; however, for clarity, the five stages are grouped into three primary stages. The Preliminary Stage includes analysis, which involves studies, observations, interviews, and curriculum reviews to identify gaps in critical thinking and constraints in connectivity. The Development Stage integrates Design (goal formulation, storyboarding, interactive strategies, and assessment design) and Development (content production, SAC programming, media-material expert validation, and iterative revisions), resulting in a valid offline application prototype. The Testing Stage combines implementation (teacher training, implementation of six meetings in the experimental class, and process monitoring) and Evaluation (pretest-posttest, paired t-test, N-Gain, and teacher feasibility questionnaire), which proved the effectiveness of the media. Thus, no ADDIE stages were omitted or reduced; The three-stage grouping is only a presentation strategy, not a model simplification. The following phases of this development process will be elucidated in three research and development procedures.

Participants

Purposive sampling was employed to select 20 teachers and 24 students who met specific inclusion criteria: teachers had at least two years of experience in science teaching and expressed a willingness to participate in media trials. In contrast, students demonstrated basic digital literacy and regular attendance. Exclusion criteria included teachers or students who were unable to commit to all trial sessions. This sample size was considered adequate to represent typical instructional practices and learner characteristics in the Purwantoro District elementary school context (Bostley & Peters, 2023). Students were selected based on their ability to engage in technology-based learning and their participation in active learning. The objective of this sample selection was to guarantee that the participants could provide reliable data regarding the efficacy of SAC media in enhancing critical thinking abilities and the media's relevance to field conditions.

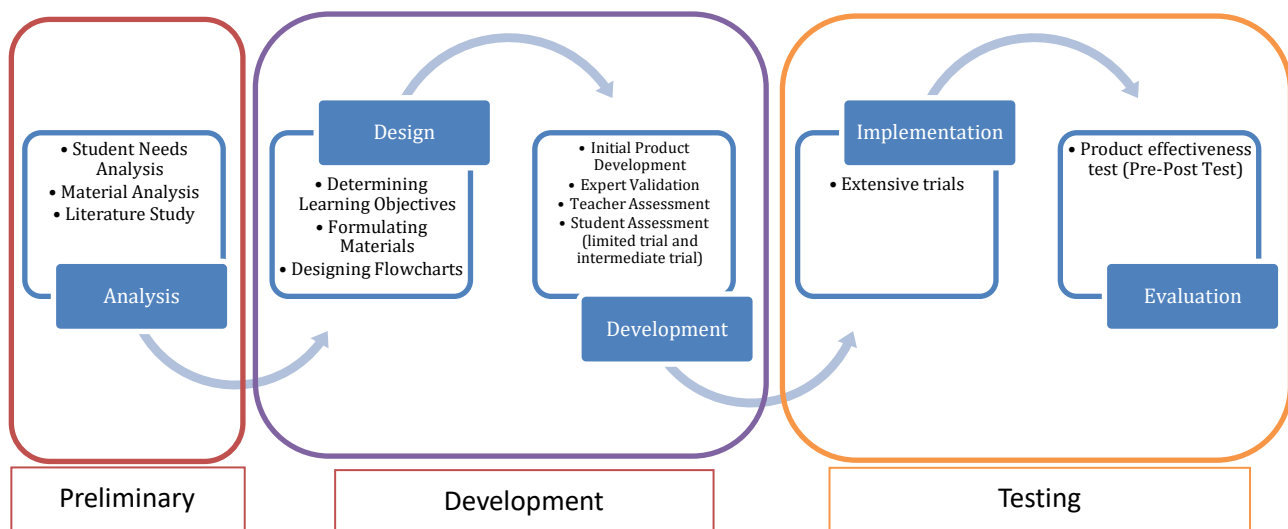


Figure 1. Stages of Developing Interactive Learning Media Based on Smart Apps Creator

Instruments and Data Collection

Three primary instruments were implemented in this investigation: classroom observations, a media feasibility questionnaire, and a critical thinking skills test. The critical thinking skills test was developed using indicators of analysis, inference, evaluation, and explanation aligned with the Grade V IPAS curriculum to measure students' critical thinking abilities (Romualdi & Sudrajat, 2024; Chen et al., 2025; Hamdani et al., 2022). Item construction included expert review and a small pilot test, and reliability was confirmed through Cronbach's Alpha ($\alpha = 0.86$) for internal consistency.

The media feasibility questionnaire was implemented to evaluate the feasibility of SAC-based learning media from the viewpoints of both teachers and students (George Lee, 2019; Ariesta & Purwanti, 2019), and was validated by media and materials experts prior to use.

Table 1. Learning Media Validation Instrument Grid

Aspect	Indicator
Software engineering	1) Effective and efficient media use
	2) Reliability and reusability
	3) Maintainability and compatibility
	4) Usability (ease of use)
	5) Appropriate selection of software types for development
	6) Presentation of learning objectives
	7) Presentation of the relationship between learning objectives and the curriculum
Learning Design	1) Presentation of media content with learning objectives
	2) Appropriate use of learning strategies in videos
	3) Learning motivation
	4) Contextual and actual
Visual Communication	1) Communicative
	2) Creative
	3) Simple and engaging animations
	4) Audio quality
	5) Visual quality

To evaluate student interactions with the media during the learning process, classroom observations were conducted. Questionnaires, written assessments, and direct observations were implemented both during and following the integration of the media into the learning process. Each validator or media feasibility tester in this study underwent a validation process that involved experts, including media experts, material experts, and student representatives (Mishra et al., 2019). The instrument layout for the SAC product validation sheet, as developed, is shown in Tables 1, 2, and 3.

Table 2. Material Expert Instrument Grid

Aspect	Indicator
Learning Objectives	1) Clarity of learning objectives 2) Suitability of objectives to the material
Learning Materials	1) Clarity of material delivery 2) Learning flow
Learning Methods	1) Appropriateness of method selection 2) Benefits
Learning Activities	1) Introduction 2) Content 3) Conclusion

Table 3. User Instrument Grid (Teachers and Students)

No.	Aspect	Indicator
1	Increase user motivation and effectiveness	1) Message Clarity 2) Stand Alone 3) User Friendly
2	Content Representation	1) Visualization with Media 2) Using High Resolution Quality 3) Can be used in a classroom or individually

The excellence of learning media based on Smart Apps Creator (SAC) was assessed by each expert in accordance with their area of expertise. The average percentage of validation results was calculated after data were collected from questionnaires during the trial of interactive multimedia products, which were analyzed using descriptive techniques (Ullah & Anwar, 2020). For SAC media to be deemed feasible, the feasibility analysis must obtain a minimum score of 63%, indicating that the media is "Feasible" according to the established criteria (Sri Utaminingsih et al., 2024). The SAC multimedia feasibility criteria matrix is presented in Table 4.

Table 4. Multimedia Interactive eligibility criteria

Percentage	Qualification	Decision
82 – 100%	Very good	Very Eligible
63 – 81%	Good	Eligible
44 – 62%	Enough	Less Eligible
25 – 43%	Deficient	Not Eligible
0 – 24%	Very Deficient	

At the same time, the efficacy of this media was assessed using a t-test and N-Gain, which assesses the enhancement in students' critical thinking abilities before and after utilizing SAC media. The media's efficacy in enhancing students' critical thinking abilities was classified using the N-Gain criterion, with high, medium, and low categories (Wandani et al., 2023). Table 5 illustrates the N-Gain criterion.

Table 5. N-Gain Criteria

N-Gain (g)	Interpretation
$g \geq 0,7$	High
$0,3 \leq g < 0,7$	Medium
$g < 0,3$	Low

FINDINGS

Preliminary Stage: A Need Analysis Phase Outcomes

Aligned with the Analysis stage of the ADDIE framework, observations and document studies conducted from January 7 to 22, 2025, at five elementary schools in Purwantoro District showed that IPAS learning for Phase C (Grade V) relied heavily on direct instruction, lectures, question-and-answer sessions, and assignments using textbooks, worksheets (LKPD), and static images. While aligned with curriculum goals, the approach emphasized memorization, limiting students' ability to analyze and engage critically with IPAS content.

Table 6. Observation and Document Study Results

Aspect	Description	Source/Method
Lesson Duration	2 days	Teaching Module
Model Used	Direct Instruction	Teaching Module/Observation
Methods Used	Lecture, Q&A, Assignments	Teaching Module/Observation
Media Used	Textbooks, LKPD, Images	Teaching Module/Observation
Identified Issues	Inappropriate model and media selection, reliance on memorization	Observation

There is a significant awareness of the need for learning media founded on Smart Apps Creator (SAC) to support science and science learning, as evidenced by the results of interviews and questionnaires with teachers. Teachers expressed concerns about the current media and were in complete agreement that SAC-based media could be a viable solution for enhancing student comprehension, particularly in areas such as problem-solving and providing distinct assessment exercises. Furthermore, they asserted that SAC media can contribute to a deeper understanding of science and scientific concepts. However, the use and awareness of SAC-based media in the classroom remain limited. Table 7 provides an analysis of the requirements of teachers for desired SAC-based media to facilitate science and scientific learning.

Table 7. Analysis of Teacher Needs for SAC-Based Media

Questions	The answer is "Yes"	Percentage
Problems with current science media	20	100%
Media needs to support problem-solving	20	100%
Media needs to improve science understanding	20	100%
Media needs to develop separate evaluation exercises within science media	20	100%

This table demonstrates that teachers strongly acknowledge the significance of SAC-based media in supporting science learning, particularly in enhancing student understanding and providing relevant exercises, despite the fact that awareness and use of this media are still limited. The analysis of student needs for Smart Apps Creator (SAC)-based learning media has revealed that students have a strong preference for media that is interactive, flexible, and accessible at any time without the need for an internet connection.

The majority of pupils have access to the requisite devices to utilize these media, including laptops, mobile phones, or LCDs (100%). Additionally, a significant number of students are interested in utilizing mobile phones to access scientific media, with 75% of students opting to use their phones for educational purposes. Additionally, 90% of students opted for mobile-based media that displayed concise, comprehensible text. Furthermore, all students desired media tailored to their thinking patterns and accessible anytime and anywhere, reflecting the importance of flexibility in learning. Students also expressed a strong preference for media that conveyed plain and concrete messages, suggesting that they are interested in learning that is immediately applicable and easily comprehensible. The results of the analysis of student requirements in relation to SAC-based media are summarized in Table 8.

Table 8. Analysis of Student Needs for SAC-Based Media

Questions	The answer is "Yes"	Percentage
Access to devices (e.g., LCD, laptop, cell phone)	20	100%
Use of cell phones to view science media	15	75%
Science media on cell phones with short text	18	90%
Preference for media tailored to student thinking	20	100%
Preference for science media that can be accessed anytime/anywhere	20	100%
Interest in SAC media with clear and concrete messages	20	100%

The analysis revealed a significant gap in fostering critical thinking skills due to the reliance on traditional, teacher-centered methods and non-interactive media like textbooks and images. These approaches prioritized memorization over analytical skills, failing to engage students in active, student-centered learning or support the development of 21st-century skills like critical thinking in IPAS education.

Table 9. Identified Gaps in IPAS Learning

No	Identified Gap	Source
1	Reliance on memorization-based learning	Observation, Document Study
2	Limited use of interactive, digital media	Interviews, Questionnaires
3	Teacher-centered methods hindering critical thinking	Interviews, Observations
4	Lack of media supporting flexible, student-centered learning	Questionnaires

Teachers underscored the necessity of digital media to overcome connectivity challenges in Purwantoro, where unstable internet signals limit online resources. SAC-based media, with its offline functionality, was seen as an effective solution to promote 21st-century skills, particularly critical thinking, by enabling interactive, engaging, and student-centered learning that encourages exploration and problem-solving without reliance on memorization.

Development Stage: Design Phase and Development Phase Outcomes

Corresponding to the Design and Development stages of the ADDIE framework, the SAC-based interactive learning media for IPAS (Phase C) was designed to integrate engaging multimedia elements, including animations, interactive quizzes, and problem-solving tasks, to facilitate student-centered learning. The conceptual framework emphasizes clear learning objectives, structured content delivery, and interactive activities to build IPAS concepts inductively. Figure 2 is a display of the media flowchart design that was developed.

To cultivate student engagement and analytical thinking, the design incorporates interactive elements and problem-solving tasks, including scenario-based questions and drag-and-drop activities. These characteristics facilitate students' exploration, analysis, and synthesis of IPAS concepts, thereby transitioning from memorization to critical thinking, which aligns with the requirements identified in the preliminary study. The IPAS curriculum for Phase C was meticulously aligned with the SAC-based media to ensure that the

content was relevant to students in Grade V, encompassing science, social studies, and the arts. The media supported the curriculum objectives by integrating tasks that fostered critical thinking skills, including the interpretation of data, analysis of scenarios, and drawing of conclusions, as specified in the Curriculum Unit Education (KSP). This alignment guaranteed that the media directly supported the attainment of educational objectives and improved the analytical skills of students.

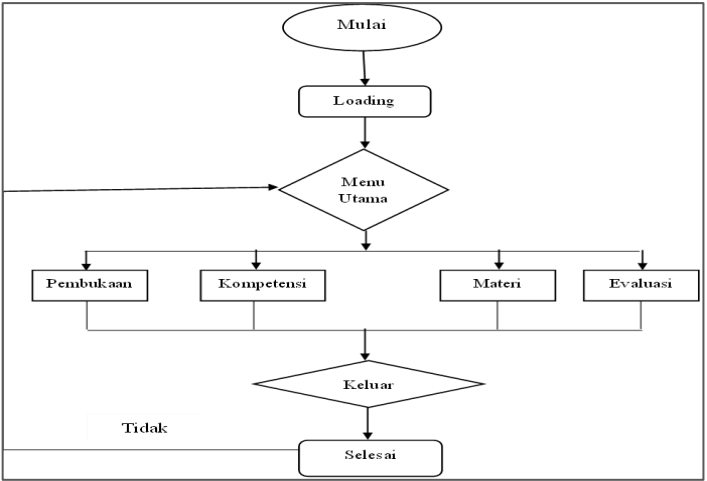


Figure 2. Flowchart of SAC-based Interactive Learning Media

Smart Apps Creator was employed to integrate multimedia elements, such as visualizations (e.g., animations and images), audio narration, and interactive tasks (e.g., quizzes and problem-solving exercises), into the development of the SAC-based media. These components were intended to facilitate student-centered learning, address connectivity issues in Purwanto District, and be accessible offline. Initial findings of the media that have been developed are summarized in Figure 3.



Figure 3. SAC-Based Interactive Learning Media

In terms of media and materials, the validation results of the Smart Apps Creator (SAC)-based learning media demonstrated exceptional acceptability among experts. The feasibility and quality of the media that had been developed were assessed by two media experts and two material experts individually during the validation process. All validators awarded high scores, and the average percentage of validation results suggested that the media met very high feasibility standards, as a consequence of the evaluation results. These findings suggest that learning media based on SACs are highly appropriate for facilitating the learning of science. The validation results from the specialists are summarized in Table 10.

Table 10. Expert Validation Results

Validator	Average (%)	Qualification	Decision
Media Expert I	86.5%	Very Good	Very Eligible
Media Expert II	82.3%	Very Good	Very Eligible
Subject Matter Expert I	84.6%	Very Good	Very Eligible
Subject Matter Expert II	83.9%	Very Good	

Analysis of the validation results by two media experts and two content experts showed that the Smart Apps Creator (SAC)-based learning media achieved scores ranging from 82.3% to 86.5%, categorized as "Very Good" to "Very Adequate." However, a thorough evaluation of each aspect revealed significant strengths and areas for improvement. Media Expert I gave the highest score (86.5%), with key strengths in the Visual Communication aspect, specifically audio quality, visual clarity, and animation creativity. Conversely, Media Expert II gave a relatively lower score (82.3%), indicating a need for improvement in the Software Engineering aspect, particularly in the maintainability and compatibility indicators, which have implications for optimizing the media's functionality on low-spec devices. Regarding the content aspect, both content experts gave consistent scores in the range of 83.9% to 84.6%, with strengths in the clarity of learning objectives and the material's alignment with the curriculum. However, improvements were noted in the Learning Activities aspect, particularly in the conclusion component, which was deemed to require strengthening summarization elements and metacognitive prompts to strengthen the transfer of critical thinking skills.

Testing Stage: Implementation and Evaluation Phase Outcomes

Reflecting the Implementation and Evaluation stages of the ADDIE framework, a random sampling method was employed to select the sample for the implementation of interactive learning media based on Smart Apps Creator (SAC) with Phase C Science material in elementary schools in Purwanto District. Each elementary school was randomly selected, and the four selected schools were subsequently divided into two groups: an experimental group with 54 students and a control group with 57 students. Each school had an equal opportunity to be selected. The researcher conducted specialized training for the teachers who accompanied the experimental group on the use of SAC-based learning media prior to implementing the learning intervention. In contrast, the control group teachers employed traditional learning methods, including lectures, question-and-answer sessions, and assignments with Student Worksheets or picture media. The experimental group utilized SAC media offline during six meetings, while the control group adhered to conventional learning methodologies. A pre-test was administered to each group prior to the learning experience, and a post-test was administered afterward to assess the development of students' critical thinking abilities. The effectiveness of utilizing SAC-based media in enhancing students' critical thinking skills will be assessed by compiling the test results.

Limited and medium-scale trials were conducted to assess the media's usability and effectiveness, with teachers as the primary respondents. The limited trial (February 5, 2025) yielded a score of 92.50% (Very Good), indicating high initial usability and engagement. The medium trial (March 14–15, 2025) yielded a score of 92.38% (Very Good), indicating sustained quality following minor refinements based on feedback. These trials confirmed the media's practicality, with teachers noting its engaging interface and ability to support student-centered learning and critical thinking.

Table 11. Limited and Medium Trial Results by Teachers

Trial Type	Respondents	Average Score (%)	Criteria	Feedback Highlights
Limited Trial	1 Teacher and 6 Students	92.50	Very Good	High usability, engaging interface, supports critical thinking
Medium Trial	1 Teacher and 18 Students	92.38	Very Good	Sustained quality, improved interactivity, enhances student engagement

The implementation procedure involved administering a pre-test to the experimental and control groups prior to the commencement of the learning process. Subsequently, the students were instructed in accordance with their respective groups for six meetings, and then a post-test was administered. Table 12 displays the test results.

Tabel 12. Descriptive Statistics

	N	Min	Max	Mean	Std. Deviation
Experimental Pre-Test Results	54	40	75	55,69	9,973
Experimental Post-Test Results	54	80	100	89,54	6,748
Control Pre-Test Results	57	40	70	55,96	9,703
Control Post-Test Results	57	60	100	74,04	8,579
Valid N (listwise)	54				

A prerequisite test was conducted prior to the hypothesis test to verify that the data utilized in this investigation adhered to the assumptions of normality and homogeneity. In order to guarantee that the sample was drawn from a population with a normal distribution, the normalcy test was implemented. The data can be regarded as normally distributed if the calculated significance value is greater than 0.05, as indicated by the results of the calculations conducted using SPSS. In order to guarantee that the variances of the two groups under comparison were homogeneous, the homogeneity test was implemented. The data are deemed to have the same variance if the calculated significance value exceeds 0.05. The results of the normality and homogeneity tests are presented in Table 13.

Table 13. Normality and Homogeneity Test

Groups	Statistic	df	Sig.	Levene Statistic	df2	Sig.
Experimental Pre-Test Results	0,236	54	0,148	7,363	109	0,077
Experimental Post-Test Results	0,176	54	0,166	4,496	109	0,062
Control Pre-Test Results	0,213	54	0,069	0,881	109	0,350
Control Post-Test Results	0,170	54	0,055	0,603	109	0,439

The results of the calculation revealed that the calculated significance values for the pre-test and post-test of the experimental and control groups were all greater than 0.05, suggesting that the data were derived from a normally distributed population. In the same vein, the homogeneity test results indicated that the calculated significance value was greater than 0.05, which qualified both groups for further analysis due to their homogeneous variances.

The impact of the SAC-based interactive learning media on critical thinking abilities in science learning was assessed using paired t-tests. The null hypothesis (H_0E) was rejected, and the SAC-based media substantially enhanced critical thinking skills for the experimental group (54 students), as evidenced by a t-value of -30.556 (absolute value of 28.313) and a significance level of 0.000 (<0.05) in the pre-test to post-test comparison. The control group (57 students) had a t-value of -18.070 (absolute 21.827) with a significance of 0.000 (<0.05), which rejected H_0K . This result suggests that conventional methods (lectures, question-and-

answer, assignments) were more effective than the experimental group, although the difference was less significant.

Table 14. Paired t-Test Results for Experimental and Control Groups

Group	N	t-value	df	Significance (2-tailed)	Mean Difference	95% CI (Lower, Upper)	Conclusion
Experimental	54	-30.556	53	0.000	-29.313	(-32.720, -28.391)	H0E rejected, SAC media effective
Control	57	-18.070	56	0.000	-21.827	(-19.729, -16.412)	H0K rejected, conventional methods effective

The effectiveness of the SAC-based media was further examined using N-Gain scores to capture the magnitude of improvement in critical thinking skills. The experimental group (54 students) achieved an N-Gain score of 0.75 (High), indicating a substantial increase in critical thinking ability, while the control group (57 students) reached only 0.42 (Moderate), reflecting a moderate improvement with conventional methods. The difference of 0.33 points in N-Gain clearly shows that SAC-based media produced a much stronger learning gain than traditional approaches.

Table 15. N-Gain Results for Experimental and Control Groups

Group	Sample Size	N-Gain Score	Criteria	Conclusion
Experimental	54	0.75	High	Highly effective
Control	57	0.42	Moderate	Moderately effective

These findings demonstrate that, although both groups improved significantly according to the paired t-tests (experimental $t = -30.556$, control $t = -18.070$; $p < 0.001$), the magnitude of improvement in the experimental group was markedly higher. The high N-Gain for the SAC group versus the moderate N-Gain for the control group confirms the effectiveness of SAC-based interactive learning media in enhancing students' critical thinking skills compared with conventional teaching techniques.

DISCUSSION

The findings of this study demonstrate that Smart Apps Creator (SAC)-based interactive learning media significantly improved the critical thinking skills of fifth-grade students in IPAS learning in Purwantoro District. The experimental group achieved an N-Gain of 0.75, classified as high, while the control group reached only 0.42, classified as moderate. This difference highlights that SAC media produced a significantly greater learning gain than conventional methods, supporting the study's aim to provide an offline, student-centered tool capable of fostering analytical skills in areas with limited internet connectivity. The marked improvement in the experimental group can be explained by the interactive features embedded in SAC, such as quizzes, animations, and scenario-based problem-solving tasks, which encourage students to analyze, synthesize, and evaluate information. These elements shift learning from rote memorization toward an inquiry-oriented, student-centered approach that cultivates essential 21st-century competencies (Budiarto, Asrowi, et al., 2024; Anagün, 2018). Through active engagement with multimedia components designed to stimulate exploration and critical reflection, students achieved a deeper understanding of scientific concepts.

These results are consistent with previous research underscoring the effectiveness of digital tools in developing critical thinking skills. Yanti et al. (2024) and Wahyuni & Fitria (2023) reported that interactive digital media, including videos and e-books, substantially enhance elementary students' analytical abilities. Similar findings highlight how mobile-based and blended learning environments promote critical thinking through self-directed learning and improved digital literacy (Ninghardjanti & Dirgatama, 2021; Lionenko & Huzar, 2023). Additional studies confirm SAC's potential to boost engagement and cognitive growth across educational levels (Fricticarani et al., 2025; Husna, 2022; Hati & Karo, 2025). These findings also align with the

principles of problem-based learning (PBL), which integrates interactive components such as quizzes, animations, and videos to foster active participation and deeper application of knowledge (M. Muktiarni et al., 2023; Suriaman et al., 2023).

From a practical perspective, the SAC media achieved very good usability ratings in both limited and medium-scale trials (92.50% and 92.38%, respectively), indicating a user-friendly interface that supports student-centered learning. Teachers reported that students were enthusiastic about the concise text and offline accessibility, while the interactive elements increased motivation and engagement (Putri, 2024; Triyanto et al., 2024). These results suggest that SAC media can be effectively integrated into the science curriculum and scaled to broader contexts to foster other 21st-century skills, such as collaboration and communication.

Despite these strengths, several limitations emerged during implementation. Some students initially struggled with navigation, and teachers required introductory training to maximize the technology's potential (Omariba, 2019; Merta et al., 2023). Technical challenges, including limited hardware in some schools, further constrained the process, reflecting global barriers to technology adoption in resource-limited settings (Owoyemi et al., 2022; Cyuzuzo et al., 2025). Moreover, the intervention lasted only six sessions and focused on a single district, which limits the external validity of the findings. Future studies should involve larger and more diverse samples, extend implementation periods, and provide structured teacher training to enhance generalizability and sustainability.

CONCLUSION

This study effectively accomplished its goal of developing interactive learning media utilizing Smart Apps Creator (SAC), significantly enhancing the critical thinking skills of fifth-grade students in science education within Purwanto District. The experimental group exhibited an N-Gain of 0.75 (high), in contrast to 0.42 (moderate) in the control group. Additionally, expert validation indicated excellent feasibility (82.3%-86.5%), aligning with the creation of offline media for student-centered learning in areas with restricted connectivity (t -value = -30.556, p = 0.000). It is advisable to introduce SAC media in elementary schools with varied characteristics, encompassing both urban and rural settings, and to investigate its influence on additional 21st-century skills, such as collaboration and communication, through interactive activities like group work or digital discussions, to enhance its advantages in holistic education.

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