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Development of HTML5-Based Mobile Learning Media to Enhance Critical Thinking Skills of Elementary School Students in IPAS Learning

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Abstract: This study aims to examine the validity, practicality, and effectiveness of HTML5-based mobile learning media to enhance the critical thinking skills of elementary school students in science learning (IPAS). The research method used was Research and Development (R&D) with the ADDIE model (analysis, design, development, implementation, evaluation). The study subjects were fourth-grade elementary students from two schools, SDN Yosowilangun Kidul 01 and SDN Yosowilangun Kidul 03 in Lumajang Regency. Data collection techniques included questionnaires, expert validation instruments, practicality instruments, and pretest-posttest data. Data analysis was conducted using a descriptive quantitative approach, focusing on student needs and the validity, practicality, and effectiveness of HTML5-based mobile learning media. The results showed that the HTML5-based mobile learning media had an average validity score of 88.9%, categorized as "highly valid." The practicality test, based on teacher observation and student response questionnaires, yielded an average percentage of 91.50%, categorized as "very practical," indicating that the media is suitable for use in the learning process. In the effectiveness test, the analysis of critical thinking data resulted in an N-gain score of 0.754, categorized as "high," demonstrating that the use of HTML5-based mobile learning media can significantly improve students' critical thinking skills in elementary science learning. In conclusion, the use of HTML5-based mobile learning media in science learning is valid, feasible, and highly effective for improving students' learning outcomes and critical thinking skills at the elementary level.

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Introduction

Education is crucial in society and the nation (Rahmawati, 2013). To improve the quality of human resources and determine the success of national development, a strong foundation in education is essential. According to Article 3 of Law No. 20 of 2003, the goal of national education is to develop the potential of students to become individuals who are faithful and pious to God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens. Enhancing the quality of education and shaping individuals who can compete globally is a response to the challenges of 21st-century learning (Wijaya et al., 2016). The content of 21st-century learning demands that students acquire four essential skills: communication, critical thinking, creativity, and collaboration (Septikasari, 2018).

Critical Thinking, according to Anasia et al. (2020), is an individual cognitive skill that involves detailed analysis of problems, careful understanding of issues, and the ability to identify and process information effectively to develop problem-solving strategies as part of the proposed solutions. Critical thinking is employed in the problem-solving process, making

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it essential for decision-making. It is a component of higher-order thinking, which plays a crucial role in the learning process, particularly in science education. Science education is used to explain, analyze, utilize, and predict natural phenomena, as well as to advance other disciplines and scientific technologies (Sari et al., 2022). To enhance critical thinking skills, it is essential to use media that supports the science learning process. According to Setyadi and Qohar (2017), effective learning media is engaging and can increase students' motivation and interest in learning, ultimately helping them successfully understand the material presented. The learning media created by teachers should align with developments in information and communication technology (Wahid, 2018). Technology has a significant positive impact on facilitating the teaching and learning process (Rahmad et al., 2018). One application of technology in science education is using HTML5-based mobile learning media.

Mobile Learning Media is an educational approach that involves mobile devices such as cell phones, PDAs, laptops, and tablets, allowing students to access learning materials without being restricted by space and time, wherever and whenever they are. This increases attention to the learning content, makes learning pervasive, and can encourage learners' motivation toward lifelong learning (Hernawan, 2017). According to Pratami (2013), HTML5 is a technology that enables the development of web-based applications that can be accessed on any device through a browser, including PCs, smartphones, and tablet PCs. Using HTML5-based mobile learning media in the learning process is expected to train and develop critical thinking skills, improving students' learning outcomes.

Based on the analysis of the scores of 27 fourth-grade students at SD Negeri Yosowilangun Kidul 01 Lumajang in the IPAS subject, 66% of the students scored below the Minimum Passing Criteria (KKTP), while 34% met the criteria. Observations revealed that some students were less active in the learning process due to boredom with using unengaging media. Interviews with teachers showed that most still rely on printed materials, such as worksheets (LKS) and student books, with minimal use of digital media, making the learning process less engaging. Ideally, teachers should be innovative in creating an attractive and enjoyable learning environment. Therefore, interactive learning media that aligns with 21st-century developments is needed, as well as practical media that can be used anywhere and help improve learning outcomes and critical thinking skills, such as the use of HTML5-based mobile learning media.

The development of mobile learning media has been carried out by previous researchers in various subjects. For example, research by Agustin & Wintarti (2021) resulted in an Android-based mobile learning application on the topic of Number Patterns. Based on user feedback, the use of mobile learning showed a "very good" category with a percentage of 92.75%. Another study by Astuti et al. (2017) developed Android-based mobile learning media for physics education. The validation assessment received an average percentage of 85.25%, falling into the "valid" category. Additionally, Widiastika et al. (2020) developed an Android-based mobile learning media for the concept of the circulatory system in elementary schools, with students' responses averaging 83.8% in the "very good" category.

The results of the needs analysis conducted through a questionnaire distributed to fourth-grade students at SDN Yosowilangun Kidul 01 showed that 86% of the students felt the need for HTML5-based mobile learning media in IPAS lessons. This media is intended to create an interactive, effective, and practical learning environment that can be used anytime and anywhere, helping students achieve the competencies set by their teachers. With the assistance of HTML5-based mobile learning media, it is hoped that students' critical thinking skills will improve.

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The development of mobile learning media has been carried out by researchers, including Widiastika et al. (2020), with the title "Development of Android-Based Mobile Learning Media on the Concept of the Circulatory System in Elementary Schools." However, that media could only be accessed on Android smartphones. Based on the analysis of that media, the researcher innovated by developing HTML5-based mobile learning media, which can be accessed on laptops and, through the APK build pro, can also be used on Android devices without requiring an internet connection. This allows students to learn anytime and anywhere without being limited by time or internet access. Another innovation is that the media can also be accessed via a website. Beyond the hardware and software aspects, the researcher made the learning content within the media more interactive, incorporating interactive worksheets (LKPD) and various educational games, making the media more engaging and enjoyable. Based on these issues, a research gap was identified in the development of HTML5-based mobile learning media for enhancing critical thinking skills in IPAS subjects at the elementary school level, which has not been widely explored. Therefore, this study aims to test the validity, practicality, and effectiveness of HTML5-based mobile learning media in improving elementary school students' critical thinking skills in IPAS learning.

Research Method

The research method used in this study was Research and Development (R&D) (Siyoto, 2015) with the ADDIE model (analysis, design, development, implementation, evaluation) (Cahyadi, 2019). The research subjects were students from SD Negeri Yosowilangun Kidul 01 and SD Negeri Yosowilangun Kidul 03 in Lumajang Regency. The purposive sampling area method was used to determine the research location, which, according to Sugiyono (2019), was a sampling technique based on specific considerations. The study was conducted in the 2023/2024 academic year with fourth-grade students. The sample consisted of 10 students for the small group trial and 23 students for the large group trial, and dissemination was carried out with 23 students from SD Negeri Yosowilangun Kidul 01 and 16 students from SD Negeri Yosowilangun Kidul 03. Data collection techniques involved the use of questionnaires, validation instruments, practicality instruments, and effectiveness data obtained through pretest and posttest results.

The data analysis technique in this study used a quantitative descriptive approach, which involved mathematical calculations, measurements, and hypothesis testing (Jayusman et al., 2020). The data analyzed include the validity, practicality, and effectiveness of HTML5-based mobile learning media for elementary school students in IPAS learning. The validity analysis was derived from the average validity score, which is adapted from Ridha (2021).

Table 1. Criteria for Product Validity

No.	Level of Achievement.	Interpretation	Description
1	80,1%-100%	Very Valid	Can be used without revision
2	70,1%-80%	Valid	Can be used, but with minor revisions
3	60,1%-70%	Fairly Valid	Can be used, but with major revisions
4	50,1%-60%	Less Valid	Not recommended for use due to major revisions
5	1-50%	Not Valid	Should not be used

(Ridha, 2021)

Furthermore, the analysis of the practicality of the learning media is based on observations of

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the implementation of the learning process and student responses while using the learning media, using percentage criteria adapted from Ridha (2021).

Table 2. Criteria for Practicality

No.	Level of Achievement	Interpretation
1	80,1%-100%	Very Practical
2	70,1%-80%	Practical
3	60,1%-70%	Fairly Practical
4	50,1%-60%	Less Practical
5	1-50%	Not Practical

(Ridha, 2021)

The analysis of the effectiveness of the media is obtained from the results of the pretest and posttest analyses of critical thinking skills, using criteria established by Hake (2007).

Table 3. Criteria for Effectiveness of Critical Thinking N-gain Achievement

No.	Level of Achievement	Interpretation
1	0,7<g<1	Hight
2	$0,3 \leq g \leq 0,7$	Medium
3	0<g<0,3	Low

(Hake, 2007)

Results and Discussion

HTML5-based mobile learning media is a developed product that includes elements of learning achievement (CP), learning objectives (TP), student worksheets (LKPD), content (material), educational games, and post-tests. The learning achievement (CP) section contains content aligned with the Ministry of Education and Culture Regulation 2023. The learning objectives (TP) section outlines the competencies that students must achieve based on their learning achievements (Nafiah, 2020). The student worksheets (LKPD) section includes the activities that students will engage in during the learning process. The content section provides material on forces, which will serve as a reference for students while completing the LKPD. The educational games section contains formative assessments designed to test students' understanding during the learning process, with each educational game featuring five multiple-choice questions.

Based on the results of the needs analysis from the student questionnaire, data showed that an average of 90% of students expressed a need for interactive digital media, while 10% felt they did not need it. This analysis of student needs was then used as the basis for the researcher to create a product in the form of HTML5-based mobile learning media aimed at enhancing critical thinking skills among elementary school students. This media can be accessed independently at school or home and includes various interactive activities that can be viewed and packaged in a digital format.

The development process using the ADDIE model begins with the analysis phase, where data from the needs questionnaire revealed that 90% of students expressed a need for media, while 10% felt they did not need it. Next, the design phase involved planning the product to ensure that the developed product is valid, practical, and effective. The resulting product was designed using a combination of PowerPoint, along with Canva and iSpring Suite version 10, which produces interactive HTML5-based mobile learning media that can be operated on a laptop. This is further enhanced with the help of the Builder Pro application, allowing access on Android devices as well as through a website.

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Figure 1. HTML5-Based Mobile Learning Media on Android Phones

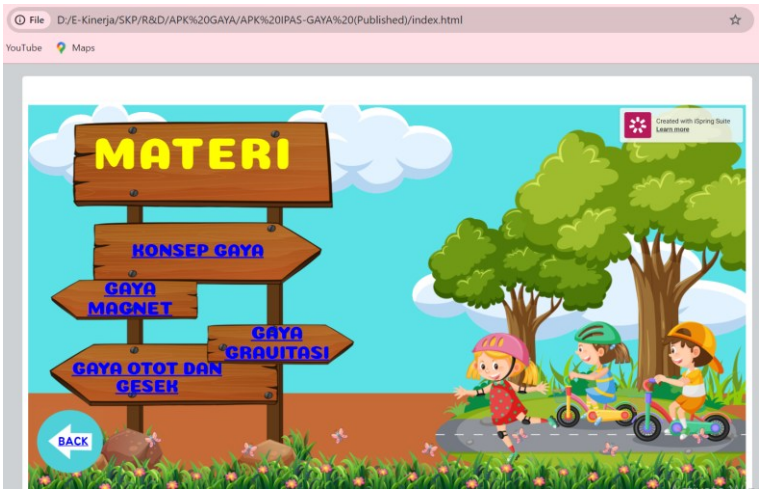

Figure 2. HTML5-Based Mobile Learning Media on PC and Website

At the development stage, the media validation was conducted by two expert validators (one in media and one in content) and one practitioner validator. The results of the validation for the HTML5-based mobile learning media indicated the following scores: Validator 1 achieved a validation score of 94.7%, Validator 2 received a score of 85.7%, and Validator 3 scored 86.3%. The average validation score for the HTML5-based mobile learning media was 88.9%, categorizing it as "very valid" and suitable for testing. The data can be seen in Table 4.

Table 4. Validator Assessment Results

No.	Assessment Aspects	Validator Assessment (%)			Aspect Percentage (%)	Criteria
		VI	V2	V3		
1.	Content	94,3	82,3	88,6	88,4	Very valid
2.	Construction	95,0	89,0	84,0	89,3	Very valid
	Average	94,7	85,7	86,3	88,85	Very valid

At the development stage, the media validation was conducted by two expert validators (one in media and one in content) and one practitioner validator. The results of the validation for the HTML5-based mobile learning media indicated the following scores: Validator 1 achieved a validation score of 94.7%, Validator 2 received a score of 85.7%, and Validator 3 scored 86.3%. The average validation score for the HTML5-based mobile learning media was 88.9%, categorizing it as "very valid" and suitable for testing. The data can be seen in Table 4.

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The evaluation phase involved testing the practicality of the HTML5-based mobile learning media in the IPAS learning process. Data on the practicality were obtained from observations recorded by teachers and student responses. During the dissemination stage, the observation of the implementation resulted in an average total score of 86%, categorizing the media as "very practical." The detailed results can be found in Table 5.

Table 5. Results of Implementation Dissemination

Meeting number-	Average (%)		Total (%)	Criteria
	SDN Yoskid 01	SDN Yoskid 03		
1	84,0	81,0	83,0	Very Practical
2	88,0	90,0	89,0	Very Practical
Average (%)			86,0	Very Practical

The analysis of the student response instrument yielded an average total percentage of 89%, categorizing the media as "very practical." This result indicates that students found the HTML5-based mobile learning media effective and engaging for their learning process. The detailed results are presented in Table 6.

Table 6. Results of Student Responses on Dissemination

No.	Assessment Aspects	Average (%)		Average (%)	Criteria
		SDN Yoso Kidul 01	SDN Yoso Kidul 03		
1.	Attractiveness of the Media	89,0	82,0	86,0	Very Practical
2.	Relevance of the Media	90,0	91,0	91,0	Very Practical
3.	Practicality and Ease of the Media	94,0	92,0	93,0	Very Practical
4.	Influence of the Media	84,0	80,0	82,0	Very Practical
Average (%)		90,0	87,0	89,0	Very Practical

The results of the improvement in critical thinking skills were obtained from the pretest and posttest scores. The data regarding the N-gain is presented in Table 7. This table illustrates the effectiveness of the HTML5-based mobile learning media in enhancing students' critical thinking abilities.

Table 7. Results of N-gain in Critical Thinking Skills Dissemination

Indicators of Critical Thinking Skills	Average Score				Total Average per Indicator	
	SDN Yoso Kidul 01		SDN Yoso Kidul 03			
	N-Gain	Category	N-Gain	Category	N-Gain	Category
Elementary clarification	0,84	High	0,72	High	0,78	High
Basic support	0,74	High	0,75	High	0,745	High
Inference	0,93	High	0,81	High	0,87	High
Advance clarification	0,77	High	0,63	Medium	0,70	High
Strategies and tactics	0,75	High	0,60	Medium	0,675	Medium
Average	0,81	High	0,70	High	0,754	High

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Based on the data in Table 4, shows that the average N-gain score for critical thinking skills indicators in this study utilized five assessment indicators from Ennis (1991), which are aspects of critical thinking skills: elementary clarification, basic support, inference, advanced clarification, and strategies and tactics. The N-gain scores for each indicator are as follows: elementary clarification with a score of 0.78, categorized as high; basic support with a score of 0.745, categorized as high; inference with a score of 0.87, categorized as high; advanced clarification with a score of 0.70, categorized as high; and strategies and tactics with a score of 0.675, categorized as moderate. The average score obtained for all indicators is 0.754, categorized as high. This indicates an improvement in critical thinking skills across each indicator at the two disseminating schools.

This research implies that in IPAS (Integrated Science) learning at the elementary school level, teachers provide learning media to guide students in understanding science concepts. This is essential, as students at the elementary level are still transitioning their thinking from concrete to abstract (Tsai, 2022). In the implementation of learning, mobile learning media can be utilized as resources that can be accessed anywhere. This advantage greatly facilitates students in accessing learning media at any time. This condition can assist teachers in creating a flexible learning environment (Yoyo, 2021).

Discussion

Validity of HTML5-Based Mobile Learning Media

The quality of a product is considered valid when its relevance to the objectives of the product development is thoroughly considered (Nieveen, 2009). During the validation process, several revisions were made to various aspects of the mobile learning media based on critiques and suggestions from validators (Ahyar, 2021). Some revisions made to the mobile learning media included changes in Prototype I regarding the use of digital student worksheets utilizing live worksheets, and revisions in Prototype II concerning accessibility, allowing the media to be accessed not only through an application but also via a website. After the revisions were made, the validation results from two expert validators/lecturers and learning practitioners/teachers showed that Prototype II achieved an average score of 91.4% for content aspects and 91.0% for construct aspects, categorized as very valid.

In the validity test of HTML5-based mobile learning media, supporting devices were also validated, such as teaching modules using the Problem-Based Learning model (Octavia, 2020). The validity of the teaching module, based on several aspects, yielded an average validation result of 92.1%, categorized as very valid (Devi, 2023). Additionally, the validity of the learning outcomes test instrument showed an average percentage of 88.8%, categorized as very valid, and the critical thinking test instrument had an average percentage of 93.3%, also categorized as very valid. Based on these findings, HTML5-based mobile learning media in IPAS learning development is considered suitable for implementation in the learning process (Hutahaean, 2020).

Practicability of HTML5-Based Mobile Learning Media

Practicality, according to Akker (1999), refers to the extent to which users find the intervention engaging and can use it under normal conditions. The practicality of HTML5-based mobile learning media in IPAS learning was obtained from the results of filling out the observation questionnaire on the implementation of learning and the student response questionnaire. The practicality test was conducted by analyzing the results of the learning implementation observation questionnaire filled out by teachers during the implementation of HTML5-based mobile learning media in IPAS learning (Bernacki, 2020). The analysis was carried out in three stages: small-scale trials, large-scale trials, and dissemination, each

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conducted over two sessions. In the analysis of learning implementation during the small-scale trial, an average score of 76% was obtained, categorized as practical. In the large-scale trial, the average score was 81%, categorized as very practical, while in the dissemination activities, an average score of 86% was obtained, also categorized as very practical.

Furthermore, the analysis of student responses was conducted in three stages: the small-scale trial, the large-scale trial, and dissemination. In the analysis of student responses during the small-scale trial, with 10 respondents, an average percentage of 97% was obtained, categorized as very practical. In the large-scale trial, with 26 respondents, the average percentage result was 87%, also categorized as very practical. Meanwhile, in the dissemination activities at SDN Yosowilangun Kidul 01, with 23 respondents, and SDN Yosowilangun Kidul 03, with 10 respondents, an average percentage of 86% was obtained, categorized as very practical. Based on the analysis of the observation questionnaire regarding implementation and the student response questionnaire, which averaged in the very practical category, HTML5-based mobile learning media in IPAS learning is very practical for use in the learning process (Firdausi, 2020).

The Effectiveness of HTML5-Based Mobile Learning Media

Effectiveness, according to Akker (1999), refers to the extent to which users find the intervention engaging and can use it under normal conditions. The effectiveness of HTML5-based mobile learning media in IPAS learning was obtained from the results of the pretest and posttest on critical thinking skills (Zubaidah, 2010). The tests were conducted at two schools: SDN Yosowilangun Kidul 01 with 23 students and SDN Yosowilangun Kidul 03 with 16 students in Lumajang Regency. The effectiveness test of critical thinking skills data analysis was conducted on students at SDN Yosowilangun Kidul 01, with a total of 23 students, resulting in an average pretest percentage of 39.8% and an average posttest percentage of 88.3%. Meanwhile, the results of the critical thinking test for students at SDN Yosowilangun Kidul 03, with a total of 16 students, showed an average pretest percentage of 34.7% and an average posttest percentage of 80.6%. The average N-Gain scores based on the Ennis-Costa indicators (1991) are as follows: elementary clarification had an N-gain score of 0.70, categorized as high; basic support had an N-gain score of 0.745, categorized as high; inference had an N-gain score of 0.87, categorized as high; advance clarification had an N-gain score of 0.70, categorized as high; and strategies and tactics had an N-gain score of 0.675, categorized as moderate. The overall average N-gain score from these five indicators was 0.754, categorized as high.

From the analysis of the learning outcomes test data, an average N-gain score of 0.72 was obtained, categorized as high, and for critical thinking, an average N-gain score of 0.754 was also categorized as high. This indicates a significant improvement in both the learning outcomes test and critical thinking skills, thus categorizing HTML5-based mobile learning media as very effective for use in the IPAS learning process (Himmi, 2021).

Conclusion

The results of the validity of HTML5-based mobile learning media showed an average score of 88.9%, which is categorized as very valid and can be implemented with minor revisions from expert validators/lecturers in the IPAS (Integrated Science) learning process at the elementary school level. The practicality of the HTML5-based mobile learning media, based on observations of teacher implementation and student response questionnaires, achieved an average percentage of 91.50%, categorized as very practical. These analysis

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results meet the criteria stated as suitable for use as IPAS learning media at the elementary school level (Mirdad, 2020).

The effectiveness level of HTML5-based mobile learning media for enhancing students' critical thinking skills in IPAS (Integrated Science) learning at the elementary school level is examined. From the analysis of critical thinking skills data, an N-gain score of 0.754 was obtained, categorized as high. The analysis based on the N-gain score test results indicates that the use of HTML5-based mobile learning media can improve students' critical thinking skills in IPAS learning at the elementary school level (Hayati, 2021). It can be concluded that using HTML5-based mobile learning media in IPAS learning is very effective in enhancing learning outcomes and students' critical thinking skills.

Recommendation

Based on the analysis obtained, the recommendations made by the researcher are as follows: (1) For schools, the HTML5-based mobile learning media that have been developed can be used as an alternative learning media to support the process of science education (IPA). (2) For teachers, with the development of HTML5-based mobile learning media, the author hopes for innovation and renewal in the creation of media for other subjects that can enhance learning outcomes and students' critical thinking skills in IPAS subjects. (3) For other researchers, the HTML5-based mobile learning media application can serve as a reference for developing interactive learning media products with different learning outcomes, subject matter coverage, and subjects.

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