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Development of the Android-Based Educational Game Media "Perjalanan Si Maya" as a Formative Assessment to Improve Critical Thinking Skills and Interest in Learning Science for Elementary School Students

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ABSTRACT

Objective: This research aims to develop an android-based educational game media, "Perjalanan Si Maya," as a formative assessment to improve critical thinking skills and interest in learning elementary school students. **Method:** This research is a type of development research (R&D). The development method used in this research is ADDIE (Analyse, Design, Development, Implementation, and Evaluation). **Results:** The results showed that the development of an android-based educational game media, "Perjalanan Si Maya," as a formative assessment was declared valid based on acquiring the very valid category. The result of practicality is classified as very good (very practical). The result of effectiveness Based on N-Gain, the mean value of the control class obtained a mean value in the "less effective" category. In contrast, the experimental class obtained a mean value in the "moderately effective" category. The results of student learning interest have increased from before learning to after learning using educational game media "Perjalanan Si Maya. **Novelty:** Teachers can carry out formative assessments through educational games to train students' critical thinking skills and interest in learning to become more qualified, effective, and efficient.

INTRODUCTION

Education is an effort made by someone to gain knowledge through learning to create a competent and competitive young generation in the future. Education is seen as an effort carried out consciously to make improvements in all fields and aspects of life, which is also known as a process of humanizing humans that takes place in society from generation to generation (Dantes, 2014). Education can improve a person's living standard (Suprianingsih & Wulandari, 2020). Education is closely related to learning activities which are part of the interaction that occurs in two directions between the teacher and students to achieve the learning objectives set (Al-Tabany, 2014). The quality of education is very influential for the development and progress of a nation (Hidayah, 2022). Because basically, education is a process that helps humans to develop themselves in order to be able to deal with various kinds of changes and problems they face (Yang & Kwok, 2017).

Life in the 21st century has ushered the world into an era of technological needs. Technology affects various aspects of life, especially education in Indonesia. Education is demanded to increase capable, skilled, and insightful human resources to deal with all the problems around them (Vidergor & Gottlieb, 2015). The challenge of education today is to produce human beings who can compete in the 21st-century world (Julianto et al., 2023). The 21st Century Partnership Learning Framework states, "In the 21st century, Indonesia must-have resources that have several competencies, one of which is

the ability to think critically". The learning process must carry out activities that provide opportunities for students to train and hone their critical thinking skills. According to Glaser, critical thinking is an attitude to think deeply about problems and things within the range of one's experience, knowledge of logical examination and reasoning methods, and skills to apply these methods. While according to Rizki et al. (2023) and Saphira et al. (2022), critical thinking is a thinking process that originates from activities and abilities obtained by conceptualizing, applying, analyzing, synthesizing, and evaluating information from the results of observation, reflection, communication, and action.

Critical thinking is an intellectual process for finding, analyzing, and evaluating information obtained from observations and experiences, which will later be used to make judgments in taking action (Fitriani et al., 2020). Therefore critical thinking is used to help someone make decisions regarding things that are believed to be done logically based on facts that match the circumstances. Students must be able to analyze, synthesize and conclude information obtained using their critical thinking skills to sort out bad or suitable information and make decisions about the information they get through critical thinking. Students need to be trained and accustomed to critical thinking skills so that after graduation, they are ready to compete in a global society (Anggraeni & Suratno, 2021). Widodo (2022) states that critical thinking requires students to be more thorough, focused, and planned, focus on central issues, and evaluate all parts of complex and challenging claims and arguments. Therefore critical thinking skills are essential to pay attention to, but in reality, many teachers need help understanding how to convey them effectively (Supardi, 2018).

Learning activities can be carried out effectively if students are interested in learning. Therefore, the teacher must be a motivator who can arouse enthusiasm and encourage students to study more actively (Nafisah et al., 2021). In addition to intelligence, interest influences good achievement because, without interest, all activities carried out become less effective and efficient. According to Trismayanti (2019), interest is a psychological symptom shown by focusing attention because of feelings of pleasure towards an object. From this understanding, it is evident that interest is a concentration of attention and a reaction to an object that begins with feeling happy towards the object. To attract students' interest in learning, innovation from teachers is needed through the use of learning media that can support learning activities so that learning activities become active and fun (Magdalena et al., 2021).

Based on the results of interviews and observations conducted at Mojosari Elementary School, fourth-grade students have a low interest in learning due to the mindset that students have towards learning science which assumes that science is a complex subject, so students do not have an interest in studying it more deeply. Not only that, students have low critical thinking skills because the teacher's learning activities do not encourage students to carry out thinking activities to solve problems that are directly oriented to students, so students are not used to thinking deeply. When giving questions, the teacher does not use questions based on high-order thinking skills (HOTS) which support students to think critically. Suppose seen from the student learning outcomes of 23 students, 14 students who have not completed and nine students who have completed. Learning activities are only focused on the teacher; students sit quietly listening to the teacher's explanation so that it seems monotonous.

This is in line with the opinion (Mahmuzah, 2015) that the low ability of students' critical thinking is due to factors using conventional learning models, which make students less active and directly involved in learning. In connection with the formative assessment activities carried out by the teacher, only using sheets of paper as usual. Teachers have never used assessment techniques by the times with the characteristics of 21st-century learning. This is felt to be less attractive to students, which causes students not to be actively involved in learning activities, so they lack interest in learning. Teachers should be able to carry out learning and assessments that are relevant to the characteristics of 21st-century learning.

Several studies on formative assessment have been carried out by Lestari & Setyarsih (2020) that developed formative assessment instruments—development of a formative assessment based on scientific literacy on global warming. The results of this study indicate that the development of formative assessment instruments is feasible to be used to capture the scientific literacy and critical thinking skills of high school students. The research conducted by (Nur'aini et al., 2020) developed computer-based formative assessment media on Bernoulli law material. The results showed that computer-based formative assessment media was classified as very good and feasible.

With the development of technology, assessment techniques are also changing. One of the innovations in the assessment field is the application of assessment with educational games. Games with educational purposes are used as a means of educational media with learning patterns by doing (Novaliendry, 2013). By the pattern of the game, players are required to learn in order to be able to solve existing problems (Nurdiana et al., 2017). It can be concluded that educational games are a form of the game that is useful to support the learning process so that it is more fun and creative, which is used to provide teaching and add insight and knowledge to its users through exciting media. Educational games are made to invite students to use games wisely and appropriately so that students do not only use them for entertainment but use them as practical learning tools (Mariono et al., 2021). Educational games are very suitable as learning media for students, especially elementary school students who have the characteristics of happy learning while playing (Burhaein, 2017). Educational games packaged in the form of exciting and fun animated and audio visualizations will attract students' attention, especially for use in science subjects that require media to visualize abstract theories complex for students to understand (Azizatunnisa et al., 2022). This aligns with the opinion (Saurina, 2017) that the images and sounds in educational games make children not feel bored because children are quickly bored when subjects are packaged in written form.

Science learning contains natural knowledge that exists in students' daily lives so that students can recognize and recognize it (Meidawati, 2019). Learning science in elementary schools has an important aspect that teachers must pay attention to, namely actively involving students to develop their thinking skills so that they can be designed through actual activities (Panjaitan, 2017). One of the science learning materials in grade IV elementary school is a style in which real examples can be given in everyday life. The concept of style material can be easily found in students' lives through understanding and mastering the concept with the hope that it can be implemented in students' daily lives (Ruswandari & Yermiandhoko, 2021). Technology-based learning media can be used in style material in science learning because student learning styles have changed

due to technological developments (Annisa, 2018). Based on the results of research conducted by (Anggraini et al., 2016) stated that educational games can be used as exciting and fun learning media so that students can more easily understand the material being taught and that it can support the learning process. This is supported by research conducted (Vitianingsih, 2017). Educational games can be used as an alternative learning media teachers use to change conventional learning methods into game simulation learning methods to increase students' creativity because educational games have elements of challenge, accuracy, ethics, and reason.

The development of the educational game media "Perjalanan Si Maya" will add variety to students' learning experiences, so students will be more enthusiastic about learning about critical thinking styles and abilities, and students' interest in learning science can be further enhanced. At Mojosari Elementary School, they still need to make the most of the use of technology due to the limited competence of teachers in utilizing learning applications. Even though learning technology is a scientific discipline, study programs or professions will continue to experience rapid development over time. Judging from research conducted by (Wicaksono et al., 2022) using an educational game quiz media in the form of Kahoot! for formative assessment. The results of the study show that students using the Kahoot! Suitable for use because it can quickly provide effective feedback for students so that they can directly improve their understanding of the knowledge and information needed by students. Based on this explanation, a study was conducted entitled "Development of Android-Based Educational Game Media "Perjalanan Si Maya" as a Formative Assessment to Improve Critical Thinking Ability and Interest in Learning Science for Elementary School Students" to know (1) the validity of the developed media, (2) the practicality of the developed media, and (3) the effectiveness of the developed media.

RESEARCH METHOD

The type of research used is research and development. The purpose of this research method is to produce a particular product and also to test the effectiveness of the resulting product (Sugiyono, 2018). The ADDIE model developed by Branch (2009) was chosen as the development method in this study. The ADDIE model development stages are Analysis, Design, Development, Implementation, and Evaluation. The ADDIE research model is the most complete and rational compared to other research models, so that it can be used in all forms of product development in learning (Mulyatiningsih & Nuryanto, 2014).

Figure 1 is the research steps for the ADDIE development model in the research on developing an android-based educational game media, "Perjalanan Si Maya," as a formative assessment.

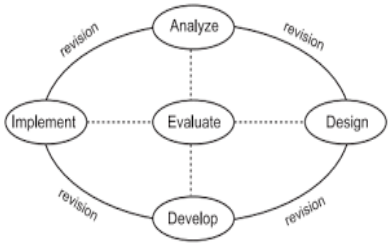

Figure 1. ADDIE Development (Branch, 2009)

Analysis Phase

At the analysis stage, the researcher conducted an initial investigation on two things: student analysis and material analysis. In the student analysis activities, the researcher made observations to know the difficulties experienced by students when learning science. From the results of observations made, it is known that the lack of students' critical thinking skills and the lack of student interest in learning science is due to a lack of innovative assessments used for formative assessment in science learning because they only use test sheets printed on paper so they feel less attractive. These problems form the basis for developing an android-based educational game, "Perjalanan Si Maya," as a formative assessment. At the same time, the material analysis aims to discover the difficulties in understanding what material students experience so that researchers can package and summarize the material more excitingly and efficiently for students to understand.

Design Phase

At this stage, the researcher carried out three stages: formulating learning objectives, preparing formative assessments, and designing educational game media. The first thing to do is to formulate learning objectives. Before making a plan for implementing the learning objectives, the researcher arranges the learning objectives to be achieved. Next is compiling formative assessment questions based on formulating learning objectives and predetermined material. These formative assessment questions will later be included in the educational game media that will be developed. The final step at the end of the design stage is to create a storyboard and flowchart. The purpose of making storyboards is to provide convenience when creating media products to be developed. In contrast, the flowchart is a flow of commands that aims to simplify the storyline in educational game media applications.

Development Phase

This stage is the realization of product development designs previously designed based on storyboards and flowcharts. So that from the pre-existing product design, it will be realized in the form of a prototype that will eventually produce an android-based educational game media, "Perjalanan Si Maya," which is packaged attractively and according to predetermined criteria. After the android-based educational game media "Perjalanan Si Maya," the next step is to carry out the validation stage by three validators to test the feasibility of the media before being implemented in learning activities.

Implementation Phase

At the implementation stage, a practicality test was carried out to determine the practicality and effectiveness of using the android-based educational game "Perjalanan Si Maya" as a formative assessment. This stage is the implementation stage of learning media made in the implementation class. The practicality test was conducted on students in fourth grades A and D at ES Mojosari 1.

Evaluation Phase

The last stage is to conduct an assessment or evaluation of the validation test stage that has been carried out. The evaluation stage aims to improve the assessment and input

provided by the validators. The subjects of this study were 15 grade IV students at ES Purwojati 2 for a limited trial. In contrast, this research was implemented on 23 class four A and 21 students of fourth class grade ES Mojosari. The research instruments used were tests and questionnaires. The data analysis technique used in this study measures educational game media's validity, practicality, and effectiveness. The following are the data analysis techniques used:

1. Data Analysis Techniques for Validity and Reliability

   The validity was carried out using the data processing program SPSS Statistics for Windows version 26 using the Pearson product-moment formula. Fundamental decision-making in the validity test, namely:

   If the value of $r_{count} > r_{table}$, then it is valid

   If the value of $r_{count} < r_{table}$, then it is invalid

   After knowing the validity of the instrument items, the next step is to calculate their reliability using the Cronbach alpha formula. Instrument reliability calculations used the SPSS Statistics data processing program for Windows version 26. The reliable calculation criteria used were 0.6, with the instrument calculation criteria declared good or reliable if the value of r > 0.60 but vice versa if the instrument was stated to be unfavorable or unreliable if the value r < 0.60. The reliability coefficient obtained will then be interpreted using the criteria in Table 1.

Table 1. Classification coefficient of reliability.

Reliability Coefficient (r)	Interpretation
0.00 ≤ r ≤ 0.20	Very Low
0.20 ≤ r ≤ 0.040	Low
0.40 ≤ r ≤ 0.60	Medium
0.60 ≤ r ≤ 0.80	High
0.80 ≤ r ≤ 1.00	very high

(Sundayana, 2016)

2. Media Validity Analysis Techniques

Table 2. Validation criteria.

Achievement Criteria	Category	Explicative
85.01% - 100.00%	Very valid	It can be used without revision
70.01 % - 85.00%	Quite valid	Usable with minor revisions
50.01% -70.00%	Less valid	Less Valid needs revisions
01.00% - 50.00%	Invalid	It cannot be used

(Akbar, 2013)

3. Practicality Analysis Techniques

   Analysis of data from observations of student activities using the formula:

$$p = \frac{F}{N} \times 100\ \%$$

Table 3. Achievement of student activities, student response criteria, and teacher response.

Score	Criteria
75.00% - 100.00%	Very good
50.00% - 74.99%	Good
25.00% - 49.99%	Enough
0.00% - 24.99%	Less

Analysis of teacher and student response questionnaires, as well as student learning interest questionnaires using the formula:

$$\text{Percentage} = \frac{\text{Overall score obtained}}{\text{Maximum Score}} \times 100\%$$

(3) Effectiveness Analysis Techniques
Data Analysis of Critical Thinking Skills Test Results
The test result data obtained were analyzed using N-Gain analysis, namely:

$$\text{N Gain} = \frac{\text{Score Posttest-Score Pretest}}{\text{Score Ideal- Score Pretest}}$$

Table 4. Gain score distribution.

N-Gain Score	Category
g > 0.70	High
0.30 ≤ g ≤ 0.70	Medium
g < 0.30	Low

Hake (Sundayana, 2016)

RESULTS AND DISCUSSION

Results

Validity

In the validation stage of the android-based educational game media, "Perjalanan Si Maya" as a formative assessment was validated by three validators. Two validators are lecturers, and one validator is the school principal. The purpose of game validation is to ensure that the media that has been developed is truly empirically feasible to be used as a learning medium based on the input or suggestions given by the validator before students in learning use the game media.

1. Educational Game Media "Perjalanan Si Maya" as a Formative Assessment
   Assessment of educational game media includes Display design, language, instructions, use of fonts, audio, and game characteristics. From the calculation, a total score of 92.00% is obtained with the achievement criteria of 85.01% to 100%, which is in the very valid category. The results of the reliability calculation obtained a score of 0.75 with a high category interpretation.
2. Critical Thinking Skills Test
   The test developed is in the form of questions to improve student's critical thinking skills. The developed test consisted of 10 questions with multiple choice questions. Assessment of critical thinking skills tests includes content, construction, language, and the benefits and uses of the test. From the validator's assessment, one obtained a total score of 95.40% with an achievement category of 85.01% to 100.00%, which is in the very valid category. The reliability value obtained is 0.646, with a high category interpretation. The second validator's assessment obtained a score of 90.00%, belonging to the achievement criteria of 85.01% to 100%, included in the very valid category. Reliability gets a score of 0.69 with a high category interpretation. The third validator's assessment scored 96.40%, belonging to the achievement criteria

85.01% to 100.00%, included in the very valid category. The reliability of the test obtained a score of 0.73 with a high category interpretation.

3. Study Interest Questionnaire

The student interest questionnaire instrument consists of two questionnaires: the questionnaire before learning and the questionnaire after learning using educational game media. Of the two questionnaires, 15 statements aimed to measure student interest in learning. The assessment of the interest in learning questionnaire instrument includes questionnaire appearance, convenience, language, writing, and questionnaire suitability. The assessment results of the student interest questionnaire instrument obtained a score of 92.10%, belonging to the achievement criteria 85.01% to 100.00% included in the very valid category. The results of the reliability calculation get a score of 0.72 with a high category interpretation.

Test the validity of the questions conducted by fourth-grade students in ES Purwojati 2 with a total sample of 15 students. The following are the results of the validity and reliability of the questions.

Table 5. Question validity.

Question Number	Pearson Correlation	Information
1	0.83	Valid
2	0.74	Valid
3	0.60	Valid
4	0.61	Valid
5	0.67	Valid
6	0.84	Valid
7	0.74	Valid
8	0.83	Valid
9	0.87	Valid
10	0.81	Valid

Table 5 shows the results of calculating the validity test of the questions; the results are obtained if the ten existing questions are declared valid. Based on the calculation of the reliability test of the questions, the results are obtained if the Cronbach Alpha value is 0.91 > 0.60; it can be concluded that the ten items tested are reliable.

Practicality

1. Student Activity

Observation of student activities begins at the beginning of learning, which begins with preparatory activities before learning, apperception activities delivered by the teacher accompanied by question and answer activities between the teacher and students, then the main activities of students observing and analyzing experimental activities related to force. Student observations were also made during group discussions, presentation of the results, and questions and answers on the results. This activity is the basis for implementing students' critical thinking skills. Table 6 is the result of student activity.

Table 6. Student activity.

Observed Activity	M1		M2	
	O1	O2	O1	O2
Prepare to learn	4	5	5	5
Answering questions from the teacher (apperception activity)	3	4	4	4
Listen to the video shows given by the teacher	4	4	5	5
Train students' critical thinking skills by analyzing events related to style	4	5	5	5
Gather information related to material and look for links with existing activities in daily life	3	4	5	5
Conduct discussion activities with groups	4	5	5	5
Presenting the results of the discussion	4	4	4	4
Listen to the information provided by the teacher	5	5	5	5
Observing and analyzing Educational Game media "Perjalanan Si Maya."	4	4	4	5
Reading learning material on Educational Game media "Perjalanan Si Maya."	4	4	5	5
Practicing critical thinking skills by answering formative assessment questions on the Educational Game "Perjalanan Si Maya."	4	5	5	5
Providing opinions about difficulties and things that are poorly understood when using the Educational Game "Perjalanan Si Maya" media	3	4	4	5
Listen to reinforcement and explanations of formative assessment questions given by the teacher	4	4	5	5
Summarize all learning materials and reflect on the activities carried out today	4	5	5	5
Pray together and listen to directions from the teacher for the next day's activities	5	5	5	5

Note: M1 (Meeting 1); M2 (Meeting 2); O1 (Observer 1) ; O2 (Observer 2)

From Table 6, student activities get 77% -100 % success. From the results of interviews conducted with teachers, information was obtained that the development of an android-based educational game media, "Perjalanan Si Maya," as a formative assessment is a new media for students and teachers, so it has a positive impact on students, namely making students more enthusiastic and enthusiastic when particStudent response questionnaires were given toating in learning.

2. Student Response

To find student response results after using android-based educational game media, "Perjalanan Si Maya" response questionnaires were given. Table 7 shows the results of the student response questionnaire.

Table 7. Student response.

Indicator	Percentage (%)
1. I feel interested in the appearance of the Android-Based Educational Game media "Perjalanan Si Maya."	100.00

Indicator	Percentage (%)
2. I easily understand the instructions for playing on Android-Based Educational Game media "Perjalanan Si Maya."	95.60
3. I find it easier to understand style material using Android-Based Educational Game media "Perjalanan Si Maya."	94.50
4. I easily understand the matter of formative assessment in Android-Based Travel Educational Game media "Perjalanan Si Maya."	92.40
5. I feel happy giving formative assessments of style material using Android-Based Educational Game "Perjalanan Si Maya."	100.00

Based on Table 7, a score of 96.52 is included in the outstanding category's 75.00% - 100.00% criteria. From these acquisitions, students look enthusiastic and happy when learning using the android-based educational game "Perjalanan Si Maya" as a formative assessment in learning.

3. Teacher Response

Teacher response questionnaires were given to the principal and two teachers at ES Mojosari. Table 8 shows the results of the teacher's response.

Table 8. Teacher response.

Assessment Indicator	Percentage (%)
1. Do you find it easy to understand the instructions for using the Android-Based Educational Game media " Perjalanan Si Maya" as a formative assessment?	100
2. Is the development of the Android-based educational game media "Perjalanan Si Maya" a formative assessment of the indicators of achieving learning objectives?	100
3. Does the development of the Android-based Educational Game "Perjalanan Si Maya" as a formative assessment make it easier for you to achieve your learning objectives?	91.7
4. Does the Android-based Educational Game "Perjalanan Si Maya" as a formative assessment provide an accurate picture of the studied material?	100
5. Is the Android-based Educational Game "Perjalanan Si Maya" a practical formative assessment of time used in learning?	91.7

Based on Table 8, it can be seen that the teacher's response obtained a score of 96.66 with criteria of 75.00%-100.00% in the very good category. Using the android-based educational game media "Perjalanan Si Maya" as a teacher's formative assessment makes it easier to deliver learning material. It is more efficient when giving formative assessment questions on the android-based educational game media "Perjalanan Si Maya."

Effectiveness

1. Learning Outcomes of Critical Thinking Skills

   To see an increase in students' critical thinking skills using the results of the pretest and post-test after participating in learning using the android-based educational game media "Perjalanan Si Maya" as a formative assessment. Figure 2 shows the results of students' critical thinking tests in the control class.

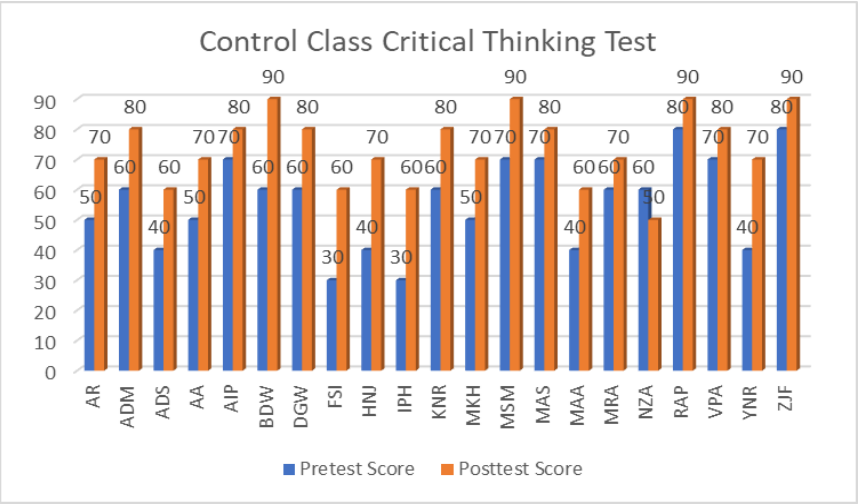

Figure 2. Control class critical thinking test.

From the results of the pretest in Figure 2, it can be seen that student scores are in the range of 30-80, with 15 students not completing and six students completing. At the same time, the students' post-test scores were 50-90, with five students not completing and 16 students completing.

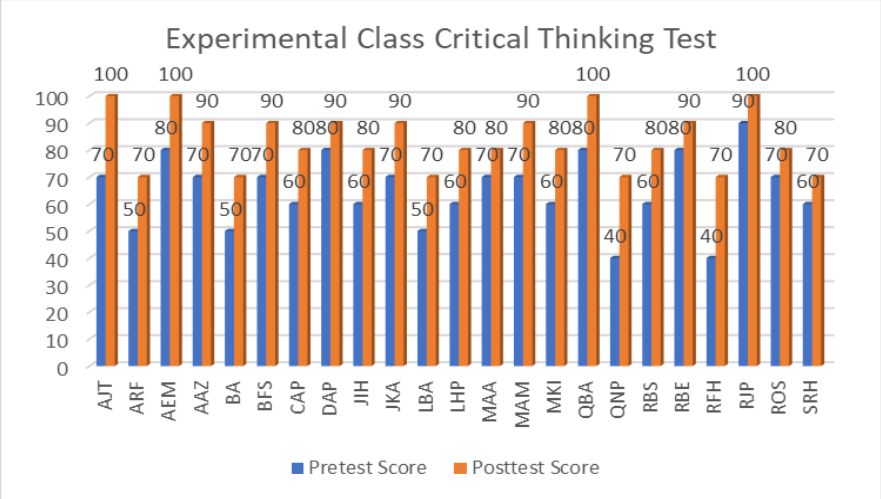

Figure 3. Experimental class critical thinking test.

Based on Figure 3, the pretest scores obtained by the experimental class ranged from 40-90, with ten students not completing and 13 students completing. In comparison, the students' post-test scores were in the range of 60-100 scores with 23 students' completeness.

2. Observation of Students' Critical Thinking Skills

Apart from the results obtained from the pretest and post-test scores, the increase in students' critical thinking skills can be seen from observations made when students presented the results of discussions and carried out group discussion activities. Observations were made during two meetings in the control class, and the following experiments were the results of students' critical thinking skills.

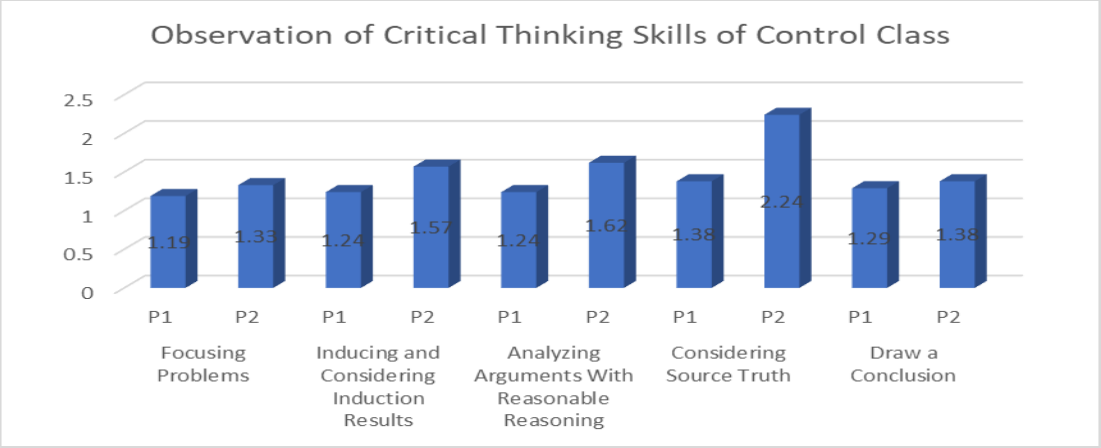

Figure 4. Observation of critical thinking skills of the control class.

Figure 4 shows that the indicators of focusing problems obtained an average score of at the first meeting 1.19 and at meeting two at 1.33. Indicator inducing and considering the induction results at meeting 1 got an average score of 1.24, while meeting two was 1.57. The indicator of analyzing arguments with the reasoning in the first meeting obtained an average score of 1.24, and in the second meeting obtained 1.62. Furthermore, the indicator considering source truth at the first meeting scored 1.38, and the second meeting was 2.24. Finally, the indicators conclude to obtain an average of 1.29 at meeting one and increase to 1.38 at meeting 2.

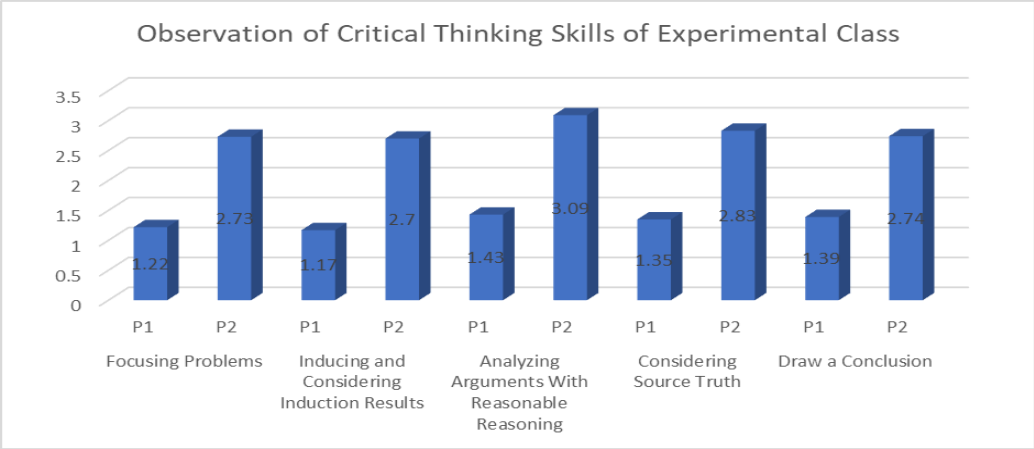

Figure 5. Observation of critical thinking skills of the experimental class.

In the experimental class, the indicator of the focusing problem on the problems of the experimental class got an average score of 1.22 at meeting 1 and 2.73 at the second meeting. Inducing and considering the induction, results obtained an average of 1.17 at the first meeting and 2.70 at the second meeting.

The indicator of analyzing arguments with rational reasoning obtained an average of 1.43 at the first meeting and 3.09 at the second meeting. Furthermore, considering sources of truth obtained an average of 1.35 at the first meeting and 2.83 at the second meeting. Finally, concluding was obtained at 1.39 at the first meeting and increased to 2.74 at the second meeting.

3. Learning Interest Results

Two questionnaires are used, namely a questionnaire of interest in learning before and after learning using the android-based educational game media "Perjalanan Si Maya" as a formative assessment to see an increase in student interest in learning. Table 9 shows the results of students' interest in learning before learning.

Table 9. Study interest questionnaire before learning.

Indicator	Score
I feel happy with the natural science learning style material	75.00
I am passionate about taking style subject matter lessons	71.00
I am passionate about taking style subject matter lessons	67.00
I asked the teacher if there was material that I did not understand	69.00
I can focus on the problems given by the teacher	66.00
I can analyze the problems given by the teacher	68.00
I feel more interested in learning science-style material	70.00
I am enthusiastic about the learning process	65.00
I easily understand the concept of material styles	70.00
I take an active part in learning in class	71.00
I actively ask and answer questions from the teacher	71.00
I am actively involved in group discussions	67.00
I come to find out the truth of a problem	60.00
I can conclude that the existing problems	68.00
I participate in giving arguments or opinions when a friend is giving a presentation	64.00

Based on Table 9, the student interest questionnaire before learning, the results obtained were 59.20%. Furthermore, the interest questionnaire after learning is depicted in Table 10. The questionnaire after learning obtained a result of 88.30%. From the results of the student learning interest questionnaire before and after learning in Tables 9 and 10, an increase of 29.1% was obtained.

Table 10. Study interest questionnaire after learning.

Indicator	Score
I feel happy when the formative assessment of style material is given using the Educational Game "Perjalanan Si Maya" media	102.00
I am excited to take part in the style subject matter when it is delivered using the Educational Game "Perjalanan Si Maya" media	99.00
I pay attention to the teacher while explaining the subject matter	103.00
I asked the teacher if there was material that I did not understand	111.00
I can focus on the problems given by the teacher	102.00
I can analyze the problems given by the teacher	100.00

Indicator	Score
I feel more interested in the provision of formative assessment of style subject matter delivered using the Educational Game "Perjalanan Si Maya" media	99.00
I am enthusiastic about the learning process	102.00
I easily understand the concept of learning material that is presented using the Educational Game "Perjalanan Si Maya."	104.00
I took part in using the Educational Game media "Perjalanan Si Maya" in-class learning	101.00
I actively ask and answer questions from the teacher	100.00
I am actively involved in group discussions	105.00
I come to find out the truth of a problem	104.00
I can conclude that the existing problems	92.00
I participate in giving arguments or opinions when a friend is giving a presentation	100.00

Discussion

The purpose of developing an android-based educational game media, "Perjalanan Si Maya," as a formative assessment is to produce valid, practical, and effective learning media so that it can help students more easily understand learning, improve students' critical thinking skills, and increase students' interest in learning. This study uses the ADDIE development model. The ADDIE model systematic development stages and the needs of research and development of the android-based educational game media "Perjalanan Si Maya" as a formative assessment. Three aspects are used as a reference in the development of this media: validity, practicality, and effectiveness. The initial stages in this research began with the development of an android-based educational game media, "Perjalanan Si Maya," using the ADDIE development model; after the media was completed, the next step was validation on the validator. After the validation phase is complete, it is continued with small or limited group trials, and the next stage is large group trials or implementation.

Based on the results of the development of the android-based educational game media "Perjalanan Si Maya" as a formative assessment, the results show that the android-based educational game media "Perjalanan Si Maya" as a formative assessment can make it easier for students to learn, especially on style material. This media is an innovation in learning. This media is presented with animated images and sound with an attractive display of images to make students more interested when using the android-based educational game media "Perjalanan Si Maya" as a formative assessment in learning. This media has supporting features such as instructions for use, description of the material, student identity, illustration of questions, choice of questions and answers, and discussion of questions that make it easier for students to use the media and easily understand the material. Materials and questions. On the main menu of educational games, there are several menu sections that students can choose from, such as the instructions for use menu, material menu, game menu, and developer profile menu.

Based on the results of the validation carried out, it is obtained that all aspects of validation include media validation, material, critical thinking questions, and obtaining a score with achievement criteria of 85.01-100% with a very valid category. Learning media is declared valid if the media is by the research objectives. The validator provides an appropriate assessment of the media so that teachers can use it as an intermediary

for delivering learning material (Didik & Yuliani, 2013). This aligns with Niveen's opinion, which says that the quality of learning tools must meet valid criteria based on construct and content validity. So if it meets these two criteria, the media can be said to be valid (Riva'i et al., 2020).

The learning framework in the 21st century requires students to have various skills, study skills, life and career skills, and technology skills. The 21st-century learning paradigm emphasizes that students be able to find out from all sources, formulate problems, and do analytical thinking, as well as cooperation and collaboration in solving problems. Everyone must have critical thinking skills, digital literacy knowledge and skills, information literacy, media literacy, and master information and communication technology to face learning in the 21st century (Jagodziński & Wolski, 2015). Critical thinking is a systematic process that allows students to formulate and evaluate their beliefs and opinions Wardani et al. (2017). Critical thinking skills are critical to developing so students more easily understand concepts and are sensitive to problems. Hence, they can understand and solve problems and apply concepts in different situations.

Critical thinking can be developed in learning by increasing meaningful student experiences. This experience can be an opportunity to provide arguments orally or in writing, such as being a scientist. Critical thinking is needed to answer the problems faced in life. By thinking critically, a person can organize, change, improve, and adjust his thoughts so that he can act appropriately. Critical thinkers are good at reasoning; they use their reasoning as the basis for their thoughts. Efforts to improve critical thinking skills in science learning can be made by familiarizing students with science questions based on Higher Order Thinking Skills (HOTS) (Sidiq et al., 2021). Seeing the importance of critical thinking skills in science, HOTS-based science questions should be used as early as possible. Therefore, problem habituation began to be applied at the elementary school student level (Ishartono et al., 2021). This is the most basic school level where basic sciences are taught, including science.

High-grade elementary school students (grades 4, 5, and 6) are generally between 10-13 years old. Students in this class belong to Generation Z seen, based on that age range. Generation Z needs technology. This generation grew up in an era of unlimited access to information, wherever and whenever, with new trends that are continuously relentless (Suryanti et al., 2021). This dominant generation cannot be separated from gadgets. Teachers with this condition have an excellent opportunity to use gadgets as a medium for learning science. This aligns with research (Clayton & Murphy, 2022), which states that appropriate smartphones can stimulate students to learn. In the world of education, gadgets, and games have a positive impact. According to Ansari (2017), with smartphones and games, students become more productive and active, taking into account the appropriate time of use. With the media, the presentation of material can build students' curiosity and stimulate students to react both physically and emotionally. In short, learning media can help students create a more lively learning atmosphere that is more varied and exciting (Falahudin, 2014). They explained that media is a channel of messages and can stimulate the students' thoughts, feelings, and will to encourage the learning process (Wahidin et al., 2018). Material packaged through the media is displayed more clearly, and entirely and attracts students' learning interest so that it can be a fun learning tool (Oktavia & Agustin, 2019). According to research by

Sunaengsih (2016), learning media that are packaged attractively can attract students' attention so that they can make learning fun. Active learning can improve students' cognitive abilities (Zufriady & Kurniaman, 2019). Research by Schweppe & Rummer (2014) The correct use of multimedia can make learning meaningful so that students can be helped when understanding knowledge so they can store it in long-term memory. Students can also help apply the knowledge given to new, different, and real situations.

The use of the Android-based educational game media "Perjalanan Si Maya" as a formative assessment can provide new experiences for students when learning because it can be done anytime and anywhere with the help of an Android smartphone which can increase students' enthusiasm for learning. Using the android-based educational game media "Perjalanan Si Maya," which is used for formative assessment, can provide convenience for teachers, namely being able to provide feedback quickly. Also, the teacher can correct student mistakes when absorbing information so that the teacher can immediately provide the information students need when they answer the wrong questions. Game-based learning provides a virtual learning environment, repeated independent learning, and continuous feedback interaction to increase student interest and motivation in learning (Ucus, 2015).

Providing rapid feedback will have an impact on student achievement. This is in line with research conducted by Sulistyowati et al. (2017), which explains that the feedback provided will positively impact student learning outcomes. Research conducted (Febriyanti, 2015) showed that the learning outcomes of students given feedback would be higher than those given delayed feedback. Koll & Rietz 2016) said that providing feedback can increase student motivation so they can be more confident when working on questions, resulting in increased learning outcomes. This proves that direct feedback can improve student learning outcomes.

The development of educational game learning media based on the android "Perjalanan Si Maya" as a formative assessment has three theoretical foundations of learning, namely the theory of behaviorism, the theory of constructivism, and Edgar Dale's cone of experience theory. According to the theory of behaviorism, the most important thing in learning comes from forming associations between stimulus and response. The stimulus given in this study was the use of educational game media in learning. At the same time, the response elicited an increase in students' thinking skills after using educational game media in learning. Based on constructivism theory, people construct their knowledge and knowledge of the world through their experiences (Bada & Olusegun, 2016). This is supported by Dale's theory which states that the learning experience gained by students can measure the success of student learning. Dale argues that learning is best through direct experience, not just seeing how people enjoy (demonstrating) or hearing people tell stories.

CONCLUSION

Fundamental Finding: Based on the findings, it can be concluded that the android-based educational game media "Perjalanan Si Maya" as a formative assessment of style material developed is valid, practical, and effective so that it is feasible to use to improve student's critical thinking skills and interest in learning. **Implication:** It is hoped that researchers can use the research results to develop learning activities that can provide facilities for students to improve critical thinking skills and interest in

learning through educational game media for formative assessments. **Limitation:** Teachers are expected to be able to carry out learning innovations in improving students' critical thinking skills and students' interest in learning so that they can produce graduate students whom are researchers researching to determine the critical thinking skills of fourth-grade students. **Future Research:** Teachers are expected to be able to carry out learning innovations in improving critical thinking skills and students' interest in learning so that they can produce quality student graduates in the future.

REFERENCES

Akbar, S. (2013). *Instrumen perangkat pembelajaran*. PT Remaja Rosdakarya.

Al-Tabany, T. I. B. (2014). *Mendesain model pembelajaran inovatif: Progresif dan kontekstual*. Kencana.

Anggraini, A. F., Erviana, N., Anggraini, S., & Prasetya, D. D. (2016). Aplikasi game edukasi petualangan nusantara. *Prosiding SENTIA*, *8*, 168–172.

Annisa, S. N. (2018). Pengembangan media pembelajaran interaktif IPA berbasis model pembelajaran guided inquiry pada materi gaya di kelas IV SD negeri 101776 sampali. *School Education Journal Pgsd Fip Unimed*, *8*(2), 217–229. https://doi.org/10.24114/sejpgsd.v8i2.10199

Anshari, M., Almunawar, M. N., Shahrill, M., Wicaksono, D. K., & Huda, M. (2017). Smartphones usage in the classrooms: Learning aid or interference? *Journal of Education and Information Technologies*, *22*(6), 3063–3079. https://doi.org/10.1007/s10639-017-9572-7

Azizatunnisa, F., Sekaringtyas, T., & Hasanah, U. (2022). Pengembangan media pembelajaran interaktif game edukatif pada pembelajaran IPA kelas IV sekolah dasar. *OPTIKA: Jurnal Pendidikan Fisika*, *6*(1), 14–23. https://doi.org/10.37478/optika.v6i1.1071

Bada, S. O., & Olusegun, S. (2016). Constructivism: A paradigm for teaching and learning. *Arts and Social Sciences Journal*, *7*(4), 66–70. https://doi.org/10.4172/2151-6200.1000200

Branch, R. M. (2009). *Instructional design: The ADDIE approach (Vol. 722)*. Springer Science & Business Media.

Burhaein, E. (2017). Aktivitas fisik olahraga untuk pertumbuhan dan perkembangan siswa SD. *Indonesian Journal of Primary Education*, *1*(1), 51-60. https://doi.org/10.17509/ijpe.v1i1.7497

Clayton, K., & Murphy, A. (2022). Smartphone Apps in education: Students create videos to teach smartphone use as tool for learning. *Journal of Media Literacy Education*, *8*, 99–109. https://doi.org/10.23860/jmle-8-2-5

Dantes, N. (2014). *Landasan pendidikan tinjauan dari dimensi makropedagogis*. Graha Ilmu.

Didik, P., & Yuliani, Y. (2013). Pengembangan media komik IPA terpadu tema pencemaran air. *Jurnal Pendidikan Sains*, *1*(1), 71–76.

Falahudin, I. (2014). Pemanfaatan media dalam pembelajaran. *Jurnal Lingkar Wisyaiswara*, *1*(4), 104–117.

Febriyanti, C. (2015). Pengaruh bentuk umpan balik dan gaya kognitif terhadap hasil belajara trigonometri. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, *3*(3), 203–214. https://doi.org/10.30998/formatif.v3i3.125

Fitriani, A., Zubaidah, S., Susilo, H., & Al Muhdhar, M. H. I. (2020). PBLPOE: A learning model to enhance students' critical thinking skills and scientific attitudes. *International Journal of Instruction*, *13*(2), 89–106. https://doi.org/10.29333/iji.2020.1327a

Hidayah, N. (2022). Pandangan terhadap problematika rendahnya mutu pendidikan di indonesia. *Jurnal Pendidikan dan Konseling*, *4*(4), 6593–6601 https://doi.org/10.31004/jpdk.v4i4.9183

Ishartono, N., Desstya, A., Prayitno, H. J., & Sidiq, Y. (2021). The quality of HOTS-based science questions developed by indonesian elementary school teachers. *Journal of Education Technology*, *5*(2), 236–245. https://doi.org/10.23887/jet.v5i2.33813

Jagodziński, P., & Wolski, R. (2015). Assessment of application technology of natural user interfaces in the creation of a virtual chemical laboratory. *Journal of Science Education and Technology*, *24*(1), 16–28. https://doi.org/10.1007/s10956-014-9517-5

Julianto, J., Wiryanto, W., Rukmi, A. S., Hidayati, F., & Rahmawati, E. (2023). Analysis of critical thinking skills of prospective elementary school teacher student. *IJORER : International Journal of Recent Educational Research*, *4*(3), 286–295. https://doi.org/10.46245/ijorer.v4i3.302

Koll, S. V., & Rietz, C. (2016). Effect of web-based feedback on students' learning. *International Journal of Teaching Ang Learning in Higher Education*, *28*(1), 385–394.

Lestari, D., & Setyarsih, W. (2020). Kelayakan instrumen penilaian formatif berbasis literasi sains peserta didik pada materi pemanasan global. *IPF: Inovasi Pendidikan Fisika*, *9*(3), 561–570. https://doi.org/10.26740/ipf.v9n3.p561-570

Magdalena, I., Fatakhatus, S. A., Pebrianti, A. R., Jannah, A. W., Susilawati, I., & Tangerang, U. M. (2021). Pentingnya media pembelajaran untuk meningkatkan minat belajar siswa SDN meruya selatan 06 pagi. *EDISI : Jurnal Edukasi dan Sains*, *3*(2), 312–325.

Mahmuzah, R. (2015). Peningkatan kemampuan berpikir kritis matematis siswa SMP melalui pendekatan problem posing. *Jurnal Peluang*, *4*(1), 64–72. https://doi.org/10.35194/jp.v6i2.123

Mariono, A., Bachri, B. S., Kristanto, A., Dewi, U., Sumarno, A., Kholidya, C. F., & Pradana, H. D. (2021). Online learning in digital innovations. *Journal of Education Technology*, *5*(4), 547-564. https://doi.org/10.23887/jet.v5i4.40115

Meidawati, S. A. N. B. R. (2019). Persepsi siswa dalam studi pengaruh daring learning terhadap minat belajar IPA. *SCAFFOLDING: Jurnal Pendidikan Islam dan Multikulturalisme*, *1*(2), 30–38. https://doi.org/10.37680/scaffolding.v1i2.117

Mulyatiningsih, E., & Nuryanto, A. (2014). *Metode penelitian terapan bidang pendidikan*. Alfabeta.

Nafisah, N. S., Murtono, M., & Ismaya, E. A. (2021). Peran guru dalam memberikan motivasi belajar siswa sekolah dasar pada masa pandemi COVID-19. *Jurnal Educatio FKIP UNMA*, *7*(1), 149–155. https://doi.org/10.31949/educatio.v7i1.892

Novaliendry, D. (2013). Aplikasi game geografi berbasis multimedia interaktif (studi kasus siswa kelas IX SMPN 1 RAO). *Jurnal Teknologi Informasi & Pendidikan*, *6*(2), 106–118.

Nur'aini, D. A., Lestari, P. D., & Kurniawan, B. R. (2020). Pengembangan asesmen formatif berbasis komputer untuk mengetahui penguasaan konsep siswa pada materi hukum bernoulli. *Jurnal Riset Pendidikan Fisika*, *5*(2), 106–112. http://dx.doi.org/10.17977/um058v5i2p106-112

Nurdiana, D., Rahadian, D., & Suryadi, A. (2017). Game edukasi pengenalan nama buah dan sayuran dalam bahasa inggris untuk sekolah dasar. *JTEP-Jurnal Teknologi Pendidikan Dan Pembelajaran*, *2*(1), 198–204. https://doi.org/10.31980/tp.v2i1.110

Oktavia, A., & & Agustin, H. (2019). Umbul card: A traditional game as nutrition education media among elementary school students. *International Journal of Educational Research Review*, *5*(1), 1–9. https://doi.org/10.24331/ijere.646821

Panjaitan, S. (2017). Hasil belajar IPA melaui media gambar. *Jurnal Priamary Program Studi Pendidikan Sekolah Dasar*, *6*(1), 252-266. https://doi.org/10.31004/basicedu.v4i2.332

Rizki, I. A., Saphira, H. V., Alfarizy, Y., Saputri, A. D., Ramadani, R., & Suprapto, N. (2023). Adventuring physics: Integration of adventure game and augmented reality based on android in physics learning. *International Journal of Interactive Mobile Technologies (IJIM)*, *17*(1), 4–21. https://doi.org/10.3991/ijim.v17i01.35211

Riva'i, Z., Ayuningtyas, N., & Fachrudin, D. A. (2020). Pengembangan media pembelajaran berbasis aplikasi android pada materi himpunan kelas. *Delta-Pi: Jurnal Matematika Dan Pendidikan Matematika*, *9*(2), 106–119. https://doi.org/10.33387/dpi.v9i2.2277

Ruswandari, D. A., & Yermiandhoko, Y. (2021). Pengembangan game edukasi "quizpoly" berbasis android pada mata pelajaran IPA materi gaya untuk siswa kelas IV SD. *JPGSD:*

Jurmal Pendidikan Guru Sekolah Dasar, *9*(7), 2777–2787.

Saurina, N. (2017). Game edukasi sebagai media pembelajaran untuk kelas IV SDN banjarsugihan II menggunakan blender 3D. *Jurnal Sistem Dan Informatika (JSI)*, *2*(2), 128–134. https://doi.org/10.32528/justindo.v2i2.1049

Saphira, H. V., Rizki, I. A., Alfarizy, Y., Saputri, A. D., Ramadani, R., & Suprapto, N. (2022). Profile of students ' critical thinking skills in physics learning : A preliminary study of games application integrated augmented reality. *Journal of Physics: Conference Series*, *2377*, 1-10. https://doi.org/10.1088/1742-6596/2377/1/012088

Schweppe, J., & Rummer, R. (2014). Attention, working memory, and long-term memory in multimedia learning: An integrated perspective based on process models of working memory. *Educational Psychology Review*, *26*(2), 285–306. https://doi.org/10.1007/s10648-013-9242-2

Sidiq, Y., Ishartono, N., Desstya, A., Prayitno, H. J., Anif, S., & Hidayat, M. L. (2021). Improving elementary school students' critical thinking skill in science through hots-based science questions: A quasi-experimental study. *Jurnal Pendidikan IPA Indonesia*, *10*(3), 378–386. https://doi.org/10.15294/JPII.V10I3.30891

Sugiyono, S. (2018). *Metode penelitian kuantitatif, kualitatif, dan R&D*. Alfabeta.

Sulistyowati, S., Sujito, S., & Kusairi, S. (2017). Pengaruh pemberian feedback formatif online materi fluida dinamis berbasis isomorphic problems terhadap prestasi belajar siswa. *Seminar Nasional Fisika Dan Pembelajarannya*, 51–58.

Sunaengsih, C. (2016). *Pengaruh media pembelajaran terhadap mutu pembelajaran pada sekolah dasar terakreditasi A*. *Mimbar Sekolah Dasar, 3*(2), 177–184. https://doi.org/10.17509/mimbar-sd.v3i2.4259

Sundayana, R. (2016). *Statistika penelitian pendidikan*. Alfabeta.

Supardi, Z. A. I. (2018). Effectiveness of OR-IPA model to improve the pre-service physics teacher ' s critical thinking skills. *International Conference on Educational Research: Faculty of Education, Khon Kaen University, Thailand*, *1*, 629–635. http://dx.doi.org/10.33225/jbse/18.17.300

Suprianingsih, N. W. S., & Wulandari, I. G. A. A. (2020). Model problem posing berbantuan media question box berpengaruh terhadap kompetensi pengetahuan matematika siswa SD. *Jurnal Mimbar Ilmu*, *25*(3), 308–318. https://doi.org/10.23887/mi.v25i3.25472

Suryanti, S., Widodo, W., & Yermiandhoko, Y. (2021). Gadget-based interactive multimedia on socio-scientific issues to improve elementary students' scientific literacy. *International Journal of Interactive Mobile Technologies*, *15*(1), 56–69. https://doi.org/10.3991/IJIM.V15I01.13675

Trismayanti, S. (2019). Strategi guru dalam meningkatkan minat belajar peserta didik di sekolah dasar suci. *Al-Ishlah: Jurnal Pendidikan Islam*, *17*(2), 1-14. https://doi.org/10.35905/alishlah.v17i2.1045

Ucus, S. (2015). Elementary school teachers' views on game-based learning as a teaching method. *Procedia - Social and Behavioral Sciences*, *186*, 401–409. https://doi.org/10.1016/j.sbspro.2015.04.216

Vidergor, H. E., & Gottlieb, M. (2015). High order thinking, problem based and project based learning in blended learning environments. *Applied Practice for Educators of Gifted and Able Learners*, 217–232. https://doi.org/10.1007/978-94-6300-004-8_11

Vitianingsih, A. V. (2017). Game edukasi sebagai media pembelajaran pendidikan anak usia dini. *Inform : Jurnal Ilmiah Bidang Teknologi Informasi Dan Komunikasi*, *1*(1), 1-14. https://doi.org/10.25139/inform.v1i1.220

Wahidin, W., Unang, U., & Syaefuddin, A. (2018). Pendidik dalam perspektif pendidikan islam. *Al-Ikhtibar: Jurnal Ilmu Pendidikan*, *5*(1), 652–671. https://doi.org/10.32505/ikhtibar.v5i2.556

Wardani, S., Lindawati, L., & Kusuma, S. B. W. (2017). The development of inquiry by using

android-system-based chemistry board game to improve learning outcome and critical thinking ability. *Jurnal Pendidikan IPA Indonesia*, *6*(2), 196–205. https://doi.org/10.15294/jpii.v6i2.8360

Wicaksono, I., Aprilia, I., & Supraptiningsih, L. K. (2022). Penerapan asesmen formatif pembelajaran fisika dengan kuis game edukasi dan penilaian diri siswa SMA. *Education Journal : Journal Educational Research and Development*, *6*(2), 139–150. https://doi.org/10.31537/ej.v6i2.739

Widodo, W. (2022). Online flipped classroom : Developing postgraduate science education students ' critical thinking skills. *Journal of Science Learning*, *5*, 1-19. https://doi.org/10.17509/jsl.v5i3.43107

Yang, S., & Kwok, D. (2017). A study of students' attitudes towards using ict in a social constructivist environment. *Australasian Journal of Educational Technology*, *33*(5), 50–62. https://doi.org/10.14742/ajet.2890

Zufriady, Z., & Kurniaman, O. (2019). The effectiveness of learning basic concepts of art for primary teacher education students using nomor acak learning model. *Mimbar Sekolah Dasar*, *6*(1), 32-70. https://doi.org/10.17509/mimbar-sd.v6i1.15241

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