Innovation in Learning Applications Based on the Adaptive Inquiry Approach as a Means to Enhance Students' Critical Thinking Skills

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ABSTRACT

This study aims to develop a draft of a learning application based on the Adaptive Inquiry Approach, which integrates inquiry models with learning style adaptive systems and to evaluate the product's feasibility and its evaluation instrument characteristics. This study employed a Research and Development (R&D) approach using the Luther-Sutopo development model, restricted up to the initial product and instrument testing stage. The subjects for the instrument testing were 4th–6th-grade students at Muhammadiyah Bantaeng Elementary School. Data were analyzed using descriptive quantitative techniques to calculate the feasibility interpretation index and empirical analysis of the test items (discriminatory power and difficulty level). Expert validation indicated that the product draft is highly feasible, with average interpretation indices of 82.50% from model concept experts, 86.00% from learning technology experts, 83.13% from design and graphics experts, and 81.82% from learning style experts. The characteristics testing of the mathematics test instruments demonstrated good empirical quality, where all pre-test and post-test items achieved a discrimination coefficient of ≥ 0.3 (good category) and a difficulty index within the ideal range ($0.3 \leq P \leq 0.7$). Supporting materials, including the model guidebook and teacher's guide, were also declared highly feasible, with average validation scores exceeding 81%. The draft of the learning application based on the Adaptive Inquiry Approach and its evaluation instruments have been proven theoretically and empirically valid and reliable, making it highly feasible to proceed to the large-scale implementation phase to measure students' critical thinking skills.

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1. Introduction

In the era of Society 5.0, critical thinking skills are one of the main competencies that students must possess to face global challenges. Critical thinking skills are one of the core skills that students must have in the era of Society 5.0, as they form the foundation for facing complex and dynamic global challenges (Maftuhah, 2024). This skill is not only important in academic aspects but also plays a role in shaping students' analytical, evaluative, and creative abilities to filter information and make the right decisions (Topali et al., 2023). This aligns with findings that adaptive learning to improve critical thinking skills is necessary, especially in Indonesia's Merdeka Belajar curriculum (Susilana et al., 2024). Learning based on strengthening critical thinking is believed to enhance analytical skills in absorbing knowledge while also sharpening creativity in processing information.

However, reality shows that these abilities still need to be questioned, especially post-pandemic, which has affected learning patterns and models in schools. The prolonged online learning model has led students to become passive, thereby hindering their cognitive, affective, and psychomotor abilities (Hosen et al., 2021). Other studies indicate that online learning processes without effective participatory strategies contribute to the weakening of students' critical thinking skills (Akfal et al., 2025). Instructional development in learning is not only carried out with learning approaches and models, but also requires innovative media to improve critical thinking skills (Muwafiq & Nugroho, 2025). This situation underscores the urgency of creating innovative learning applications that can revive students' critical abilities (Carniel et al., 2023). This highlights the importance of innovation in designing learning applications that are more adaptive in developing students' critical thinking skills.

Various learning applications that exist today are generally uniform, providing the same treatment to all students without considering individual learning style diversity. Most of the available learning applications still adopt this uniform approach by giving the same treatment to all students, without taking learning style differences into account (Narimo et al., 2025). In fact, each student has unique learning characteristics, whether visual, auditory, reading/writing, or kinaesthetic. A uniform model actually limits students' natural expression in learning, thereby failing to maximize their critical thinking abilities (El-Sabagh, 2021). A recent meta-analysis shows that inquiry-based learning consistently improves students' critical thinking skills (Anugrah et al., 2025). Therefore, it is essential to develop adaptive learning applications that can accommodate diverse student learning styles and optimally foster the growth of their critical thinking skills.

Various previous studies have highlighted the effectiveness of learning models in developing critical thinking, such as approaches through the integration of inquiry and adaptability. Inquiry-based learning has been proven effective in enhancing critical thinking skills because it places students as active subjects who learn through investigation and reflection (Alfroni et al., 2019). Meanwhile, adaptive systems in learning allow personalization according to individual learning styles and pace, which positively impacts engagement and learning outcomes (Chen & Chen, 2025). The effectiveness of Inquiry-Based Science Education (IBSE) in facilitating students to independently discover concepts (Hasibuan et al., 2025). Inquiry based on real activities can improve critical thinking skills (Bhuttah et al., 2024). The integration of adaptive systems in inquiry-based learning is now also being developed through AI technology to create more personalized learning paths (Penn et al., 2025). The inquiry model encourages students to construct understanding through scientific investigation, ultimately developing critical thinking (Uslan et al., 2025). Overall, these various studies confirm that inquiry-based learning models, especially when combined with adaptive systems, are able to effectively develop critical thinking skills while increasing student engagement and learning outcomes.

Nonetheless, almost all of these studies still rely on traditional inquiry without integrating the principle of adaptability. While the integration of inquiry and adaptive systems has been reported in existing literature, a significant research gap remains. In the era of digital transformation, the integration of adaptive learning into inquiry-based learning is a need that has not been widely explored (Yusra et al., 2022). Through the integration of these two concepts, learning applications based on the Adaptive Inquiry Approach are expected to facilitate in-depth exploration of religious concepts while also considering the unique learning needs of each student (Plooy et al., 2024). Adaptive technologies such as auto-prompting have been shown to increase student curiosity and engagement in inquiry-based learning (Tang, 2024). Thus, learning not only enhances cognitive outcomes but also empowers critical thinking skills comprehensively (Arifin et al., 2025). The novelty of this research lies in the development of a learning application based on the Adaptive Inquiry Approach, which combines the strengths of inquiry with an adaptive system based on learning styles to explicitly empower students' critical thinking skills.

To ensure the methodological rigor of this new digital framework, this study focuses on the foundational phases of educational software engineering. Specifically, this study aims to design a learning application based on the Adaptive Inquiry Approach and rigorously evaluate its product feasibility through multidisciplinary expert validation, while simultaneously establishing the empirical validity and reliability of its mathematical critical thinking evaluation instruments. This research provides a verified, high-quality digital framework prepared for subsequent field implementation in elementary education.

2. Method

This research method uses a Research and Development (R&D) approach with the Luther-Sutopo development model which consists of six main stages, namely: (1) concept, (2) design, (3) material collection, (4) assembly, (5) testing, and (6) distribution (Sutopo, 2010). This approach was chosen because it is in accordance with the research objectives which aim to produce a learning application product based on the Adaptive Inquiry Approach while also testing its effectiveness in improving students' critical thinking skills. Before empirical testing, the product draft (comprising the learning application, the adaptive inquiry model guidebook, and the teacher’s manual) underwent a rational validation process by multidisciplinary experts. A total of 12 internal and external validators were selected based on strict professional criteria:

a. Model Concept and Adaptive Inquiry Experts (2 validators): University lecturers holding a doctoral degree in Education or Physics/Mathematics Pedagogy with at least 5 years of research experience in inquiry-based learning.
b. Learning Technology Experts (2 validators): Experts with a minimum of a Master’s degree in Educational Technology, specializing in digital instructional designs and e-learning systems.
c. Application Design and Graphics Experts (2 validators): Professional UI/UX designers or multimedia lecturers with proven expertise in software interface design and aesthetics.
d. Learning Style Experts (2 validators): Educational psychologists specializing in student cognitive styles and psychometrics.
e. Linguists (2 validators): Lecturers or experts in Indonesian Language and Literature, ensuring compliance with standard grammatical rules.
f. Mathematics Material Experts (2 validators): Senior mathematics educators or curriculum specialists with extensive experience in developing higher-order thinking skill (HOTS) content for elementary education.

The selection of subjects was based on several considerations:

a. Cognitive development stage: Students at this level are in the concrete operational phase towards formal according to Piaget, so it is very appropriate to train critical thinking skills through adaptive inquiry learning strategies (Nhung et al., 2025).
b. The need for learning innovation: Post-pandemic, elementary school students' critical thinking skills have shown a downward trend, mainly due to more passive online learning (Nhung et al., 2025).
c. Accessibility and relevance: Elementary schools were chosen as research locations because they have a variety of student learning styles (visual, auditory, kinaesthetic, reading/writing) that are suitable for the development of adaptive applications (Liu et al., 2021).

To calculate the expert validation scores for the application and guidebooks, the total obtained scores were converted into a percentage known as the Mean Interpretation Index (P), calculated using the following formula:

$$P = \frac{\sum X}{Y} \times 100\%$$

Where:

P = Final percentage of the interpretation index (%)
$\sum X$ = Total score awarded by the validators
Y = Maximum possible score based on the evaluation scale

Product draft validation is the process of assessing whether the product draft being developed aligns with existing theoretical requirements. This validation is rational and therefore not based on actual facts. Interpretation of the assessment categories is classified using the scale in Table 1.

Table 1. Product draft validation assessment categories

Percentage	Category
0% - 20%	Very inadequate
21% - 40%	Unadequate
41% - 60%	Fairly adequate
61% - 80%	Adequate
81% - 100%	Very adequate

3. Research Findings

Media Product Validation

This study designed learning media based on the adaptive inquiry model to support the learning process with the goal of improving students' critical thinking skills. The following are some of the features provided by the media product:

a. Accessible by anyone, from anywhere, at any time, as long as the user is connected to the internet and the media application is connected to the hosting.
b. Determining learning style preferences, including visual, auditory, reading/writing, and kinaesthetic.
c. Displaying user registration data and a diagram of the results of each user's identification.
d. Presenting test questions, both initial and final, in essay and multiple-choice formats.
e. Providing a question bank that can be managed (edited and configured) by the teacher administrator, with the number of questions to be used by student users.
f. Preparing and presenting online learning materials using a four-learning model tailored to the learning style preferences of each student.

g. Providing learning materials in the form of text, audio, video, and simulations.
h. Displays initial and final test results reports.
i. Provides a printed report of the overall final learning outcomes.

Following the development and validation stages, the learning application designed through the Adaptive Inquiry Approach produced a display. The results of the learning media application are shown in Figure 1 below.

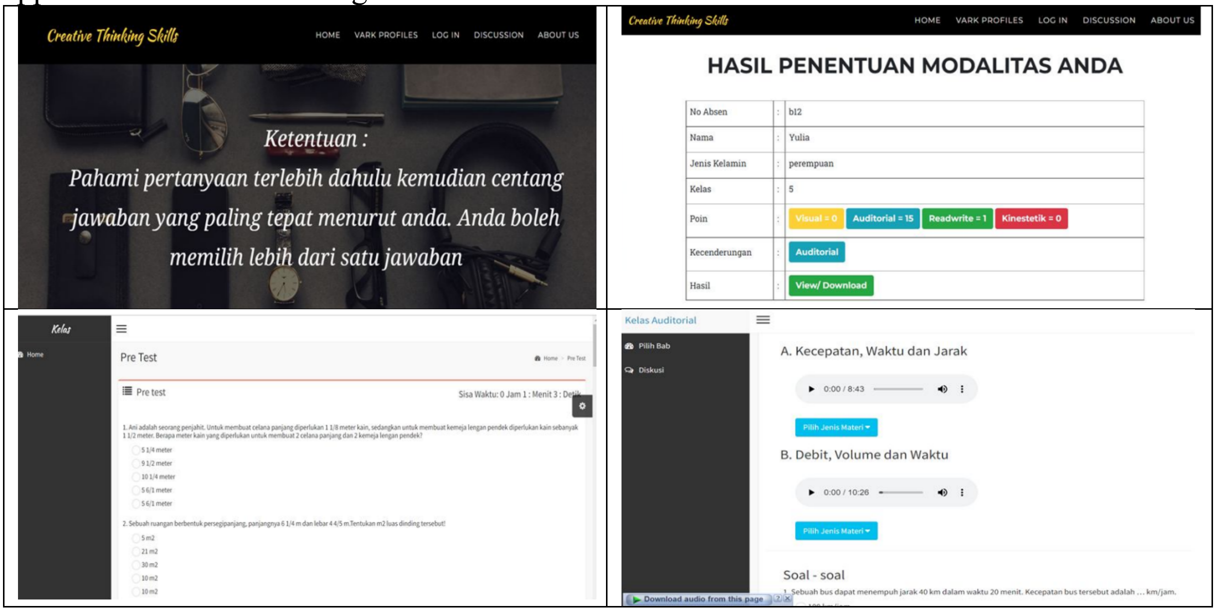

Figure 1. Display of the results of the learning application product

Based on the application's display, it appears that the learning media application has a home page containing operating instructions for determining learning styles. When accessing the learning style determination menu, students are presented with 16 questions to answer based on their personality or character tendencies. The top right image will appear after the application identifies a specific learning style. Students will then be taken to the classroom, preceded by an initial test. The learning process is fully tailored to the learning style identified by the learning media application: visual, auditory, read/write, or kinesthetic.

During the application development process, a feasibility test is also conducted to assess user acceptance of the application being developed and designed. The product draft, consisting of the learning application media and model guide, is then validated by experts. The experts who validated the media application are a number of experts, with the division of validation areas shown in Table 2 below and a summary of expert validation of the learning concepts is shown in Table 3 below.

Table 2. List of validation fields in the application

No	Validation Fields	Number of Validators
1	Learning model concept	2 Validators
2	Learning technology	2 Validators
3	Application design and graphics	2 Validators
4	Determining learning style preferences	2 Validators
5	Model guidelines	2 Validators
6	Implementation of the adaptive inquiry learning concept	2 Validators

Table 3. List of validation fields in the application

No	Aspect	Interpretation Index (%)

1	Syntax	87.50
2	Social system	87.50
3	Reaction principle	75.50
4	Support system	75.50
5	Learning impact	87.50
	Mean Interpretation Index	82.50

The expert validation results yielded an average interpretation score of 82.50%, indicating that the learning model concept is highly feasible. The syntax model assessed has clear, systematic, and logical stages, and can be used to measure critical thinking skills. Students assessed were able to formulate answers in their own words, enthusiastically ask questions, and actively participate in debates when applying the model. The model assessed provides opportunities for students to be proactive, responsive, innovative, communicative, and respectful. The model is complemented by learning tools in the form of modules and worksheets, which were deemed satisfactory by the experts. Students, targeted by the implementation model, were able to understand the material, work cooperatively, and develop critical thinking skills as an instructional impact of the implementation model. The experts assessed that this learning model can have a complementary impact, namely accustoming students to active problem-solving and fostering effective communication between students, ultimately fostering critical thinking. The experts' recommendations included a slightly more detailed support system. A summary of the expert or learning technology expert validation of the learning application can be seen in Table 4 below.

Table 4. Summary of validation results by learning technology experts

No	Aspect	Number of Indicator	Interpretation Index (%)
1	Teaching Materials	4 indicators	81.25
2	Learning Process	3 indicators	91.67
3	Assessment	4 indicators	81.25
4	Activities Supporting Learning	3 indicators	91.67
5	Materials to Improve Student Competence	5 indicators	85.00
6	Critical Thinking Aspects	6 indicators	87.50
	Average Interpretation Index		86.00

Table 4 provides information on the assessment results from two learning technology experts, with an average interpretation index of 86.00%. Based on the assessment scale, both learning technology experts deemed the developed learning application product draft very suitable for testing.

The suggestions and input provided by learning technology experts 1 and 2 can be summarized as follows: 1) In general, the material presented needs some improvement in terms of depth and breadth. 2) Regarding the assessment aspect, the material needs to be distributed more evenly; 3) The indicator descriptions need to be clarified, and the time allocation should be increased or adjusted. 4) The appropriateness of the questions to the problem aspects requires some clarification.

Table 5 provides information on the assessment results from two software application design and graphics experts, with an average interpretation index of 83.13%. Based on the assessment scale, both software application design and graphics experts deemed the developed learning application draft very suitable for testing. Suggestions for improvement from design and graphic experts include: 1) organizing text, images, and illustrations for easier comprehension and interpretation; 2) paying attention to white space in the content; 3) maintaining consistency in font and font size across each page from beginning to end; 4) making sentences more flexible in terms of language for ease of comprehension; 5) optimizing white space management in each display with appropriate content. A summary of the validation results from design and graphic experts for software applications is shown in Table 5 below.

Table 5. Summary of validation results by design and graphic experts for software applications

No	Aspect	Number of Indicator	Interpretation Index (%)
1	Organization	4 indicators	87.50
2	Attractiveness	2 indicators	87.5
3	Font Size and Shape	3 indicators	91.67
4	Space (white space)	1 indicator	100
5	Consistency	3 indicators	79.17
6	Presentation of Images/Videos/Text	5 indicators	92.50
7	Language	2 indicators	81.25
Average Interpretation Index			83.13

The following is a summary of the validation results by learning style preference experts. Table 6 provides information on the assessment results from two learning style experts, with an average interpretation index of 81.82%.

Table 6. Summary of validation results by learning style experts

No	Aspect	Number of Indicator	Interpretation Index (%)
1	Linguist	3 indicators	87.50
2	Sentence Accuracy	4 indicators	84.37
3	Perception	4 indicators	75.00
Average Interpretation Index			81.82

Based on the assessment scale category, it shows that both learning style experts assess the draft of the developed learning application as very suitable for testing. Some suggestions for improvement from the learning style experts are: 1) more appropriate word choice; 2) improvement of sentence writing according to the meaning and significance of the sentence; 3) improvement of writing so as not to cause double meaning; 4) in terms of learning style determination, it needs to be emphasized more; 5) broader perspective. After validation of the learning application that will be used in learning, the next step is to conduct a construct validation test to measure the suitability between the indicators and items that have been formulated according to the material and in accordance with the theory. Before conducting a construct analysis, an analysis is carried out on the level of difficulty, discriminatory power and reliability of the instrument to determine the rules that apply in the development instrument that is suitable for use in Mathematics learning in empowering the critical thinking skills of students participating in the lesson. The results of the discriminatory power analysis can be seen in Table 7.

Table 7. Results of the Analysis of the Discriminatory Power of Mathematics Questions (Pre-test)

Item	Biserial coefficient	Category
1	0.350	Good
2	0.300	Good
3	0.330	Good
4	0.340	Good
5	0.430	Good
6	0.350	Good
7	0.420	Good

Item	Biserial coefficient	Category
8	0.420	Good
9	0.310	Good
10	0.430	Good

In the Mathematics questions (pre-test questions), the discriminatory power of the items was categorized as good, namely that if D ≥ 0.3, the items are considered to have good discriminatory power (Cahyaningsih et al., 2024). Furthermore, in the mathematics questions for the post-test, the discriminatory power of the items was also measured. The results of the analysis can be seen in Table 8. In the Mathematics questions (post-test questions), the discriminatory power of the items was categorized as good, namely that if D ≥ 0.3, the items are considered to have good discriminatory power.

Table 8. Results of the Analysis of the Discriminatory Power of Mathematics Questions (Post-test)

Item	Biserial Coefficient	Category
1	0.300	Good
2	0.300	Good
3	0.340	Good
4	0.360	Good
5	0.300	Good
6	0.300	Good
7	0.340	Good
8	0.320	Good
9	0.300	Good
10	0.350	Good

To ensure the suitability of this instrument for use, an analysis of the difficulty level of each item was conducted. The results of the difficulty analysis for the pre-test items in Mathematics are shown in Table 9.

Table 9. Results of the Difficulty Analysis for Mathematics Items (Pre-test Items)

Item	Biserial Coefficient	Category
1	0.565	Good
2	0.440	Good
3	0.525	Good
4	0.570	Good
5	0.475	Good
6	0.505	Good
7	0.530	Good
8	0.530	Good
9	0.585	Good
10	0.535	Good

Table 9 shows that the scores for all items range from 0.3 to 0.7. This indicates that all items fall within the criteria for a good level of difficulty. This aligns which states that a good difficulty level for descriptive items is $0.3 \leq P \leq 0.7$ (Cahyaningsih et al., 2024). The analysis of the difficulty level for the post-test items in Mathematics is then continued, as shown in Table 10.

Table 10. Results of the Difficulty Analysis for Mathematics Items (Post-test Items)

Item	Biserial coefficient	Category
1	0.700	Good
2	0.690	Good
3	0.690	Good

Item	Biserial coefficient	Category
4	0.700	Good
5	0.700	Good
6	0.690	Good
7	0.700	Good
8	0.700	Good
9	0.680	Good
10	0.695	Good

Table 10 shows that the scores for all items fall within the criteria for a good level of difficulty. The summary of the validation results for the learning model's feasibility is presented in Table 4.10 below. Table 11 provides information on the assessment results from two experts, with an average interpretation index of 81.82%. Based on the assessment scale categories, both learning style experts rated the developed draft learning application as highly feasible for pilot testing.

Table 11. Learning Feasibility Validation Results

No	Learning Stage	Number of Indicator item	Interpretation Index (%)
1	Ask a question	2	87.50
2	Formulate an answer	2	75.00
3	Apply the case study	3	81.25
4	Motivate questions	1	75.00
5	Enable debate	2	87.50
6	Provide	1	75.00
	Average Interpretation Index		81.82

Some suggestions for improvement from the validators include: 1) shorter and more open-ended questions; 2) simpler case studies; 3) improved methods for motivating students to ask questions; 4) improvements to the PUEBI (Information and Training for Mathematics). For the development of the selected Mathematics material, a learning guide module was subsequently developed containing core material, instructions for use and implementation. The learning model guidebook was validated by Mathematics material experts before being used in the learning process. The validation results can be seen in Table 12.

Table 12. Results of Expert Validation for Model Guide Material

No	Learning Stage	Number of Indicator item	Interpretation Index (%)
1	Completeness of Material	2	87.50
2	Accuracy of Material	1	75.00
3	Up-to-date Material	1	75.00
4	Material develops thinking skills	2	93.75
5	Material follows a scientific system	2	81.25
6	Basic concepts of material	1	87.50
7	Sub-topic concepts	1	87.50
8	Image concepts	1	75.00
9	Material delivery techniques	1	87.50
10	Material can empower critical thinking skills	1	87.50
11	Relevance to everyday life	1	87.50
	Average Interpretation Index		84.82

The expert validation results for the learning model guidebook material obtained a score of 84.82%, indicating it is highly feasible/relevant and therefore suitable for use in Mathematics teaching. Suggestions from the experts included: 1) more straightforward sentence writing; 2) more systematic presentation; 3) better alignment of images with concepts.

After being deemed highly suitable for use in learning, the next step was to validate the learning model guidebook with a linguist to assess its suitability for proper and correct use of Indonesian. The results of the linguist validation are shown in Table 13.

Table 13. Results of the linguist validation of the model guidebook

No	Aspect	Number of Indicator	Interpretation Index (%)
1	Good and correct Indonesian Language	2	87.50
2	Application presentation	1	75.00
3	Language clarity	1	75.00
4	Language appropriateness	2	87.50
Average Interpretation Index			83.33

The validation results for the model guidebook by language experts obtained a score of 83.33%, indicating it is very relevant/good, and therefore suitable for use in Mathematics teaching. Recommendations from the language expert validator were: 1) simplify the language for ease of understanding; 2) avoid ambiguous sentences and make them more standard. After the model guidebook was deemed very suitable for use in teaching, the next step was to validate the teacher's guidebook with a graphic design expert to determine its appeal and suitability for the images to the material. The results of the graphic design expert validation for the teacher's guidebook are shown in Table 14. The expert validation results for the graphic design of the mathematics teacher's guidebook obtained a score of 81.44%, indicating it is very suitable/good, and therefore suitable for use in Mathematics teaching. Comments were given that the module book met the standards for composition and its appearance was quite good.

Table 14. Results of the graphic design expert validation for the teacher's guidebook

No	Aspect	Number of Indicator	Interpretation Index (%)
1	Module Physical Size	2	87.50
2	Module Cover Layout	4	87.50
3	Module Typography	4	81.25
4	Module Illustrations	2	81.25
5	Module Content Layout	9	79.17
6	Module Content Typography	8	69.69
7	Module Content Illustrations	4	81.25
Average Interpretation Index			81.44

After the graphic validation of the teacher's guidebook, the next step was to validate the teacher's guidebook. A summary of the validation results is shown in Table 15.

Table 15. Teacher's Guide Validation Results

No	Aspect	Number of Indicator	Interpretation Index (%)
1	Module Content	3	83.33
2	Material	4	81.25
3	Evaluation	4	81.25
4	Presentation	7	82.14
5	Language/Readability	5	77.50
6	Module Display	1	87.50
Average Interpretation Index			82.16

The teacher's guide validation result obtained a score of 82.16%, indicating it is very suitable/good, and therefore suitable for use in the mathematics learning module. Comments from the validators included: 1) the language used has been simplified to make it easier for students to understand; 2) the font size has been adjusted.

The results of the learning application validation test indicated that the learning application is generally suitable and good, according to learning technology experts, design and graphics experts, learning style experts, and language experts. Therefore, the developed product has the validity to be tested in Mathematics learning, but with several revisions.

The revision of the application's media design will refer to the suggestions and recommendations from the experts. Several aspects of the content need to be improved as suggested, including the addition of adequate and engaging illustrations, the presentation of video material to avoid boredom or monotony, and several sections of the application pages will be made more attractive with attractive colour schemes. Improvements to the use of spelling, use of capital letters, word order and punctuation also need to be considered for revision.

The development of the learning application based on the Adaptive Inquiry Approach yielded high feasibility scores across all expert validation domains, with an overall average exceeding 80% (Tables 3 through 6, and Tables 11 through 15). These metrics transition the product from a theoretical prototype to a valid educational instrument ready for field deployment. The high conceptual score from model experts (82.50%) specifically confirms that the application successfully translates the complex syntax of inquiry into a structured, functional digital environment. Rather than serving as a static repository of information, the media functions as an active scaffolding mechanism that prompts students to investigate, question, and engage in cognitive debates.

These validation findings strongly align with recent advancements in personalized educational technology. Previous implementations of inquiry models, such as the Inquiry-Based Science Education (IBSE) frameworks noted by Hasibuan et al. (2025) and Bhuttah et al. (2024), demonstrated substantial success in traditional brick-and-mortar settings but faced significant limitations when migrated to uniform digital platforms. By embedding an adaptive layout that responds to individual needs, this application addresses the critical limitations identified by Narimo et al. (2025), where uniform digital delivery failed to optimize diverse student capacities. Furthermore, the inclusion of an automated prompting framework closely mirrors the work of Tang (2024), which verified that real-time digital scaffolding significantly heightens curiosity and deeper text engagement in young learners.

Despite the strong validation and psychometric results, this study possesses distinct limitations that must be acknowledged to guide future scientific inquiry. The primary boundary lies in its developmental scope: this research was strictly limited to design, multidisciplinary expert validation, and initial empirical testing of the instrument's psychometric characteristics. Consequently, no long-term causal field experimentation was conducted to empirically measure the longitudinal growth of students' critical thinking skills under the influence of this software. Additionally, the subject trial was confined to a single institutional environment (Muhammadiyah Bantaeng Elementary School) with a sample size of 30 upper-grade students.

Therefore, future research trajectories should focus on moving this validated framework into large-scale, multi-site experimental testing. Researchers are encouraged to deploy this verified application within a randomized cluster controlled trial (RCT) over a full academic semester. Such longitudinal studies will provide the empirical data necessary to track actual cognitive gains, map the precise velocity of critical thinking development across varied demographics, and evaluate the long-term sustainability of adaptive inquiry software in standard elementary school systems.

4. Conclusion

This research successfully developed and validated a learning application based on the Adaptive Inquiry Approach to strengthen students' critical thinking skills in the Society 5.0 era. This application integrates an inquiry learning model with an adaptive system tailored to students' learning styles (visual, auditory, reading/writing, and kinesthetic), making it more responsive to individual needs. Validation results from various experts namely covering learning models, technology, graphic design, learning styles, linguistics, and teaching materials, showed an average score above 80%, placing the product in the "very feasible" category. The pre- and post-learning test instruments were also proven to have good discriminatory power and difficulty levels, making them reliable for measuring critical thinking skills.

Overall, this application not only provides materials in the form of text, audio, video, and simulations but also encourages students to actively ask questions, debate, and solve problems. The resulting instructional impact is an increase in students' analytical, evaluative, and creative abilities. Thus, the combination of inquiry and an adaptive system proves to be a promising innovation for revitalizing students' critical thinking skills.

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