Article

Development of Educational Game Based on Socio-Scientific Issues to Improve Logical Thinking Ability

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ABSTRACT

Science learning requires a complex thinking process that must be developed in it. Logical thinking skills are needed in science learning because it helps students understand scientific concepts systematically and rationally. One of the learning media that can be used to improve logical thinking skills is Articulate Storyline which is integrated with Socio-Scientific Issues. This research uses the Research and Development (R&D) method with the ADDIE model. The data collection was carried out by expert validation, student questionnaires, and tests. The research subjects were students of class VII G State Islamic Junior High School 2 Ponorogo (MTsN 2 Ponorogo). The data obtained were analyzed for validity using the Aiken Index. Meanwhile, the questionnaire was analyzed using the average percentage and the test data was analyzed using the T-test and N-Gain. Based on the results of the research that has been obtained, the Aiken Index value is 0.95 with very valid validity. The practicality obtained a percentage of 83% with an increase in pretest and post test results for each indicator. Thus, this study shows that this media is effective in improving students' logical thinking. For further research, it is recommended to develop similar media applied to other topics and levels.

INTRODUCTION

As time goes by, the world of education is developing in an increasingly advanced direction. Likewise, the demands in the world of education are increasingly complex. 21st century education requires students to be able to have important skills that can face complex challenges in the future. One of the thinking skills that must be possessed by students is logical thinking ability. Science learning requires a complex thinking process that must be developed in it, including logical thinking ability. Moreover, science is learning related to the physical world with an impact that can not only change the environment, but can also change human views in dealing with everyday problems (Arifiya, 2023). The coverage of materials in science aims to understand natural phenomena and interrelated objects, so that thinking skills are needed in science learning.

The improvement of students' academic achievement during the learning process is influenced by their logical thinking ability. Science learning cannot be separated from the scientific process, where there is a correlation between the two (Anggraini & Irawan, 2021). In science learning, a scientific process takes place which includes the process of observing, questioning, gathering information, reasoning, and communicating ideas so that through the learning process carried out it is expected to provide direct experience to students involving logical thinking ability (Fuadah & Fatmahanik, 2022). So that through a scientific process that encourages involvement can help students to gradually hone their thinking skills.

Science learning is inseparable from learning that involves the problem-solving process in it. A problem will not provide a conclusion without a solution. The solution of the problem is through the process of how one can think to determine the appropriate strategy in solving the problem (Faradina & Mukhlis, 2020). So that through logical thinking can help students to develop problem-solving strategies, so that problems can be solved with the right solution (Arifin & Irawan, 2021). Thus, science learning helps students to be able to develop logical thinking ability through the learning process.

Students can be said to have logical thinking ability if they have the characteristics or indicators of logical thinking ability. The ability to think logically in students can be seen based on indicators in the learning process which include order of thinking, ability to argue, and drawing conclusions (Zulfickar & Oktariani, 2020). he characteristics of logical thinking include: 1) order of thinking, where students are able to determine the stages systematically in solving problems; 2) Argumentative ability, where students can provide arguments accompanied by relevant reasons and evidence; 3) inference, where students can provide conclusions from problem solving appropriately (Fitri et al., 2023). Through these characteristics or indicators a student is said to have the ability to think logically.

Logical thinking skills can be honed through integrating an approach in learning, one of which is through the Socio-Scientific Issues approach. Because through Socio-Scientific Issues students can connect real issues in people's lives with scientific contexts (Kinskey & Zeidler, 2021). The purpose of this approach is not only related to science, but aims to be able to build students' ethical, moral and intellectual development as well as awareness of the relationship between social problems and science (Fadly et al., 2024). Through the Socio-Scientific Issues approach, it helps students in the learning process to develop high-level thinking skills in dealing with problems in the real world (Masruroh & Muna, 2024). Based on this, the Socio-Scientific Issues approach can be an option that is integrated in a learning media to encourage students' logical thinking skills.

Various studies on the development of Articulate Storyline media show positive results in the learning process. The learning process can be optimized and student learning outcomes can improve by utilizing the right Articulate Storyline learning media (Akhlilia et al., 2024). So based on this, it is possible to improve logical thinking skills through the use of Articulate Storyline learning media. This is shown through an increase in critical thinking skills through interactive learning media Articulate Storyline based on critical thinking skills used by students in the learning process (Legina & Sari, 2022). Science learning using Articulate Storyline with the STEM model can also effectively increase student creativity (Nurmala et al., 2021).The Articulate Storyline application was effectively successful in meeting the needs and increasing the learning motivation of junior high school students (Zulfikar Mubar et al., 2024). Various studies on the development of learning media to be able to improve the thinking skills possessed by students have been carried out. However, there is no research that utilizes Articulate Storyline integrated with the Socio-Scientific Issues approach. Through this research, the development of learning media in the form of educational games based on Socio-Scientific Issues (SSI) specifically designed to improve students' logical thinking skills, by utilizing the Articulate Storyline platform which allows the integration of interactive and narrative elements effectively.

Through the results of the initial identification of existing problems at State Islamic Junior High School 2 Ponorogo (MTsN 2 Ponorogo), it shows that students' logical thinking ability are still relatively low, characterized by students' lack of interest in abstract learning and the lack of interactive and contextual learning media. One of the relevant approaches to overcome these problems is to develop learning media based on Socio-Scientific Issues (SSI), which can link the subject matter with social issues in the context of science. To support this, the utilization of technology in the form of educational game learning media using Articulate Storyline is an innovative solution that is able to present material in an interesting, interactive, and in accordance with student learning characteristics. Therefore, this research aims to develop educational game learning media based on Socio-Scientific Issues to improve students' logical thinking ability.

METHODS

This research is a type of Research and Development (R&D). The location of this research is one of the Madrasah Tsanawiyah located in the Ponorogo district. The research implementation time, starting from the development stage to product evaluation, took place from December to April 2025. The subjects in this study were students of class VII G bilingual MTsN 2 Ponorogo who were selected using purposive sampling technique. The research procedure for developing Socio-Scientific Issues-based Articulate Storyline learning media uses the ADDIE development research model. The ADDIE development model was chosen in this study because the ADDIE model has simpler and more effective stages for developing a learning media (Sutarti & Irawan, 2017). The learning media developed in accordance with the stages in the ADDIE model which consists of five stages in Figure 1 below:
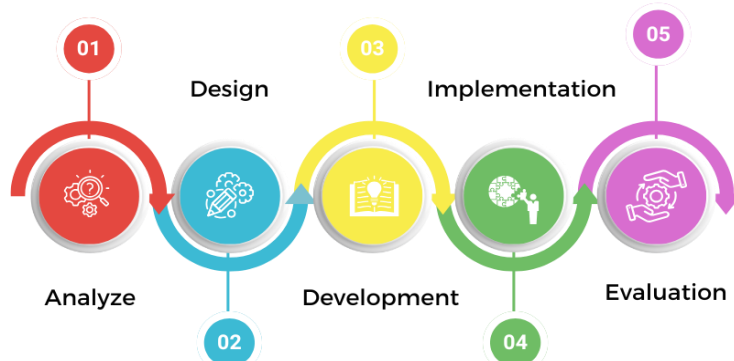
Figure 1. Flow of Stages of the ADDIE Development Research Model (Rashid, 2022)

Data collection techniques are carried out through three stages stages, namely expert validation, questionnaires, and tests. Expert validation is carried out to three validators which include validator media experts, material experts and linguists. While the questionnaire was given to 32 students who became research subjects. The questionnaire given to students is a questionnaire that contains students' responses to the practicality of the media. While the test was conducted in this study by giving questions to 32 students using pretest and posttest.

Data analysis in this study was carried out through three stages, according to the data collection techniques used, namely: validity analysis using Aiken's Index, questionnaire analysis by calculating the average percentage, and analysis of test results through t-test and N-Gain calculation. Data from validation results from experts were analyzed using the Aiken validity formula as described in the following calculation (Irawan & Wilujeng, 2020).

$$V = \sum \frac{s}{n(C-1)}$$

Description:
S = R-L0

S = the score given by the validator minus the lowest score
V = Aiken index
R = score given by the validator
L0 = lowest score
C = highest score
n = number of validators

So that the Aiken index will be obtained which is interpreted into the Aiken Index criteria, so that the validity of the instrument used can be known. The criteria for the Aiken Index results can be seen in Table 1.

Table 1. Aiken Index Validity Criteria

Validity Index	Interpretation
$0 \leq V \leq 0,4$	Invalid
$0,4 \leq V \leq 0,8$	Medium validity
$0,8 \leq V \leq 1$	Highly valid

(Irawan & Wilujeng, 2020)

The questionnaire results were analyzed through the percentage of responses from all respondent data using the following formula.

$$P = \frac{f}{n} \times 100\%$$

Description:
P = data percentage number
f = number of scores obtained
N = maximum number of scores

The percentage results that have been obtained are then grouped in each category based on the score according to the Likert scale. So that the conclusion of the students' response to the developed media is obtained. The score interpretation criteria based on the Likert scale refers to Table 2 below.

Table 2. Media Practicality Interpretation Criteria

Percentage	Intepretation Category
$80\% \leq x \leq 100\%$	Very practical
$60\% \leq x \leq 80\%$	Practical
$40\% \leq x \leq 60\%$	Quite Practical
$20\% \leq x \leq 40\%$	Not Practical
$0\% \leq x \leq 20\%$	Very Impractical

(Sugiyono, 2017)

After obtaining the value of each student, the N-gain score was calculated using SPSS. As for knowing the magnitude of the increase in the N-Gain score can be seen in the reference Table 3. Through the N-Gain score, it can be seen whether the learning media of Articulate Storyline educational game based on Socio-Scientific Issues is effective to improve students' logical thinking ability.

Table 3. N-Gain Criteria

N-Gain Value	Interpretation
$0,70 \leq g \leq 100$	High
$0,30 \leq g \leq 0,70$	Medium
$0,00 \leq g \leq 0,30$	Low
$g = 0,00$	No improvement
$-1,00 \leq g \leq 0,00$	There was a decrease

(Sukarelawan et al., 2024)

RESULTS AND DISCUSSION

The learning media products developed are learning media that utilize digital media. Where this learning media can be accessed by students for free through the bit.ly/4ja670q link that has been shared. Articulate Storyline educational game learning media developed in the form of output in the form of html5 or web. This will certainly make it easier for students to access the learning media that has been developed without having to install it first. So that

students can access educational game learning media anywhere and anytime. The results of media development are visualized through Figure 2 below.

a. Educational game start

b. Main menu page

c. Game selection page

d. Multiple choice game display
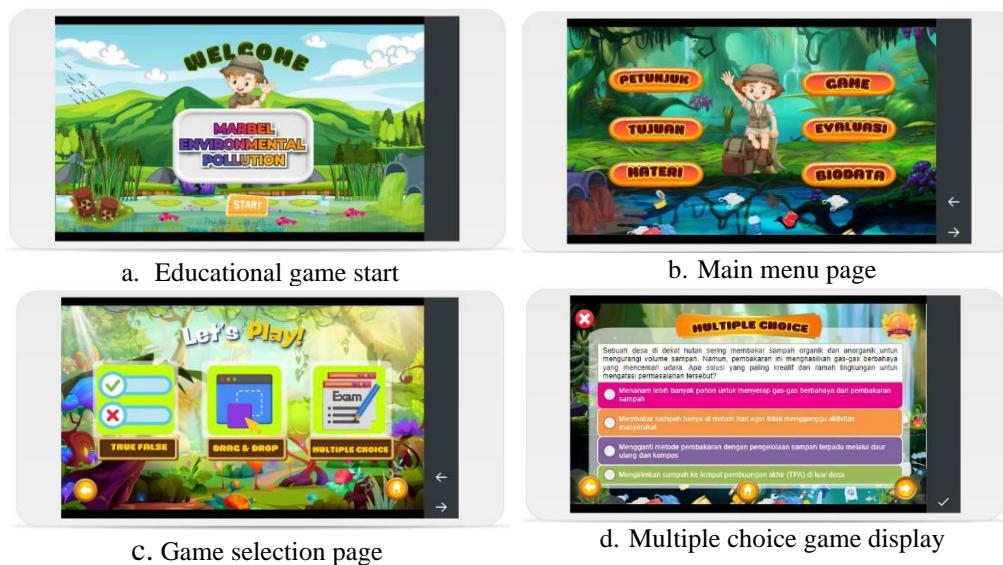
Figure 2. Educational Game Display on The Mobile Screen

After the media is developed, the validity test, practicality test, and effectiveness test are carried out to determine the feasibility of the media in supporting the improvement of students' logical thinking ability. The results of the Aiken Index validity analysis of Articulate Storyline educational games were calculated based on material, media and language aspects. The validity of the Aiken Index based on material aspects can be seen in Table 4.

Table 4. Aiken's Index Validity Test Results

Item	Expert			S1	S2	S3	$\sum$ S	n (c-1)	V	Validity
	I	II	III							
Item 1-26	130	130	115	104	104	89	297	312	0,951923	highly valid

Table 4. shows that the validity of the Aiken Index with coverage of material, media and language aspects obtained a value of 0.95 with a very valid valid validity statement. With the validity of Articulate Storyline educational game learning media which is very valid, it shows that the media is very feasible in terms of material, media and language to be used in the learning process. The category of educational game learning media developed with Articulate Storyline shows in a very valid category proving that Articulate Storyline can be used to develop a quality learning media. In line with research conducted by Nabilah et al that the development of science learning media through Articulate Storyline is feasible for use in science learning (Nabilah et al., 2020). Another study conducted by Nissa et al, revealed that the Articulate Storyline application which was used to develop learning media with Algebra material, obtained validity in the valid category (Nissa et al., 2021). Heliawati et al. in their research also mentioned that gamification-based learning developed using the user-friendly Articulate Storyline 3 multimedia is a solution in facilitating students to learn (Heliawati et al., 2022). In line with research conducted by Zahra et al, that Articulate Storyline learning media developed with the ADDIE model can improve student learning outcomes (Zahra, 2024). Research by Fatia & Ariani also showed similar results that the Articulate Storyline learning media with the development of the ADDIE model obtained valid results from the validators (Fatia & Ariani, 2020). Thus, Articulate Storyline can be utilized in developing interactive learning media.

The practicality of educational game learning media in learning can be measured through student response questionnaires to its use in the classroom. Based on the practicality test of the Articulate Storyline educational game learning media mentioned in the research results, a value of 83% was obtained, indicating that the product developed was in the very practical category.

The very practical practicality category means that the learning media developed is easy to use and useful in supporting the learning process. In line with research conducted by Sindu et al, the Articulate Storyline learning media with very practical criteria, shows the success of Articulate Storyline 3-based learning tools (Sindu et al., 2020). Similar research conducted by Rohmah showed that students gave a positive response to the Articulate Storyline learning media developed (Rohmah, 2024). The success in developing Articulate Storyline learning media indicates that students feel interested in the learning media developed to help students understand the material in learning activities.

Practicality does not only focus on the ease of using learning media. However, it is also seen based on the attractiveness and usefulness of learning media for students. The use of learning media is one of the strategies to create a joyful learning atmosphere. Through the use of learning media, Articulate Storyline educational game can encourage the creation of joyful learning. In line with research conducted by Sundaram and Ramesh which revealed that learning done with game-based joyful learning can increase student attention in learning (Sundaram & Ramesh, 2022). Thus, the use of educational games can create a fun atmosphere that encourages student engagement in learning.

One of the factors that make educational games a very practical category is their ability to present material interactively. Students do not only read or listen to material explanations, but students are directly involved in completing challenges and simulations in the game (Mufidah et al., 2023). The interactivity of educational games encourages students to be more enthusiastic about learning and involved in the learning process (Rambe et al., 2024). In line with research conducted by Jufuf which shows that game-based learning (gamification) can encourage student motivation to learn (Jusuf, 2020). With the interactivity in the Articulate Storyline educational game, students feel more interested in the learning media developed.

The practicality of Articulate Storyline educational game learning media is also seen in the ease of access to this media. Students can easily access this learning media only through links. Learning media in the form of html5 or commonly known as the web is one of the learning media that is easy to access without installing (Kurniawan & Harmanto, 2020). Thus, the use of digital educational game learning media allows students to be able to access via cellphone independently anywhere and anytime. So that educational game learning media is more flexible to be used by students. The ability of educational games to provide feedback is also a supporting factor for the practicality of this media. When students answer questions or complete challenges in one level, they will immediately get the results of the answers and scores that have been obtained at that level. In addition, the system will automatically provide feedback in the form of a description of the completeness of the score that students have obtained at that level (Wangi et al., 2022). Automatic feedback is one of the concepts in gamification which is one of the advantages of gamification.

Based on the pretest and postest results that have been obtained, then analyzed with paired sample T test. So that the results are shown in Table 5 below.

Table 5. Paired Sample T Test Result

|		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	*Pretest - Posttest*	-18.031	12.159	2.149	-22.415	-13.648	-8.389	31	.000

The results of the paired sample t-test test in Table 4.24 of the pretest and posttest data obtained a significance value (sig.) of 0.000 which indicates that there is an average difference. In statistical tests, the significance value is below 0.05, these results indicate that there is a significant change in the pretest and posttest scores. The significant change in the results obtained shows that the learning media of Articulate Storyline educational game based on Socio-Scientific Issues has an influence on students' logical thinking ability. In this case, it is indicated by an increase in students' logical thinking ability through pretest and posttest. Educational game learning media that has been tested in the classroom needs to be evaluated whether educational game learning media is effective to use. The N-Gain value that has been obtained is then compared with the category that has been determined in N-Gain. The results of the calculation of the N-Gain value can be seen in Table 6.

Table 6. N-Gain Test Result

		N	Minimum	Maximum	Mean	Std. Deviation
Ngain		32	.00	1.00	.4733	.25973
Valid (listwise)	N	32				

Based on the results of the N-Gain test in Table 6, the mean value is 0.47, which means that the magnitude of the increase in the N-Gain score is at a moderate interpretation. This shows that the educational game Articualte Storyline based on Socio-Scientific Issues can improve students' logical thinking ability at a moderate level. The increase indicates that this learning media is effective in helping students to improve their logical thinking ability, although it has not reached a high category. Thus, the use of educational games based on Socio-Scientific Issues can be an alternative in learning, especially to train students' logical thinking ability on socioscientific issues.

Data from the pretest and posttest results were analyzed by grouping the scores based on each of the predetermined logical thinking ability indicators, so as to provide a morespecific picture of student development on each logical thinking indicator. The percentage of logical thinking ability indicators based on pretest and posttest results is shown in Figure 2.
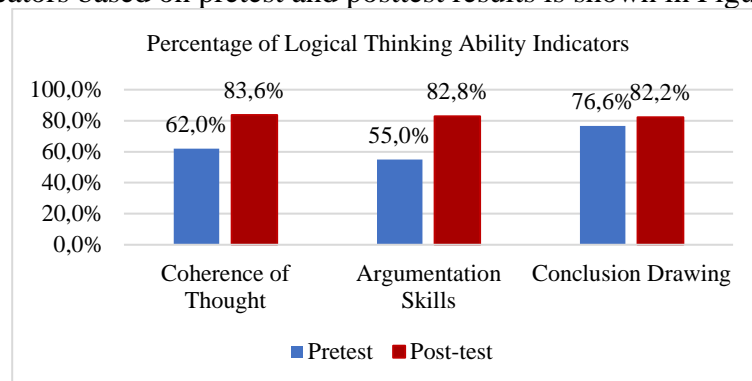
Figure 3. Percentage of Logical Thinking Ability Indicators in Pretest and Posttest

Based on the graph shown in Figure 2, it shows an increase in students' logical thinking ability based on three indicators, namely order of thinking, argumentation skills, and inference, which are compared between pretest and posttest results. Based on this data, it can be seen that there is an increase in all indicators after learning using educational game learning media. Where the indicator with the highest increase is the indicator of the order of thinking, while the indicator with the lowest increase is the inference indicator. The coherence of thinking indicator increased from 60% during the pretest to 83.6% during the posttest. Similarly, the argumentation ability indicator increased from 55% to 82.8%. Meanwhile, the conclusion drawing indicator increased from 76.6% to 82.2%. The increase in the three indicators shows that the use of Articulate Storyline educational game based on Socio-Scientific Issues in the learning process has a positive impact on improving students' logical thinking ability..

The percentage increase in the three indicators of logical thinking ability shows that the use of educational game media based on Socio-Scientific Issues (SSI) developed through Articulate Storyline is effective in supporting the learning process. This media presents contextual issues that encourage students to think coherently, organize arguments logically, and draw conclusions based on data (Khishfe, 2021). The interactivity and the connection of the material with real life in the game make learners more cognitively engaged, thus having a positive impact on improving logical thinking ability.

The use of educational game learning media Articulate Storyline based on Socio-Scientific Issues encourages student involvement in the learning process, so that students not only listen to concept explanations. Educational games developed in an interactive form through the Articulate Storyline platform provide a more concrete learning experience than just listening or reading (Nurhidayah et al., 2025). According to Richard Mayer through the Cognitive Theory of Multimedia Learning explains that learning will be more effective if it involves words and images simultaneously, because the human brain processes information through multiple channels (visual and audio) (AlShaikh et al., 2024). Educational games are one of the digital-based media that use multimedia elements such as text, narration, animation, and visual interaction to effectively help students understand concepts more deeply (Cavanagh & Kiersch, 2023). When students have to analyze a problem and make decisions based on information presented visually and verbally, their logical thinking process is also activated and strengthened.

A number of previous studies have also mentioned that Articulate Storyline learning media can improve various student abilities. As research conducted by Daryanes et al. revealed that the development of interactive learning media Articulate Storyline based on the case method can improve problem solving skills (Daryanes et al., 2023). Sindu et al. in their research showed that there was a significant effect of the application of Articulate Storyline 3-based learning objects on cognitive abilities (Sindu et al., 2020). In addition, a study from Ramadhani et al. stated that interactive learning media based on Articulate Storyline is very effective in improving students' science literacy (Ramadhani et al., 2024). A similar study conducted by Setianingrum et al. stated that learning using Articulate Storyline as a learning medium on pollution material with an inquiry model is effective for fostering students' creative thinking skills (Setianingrum et al., 2023). These various research results reinforce that the use of Articulate Storyline learning media is not only visually appealing, but also effective in improving logical thinking ability.

The Socio-Scientific Issues approach in the Articulate Storyline educational game effectively encourages logical thinking ability through the pollution issues presented. In this case, David Ausubel's meaningful learning theory emphasizes that learning will be effective if new information is connected to existing knowledge (Alti et al., 2022). In the context of educational games based on Socio-Scientific Issues, students are invited to link the environmental pollution issues raised in the game with the science knowledge they have learned. Through this process, students not only memorize, but also understand and process information logically, because they are required to apply concepts in meaningful and contextual situations. Other findings in Almasari and Fadly's research revealed that contextual learning models with the Socio-Scientific Issues approach can improve students' logical thinking ability (Almasari & Fadly, 2024). So that the application of the Socio-Scientific Issues approach can encourage the improvement of logical thinking ability in students.

Various other studies mention that the Socio-Scientific Issues approach can encourage the improvement of various abilities and skills possessed by students. As in previous research conducted by Setyaningsih et al, revealed that integrating socio-scientific issues can train students to develop argumentation skills (Setyaningsih et al., 2019). In line with the study conducted by Kumar et al, that the Socio-Scientific Issues approach can encourage argumentation and decision-making skills (Kumar et al., 2024). Similar research conducted by

Ramos et al that learning by applying technology combined with the Socio-Scientific Issues approach and Problem Based Learning allows students to analyze and solve situations that directly involve them, so as to encourage students' thinking skills (Hernández-Ramos et al., 2021). Thus, these studies can strengthen the effectiveness of the Articulate Storyline educational game learning media based on Socio-Scientific Issues in improving students' logical thinking ability.

This research has an important contribution in the development of learning media by integrating interactive educational games based on Articulate Storyline and the Socio-Scientific Issues (SSI) approach to improve students' logical thinking ability. This approach offers innovation compared to previous studies that generally only emphasize the use of digital media or the application of the SSI approach separately. Through combining the two, this research presents a contextualized, engaging, and interactive learning experience that can be accessed through links, where students not only passively receive information, but are also actively involved in analyzing and solving real problems relevant to their lives. The implication of this research shows that the utilization of technology-based media combined with a contextual approach can encourage a more meaningful learning transformation, while supporting the development of higher-order thinking skills essential in 21st century education.

CONCLUSION

Based on the research on the development of educational game learning media Articulate Storyline based on Socio-Scientific Issues that has been done, it can be concluded that the learning media for educational games Articulate Storyline based on Socio-Scientific Issues developed with the ADDIE model obtained validity in the very valid category. So that the Articulate Storyline educational game learning media is suitable for use in the learning process. While the practicality of educational game learning media, obtained a value with a percentage of 83% which shows in the very practical category. This shows that students give a positive response to the learning media developed. The effectiveness of the Articulate Storyline educational game learning media developed shows in the medium category. So that the learning media for educational games Articulate Storyline based on Socio-Scientific Issues is effective for improving logical thinking ability. This is shown through a significant increase in pretest and posttest results on each logical thinking indicator consisting of order of thinking, argumentation skills, and conclusion drawing.

This research shows that the development of learning media based on Socio-Scientific Issues through Articulate Storyline can be a feasible and practical alternative in supporting the learning process in the classroom. In addition, this media also has the potential to improve students' logical thinking skills, so it can be applied in learning that emphasizes reasoning and decision making based on contextual issues. This study has limitations in the scope of the topic which is still limited to the issue of environmental pollution and subjects who come from one level of education, so the results cannot be widely generalized. In addition, the short duration of implementation has not allowed to observe the long-term impact on students' logical thinking skills. Therefore, future research is recommended to develop similar media on different topics and education levels, as well as implement the media over a longer period of time to assess long-term effectiveness. Integration of more complex gamification elements is also recommended to improve student engagement and learning outcomes.

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