Journal of
General Education Science

BERPUSI PUBLISHING

Open Access

Vol 3 No 1 2025
Page 280-290
ISSN 2963-0096

Development of Interactive Learning Media Based on Articulate Storyline on Temperature, Heat, and Expansion Materials With The Wasaka Stem-K Learning Model

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ABSTRACT
The research on the development of *articulate storyline* media with the STEM-K WASAKA learning model on temperature, heat, and expansion material aims to describe the validity, practicality, and effectiveness of interactive learning media. This study uses the Research and Development (R&D) method with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model. Data collection techniques use expert validation sheets, teacher response questionnaires and student response questionnaires, and test questions. This study produced: (1) the validity score of the *articulate storyline* interactive learning media was 95.98% with a very valid category; (2) the practicality score of the *articulate storyline* interactive learning media was 95.94% by teachers and 88.33% by students, indicating very practical criteria; (3) the effectiveness score of the *articulate storyline* interactive learning media was obtained from the pretest and posttest values with an N-gain score of 0.7 which was categorized as very effective. Similar learning can be used and developed on other materials in science subjects and other subjects. Thus, teachers can utilize *articulate storyline* as an alternative interactive learning media that supports conceptual understanding and trains students' skills. Based on these results, it can be concluded that the *Articulate Storyline* media for temperature, heat, and expansion materials is stated to be very valid, very practical, and very effective for use in science learning for junior high school grade VII.

Keywords : Media *articulate storyline* , STEM-K WASAKA learning model, temperature, heat, expansion

Introduction

Physics instruction on temperature, heat, and expansion at the junior high school level is still dominated by the lecture method with the aid of presentation media such as PowerPoint (PPT). This method is chosen because it is considered efficient and easy to implement, but it has limitations in terms of interactivity and depth of conceptual understanding. In the context of the Independent Curriculum, which emphasizes active and meaningful learning, this approach is considered suboptimal in improving students' analytical thinking and 21st-century skills (Hidayat, 2022; Tambak, 2022). One of the main weaknesses of the lecture method is its one-way nature, where the teacher is the center of information and students are passive. This hinders students' active involvement in building an understanding of abstract, contextual concepts, such as the relationship between temperature, heat, and expansion in everyday phenomena. The lack of exploratory activities, discussions, or experiments in learning tends to make students' understanding rote and non-applicable. In terms of learning media, interviews with science teachers indicate that learning resources are still limited to printed modules and PowerPoint presentations. Printed modules, while

structured, lack interactive visualizations, while PowerPoint presentations often present only static text and images, under-supporting conceptual understanding that requires visual dynamics. According to Putri (2023), the use of static media such as PowerPoint presentations is ineffective for explaining physical phenomena that require simulations or demonstrations and can lead to misconceptions. Furthermore, lecture methods and presentation media do not provide direct feedback on student understanding. When teachers present a formula such as $Q = m \cdot c \cdot \Delta T$, not all students can apply it without active practice or experimentation. This limitation is further exacerbated by the lack of facilities and teachers' skills in developing engaging media (Supriyadi et al., 2022).

This situation demonstrates the need for a participatory and experience-based learning approach, both in terms of teaching strategies and media development. Approaches such as Problem-Based Learning, Discovery Learning, or STEM-based learning can increase student participation through experiments and problem-solving activities. Interactive media such as e-modules, PhET simulations, or experimental videos can facilitate visualization and strengthen conceptual understanding (Azmi et al., 2024; Wati, 2024). A specific learning strategy with potential for integration into this context is the STEM-K WASAKA concept, which consists of the syntax of Convey, Discover, Elaborate, Monitor, and Develop. This model is adapted from Karismaku learning, which integrates character values and local wisdom. STEM-K WASAKA guides students not only to understand scientific concepts but also to connect them to real-life and local contexts (Rusilowati et al., 2022). To support the implementation of this model, interactive and flexible learning media are required. *Articulate Storyline* is software that enables the development of interactive digital content, complete with audio, video, animation, and quiz elements. This educational tool has proven successful in maximizing student *engagement* and learning *outcomes (Safira et al., 2021)*. However, based on a review of the existing literature, no studies have been found that explicitly construct educational media using *Articulate Storyline* integrated with the STEM-K WASAKA approach for the discussion of temperature, heat, and expansion at the junior high school level. This material requires in-depth visualization and contextual methods. Therefore, the creation of interactive learning media through *Articulate Storyline* with the STEM-K WASAKA model is an urgent need to address the challenges of science learning in the Independent Curriculum era. This study aims to produce learning aids that have validity, practicality, and effectiveness as a creative solution in strengthening the learning process that is interactive, contextual, and oriented towards strengthening character and local wisdom.

Research Methodology

This research is categorized as research and development (*R&D*) that seeks to develop interactive learning aids through *Articulate Storyline* using the STEM-K WASAKA learning model on the topic of temperature, heat, and expansion for junior high school level. The development approach model implemented is the ADDIE framework which has five stages: Analysis, Design, Development, Implementation, and Evaluation (Apriliani, 2022). In the analysis stage, researchers conducted a preliminary study involving interviews with science teachers and classroom observations to identify learning needs, barriers encountered, and student characteristics. The analysis results were used as the basis for developing interactive learning tools using the *Articulate Storyline platform*, which aligns with the Merdeka Curriculum and the WASAKA STEM-K approach (Rustandi, 2021). The design stage includes developing a learning flow and media display according to the STEM-K WASAKA syntax: *Convey*, *Discover*, *Elaborate*, *Monitor*, and *Develop*. The main objective of the design stage is to develop an initial design for appropriate educational media according to student demands, the characteristics of the content, and the learning approach used (Habibi & Setyaningtyas, 2021). Furthermore, evaluation tools are designed in the form of initial and final test instruments, as well as a questionnaire to measure the practicality of the media. *Articulate Storyline* software. The media included animation, narrative audio, experimental videos, and interactive quizzes. The development results were verified by three experts: a content expert, a media expert, and a learning expert. A validation process was conducted to ensure the appropriateness of the content, visual appearance, and integration with the learning syntax. The implementation phase was conducted through small-scale trials with teachers and large-scale trials with purposively selected seventh-grade junior high school students. The implementation process included media use in learning, implementation observations, questionnaire responses from teachers and students, and the implementation of initial and final exams. The evaluation phase was conducted to measure the quality of the media in terms of validity, practicality, and effectiveness. The evaluation was formative and summative to improve and measure the final results of the developed media.

The target of this research is the teachers and students of class VII E of SMP Negeri 5 Banjarmasin. The research execution was carried out in the even semester of the 2024/2025 academic period, precisely between May and June 2025. The research was conducted at SMP Negeri 5 Banjarmasin. Address: Jl. Belitung Darat RT. 19 No.132. RT / RW: 19 / 0. North Belitung Village. West Banjarmasin District. Regency, Banjarmasin City, South Kalimantan 70116. The tools used to collect information or measure objects from a research variable are usually called research instruments (Muslihin *et al.,* 2022). The tools and instruments used in this research consist of: Interactive learning tools using the *Articulate Storyline platform* ; The pretest and posttest questions consist of 15 multiple choice items; Media validation instrument for content experts, media experts, and learning experts;

Educator and student response questionnaire. The data analysis method in this research includes an analysis of the validity of the learning media, each element of the learning media is evaluated by a validator expert with a value range of 1 to 5. The formula used in analyzing the validation data is as follows:

$$V = \frac{Tsh}{Tse} x100\% \text{..... (1)}$$

(Ikrimah, 2023)

Explanation:
V = Percentage of Validity Level
Tse = Total empirical score (Maximum score amount)
Tsh = Total expected score (Total score of validator's review)
This development research involved three experts as validators. To determine the overall percentage, the researchers calculated combined validity using the following formula:

$$\mathrm{V} = \frac{\mathrm{V1} + \mathrm{V\,2} + \mathrm{V3}}{3} \text{..... (2)}$$

A research instrument is deemed valid (good/adequate) when the combined validation results indicate a percentage above 70%. However, if the validator recommends revisions, the researcher can implement the improvements first. Validity testing is conducted using a developed validity evaluation sheet and reviewed against validity benchmarks.

Table 1. Learning Media Validity Categories

Validity Criteria	Validity Level
Very Valid, or can be used without revision	85.01%-100.00%
Fairly Valid, or can be used with minor revisions	70.01%-85.00%
Less valid, it is recommended not to use it because it needs major revision.	50.01%-70.00%
Invalid, or may not be used	01.00%-50.00%

(Ikrimah, 2023)

The analysis of the practical aspects of learning media was conducted through a questionnaire of educator and student responses. Each item in the questionnaire was evaluated using a Likert scale of 1-5, with a value of 1 indicating "very impractical" and a value of 5 indicating "very practical." The formula used to calculate the percentage of practical aspects is as follows:

$$\text{Practicality (\%)} = \frac{\text{Skor Total Diperoleh}}{\text{Skor Maksimal}} x\ 100\% \text{..... (3)}$$

Information:
The total value obtained = the sum of the values given by all respondents for all questionnaire items.
Maximum score = number of respondents × number of questionnaire items × highest score per item (5 if using a Likert scale of 1–5).

Table 2. Practicality Result Interpretation Criteria

Percentage (%)	Category
81 – 100	Very Practical
61 – 80	Practical
41 – 60	Quite Practical
21 – 40	Less practical
0 – 20	Impractical

(Ikrimah, 2023)

The analysis of the effectiveness of learning media is measured from the learning outcome test by conducting *a pretest* and *posttest* . To determine the improvement in the results of the students' intellectual learning process, the average *pretest* and *posttest data* is calculated by applying the Maltzer (2002) *normalized* gain formula which is presented as follows.

$$(g) = \frac{posttest\ score - pretest\ score}{maximum\ score - pretest\ score} \text{..... (4)}$$

N-gain value obtained can then be interpreted as in the table below:

Table 3. Normalized gain score categories

N-gain score	Category
$g < 0.7$	High or very effective
$0.3 \leq g < 0.7$	Moderate or effective
$g < 0.3$	Low or moderately effective

(Nita, 2020)

Results and Discussion

The output of this research is an interactive educational media assisted by *Articulate Storyline* for the discussion of temperature, heat, and expansion with the STEM-K WASAKA learning model. The preparation of this learning media adopts the ADDIE approach, which includes five phases, namely the analysis phase, design phase, development phase, implementation phase, and evaluation phase. This research is intended to determine the level of validity, practicality, and effectiveness of the product. The developed product was then tested on teachers and class VII E of SMP Negeri 5 Banjarmasin consisting of 29 people in measuring its validity, practicality, and effectiveness.

Validity Results

Based on this research, the validation process was carried out by collecting data from three expert media validators. This validator team consisted of two lecturers from the Science Education Study Program, FKIP ULM, and one educator from SMP Negeri 5 Banjarmasin. The learning media validation process involved six assessment dimensions. The validity data obtained from the validators can be seen below:

Table 4. Results of Learning Media Validation by Experts

No	Assessment Indicators	Validator Score			Validity Percentage (%)	Category
		V1	V2	V3		
1	Content Aspect	23	22	24	92.00	Very Valid
2	Presentation Feasibility Aspect	10	9	10	96.67	Very Valid
3	Language Feasibility Aspects	15	14	15	97.78	Very Valid
4	Display Design Aspects	50	45	50	96.67	Very Valid
5	Interactivity Aspect	15	14	15	97.78	Very Valid
6	Convenience Aspect	20	18	19	95.00	Very Valid
	Average				95.98	Very Valid

Referring to the results of the learning media evaluation by three validator experts, all analyzed aspects, namely content, presentation, language, display design, interactivity, and ease of use, obtained the "Very Valid" category with a validity percentage ranging from 92.00% to 97.78%. The average overall validity percentage was 95.98%, which indicates that the learning media is considered very suitable for implementation in learning activities. The validator team provided various input for improvements to the learning media, including: adapting images to the surrounding environment, improving key words for each topic, increasing the number of questions, providing instructions on the main menu, and completing learning objectives. These suggestions served as the basis for the media revision process to maximize its effectiveness and align with student interests.

Practicality Test Results

Media practicality was measured through a questionnaire of educator responses and student responses. The practicality of the learning media, according to educator responses, included aspects of content/material accuracy, visual presentation, interactive features, grammar, curriculum suitability, and practicality of media use. The practicality results are observed below:

Table 5. Practical Results by Teachers

Assessment Aspects	Practicality Percentage (%)	Practicality Criteria
Content/Material Suitability Aspects	96.67	Very Practical
Visual Appearance Aspect	95.00	Very Practical
Interactivity Aspect	95.00	Very Practical

Language Aspects	97.50	Very Practical
Aspects of Conformity to the Curriculum	97.50	Very Practical
Practical Aspects of Media Use	95.00	Very Practical
Average (%)	95.94	
Practicality Criteria	Very Practical	

Practicality test data from teachers indicates that this learning media falls into the "Very Practical" category, achieving a practicality rating of 95.94%. These results confirm that the media is easy for educators to apply in their learning and is appropriate for the content and approach used. Teachers received positive feedback, as follows: Teacher feedback was very positive. Teachers found the media engaging, interactive, and facilitated the understanding of science concepts such as temperature and heat through the animations and simulations provided. Furthermore, teachers appreciated the STEM-K approach, which connects learning to real life and local culture, and noted that such media is still rarely available in schools. Students also noted practicality, as noted below:

Table 6. Student Practical Results

Assessment Aspects	Practicality Percentage (%)	Practicality Criteria
Content/Material Suitability Aspects	91.09	Very Practical
Visual Appearance Aspects	90.23	Very Practical
Interactivity Aspect	86.78	Very Practical
Language Aspects	87.93	Very Practical
Practical Aspects of Media Use	86.21	Very Practical
Average (%)	88.33	
Practicality Criteria	Very Practical	

The data also indicated that this learning media received a "Very Practical" rating of 88.33%. This finding demonstrates that students found the content easy to understand and relevant. The media was highly accepted by students in the learning process. Positive responses from students indicated that the media was engaging, interactive, and helped them better understand concepts. Furthermore, the language used was easy to interpret, the images were relevant to everyday life, and the media provided a fun learning experience, which even motivated them to study harder.

Effectiveness Test Results

The learning achievement test consisted of 15 multiple-choice questions, and the results were analyzed using an average calculation using N-gain. A trial was conducted with 29 students to determine the effectiveness of the formulated learning media. The results of the n-gain test calculation were as follows:

Table 7. N-Gain Test

	Pretest	Posttest	Posttest-Pretest	Ideal Score (100-pre)	N-Gain Score
Mean	41.34	82.45	41.11	58.66	0.70

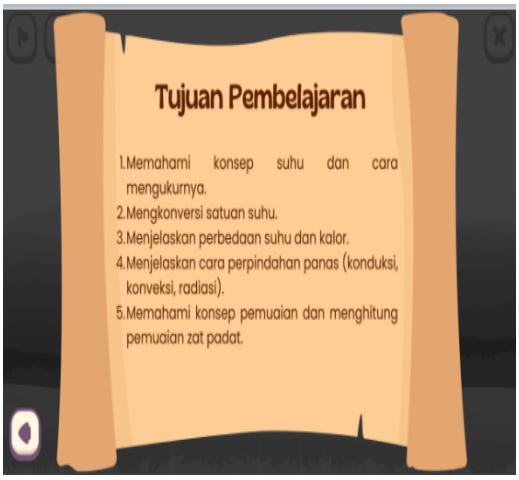
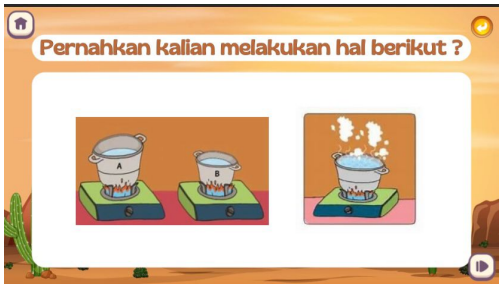
This table indicates that the implementation of the designed learning media positively impacted student learning outcomes. The average score for the initial exam was 41.34 and the final exam was 82.95, indicating an increase. The N-Gain value, which is in the high category of 0.7, indicates that the media was effectively used by students.

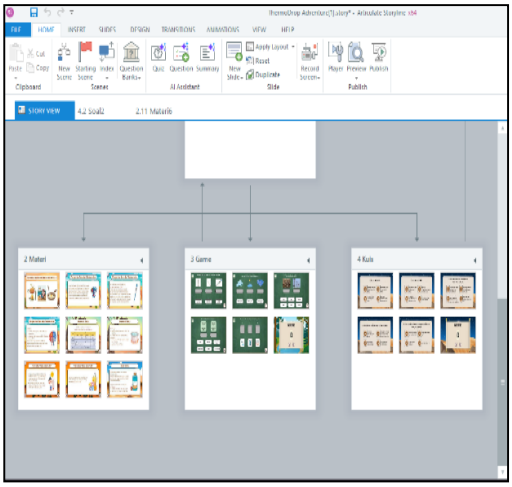
The results of this research development are interactive learning media based on *articulate storylines on* temperature, heat, and expansion content using the STEM-K WASAKA learning model. This research was conducted based on the ADDIE approach model procedure, which includes the stages of analysis, design, development, implementation, and assessment (Salamah et al., 2020). However, it not only produced interactive learning media production results but also produced data on validity, practicality, and effectiveness. The results of this study are directly proportional to the investigation of Mufidah & Khori (2021), which presented that the *Articulate Storyline media* was validated by substance validators by 90%, media validators by 84.7%, and practicality testing by learning practitioners by 88%, and field testing by 95%, all of which were in the very feasible and very effective categories. These findings are also corroborated by research by Syah et al. (2020), which explains that the *Articulate Storyline media* achieved a validity score of 94.14% and a student evaluation result of 92.87%, both of which are categorized as very feasible . Thus, the media developed in this study has proven to be of high quality and suitable for use in the learning process.

Media Validity

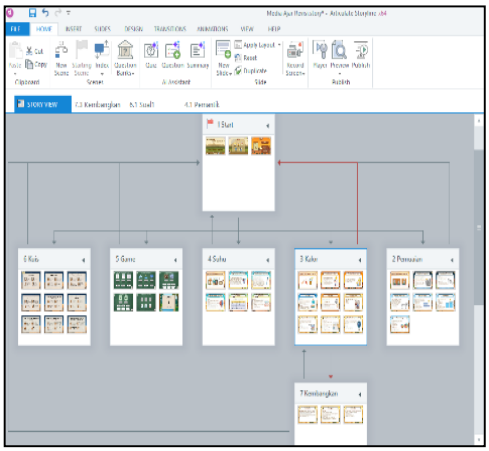
Interactive learning media based on *Articulate Storyline* was validated by two lecturers from the Faculty of Teacher Training and Education, Universitas Muhammadiyah Yogyakarta (FKIP ULM) and one teacher from SMP Negeri 5 Banjarmasin. Validation was conducted on six aspects. The validation results revealed that the media was categorized as highly valid. This validity indicates that media features such as color, images, audio, animated videos, and interactivity have attracted and aroused students' interest in learning (Rahayu & Ulumiyah, 2021; Indriani et al., 2021). Furthermore, the media was also considered easy to operate via various gadgets, both notebooks and mobile phones, and can be applied anytime and anywhere (Safira et al., 2021; Sudargini & Purwanto, 2020). This finding is supported by Havizul's (2020) statement that content presented through interactive media can support student understanding. Widiastika et al. (2021) also stated that attractive visualizations, color, animation, and video in learning media can optimize student understanding and learning outcomes. Even though it was categorized as very valid, researchers still implemented improvements based on the suggestions of validator experts to perfect the media before implementation (Rohmah & Buhari, 2020). The results of the improvement of the *articulate storyline media* on the content of temperature, heat and expansion can be examined in the description below:

Table 8. Articulate Media Storyline Revisions

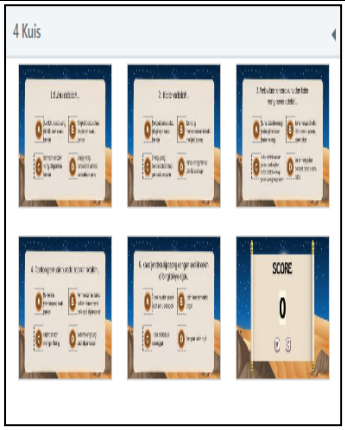
Before Revision	After Revision
 Learning objectives are not complete	 Completing learning objectives
 The lighter has only one question	 Igniter on temperature material
 Igniter on expanding material	 Igniter on heat material

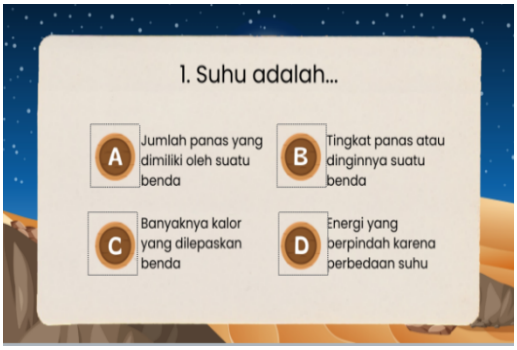


Storyboard view before adding questions

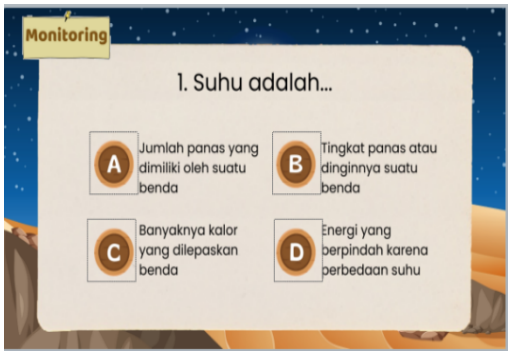


Storyboard view after adding questions

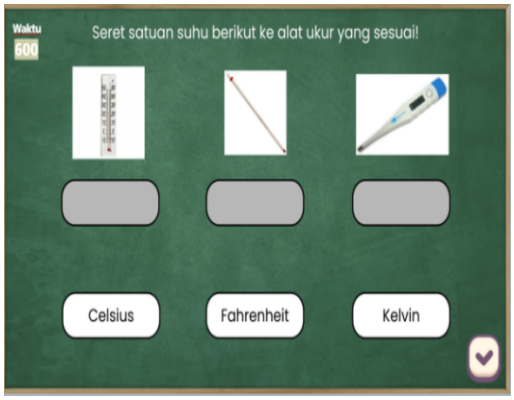




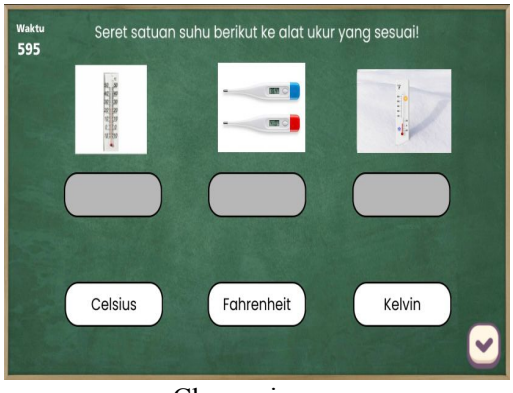
The evaluation questions only consist of 5 questions



Adding questions to 15 questions



Drag and drop image is not suitable



Change image

In accordance with the responses and guidance provided by several validator experts, improvements are necessary to achieve the feasibility of the developed tools and instruments. This aligns with Bombang et al.'s (2022) statement

that validation data serves as a reference for improvements in optimizing the developed learning tools.

Media Practicality

Media practicality is reviewed in terms of practicality of use, both by educators and students, as well as from its application in meaningful, interesting learning activities that can enhance creativity (Annur & Sari, 2024). The practicality test of interactive media with the *Articulate Storyline platform* on the topic of temperature, heat, and expansion was implemented through teacher *feedback surveys* (preliminary phase) and students (main phase). Five science teachers of SMP Negeri 5 Banjarmasin responded with a practicality score of 95.94% (very practical category), covering aspects of content, visuals, interactivity, language, curriculum suitability, and ease of use. Meanwhile, the test on 29 students of class VII E resulted in a score of 88.33% (very practical category), with similar assessments on these aspects. This media is also adapted to the STEM-K WASAKA learning model and has proven practical to apply in a real classroom context.

Media Effectiveness

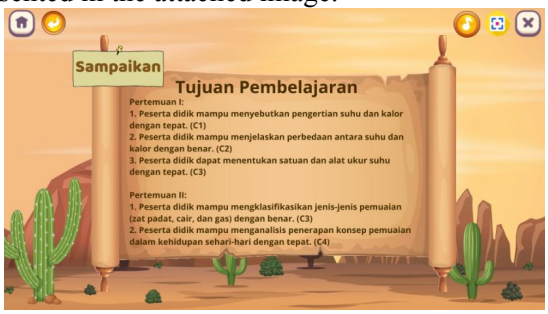
The effectiveness test of learning media was carried out by comparing the results of the pretest and posttest of students using interactive media based on *the Articulate Storyline Application* based on learning methods. STEM-K WASAKA. Learning achievement assessment is applied at the beginning and end of the learning activities to see the improvement of students' understanding of the material of temperature, heat, and expansion. Based on the implementation of a comprehensive field test on 29 students of class VII E of SMP Negeri 5 Banjarmasin, the average initial assessment score was 41.34 and the final assessment was 82.45. Calculations using the N-Gain test resulted in a score of 0.70 which is included in the very effective category. This media not only successfully optimized learning achievement but also created a more active, enjoyable, and contextual learning experience. Students appeared more enthusiastic, actively engaged, and demonstrated a better understanding of the material after using the media. Therefore, it can be concluded that the developed learning media is effective for use in the science teaching and learning process, particularly in the topics of temperature, heat, and expansion.

WASAKA STEM-K learning model based on articulate storyline

The WASAKA STEM-K model is a learning model that integrates science materials with local wisdom on peatland fire mitigation, applying STEM *(Science, Technology, Engineering, and Mathematics) concepts* to the science education process (Annur, 2022). This model consists of five learning phases: Convey, Discover, Elaborate, Monitor and Evaluate, and Develop (Annur, 2022; Rusilowati, 2023). In this study, the material on temperature, heat, and expansion is used as the context for integrating the STEM-K WASAKA model into *Articulate Storyline -based media* . In the Convey phase, the teacher conveys the objectives and builds students' motivation and Wasaka character. The Discover and Elaborate phase encourages students to find connections between the material and STEM elements and local values, as well as to design simple technology-based solutions. The Monitoring and Evaluation phase involves the teacher in monitoring learning activities and evaluating the achievement of objectives. The Develop phase concludes with activities to design a final assignment and reflect on learning (Rusilowati, 2023). The development of this media uses the complete syntax of the STEM-K WASAKA model as a learning structure in the media being developed.

a. Convey

Stroyline articilate media contains the STEM-K WASAKA learning model with convey syntax. The display of convey syntax in the media is presented in the attached image.



Picture 1. Syntax Conveyed in Learning Media

The articulate storyline media has a learning objectives page that contains learning objectives for teachers and also contains a syntax for delivery based on the STEM-K WASAKA learning model, where a teacher delivers learning objectives with the hope that learning objectives can be achieved, not only conveying the educator but also motivating students to be directly involved in learning.

b. Find out

Stroyline articilate media contains the STEM-K WASAKA learning model with discover syntax. The

appearance of the discover syntax in the media is presented in the attached image.

Picture 2. Syntax of Finding in Learning Media

The articulate storyline media contains video pages on the heat material, a video in the form of "processed fish as a companion to prevent stunting" and also contains syntax find. The video contains news events on traditional fish preservation with smoking techniques, in Kalimantan itself this smoking technique is often used by the Banjar community to preserve caught fish. In this phase, educators guide students to identify the relationship between learning content and local cultural values contained in the video. This is based on the syntax of the STEM-K WASAKA learning model used, where students find the relationship between STEM science learning materials and local wisdom.

c. Elaboration

Stroyline articilate media contains the STEM-K WASAKA learning model with elaboration syntax. The elaboration syntax display is presented in the attached image.

Picture 3. Elaboration Syntax in Learning Media

The articulate storyline media contains an assignment page on the heat material and there is an elaboration syntax, the assignment page directs students to create a simple fish smoking tool design either manually or digitally in the form of an A3-sized poster. This is based on the learning model used where the elaboration syntax, the teacher provides opportunities for students to express ideas, thoughts, and creations in expressing concepts or cognitive domains.

d. Monitoring & Evaluation

Stroyline articilate media contains the STEM-K WASAKA learning model with Monitoring & Evaluation syntax. The display of monitoring & evaluation syntax in the media is visualized in the displayed image.

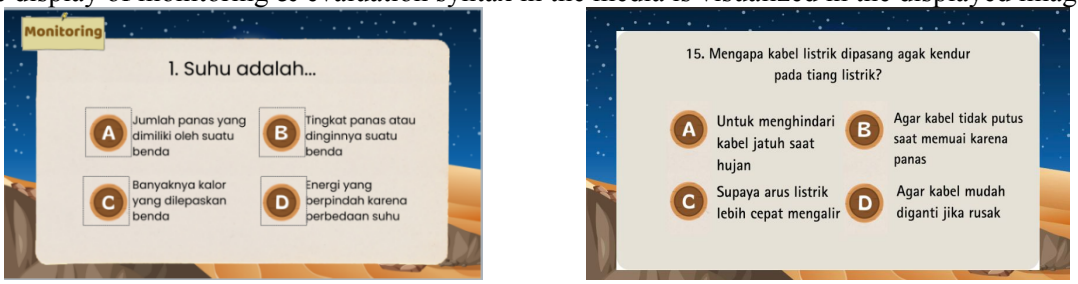


Figure 4. Monitoring & Evaluation Syntax in Learning Media

Media *articulate sroryline* contains a *multiple choice* question page with 15 questions and also contains a monitoring syntax. The Monitoring phase is part of the syntax of the STEM-K WASAKA learning model, in this phase, monitoring is carried out on the level of achievement of learning objectives by students after the implementation of learning activities . In this research, the Monitoring phase is implemented through the presentation of evaluation questions containing multiple choice questions in order to measure students' mastery of concepts on the content of temperature, heat, and expansion. Through this phase, an overview is obtained of the extent to which students are able to understand the material after applying the *articulate storyline*- based learning media that has been prepared . In addition, the monitoring phase also functions to assess the effectiveness of the learning media, whether the media is able to improve learning outcomes and support development. The Monitoring phase not only operates as a learning outcome assessment tool, but also as a forum for reflection and evaluation of the quality of the

media and the learning process.

e. Develop

The Develop phase is the final stage in the syntax of the WASAKA STEM-K learning model, which focuses on students' activities in summarizing learning outcomes and designing prototypes or solutions based on previously created designs. In this phase, educators act as mentors, guiding students to integrate the knowledge and skills they have acquired into a tangible product. This activity is illustrated in the following figure:

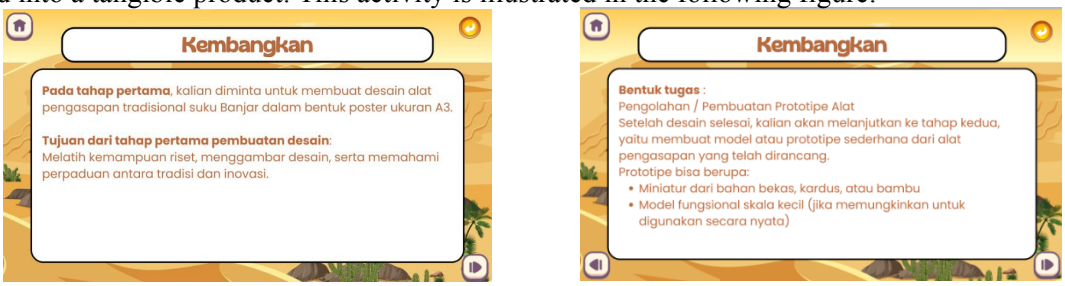


Figure 5. Syntax Development in Learning Media

The Develop Assignment Display, which is designed to encourage students to develop ideas into simple works or prototypes. However, in the implementation of this study, the Develop phase could not be realized optimally due to limited time allocation and the scope of the trial. In addition, the implementation of this phase requires additional time and supporting equipment that could not be facilitated during the trial process. Therefore, although it has been designed in the learning flow, the Develop phase cannot be implemented comprehensively in this study, but it is still included as part of the learning design to demonstrate the potential for further development that can be carried out in actual classroom application.

Conclusion

Referring to the results of the study and development of interactive learning media based on *Articulate Storyline* in the discussion of temperature, heat, and expansion using the ADDIE model, several conclusions were obtained. First, data from expert validation revealed that the media developed had very good validity with an achievement of 95.98%, therefore it is suitable for use in learning activities. Second, from a practicality perspective, *the feedback from* educators and students' questionnaires showed scores of 95.94% and 88.33%, respectively, which are included in the very practical category, indicating that the media is easy to use and supports the learning process. Third, the media was declared very effective based on the N-Gain value reaching 0.70 which indicates a significant increase in students' mastery of concepts and skills through the STEM-K WASAKA approach.

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