

The Development of Articulate Storyline Interactive Learning Media on Mechanical Waves Material to Improve Student's Scientific Reasoning

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Received: June 13, 2025

Revised: December 21, 2025

Accepted: April 25, 2026

Published: April 30, 2026

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DOI: [10.29303/jppipa.v12i4.11676](https://doi.org/10.29303/jppipa.v12i4.11676)

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Abstract: This study aims to evaluate the feasibility, practicality and effectiveness of articulate storyline interactive learning media to improve student's scientific reasoning in mechanical waves material. The development adopted the Analyze, Design, Development, Implementation, and Evaluation (ADDIE) model. The study used pretest-post test control research design on 64 students of class XI at one of the senior high school in Yogyakarta. The students were divided into two trial classes: X, the experiment class, and Y as the control class. The result of this study indicated that development of articulate storyline interactive learning media is effective to improve student's scientific reasoning. This is evident from the result of the feasibility assessment by expert lecturers and practitioners scored very well. The effectiveness of the articulate storyline interactive learning is demonstrated by the average rise in posttest scores, showing an N-gain test result of 0.34, which falls into the medium range. In addition, the effect size value is 0.536 in the medium category. As well as obtaining the effectiveness of its use the medium effect for student's scientific reasoning. Learning using articulate storyline interactive learning media is more effective and positively impacts student in learning physics, especially in mechanical waves material

Keywords: Articulate storyline; Interactive media; Mechanical waves; Scientific reasoning

Introduction

The phenomenal development of technology has influenced human life in many aspects, including education. In this Society 5.0 which is impacting the educational landscape can be seen from the integration of digital technologies in the learning process. Using modern technology can increase student engagement in learning. Technology development must be integrated into the learning process in order to build 21 century skills (Daryanes et al., 2023). Educational institutions are challenged to find strategies can produce student succeed in work and life the future.

Scientific reasoning (SR) represents a key area of focus in science education and is considered essential in the world of 21st Century skills. According Lawson,

scientific reasoning is fundamental in producing scientific knowledge (Bao et al., 2022). Creating experiment, testing hypothesis, tabulated data, and create conclusions based on data are the basic scientific method. These scientific techniques and ideas are crucial not just for work-related uses but also for addressing issues we encounter in daily living (Engelmann et al., 2016). A thorough comprehension of these concepts can infl civic engagement in science learning (Krell et al., 2020), which are representations of indicator scientific reasoning (Krüger et al., 2020). Scientific reasoning is a complicated system that includes understanding scientific knowledge, recognizing how this knowledge exists, and comprehending why this knowledge exists (Krell et al., 2023). This complexity is crucial for

How to Cite:

Amalia, A., & Jumadi, J. (2026). Development of Articulate Storyline Interactive Learning Media on Mechanical Waves Material to Improve Student's Scientific Reasoning. *Jurnal Penelitian Pendidikan IPA*, 12(4), 992-998. <https://doi.org/10.29303/jppipa.v12i4.11676>

functioning effectively within today's knowledge-based society.

Scientific reasoning is basic for fundamental cognitive abilities to thinking and reasoning within science education. These competencies is important for all education, from primary to university. But, In Indonesian the majority of student in senior high school have low levels of scientific reasoning skills (Yana et al., 2023). Based on research conducted by (Winarti et al., 2015) show that no student has the formal reasoning level, only 65,52 % of student have the operational concrete reasoning level. The result of similar research also indicates that scientific reasoning of high upper-secondary school in Surabaya with average score 3,87 (Erlina et al., 2018) and Jember 27,22 (Winarti et al., 2015) including low category. Therefore, scientific reasoning has been involved in the process of learning sciences, one of in physics.

Understanding material physics is closely connected to scientific reasoning. The learning process in physics not only mastering theoretical content such as fact, concept, and principles but also engaging in scientific inquiry, collecting evidence, conducting analysis, and evaluating one's understanding of physical phenomena (Toplis, 2015). Besides from that, student do not understand with the basics concept of the material correctly (Putri et al., 2023). Previous studies found that difficulties in learning physics, especially in mechanical waves. This in show by researchers (Tumanggor et al., 2020) which is the misunderstanding arose regarding the general characteristics of waves by 32.4% and affected the topics of wave frequency, wave sources, and properties of the medium by 30%. It appears that misconceptions about the interpretation of the concept compared to the valid conception, such as that the speed of mechanical waves propagation is influenced by the shape, pulse, frequency, and wavelength, without considering the properties of the medium (Negoro et al., 2023; Reyes & Rakkapao, 2018). Due to there are many misconception, it is necessary to improve learning models or media to enhance conceptual understanding on the topic mechanical waves.

One form of the teaching materials that can be used following developments is interactive media. Interactive media design not only to present information but also to facilitate user interaction with the content (Sugiarto et al., 2023; Ayudianti et al., 2023). One of application that can be used to create interactive media is articulate storyline. As an interactive platform, articulate storylines merge various media elements into one application and offers responsive interaction to support learning process (Daryanes et al., 2023). Articulate storyline is software-based tool that can be used communication, presentation, and learning resources it

allows users to create customized templates or provide by this application with the option to modify various characters (Rafmana et al., 2018). Therefore, the application offers flexibel design capabilities that can be adapted of the material being adapted.

Previous studies that have examined interactive learning media found that development of articulate storyline can be used to support the learning process and develop 21st century abilities (Arwanda et al., 2020). Rachmawati et.al (2020) also conducted research creates web-assited learning media can effectiv to develop student's creative thinking skills in very good category. Research conducted by create e-modul assited with articulate storyline valid and practice to improve student think critically (Saralee et al., 2024). Based on several study show that develop learning media with articulate storyline influences many skills necessary in the future.

Based on the background that has been explained, researchers will develop articulate storyline interactive learning media on mechanical waves to improve scientific reasoning. In addition, product developed will also evaluate the feasibility, practicality, and effectiveness.

Method

The research employs a Research and Development (R&D) approach. This model includes five stages: analysis, design, development, implementation, and evaluation. This reseach aimed to develop an articulate storyline interactive learning media on mechanical waves to improve student's scientific reasoning skills. The description of the research steps is:

- 1) Analyze stage: The initial analysis stage to determine the difficulties experienced in learning activities. This stages to gather essential information to support the development of product learning media. It involves analyzing needs, content, and student characteristics. To achive this, interviews and preliminary observation with teachers.
- 2) Design stage: The design stage consists of activities designing a flowchart and initial storyboard of articulate storyline interactive learning media. Research will prepare the instrument to be used for product validation and data collection.
- 3) Development stage: The development stage is creating the learning media. Expert validation will revise the media, material pedagogy. Th result of this stage is producing valid articulate storyline interactive learning media and istruments tes can be implemented in the classroom.
- 4) Implementation stage: The implementation stage refers to the process of implementation of the product

being developed. The product is applied in classrooms to determine the effectiveness of the product in improving student's scientific reasoning.

- 5) Evaluation stage: Evaluation is the stage where research data is tabulated and analyzed. At this stage, final research results and conclusions are obtained, including how to improve student's scientific reasoning and how effective valid articulate storyline interactive learning media.

This research design can be seen in Figure 1.

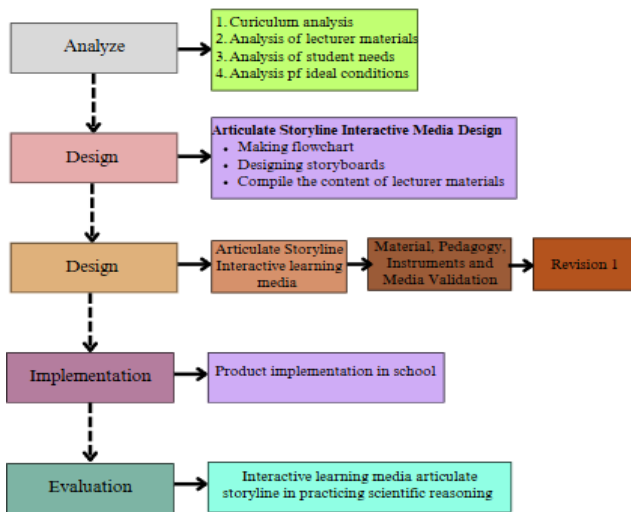


Figure 1. Flow Diagram of Interactive Articulate Storyline Media Development for Education.

Data collection

Data collection techniques used test and non-test instruments. The test instrument is multiple choice with justification to measure scientific reasoning. Besides, the non-test instruments use a questionnaire and interview sheets. Before being used, all data collection instruments have been validated by expert validators. Instrument test represents each indicator scientific reasoning. The instrument used has been declared valid and reliable.

Data Analysis

Articulate Storyline Interactive Learning Media Validity

Based on the results of the product media analysis, a Likert Scale 4 was used to rate each on all aspects that presented in table. Product media was validated by two validators, that consist physics teacher as practitioners and expert validator. The score conversion for validation result to criteria product validation is shown in Table 1.

Table 1. Criteria Validation Product

Score Intervals	Score Category
$3,25 < \bar{X} \leq 4$	Very good
$2,5 < \bar{X} \leq 3,25$	Good
$1,75 < \bar{X} \leq 2,5$	Not Good
$1 < \bar{X} \leq 1,75$	Very Not Good

Articulate Storyline Interactive Learning Media Practicality

Data from student response questionnaires can be analyzed to determine practicality. In this study, used Likert Scale with 4 alternative answers, namely 4 means strongly agree, 3 means agree, 2 means disagree, 1 means disagree. The result of student response questionnaires is calculated using the formula:

$$\% \text{score} = \frac{\text{score obtained}}{\text{Total Score}} \times 100\% \quad (1)$$

Criteria for the practicality-based student responses are presented in Table 2.

Table 2. Criteria Practicality Product

Score Intervals	Score Category
86-100%	Very practical
76-85%	Practical
60-75%	Quite practical
55-59%	Less practical
$\leq 54\%$	Impractical

The effectiveness of Articulate Storyline Interactive Learning Media

The effectiveness testing used experimental design pretest-posttest control group design. For class selection in quasi-experimental research design using cluster random sampling technique. The class design in this study show in Table 3.

Table 3. Research Design

Class	Pre-test	Treatment	Post-test
Experiment	O ₁	X ₁	O ₂
Control	O ₁	X ₂	O ₂

Note:

O₁ : Pre-test scientific reasoning

O₂ : Post-test scientific reasoning

X₁ : Learning using Articulate Storyline Media

X₂ : Learning using power point media

The result of the pretest and posttest were tested with standard N-gains to determine the increase in student's scientific reasoning. Formula to calculate N-gain:

$$g = \frac{\bar{X}_{\text{sesudah}} - \bar{X}_{\text{sebelum}}}{\bar{X}_{\text{maks}} - \bar{X}_{\text{sebelum}}} \quad (2)$$

To evaluate the impact of the articulate storyline media intervention, hypothesis testing using inferential statistical methods can be conducted. But data can ensure normal and homogenous distribution. To find out whether the pre-post result in experimental and control class differs significantly, further analysis was carried out using the Paired Sample Test (t-test) with analysis SPSS software. In addition, the size effect can be seen by

calculating Cohen's values from the tranformation of the partial eta squared value. Based on the criteria established by Cohen (1998), the effect size can be categorized according to the following classifications Table 4.

Table 4. Effect Size Eta Squared Category

<i>Eta Squared</i> (η^2)	Criteria
$0 < \eta^2 \leq 0,2$	Small
$0 < \eta^2 \leq 0,8$	Medium
$\eta^2 \geq 0,8$	Large

Result and Discussion

Articulate Storyline Interactive Learning Media

The developed media product can be accessed via an HTML web link using either a smartphone or a laptop. The media has been integrated with the PhET simulation website, which supports students in conducting virtual experiments. The Articulate Storyline includes menus for learning materials, practice questions, evaluations, and virtual laboratory activities. The outcomes from creating the interactive learning media using Articulate Storyline are as follows.:



Figure 2. Page Cover

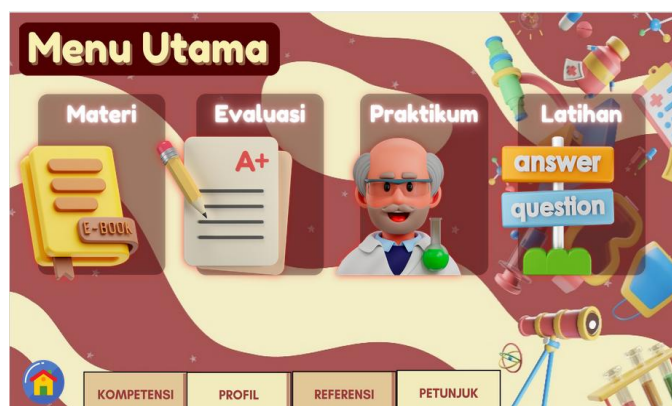


Figure 3. Main menu

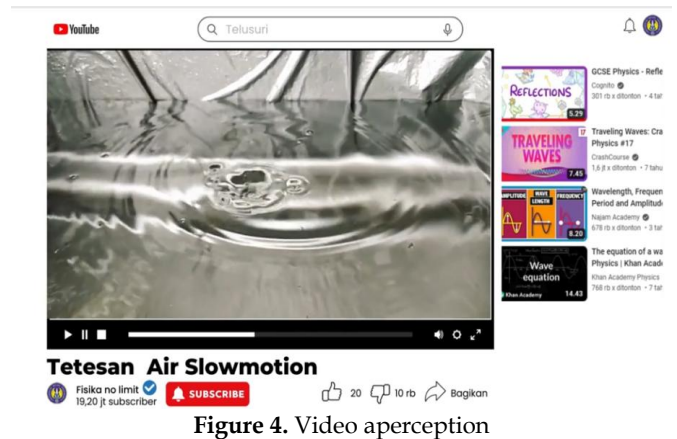


Figure 4. Video aperception

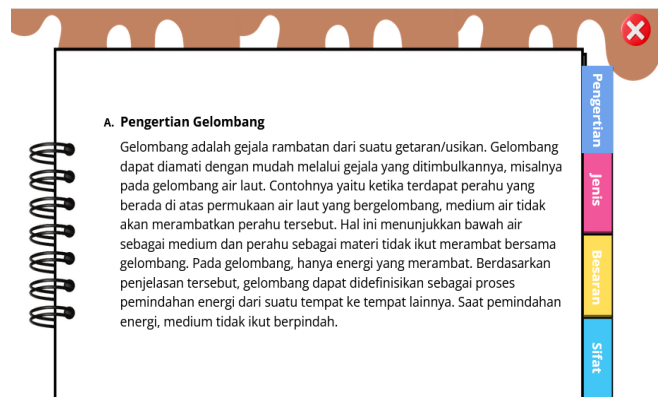


Figure 5. Material mechanical wave

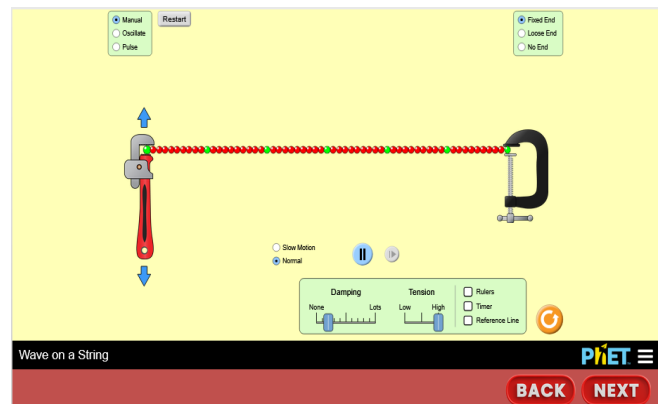


Figure 6. Practicum menu

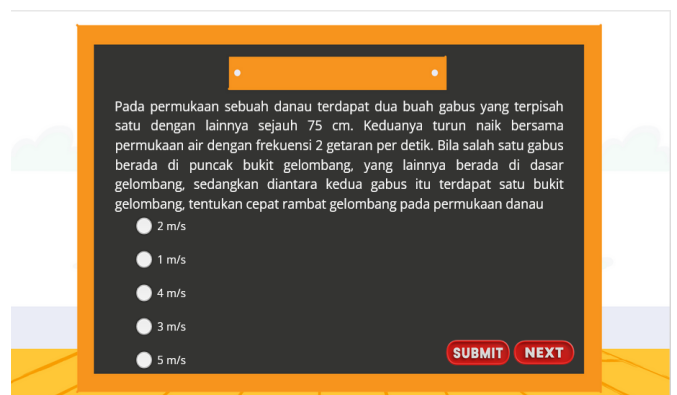


Figure 7. Exercise

Validation of Articulate Stroyline Interactive Learning Media

At this stage, the media has been created is assesed by media expert using validation instrument. After the product is assesed by expert validators, product has been revision according to the suggestions. The result of the product validation is presented in Table 5.

Table 5. Result of validators assessment product

Indicator	Average Score		Criteria
	Expert	Practicy	
Material	4.25	5.00	Very Good
Visual	4.33	5.00	Very Good
Accessibilty	4.50	5.00	Very Good
Functional	4.00	5.00	Very Good
Language	4.33	5.00	Very Good
Total average		4.57	Very Good

Practicality of Articulate Stroyline Interactive Learning Media

Table 6. Result of validators assessment product

Content Practically	Score	Criteria
Student response	90%	Very Practicall

This product media articulate Stroyline Interactive which has been declared valid is the tested to determine practicaliy. The product trial in 32 class XI student at SMAN 10 Yogyakarta. Based on practicaliy, it was found that score of the student response questionnaire was 90% with category very practical. The media were designed to facilitate learning and offer engaging instructional experiences that are accessible anytime and anywhere, based on learners' needs.

Effectiveness of Articulate Stroyline Interactive Learning Media

To assess the effectiveness of the created product by comparing students' scientific reasoning prior to and following the use of interactive learning media. Data analysis employs the Paired Sample T-Test to assess the differences between pre-test and post-test results in classroom experiments and control groups. The data follows a normal distribution; therefore, the subsequent step is to conduct a hypothesis test. The decision-making process in this paired sample t-test relies on the significance value (2-tailed).

Table 7. Paired sample t-test results

	Sig. (2-tailed)
Pre-post test	.000

Based on the table above, the significance values for scientific reasoning ability are sig >0.05. This indicates that there is a significant difference in scientific reasoning skills and between the experimental and control classes. Therefore, the use of interactive learning

media supported by Articulate Storyline software has a measurable impact on the learning process. In addition, this is also proven through the average increase test (N-gain) by comparing the increase in pretest and posttest results calculated using the N-gain index analysis.

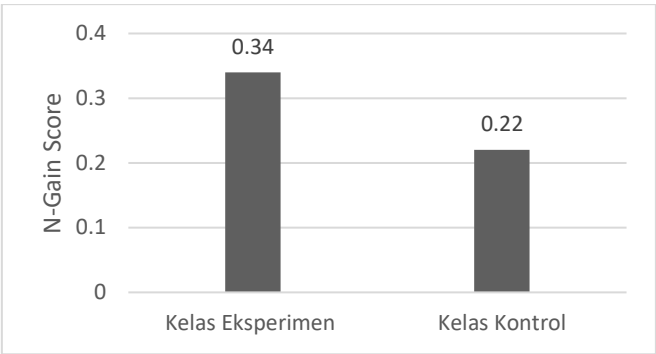


Figure 8. N-gain score scientific reasoning

Based on the diagram above, the experimental class obtained the highest N-gain score. This indicates that the class experienced a greater improvement in scientific reasoning ability compared to the control class. This improvement can be attributed to the use of the developed interactive learning media supported by Articulate Storyline software in the experimental class. Regarding the effect size can be seen on cohen's value. The result of effect size is presented in Table 7.

Table 8. Effect size value

	Partial Eta Squared	Criteria
Scientific reasoning	0.536	Medium

The contribution of the interactive learning media supported by Articulate Storyline software to the improvement of students' scientific reasoning ability and learning motivation was measured. The data showed a contribution value of 0.536 for the scientific reasoning variable, which falls within the moderate category. This is supported Indirawati Leztiyani (2021), who emphasized that Articulate Storyline 3, as an interactive medium, can enhance student engagement through various practical features and tools that support a more enjoyable learning experience. Moreover, using HTML5 as the publishing platform supports this method, as HTML5 allows for the incorporation of rich multimedia elements like audio, video, and animations, which improves the interactivity and efficacy of learning materials created with Articulate Storyline (Moriska & Hanif, 2024; Mayrita et al., 2024). One of the advantages of this medium is its flexibility, enabling both teachers and students to access learning materials without being constrained by spatial or temporal limitations, as it is available anytime and anywhere (Hastuti et al., 2021;

Aspahani et al., 2020). Furthermore, Implementation of articulate storyline is effective to enhance student's scientific reasoning.

Conclusion

The use of Articulate Storyline-based interactive learning media on the topic of mechanical waves has a significant impact on improving scientific reasoning compared to conventional instruction. The results of the N-Gain test indicate that the experimental class utilizing the media product demonstrated a higher increase. Furthermore, the developed media following validation and student feedback was declared valid, practical, and effective in enhancing students' scientific reasoning skills.

Acknowledgments

All authors would like to express their gratitude to everyone who has contributed to this research.

Author Contributions

J contributed to media development, data analysis, and the writing of the scientific article; while P supervised the research process and provided input on the developed product.

Funding

This study did not obtain any financial support from outside sources.

Conflicts of Interest

The author declares no conflict of interest.

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