Development of Articulate Storyline Media on Biodiversity Content Featuring Tropical Rainforests to Enhance Students' Critical and Creative Thinking Skills

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Abstract: This research aimed to develop and assess the practicality and effectiveness of the Articulate Storyline Media (ASM) for teaching biodiversity, focusing on tropical rainforest content, for 10th-class students. The study applied the Research and Development (R&D) method using the ADDIE model (Analyze, Design, Develop, Implement, and Evaluate). Data collected were student responses for practicality and test results in assessing critical and creative thinking skills. Results showed that the interactive media achieved a practicality rating of 74% and 100% for the students and teacher, respectively. The effectiveness of the ASM in enhancing the creative thinking skills in the experimental class was significantly ($p<0.000$) higher, i.e., 89%, compared to 65% in the control group. These findings indicate that the Articulate Storyline media on biodiversity content efficiently and effectively enhances 10th-class students' critical and creative thinking skills.

Keywords: Biodiversity; Creative thinking; Critical; Humid tropical forests; Media articulate storyline

Introduction

The Latin word "medio" is the root of the term "media," which means "between." specifically, this term can describe communication tools that transmit data from one source to a recipient (Netriawati & Lena, 2017; Sutarman, 2009).

In today's digital era, transforming the educational field has become increasingly essential to meet the needs of the times. Innovative learning is required to cater to students' diverse needs and advance technology. The development of digital learning media can facilitate modern, interactive learning that makes the process more engaging and effective. With Android digital devices, learning can be accessed anytime and anywhere, enhancing the quality and efficiency of education by enabling students to deepen their understanding independently (Rofi'i, 2023). Examples of digital learning media applications that have been developed include Khan Academy, Quizizz, Duolingo, Google Classroom, Brilliant, and many others.

Digital learning media offers several advantages, as its features strongly support efficient and practical learning, keep pace with ongoing information developments, and can be accessed anytime and anywhere. This portability makes it ideal for acquiring general knowledge and learning new things wherever and whenever. Additionally, digital learning can be more cost-effective using existing digital devices (Daeng et al., 2017; Payo et al. 2019; Chusni, 2018; Mayanti et al., 2023; Nielsen, 2010; Pangestu et al., 2024; Wati & An, 2020; Yasmin et al., 2019). Advances in the digital

industry have created more sophisticated devices with higher specifications, opening doors for developers to create more complex and engaging applications and content.

Smartphone applications are software designed to work with operating systems developed by Google. They can be installed on smartphones, tablets, and other Android devices (Laia, 2023; Arsyah et al., 2019). Smartphone applications can be practical teaching tools that enhance students' self-capabilities and improve their academic performance (Iqbal & Mutawakkil, 2021).

Articulate Storyline is one of the effective ways to improve and deepen knowledge virtually, through constructivist and fun learning. Mastery of 21st-century skills, including students' critical thinking skills, and learning by including elements of games, videos, and simulations that can be accessed via Android smartphones, has been proven to improve students' self-regulation in learning. Mastery of 21st-century skills can be achieved through learning that pays attention to student's emotional and mental health needs, namely by including elements of games in learning. Articulate Storyline is a solution that facilitates students' learning online or offline according to their learning needs (Heliawati et al., 2022).

Articulate Storyline offers interactive quiz creation, video, and animation that enhances material delivery more efficiently and meaningfully. This software allows lesson content to be presented more visually and attractively, aiding students in understanding abstract or complex concepts. Thus, an Articulate Storyline is expected to positively contribute to the learning process.

The advantages of Articulate Storyline include its relatively easy creation mechanism, as the item functions are like those of PowerPoint. Audio, video, and various files can be imported or added to the application. Additionally, Articulate Storyline allows for creating quizzes in various formats (Agustina et al., 2022; Christina & Ganing, 2021; Safira et al., 2021; Saputri et al., 2018).

Based on the explanation above, the Articulate Storyline platform can be used as a learning medium that assists students, particularly in writing material, facilitates collaboration and communication, increases student participation in the learning process, stimulates motivation, and enhances students' academic performance (Widyaningrum et al., 2022; Hamidi & Chavoshi, 2018).

The right learning media to use in the current digital era is an Articulate storyline. Interesting media can help students explore and understand the information provided rather than just receiving material delivered by the teacher through the lecture method.

This can help teachers and students achieve learning objectives (Chaeruna et al., 2024).

Tropical rainforests are found in several regions of Indonesia, one of which is East Kalimantan. Indonesia's tropical rainforests are home to an exceptionally high level of biodiversity, including flora and fauna unique to the country. These forests play a crucial role in providing various ecosystem benefits. The primary functions of tropical rainforests include serving as habitats for millions of plant and animal species, acting as significant carbon sinks in both biomass and soil, contributing to local and global climate regulation, supplying oxygen, regulating the water cycle to reduce the risk of floods and droughts, providing food resources, serving as locations for ecological tourism and research, and preserving genetic diversity (Subagiyo et al., 2019).

Biodiversity literacy refers to knowledge and understanding of the concept of biodiversity and relevant behaviors that contribute to biodiversity conservation. The goal is for students to recognize the value of forest ecosystems. In this example, students should be aware of the social value of forests as places for recreation and nature experiences (Schneiderhan-Opel & Bogner, 2020).

Biodiversity content in education aims to understand the importance of natural resources and to use them sustainably. With biodiversity education, individuals recognize the functions of ecosystems. Thus, they learn about what needs to be done for a sustainable ecosystem. Because the importance of biodiversity and why it should be protected will be better understood, allowing students to understand that biodiversity education is not just about species diversity or ecosystem diversity (Derman, 2023).

Critical thinking skills are the ability to design and solve problems by making improvements or changes and generating new ideas. Creative thinking dramatically assists students in developing new ideas based on existing or previously acquired knowledge to solve problems from different perspectives (Mokambu, 2021; Sulistyowati, 2023; Lijanporn & Khlaisang, 2015; Afandi & Handayani, 2020; Erisa, 2021; Gunawan et al., 2021; Sulastri et al., 2022; Surya et al., 2018; Wulandari et al., 2019; Ngalimun, 2016).

Critical thinking is an individual's ability to manage their cognitive processes and develop a system of thinking in intellectual standards such as clarity, accuracy, depth, significance, precision, relevance, and logic. Critical thinking is a process that requires logical decision-making through reasoning about the actions to be taken in a situation or idea to be believed emphasizing the skill dimension and stating that critical thinking consists of effective strategies that guide individuals to think independently and cognitive

strategies consisting of micro-skills and macro abilities (Korukluoglu et al., 2022).

There are several ways to assess students' critical thinking skills in the classroom, and one is through essay tests, where students' answers are scored using a critical thinking skills rubric. According to Ennis (2011), there are six fundamental indicators of critical thinking skills: (1) Focus, where students recognize the core of the current situation so they can conclude. (2) Reason, where students provide reasons to support their conclusions. (3) Inference, where students follow specific steps to make logical inferences. (4) Situation where students express essential factors to consider when evaluating or making decisions. (5) Clarity, where students explain the terms used in their arguments. (6) Overview, where students examine the reasonableness of all those steps. Critical thinking can help students make careful judgments and solve everyday problems (Mahanal, 2019).

Creative thinking is often essential in learning, as many topics are closely related to the need to use and apply creative thinking skills. These skills are demonstrated when students develop known ideas by exploring various alternative solutions. Creative thinking in problem-solving can be assessed based on three components: fluency, flexibility, and originality (Heriyanto, 2020).

There are five indicators of creative thinking skills: (1) Fluency: the ability to generate ideas, methods, suggestions, questions, and alternative answers smoothly within a given timeframe; (2) Flexibility: the ability to produce a variety of ideas, answers, or questions from different perspectives by altering the way of thinking and the approaches used; (3) Originality: the ability to generate phrases, methods, or ideas to solve problems or create unusual and unique combinations of parts or elements that others may not have thought of; (4) Elaboration: the skill to enrich, develop, enhance, describe, or specify the details of objects, ideas, products, or situations to make them more interesting; and (5) Metaphorical Thinking: the skill to use comparisons or analogies to create new connections (Mahanal, 2019).

Creative thinking skills are a set of abilities to provide a variety of possible solutions based on the information provided by involving the construction of ideas that emphasize aspects of fluency, flexibility, novelty, and detail. Creative thinking is one of the important skills in learning biology. This skill helps students solve problems, provide new ideas, and make decisions in various situations (Nasution et al., 2023).

Creative and critical thinking complement each other and produce quality innovation and sustainable education. Creative thinking skills are considered an integral part of 21st-century skills that need to be emphasized in the science education curriculum. Creative thinking includes divergent thinking that produces more than one solution to a problem. Creative thinking is not a fixed characteristic that someone has or does not have, so creative thinking can be taught and developed in someone (Putri et al., 2023).

Method

This research uses Research and Development (R&D), which produces a specific product and then tests it to determine its practicality and effectiveness. The media development model used is ADDIE, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation.

In the analysis stage, needs analysis and material analysis are conducted. The design stage involves planning the creation of learning media using the Articulate Storyline application. In the development stage, the researcher validates the media that has been created.

Application of the Articulate Storyline Media

This study was conducted at SMA Negeri 4 Samarinda. The media trials were conducted in classes X-8 (experimental class) and X-11 (control class), each with 35 students. The two classes were randomly selected while considering previous academic performance to ensure comparable initial cognitive abilities between the control and experimental classes. These two groups allowed the researcher to measure differences in outcomes between the experimental group, which received the intervention, and the control group, which did not. Additionally, a practicality test was conducted with a sample of three students chosen to represent different abilities or characteristics to gain initial insights into the practicality of the learning media.

Data Processing and Analysis

The data analysis technique for calculating the practicality score of the learning media can be expressed using the following formula:

$$\text{Practicality} = \frac{\text{total score}}{\text{maximum score}} \times 100\% \tag{1}$$

This formula uses the total score received from the practicality assessment; the maximum score based on the practicality evaluation criteria. According to the evaluators' feedback, this calculation helps assess how practical and usable the developed learning media is.

The practically is categorized as ≤20% is not practical, 21-40% is less practical, 41-60% is moderately

practical, 61-80% is practical, and ≥81% is very practical (Milala et al., 2021).

The data analysis technique for calculating the effectiveness score of the learning media can be expressed using the N-gain formula as follows:

$$\text{N-Gain} = \frac{\text{mean posttest - mean pretest}}{100 - \text{mean pretest}} \qquad (2)$$

This N-gain calculation provides a measure of the effectiveness of the learning media in improving student performance. A higher N-Gain value indicates greater effectiveness of the media in enhancing learning outcomes.

The categories for N-Gain are low, medium, and high for $g<0.3$, $0.3 \leq g<0.7$, and $g \geq 0.7$, respectively (Hutagalung & Purba, 2023).

An unpaired t-test was applied to determine the effectiveness of using the Articulate Storyline Media.

Results and Discussion

The development of Articulate Storyline media on biodiversity focusing on tropical rainforests aims to assess the media's validity, practicality, and effectiveness. The initial appearance of the media is presented in Figure 1, i.e., the display of the selection of biodiversity media materials loaded with moist tropical forests (Figure 1a), the display of sub-chapter materials (Figure 1b), and the display of media games (Figure 1c).

The type of game in this media is a matching game between endemic fauna species and their respective habitats. To be considered interactive media, this media was developed with the addition of "games" features. This aligns with the research conducted (Limbong et al., 2022), which highlights the advantages of using interactive multimedia, including being more dynamic and less tiresome, providing a wider variety of choices according to students' preferences, offering more comprehensive subject matter reviews, and allowing for diverse feedback that can enhance students' motivation to learn. Consequently, interactive multimedia is widely developed and utilized as presentation media, games, compact discs, and interactive quizzes. Interactivity in multimedia means that users interact with the application program.
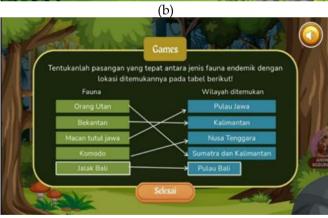
The assessment of the practicality of developing Articulate Storyline media on biodiversity focused on Tropical Rainforests, based on evaluations from 3 individual students, resulted in a percentage of 82.67%, which belongs to the high practical level (Table 1), which can be categorized as very practical. This score was derived from several aspects, indicating that users

experienced ease in accessing the media and applying the application during the learning process.

Table 2 presents the high effectiveness of using the Articulate Storyline media. The N-Gain test calculates and interprets the effectiveness of learning based on the improvement from the pretest and posttest results.

(a)

(b)

(c)

Figure 1. The initial appearance of the articulate storyline media. Main menu (a), display of sub-chapter materials (b), media games display (c)

The control class showed a moderate improvement with an N-Gain of 0.65, indicating that the learning produced a fairly good but not optimal increase. On the other hand, the experimental class demonstrated a significant improvement (p<0.000) with an N-Gain of 0.89, which indicates that the methods or learning media

applied in the experimental class were very effective in enhancing student learning outcomes. These results support the conclusion that the treatment given to the experimental group had a significantly more significant effect than the control group.

Table 1. Practical Level of the Use of the Articulate Storyline Media

Question	Score	
	Students	Teacher
1	5	5
2	4	5
3	5	5
4	3	5
5	3	5
6	4	5
7	3	5
8	3	5
9	4	5
10	3	5
Total	37	50
Practical score (P)	74.00%	100.00%

The score from students (66 students) are modus, the score from teacher is from one teacher. The scores are 1-5 for content quality and usability. P = (total score/maximum score) x 100%

Implementing the learning media showed significant results in the experimental class, with higher learning outcomes compared to the control class. Clarck et al. (2016) emphasize the importance of effective multimedia design in learning. The developed learning media has proven to facilitate better student understanding. The consistent improvement in the experimental class, with several students achieving maximum scores, indicates the effectiveness of the interactive approach in enhancing learning outcomes.

The Articulate Storyline learning media on biodiversity focused on Tropical Rainforests effectively improves students' learning outcomes and contributes to greater motivation and understanding of biodiversity material. This supports the argument that well-designed learning media can create a more engaging and immersive learning environment.

This learning media aligns with the research by Fawziah et al. (2019), which states that the use of interactive media plays an important role in assessing students' learning practice and positively impacts their academic achievement. Interactive media in the learning system also significantly engages students, making the learning exercises more appealing and improving learning outcomes.

Using instructional media in the learning process can stimulate new desires and interests, boost motivation, encourage active learning, and psychologically affect students. The success of using Articulate Storyline as an instructional medium aligns with the study by Suhailah et al. (2021), Syani et al.

(2021), Nugroho et al. (2021), and Juhaeni et al. (2021), which found that using interactive media based on Articulate Storyline made students more attentive to the learning process. The classroom atmosphere was more conducive during lessons as students were more engaged, with no off-topic conversations, thus creating a focused learning environment.

Table 2. The Effectiveness Level of the Use of Articulate Storyline Media (ASM) on Enhancing the Students' Critical Thinking

Student	Control class		Experiment class	
	N-Gain	Category	N-Gain	Category
1	0.64	Medium	0.76	High
2	0.40	Medium	1.00	High
3	0.85	High	0.80	High
4	1.00	High	0.88	High
5	0.46	Medium	1.00	High
6	0.58	Medium	0.88	High
7	1.00	High	0.85	High
8	0.71	High	1.00	High
9	0.50	Medium	0.75	High
10	0.78	High	0.86	High
11	0.42	Medium	1.00	High
12	0.50	Medium	1.00	High
13	0.71	High	0.75	High
14	0.67	Medium	1.00	High
15	0.85	High	0.86	High
16	0.64	Medium	0.94	High
17	0.50	Medium	0.87	High
18	0.50	Medium	0.86	High
19	0.46	Medium	0.86	High
20	0.50	Medium	1.00	High
21	0.42	Medium	0.86	High
22	1.00	High	0.79	High
23	0.75	High	0.83	High
24	0.67	Medium	1.00	High
25	0.77	High	0.78	High
26	0.75	High	0.83	High
27	0.72	High	0.84	High
28	0.46	Medium	1.00	High
29	0.62	Medium	0.87	High
30	0.69	Medium	1.00	High
31	0.78	High	1.00	High
32	0.69	Medium	0.84	High
33	0.50	Medium	0.87	High
34	0.63	Medium		
Mean±SD (Modus)	0.65±0.17	(Medium)	0.89±0.09*	(High)

Note: *) The data differed significantly (two-tail t-test assuming unequal variance, p= 0.0000). Control class = without ASM, Experiment class = using ASM. The N-Gain (g) score of g≥0.70, 0.30≤g<0.70, and 0.00<g<0.30 represent high, medium, and low.

Conclusion

The articulate storyline learning media on biodiversity, focusing on Tropical Rainforests, is suitable as a learning tool that can significantly aid students in understanding biodiversity concepts engagingly and interactively. The learning media is efficient and effective in improving students' critical and creative thinking skills.

Conflicts of Interest
The authors declare no conflict of interest.

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