JPPIPA 10(11) (2024)

Jurnal Penelitian Pendidikan IPA

Journal of Research in Science Education

http://jppipa.unram.ac.id/index.php/jppipa/index

Improving Critical and Creative Thinking Skills with Articulate Storyline Media in Learning Food and the Human Digestive System in Grade XI

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Received: May 17, 2024
Revised: September 10, 2024
Accepted: November 25, 2024
Published: November 30, 2024

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DOI: 10.29303/jppipa.v10i11.9127

Abstract: This development research aims to: (1) prove the feasibility and practicality of articulate storyline media in learning about food and the digestive system (2) to prove that articulate storyline media with problem based learning (PBL) model in learning about food and the digestive system is effective in improving critical and creative thinking skills (3) to prove that articulate storyline media with project based learning (PJBL) model in learning about food and the digestive system is effective in improving critical and creative thinking skills. The type of research used is Research and Development (R&D) with ADDIE development model. The subjects in this study were biology subject teachers and students of class XI MIPA 1 and XI MIPA 2 SMAN 6 Samarinda and class XI MIPA 3 and XI MIPA 4 at SMAN 4 Samarinda. Data testing was carried out by testing the feasibility of the media, the practicality of the media, the effectiveness test using the Manova test and the N-Gain test. The results of the study obtained: (1) articulate storyline media is feasible and practical to be used in the learning process (2) articulate storyline media with problem based learning (PBL) learning model in learning about food and the digestive system is effective in improving critical thinking skills (3) articulate storyline media with project based learning (PJBL) learning model in learning about food and the digestive system is effective in improving creative thinking skills. Based on the manova test, a significance value of 0.000 (sig <0.05) was obtained, so it was concluded that there are learning models that have different abilities in terms of influencing critical thinking skills and creative thinking skills simultaneously.

Keywords: Articulate storyline; Creative thinking skills; Critical thinking skills; Problem based learning; Project based learning

Introduction

The field of education is a major part of building a nation's civilization. Through the world of education, it will give birth to superior future generations who will have careers in various fields of work. 21st century learning competencies focus on improving human resources in facing competitiveness and following rapid developments in the world of work. The world of work in the era of society 5.0 will be centered on humans and technology-based. In addition to being technologically proficient, communication skills in the era of society 5.0 are also very much needed to build networks and interactions between humans to achieve certain goals.

How to Cite:
Rea, S. C. E., Maasawet, E. T., Hudiyono, Y., Raharjo, B., Palenewen, E., & Tindangen, M. (2024). Improving Critical and Creative Thinking Skills with Articulate Storyline Media in Learning Food and the Human Digestive System in Grade XI. *Jurnal Penelitian Pendidikan IPA*, *10*(11), 8899–8910. https://doi.org/10.29303/jppipa.v10i11.9127

Technological advances require everyone, both students and teachers, to be able to use technology as well as possible so that the benefits of technology for educational progress and the convenience used by teachers and students in the teaching and learning process. Technology has a significant impact on education, because it can function as a means to improve the learning process. This is in line with Sofyan et al. (2022), that technology in education gives rise to new methods that can facilitate the learning process for students in schools. With technology, methods are created that attract students' attention in learning and make it easier to understand the material.

Biology is a compulsory subject for students majoring in Mathematics and Natural Sciences in Senior High Schools. Biology is closely related to daily activities, so biology is associated with resolving conflicts and daily problems. Biology lessons force students to remember, understand and master concepts to the point of having a slightly less good final learning outcome.

One of the biology materials taught in grade XI of high school is the human digestive system, but the delivery still uses conventional media such as blackboards and pictures in books. Many biology teachers still rely on books and presentation slides in teaching, which has an impact on the low interest of students in learning. Learning media about human organs in the world of education today mostly still use books and teaching aids as aids (Faidah et al., 2022). Material about the digestive system is difficult to understand because most of the processes occur in the body and cannot be seen directly. This is in line with (Putri et al., 2019), explaining that the digestive system is abstract biology material, because students cannot directly observe the cells, tissues, and organs involved, or understand the digestive process. This is reinforced by Tamara et al. (2019) who stated that material about the human digestive system is very complicated because it involves internal organs, making it difficult to explain to students in concrete terms. Therefore, the teacher's expertise in conducting learning can also affect student learning outcomes (Azhari et al., 2023). When delivering material, educators should use appropriate models, so that students feel motivated to learn and the learning process in the classroom can take place pleasantly so that students do not feel bored and are not busy doing other activities outside of learning. Therefore, it is important to use a learning model where students act as the actors (Hasrah et al., 2022).

Problem-based learning model or also known as PBL (Problem based learning) is a learning model that encourages high-level thinking by focusing on problem-oriented scenarios and includes strategies for learning how to learn. Problem-based learning involves the process of asking questions or presenting challenges, focusing on exploring interdisciplinary relationships, engaging in authentic investigations, collaborating with others, and creating real work and demonstrations (Kolo et al., 2021). Problem-based Learning is not designed to help teachers provide as much information as possible to students. Problem-based Learning seeks to facilitate the development of students' cognitive abilities and problem-solving skills (Emor et al., 2024). Problem-based learning strategies can increase student engagement and encourage active participation in the learning process by encouraging students to collaboratively solve the challenges given (Rachmawati & Rosy, 2020) in order to foster good learning outcomes and foster superior human resources. In addition to the problem-based learning (PBL) model, there is also a project-based learning (PJBL) learning model.

Learning that confronts students with problems, but teachers can provide stimulus by implementing the Project Based Learning (PjBL) learning model. The stimulus aims to: (1) have responsibility for the work of their part in the team; (2) work in a structured manner following plans and work patterns that have been agreed upon together; (3) compete honestly and healthily. ; (4) gain reflection and other experiences after the project. Nurhadiyati et al. (2020), the PjBL learning model is able to make students active in learning. This is in line with Indriyani et al. (2019) who stated that to make students' memory of lessons last a long time, learning must make students actively associate concepts related to the material being studied. An active learning process must involve learning media to the maximum to stimulate student activity.

By using this model, students can increase their motivation and enthusiasm in participating in learning, creating new ideas and being able to solve and resolve problems correctly, namely by creating a project and then evaluating it with other students and teachers. So that students can improve their High Order Thinking Skills. The learning model will be less than optimal without learning media. Because, by using media, it can increase students' motivation and enthusiasm in participating in learning (Pratiwi et al., 2023).

The problem based learning (PBL) learning model helps students in the learning process to play an active role in efforts to find, know, and understand what the material, theory, concept and conclusion are about what is being studied. so that the learning process can be centered on students and is expected to be able to improve critical thinking skills (Rizka, 2023). Critical thinking is an emphasis on reasonable and reflective thinking, where these thoughts can be used to make decisions or solve a problem (Rudianti et al., 2021).

The project based learning (PJBL) learning model, it is expected that students will be able to develop

conceptual knowledge and creative thinking skills by working collaboratively and can provide a solution in solving a problem that occurs by finding new things and can create an idea or product. Instilling the habit of thinking creatively needs to be accustomed to students through the learning process (Sundari et al., 2023). Characteristics of creative thinking: 1) Fluency in thinking is the ability to generate many ideas for answers in solving problems or questions, 2) Flexibility in thinking is the ability to produce ideas, answers or questions that vary and see a problem from different perspectives, 3) Originality is the ability to produce original ideas as a result of one's own thoughts, provide answers that are different from others, and are rarely given by most people, 4) Elaboration is the ability to add, detail, and expand an idea. In the use of learning media that can support the learning process, which will make it easier for students to understand learning materials, and improve the quality of teacher teaching which will have an impact on the quality of student learning outcomes (Agustiawan, 2022).

Articulate storyline is one of the media that can be used in technology-based learning processes. Articulate storyline has advantages including a simple display like power point, complete features like flash so that it can create animations. Articulate storyline also provides templates that can be used for interactive media, especially for creating test questions and exercises. In addition, the program also makes it easy for users to publish online or offline. Suhailah et al. (2021) in the observations made, teachers had never used articulate storyline media in learning because teachers did not know about the media.

Referring to the background that has been described, the researcher is interested in developing articulate storyline media in learning about food and the human digestive system towards critical and creative thinking skills of class XI of State Senior High Schools in Samarinda.

Method

The research on the development of articulate storyline learning media uses the ADDIE research and development (R & D) model, which consists of five stages, namely analysis, design, development, implementation, and evaluation. At the analysis stage, the problems that occur in schools are identified, curriculum analysis is used to determine what type of curriculum is applied in schools so that learning devices can be prepared in accordance with the school curriculum, and material analysis analysis as material for making learning media. At the design stage, it contains the creation of media flowcharts, the creation of storyboards and the preparation of assessment instruments. The flowchart is in the form of a concept map made with symbols to describe the flow of material delivery in the articulate storyline media. Making a storyboard, this storyboard functions as a guideline in the process of making learning media. The instruments used are a needs analysis questionnaire, an articulate storyline media assessment questionnaire by media experts, material experts and learning device experts, as well as a media assessment questionnaire by biology teachers and a student response questionnaire.

The development stage is the stage to realize the articulate storyline media design that has been made in the design stage by creating a storyboard. In this development, the Canva application and articulate storyline software are used. Furthermore, an assessment of the material and the feasibility of the learning media is carried out by expert media lecturers, expert material lecturers, biology teachers of SMAN 6 Samarinda and students. Revisions are made based on the results of input and suggestions from expert lecturers which aim to improve the articulate storyline media before the trial.

The learning media resulting from the improvements and refinements in the revision I stage were then tested on limited students. The purpose of this stage was to find out the level of feasibility and effectiveness of the use of articulate storyline media in learning activities. At this stage, biology teachers and students provided responses and assessments of the learning media. The reviewer who came from a biology teacher was 1 person who had met the criteria, namely having experience in teaching biology subjects for at least 2 years.

Respondents in the limited test amounted to 70 students from class XI IPA SMAN 6 Samarinda who were selected randomly. The results obtained at this stage were student responses and teacher assessments of the learning media which became the reference for media improvement in the next stage. Improvements and refinements of the learning media were adjusted to student responses and teacher input. The finished product and ready for large-scale testing or field trials were the final results in the revision stage II.

This implementation stage is the result of revision II of the articulate storyline learning media then implemented to students. Then a large-scale or extensive trial in SMA Negeri 4 Samarinda class XI. The implementation was carried out in 2 classes, namely class XI MIPA 3 using articulate storyline media with a problem-based learning (PBL) model and class XI MIPA 4 using articulate storyline media with a project-based learning (PJBL) model. Students were given a questionnaire to provide responses and student responses after learning to use articulate storyline media. The implementation stage aims to see the effect

of using articulate storyline media on critical thinking skills and creative thinking skills.

The evaluation stage is carried out after the implementation stage of the learning media by students. The evaluation aims to provide an assessment of the articulate storyline media. After the evaluation, a final product revision is carried out so that the final product of the articulate storyline media has been tested for validity and is said to be suitable for use in learning that is able to develop critical and creative thinking skills.

Data analysis techniques consist of qualitative data and quantitative data. Qualitative data obtained from suggestions or comments on the validation sheet by expert validators, teachers and students and analyzed descriptively qualitatively. This data analysis is used as an improvement in the media developed. While quantitative data includes media feasibility, media practicality, media effectiveness and test instrument analysis.

Media Suitability

Media feasibility data was obtained from a validation questionnaire by learning media experts, material experts and learning device experts. The assessment of this data consists of five assessment scales, namely very feasible, feasible, less feasible, quite feasible and not feasible (Rohmaini et al., 2020).

$$P = \frac{F}{N} \times 100\% \quad (1)$$

Information:
P = Percentage figures from questionnaire data
F = Number of Respondents' Answers
N = Highest score count

Table 1. Percentage Range and Qualitative Criteria for Media Suitability by the Expert Team (Sudjana, 2017)

Percentage range (%)	Qualitative criteria
80.01-100.00	Very worthy (No revision)
70.01-80.00	Eligible (No revision)
60.01-70.00	Good enough (Revised)
50.01-60.00	Less worthy (Revision)
< 50	Not eligible (Revised)

Practicality of Media

Table 2. Likert Scale of the Questionnaire (Sudjana, 2017)

Likert Scale	Score	
	Positive statement	Negative statement
Strongly agree	5	1
Agree	4	2
Less agree	3	3
Disagree	2	4
Very disagree	1	5

The practicality of learning media is determined by teacher assessment and student response questionnaires. Teacher review data is obtained from questionnaires with positive and negative indicators. Practical if the teacher's assessment is positive for the media developed (Rawa, 2020).

Each statement is scored according to the statement format, and the total score of the assessment results is analyzed as follows (Rohmaini et al., 2020).

$$P = \frac{F}{N} \times 100\% \quad (2)$$

Information:
P = Score percentage
F = Total scores obtained
N = Maximum score

Table 3. Percentage Range, Qualitative Criteria for Testing the Practicality of Media Against Teacher and Student Assessments (Sudjana, 2017)

Percentage range (%)	Qualitative criteria
81-90	Very practical
71-80	Practical
61-70	Enough practical
51-60	Less practical
< 50	Not practical

Media Effectiveness

The use of pretest and posttest data to analyze the effectiveness of the media developed in improving cognitive abilities. The analysis used is designed to measure learning effectiveness using the following equation.

$$\text{Gain score (g)} = \frac{\text{(Posttest score} - \text{Pretest score)}}{\text{(Maximum score} - \text{Pretest score)}} \quad (3)$$

The calculation results are then classified into standard gain value criteria.

Table 4. Gain Value Criteria

Gain score (g)	Criteria
g > 0.7	High
0.7 > g > 0.5	Medium
g < 0.3	Low

Source: Adpated from hakke in Rosdianto et al. (2017)

Analysis of Test Instruments

Data analysis of critical and creative thinking ability tests of students is collected in the form of pretest and posttest results. The scores of students' test results are analyzed using descriptive statistics and inferential statistics. Descriptive statistical analysis is carried out by describing or depicting the data that has been collected, while inferential statistical analysis consists of prerequisite tests. These prerequisite tests include

multivariate normality tests and multivariate homogeneity tests. If the prerequisite test is met, then a parametric test is carried out, but if it is not met, the data will be tested using a non-parametric test.

The MANOVA test aims to determine the effectiveness of using articulate storyline media in improving critical and creative thinking skills simultaneously. The MANOVA test is seen in the Multivariate test table with the provision that if the sig. < 0.05 then there is a simultaneous difference in the use of learning models on critical and creative thinking skills.

Result and Discussion

The results of the development in this study are in the form of articulate storyline media using Research and Development (R&D) design. The researcher tried to create articulate storyline media in learning about food and the digestive system in class XI which was then used as learning media in two senior high school education units, namely SMAN 6 Samarinda and SMAN 4 Samarinda. Reviewed from the general condition of the two SMANs which have accreditation equivalent to category A (superior). This articulate storyline media will be applied using the Problem Based Learning (PBL) model and the Project Based Learning (PjBL) model.

State Senior High School 6 Samarinda is a trial school for articulate storyline media with classes XI MIPA 1 and XI MIPA 2. Class XI MIPA 1 uses articulate storyline media with the Problem Based Learning (PBL) learning model, while Class XI MIPA 2 uses articulate storyline media with the Project Based Learning (PjBL) learning model.

The following is the result of the display of articulate storyline media in the learning of "food and the digestive system" for class XI SMA.

Login Page

Figure 1. Media articulate storyline front page view

Main Menu

Figure 2. Main menu page display on media articulate storyline

Instructions Menu

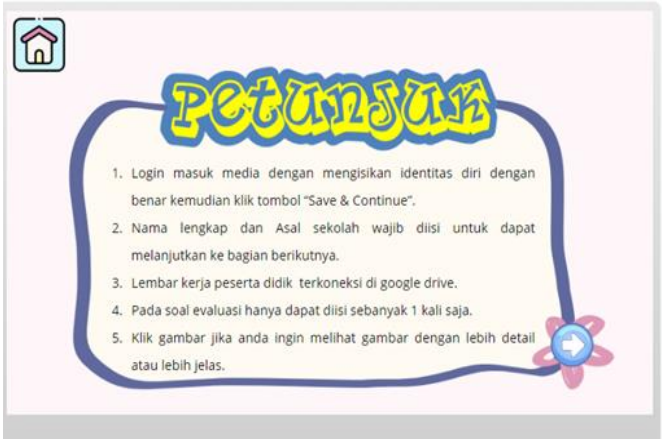

Figure 3. Display of the instructions menu on media articulate storyline

Device Description Menu

Figure 4. Display of the device description menu on the Media Articulate Storyline

Core Competency (KI) and Basic Competency (KD) Menu

Figure 5. Display of KI and KD menus on media articulate storyline

Learning Material Menu

Figure 6. Display of learning material menu on Articulate Storyline Media

Figure 7. Display of the learning material menu for meeting 1 on Articulate Storyline Media

Figure 8. Display of the learning material menu for meeting 2 on Articulate Storyline Media

Figure 9. Display of the learning material menu for meeting 3 on articulate storyline media

Media Developer Profile Menu

Figure 10. Media articulate storyline developer profile menu view

Reference Menu

Figure 11. Reference menu display on media articulate storyline

Media Suitability Test

Media Feasibility Test Articulates Storyline as Assessed by Media Experts

Based on the assessment results by media experts, it shows that the articulate storyline media on food and the human digestive system is very suitable for use.

Table 5. Results of Media Assessment by Media Experts

Assessment aspects	Assessment results
General view	24
Special view	31
Media presentation	17
Total reviewer scores	71
Total overall score	80
Media eligibility percentage	88.75%
Criteria	Very worthy

(Source: Primary Data 2023)

Media Feasibility Test Articulate Storyline Assessment of Material Experts

Based on the assessment results by material experts, it shows that the material on food and the human digestive system in the articulate storyline media is very suitable for use.

Table 6. Results of Media Assessment by Material Experts

Assessment aspects	Assessment results
Content suitability	33
Language	8
Presentation of material	13
Total reviewer scores	54
Total overall score	60
Presentation of material eligibility	90.00%
Criteria	Very worthy

(Source: Primary Data 2023)

Instrument Feasibility Test Based on Expert Assessment of Learning Devices

Based on the assessment results by learning device experts, it shows that the learning device is very suitable for use.

Table 7. Results of Expert Assessment of Learning Devices

Assessment aspects	Assessment results
Syllabus	26
Learning Implementation Plan (RPP)	47
Student Worksheet (LKPD)	47
Teaching materials	38
Pretest-Posttest Questions	20
Total reviewer scores	178
Total overall score	200
Presentation of learning device suitability	89%
Criteria	Very worthy

(Source: Primary Data 2023)

Media Practicality Test

Practicality of Articulate Storyline Media Based on Teacher Assessment

Table 8. Practicality of articulate storyline media based on teacher assessment

Assessment aspects	Assessment results	
	SMAN 6 Samarinda	SMAN 4 Samarinda
Introduction	15	12
Content	20	16
Evaluation	14	12
Closing	4	4
Media accessibility	19	16
Media view	45	44
Total score	117	104
Total overall score		130
Presentation of practicality	90%	80%
Criteria		Very worthy

(Source: Primary Data 2023)

Practicality of Articulate Storyline Media Based on Student Assessment

Table 9. Practicality of Articulate Storyline Media Based on Student Assessments

School	Class	Presentation of media practicality (%)
SMAN 6 Samarinda	XI MIPA 1	89.19
	XI MIPA 2	84.23
Average percentage of practicality		86.71
Category		Very practical
SMAN 4 Samarinda	XI MIPA 3	85.27
	XI MIPA 4	90.09
Average percentage of practicality		86.33
Category		Very practical

(Source: Primary Data 2023)

The assessment conducted by students consists of 3 aspects, namely the media presentation aspect, the media articulate storyline aspect and the language aspect. The average results of the media assessment by students can be seen in the table 9.

Effectiveness Test

The Effectiveness of Articulate Storyline Media with the Problem Based Learning (PBL) Model

The assessment of the effectiveness of articulate storyline media on students' critical thinking skills and creative thinking skills, then a MANOVA test will be carried out. The results of the MANOVA test are used to see the influence of one variable and another (critical and creative thinking) on the articulate storyline media.

Based on the table above, the four Sig. values are smaller than the significance level α = 0.05, so it is concluded that there are teaching methods that have different abilities in terms of influencing the value of critical thinking skills and creative thinking skills simultaneously.

Table 10. MANOVA Test Results

Multivariate Tests[a]							
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pilla's Trace	.997	12769.794[b]	2.000	67.000	.000	.997
	Wilks' Lambda	.003	12769.794[b]	2.000	67.000	.000	.997
	Hotelling's Trace	381.188	12769.794[b]	2.000	67.000	.000	.997
	Roy's Largest Root	381.188	12769.794[b]	2.000	67.000	.000	.997
Class	Pilla's Trace	.164	6.578[b]	2.000	67.000	.002	.164
	Wilks' Lambda	.836	6.578[b]	2.000	67.000	.002	.164
	Hotelling's Trace	.196	6.578[b]	2.000	67.000	.002	.164
	Roy's Largest Root	.196	6.578[b]	2.000	67.000	.002	.164

a. Design: Intercept + Class

b. Exact statistic

The improvement of critical and creative thinking skills of students in problem based learning (PBL) classes can be seen through the calculation of the normalized gain score.

Table 11. Normalized Gain Score

Score	Critical thinking		Creative thinking	
	Pretest	Posttest	Pretest	Postest
Minimum score	20	70	20	75
Maximum score	40	95	35	90
Average score	30.00	83.57	29.57	81.00
Average gain score		77.09%		73.16%
Gain score category		High		Medium

(Source: Primary Data 2023)

Based on the analysis table above, it can be seen that the average gain score value on critical thinking skills of class XI MIPA 3 (PBL class) is 77.09% included in the high category and the gain score value on creative thinking skills is 72.83% included in the medium category so it can be concluded that the PBL model is effective in improving critical thinking skills and quite effective in improving creative thinking skills.

The Effectiveness of Articulate Storyline Media with the Project Based Learning (PJBL) Model

Based on the table 12, the four Sig. values are smaller than the significance level α = 0.05, so it is concluded that there are teaching methods that have different abilities in terms of influencing the value of critical thinking skills and creative thinking skills simultaneously.

Table 12. MANOVA Test Results

Multivariate Tests[a]							
Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared
Intercept	Pilla's Trace	.997	12769.794[b]	2.000	67.000	.000	.997
	Wilks' Lambda	.003	12769.794[b]	2.000	67.000	.000	.997
	Hotelling's Trace	381.188	12769.794[b]	2.000	67.000	.000	.997
	Roy's Largest Root	381.188	12769.794[b]	2.000	67.000	.000	.997
Class	Pilla's Trace	.164	6.578[b]	2.000	67.000	.002	.164
	Wilks' Lambda	.836	6.578[b]	2.000	67.000	.002	.164
	Hotelling's Trace	.196	6.578[b]	2.000	67.000	.002	.164
	Roy's Largest Root	.196	6.578[b]	2.000	67.000	.002	.164

a. Design: Intercept + Class

b. Exact statistic

The improvement of critical and creative thinking skills of students in project based learning (PJBL) classes can be seen through the calculation of the normalized gain score.

Table 13. Normalized Gain Score

Score	Critical thinking		Creative thinking	
	Pretest	Posttest	Pretest	Postest
Minimum score	20	70	20	75
Maximum score	40	90	40	95
Average score	30.29	84.00	31.68	84.14
Average gain score		72.83%		77.14%
Gain score category		Medium		High

(Source: Primary Data 2023)

Based on the analysis table above, it can be seen that the average gain score value for critical thinking skills of class XI MIPA 4 (PJBL class) is 72.83%, which is included in the moderate category and the gain score value for creative thinking skills is 77.14%, which is included in the high category, so it can be concluded that the PJBL model is quite effective in improving critical thinking skills and effective in improving creative thinking skills.

The learning media produced in this study is an articulate storyline learning media with material about food and the digestive system taught in grade XI semester 2. The material covered in the articulate storyline learning media consists of three sub-topics, namely food substances, human digestive system organs, and human digestive system disorders.

The articulate Storyline media developed on the food digestive system material is able to produce media that supports the presentation of material with a combination of text, images and can produce quizzes for evaluation and the scores obtained can be seen immediately and are also equipped with quiz reviews that can be seen after getting a score to provide the correct answer so that students can know the correct answer and can immediately actively interact in learning activities.

The results of the articulate Storyline learning media development product on the food digestive system material have been validated by a media expert validator. The assessment of the media expert validator received a very decent category. The assessment of the media expert validator includes aspects of general appearance, special appearance aspects and media presentation. Based on these results, it shows an attractive media design, a simple and neat appearance, good color selection has a match between the text, the type of font and font size used are appropriate and do not confuse users in understanding the text, the display design is also attractive, both in the navigation buttons and menus are used effectively. This is supported by the opinion of Miftah et al. (2022) that the selection and use of learning media appropriately will make learning activities more interesting and more motivating for students to learn, and focus students' attention more on the topics discussed.

This articulate storyline learning media is also independent because it makes it easy for students to use it without teacher guidance. This is in line with the opinion of Yasin et al. (2017), that learning media equipped with a controller so that it can be operated by the user, this will involve a reciprocal relationship between the user and the media. The articulate storyline learning media is also able to facilitate and facilitate educators and students because the articulate storyline learning media that is created is then published in the form of a link so that it is easier for students to use by utilizing the internet network anytime and anywhere without downloading additional applications. This articulate storyline learning media can be accessed via computers, laptops or smartphones. The use of articulate storyline learning media is able to create learning activities that are more interactive, effective, interesting and can increase students' learning motivation. With the articulate storyline media, learning the material on the digestive system can be carried out at home actively, independently and flexibly.

The articulate storyline learning media, after proving its validity, then looks at the effectiveness of the articulate storyline media on critical thinking skills and creative thinking skills. However, in the test conducted, the researcher wanted to see the effectiveness of the articulate storyline media in each variable simultaneously so that in the statistical test, a multivariate statistical test was carried out. To conduct a multivariate test, a prerequisite test was first carried out, namely the multivariate normality test and the multivariate homogeneity test. The multivariate normality test uses the Mahalanobis Distance test which gives results on both variables having a data distribution that is multivariately normally distributed, while the multivariate homogeneity test uses the Box's M test which gives results that the data on critical thinking skills and creative thinking skills in class XI MIPA 1 and XI MIPA 2 have the same covariance variance or are not homogeneous.

The improvement of critical thinking skills and creative thinking skills of students in class XI MIPA 1 (Problem based learning class) can be seen through the calculation of the normalized gain score. Based on the results of the calculation of the normalized gain score for critical thinking skills, it is included in the high category while creative thinking skills are included in the medium category. The results of the calculation of the normalized gain score in class XI MIPA 2 (project based learning class) for critical thinking skills are included in the medium category and creative thinking skills are

included in the high category, so it can be concluded that class XI MIPA 1 which uses articulate storyline learning media with the problem based learning (PBL) learning model is effective in improving critical thinking skills. This is in accordance with (Rati et al., 2022), that the problem based learning (PBL) learning model requires students to be active in finding answers to the problems given so that students can gain an understanding of the learning material given. Meanwhile, class XI MIPA 2 which uses articulate storyline media with the project based learning (PJBL) learning model is effective in improving creative thinking skills. This is in line with Made (2020), that the project-based learning model is able to improve creative thinking skills in students because they participate in the learning process and develop their own skills.

Teachers and students provide an assessment of the articulate storyline learning media. Teachers are very interested in the development of this articulate storyline learning media because it is something new for teachers and students and seeing the activeness of students in learning in the classroom. The results of the teacher's assessment show that the articulate storyline learning media product developed has an average category of very good so it is very practical to use. While the results of the assessment and comments from 70 students at SMA 6 Samarinda show that the articulate storyline learning media is very practical, the button icons are cute, the images do not break when zoomed. So it can be concluded that the articulate storyline learning media can be used in large group trials or field trials.

The effectiveness of the developed articulate storyline media is a measure of the success of learning in improving critical thinking skills and creative thinking skills of participants through field trials. The field trial consists of two classes, namely class XI MIPA 3 using articulate storyline media with a problem based learning (PBL) model and class XI MIPA 4 using articulate storyline media with a project based learning (PJBL) model. The number of students in class XI MIPA 3 and XI MIPA 4 is 35 people each. In both classes, pretest-posttest is used as a measurement of the initial and final abilities of students.

The improvement of critical thinking skills and creative thinking skills of students in class XI MIPA 3 (Problem Based Learning Class) can be seen through the calculation of the normalized gain score. Based on the results of the calculation of the normalized gain score for critical thinking skills, it is included in the high category while creative thinking skills are included in the medium category. The results of the calculation of the normalized gain score in class XI MIPA 4 (project based learning class) for critical thinking skills are included in the medium category while creative thinking skills are included in the category. So it can be concluded that class XI MIPA 3 which uses articulate storyline learning media with the problem based learning (PBL) learning model is effective in improving critical thinking skills. This is in line with Jean Piaget's theory that the cognitive development abilities of humans aged 11-15 years and over are formal operational stages, where individuals can do hypothetico-deductive reasoning, which means that individuals can formulate hypotheses (best guesses) about how to solve problems and reach conclusions systematically (Marinda, 2020). Meanwhile, class XI MIPA 4 which uses articulate storyline learning media with the project based learning (PJBL) learning model is effective in improving creative thinking skills. Based on these results, it is in accordance with (Wahyuni et al., 2022), that the use of interactive learning media can arouse new desires, interests, motivation and stimulation of learning activities, and increase understanding of the material because of the interesting presentation of the material. The use of interactive media in the learning process without the assistance of the right learning model will certainly not produce maximum results.

Conclusion

Based on the research results, development of articulate storyline media and the results of the analysis that has been carried out, several things related to this research can be concluded as follows: The developed articulate storyline media has met the eligibility criteria that can be seen in the media aspect, material aspect and learning device aspect. The validation results given by the media expert validator, material expert and learning device expert stated that it was very feasible, so that the articulate storyline media in learning about food and the digestive system was declared feasible to be used in the learning process. The practicality of the articulate storyline media based on teacher and student assessments shows that it is very practical. Media articulate storyline with problem based learning (PBL) learning model in learning about food and the digestive system is effective in improving critical thinking skills and quite effective in improving creative thinking skills. Articulate storyline media with project based learning (PJBL) learning model in learning about food and the digestive system is quite effective in improving critical thinking skills and effective in improving creative thinking skills.

Acknowledgments

I would like to thank my supervisor and examiners, who have guided me in writing this journal. I would also like to thank my family who have provided moral and material support during the process of writing this article.

Author Contributions

In this paper, the authors have contributed to the following sections: conceptualization, research methodology, software, formal analysis, data sources, data curation, and original drafting by S. C. E. R.; supervision by E. T. M. and Y. H.; editing by E. T. M., Y. H., B. R., E. P., and M. T.

Funding

This research did not receive external funding and was conducted independently with the aim of providing information and findings that are fair to the research objectives.

Conflicts of Interest

In this article, the author confirms that there is no conflict of interest during the journal writing process. The author does not have the power to dictate policies implemented by the schools studied. There is no data manipulation by the author, and the schools studied are only used as sources of information, not actively involved in writing the research findings.

References

Agustiawan, H. (2021). Studi Literatur Pengaruh Group Investigation terhadap Berpikir Kritis dan Oral Activity Siswa. *Bioeduca: Journal of Biology Education,* *3*(1), 20-36. https://doi.org/10.21580/bioeduca.v3i1.6625

Azhari, N. S., Simangunsong, H. H., Hrp, I. A. A., Afdilani, N., & Tanjung, I. F. (2023). Penerapan Project Based Learning (PJBL) untuk Meningkatkan Hasil Belajar Siswa Kelas XII IPA 1 SMA Negeri 2 Percut Sei Tuan Pada Materi Gen. *Biodik*, *9*(1), 46–51. https://doi.org/10.22437/bio.v9i1.19187

Emor, V., Tanor, M., & Ch.Posumah, D. (2024). Penerapan Model Problem Based Learning Untuk Meningkatkan Hasil Belajar Siswa Biologi Di SMA Negeri 2 Langowan Vilia Emor. *Konstanta : Jurnal Matematika Dan Ilmu Pengetahuan Alam*, *2*(1), 172–184. https://doi.org/10.59581/konstanta-widyakarya.v2i1.2261

Faidah, S. T. R., Salsabila, A., & Riandi. (2022). Desain Inovasi Media Pembelajaran dengan Penerapan Augmented Reality pada Materi Sistem Pencernaan (Learning Media Innovation Design With Augmented Reality Application on Digestive System Material). *BIODIK: Jurnal Ilmiah Pendidikan Biologi*, *08*(04), 76–83. Retrieved from https://online-journal.unja.ac.id/biodik

Hasrah, H., Khaerati, K., & Yunus, N. M. (2023). Pengembangan Media Pembelajaran Handout Berbasis Discovery Learning Di SMAN 17 Luwu. *Al-Nafis: Jurnal Biologi dan Pendidikan Biologi,* *2*(2), 77-89. http://dx.doi.org/10.46339/al-nafis.v2i2.907

Indriyani, D., Desyandri, D., Fitria, Y., & Irdamurni, I. (2019). Perbedaan Model Children'S Learning in Science (Clis) Dan Model Scientific Terhadap Hasil Belajar Siswa Pada Pembelajaran Tematik Terpadu Di Sekolah Dasar. *Jurnal Basicedu*, *2*(1), 627–633. https://doi.org/10.31004/basicedu.v3i2.216

Kolo, E., Nahak, S., & Disnawati, H. (2021). Penggunaan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Hasil Belajar Siswa Materi Aritmetika Sosial. *RANGE: Jurnal Pendidikan Matematika*, *2*(2), 115–122. https://doi.org/10.32938/jpm.v2i2.698

Marinda, L. (2020). Teori Perkembangan Kognitif Jean Piaget Dan Problematikanya Pada Anak Usia Sekolah Dasar. *An-Nisa' : Jurnal Kajian Perempuan Dan Keislaman*, *13*(1), 116–152. https://doi.org/10.35719/annisa.v13i1.26

Miftah, M., & Rokhman, N. (2022). Kriteria pemilihan dan prinsip pemanfaatan media pembelajaran berbasis TIK sesuai kebutuhan peserta didik. *Educenter : Jurnal Ilmiah Pendidikan*, *1*(9), 641–649. https://doi.org/10.55904/educenter.v1i9.92

Nurhadiyati, A., Rusdinal, R., & Fitria, Y. (2020). Pengaruh Model Project Based Learning (PJBL) terhadap Hasil Belajar Siswa di Sekolah Dasar. *Jurnal Basicedu*, *5*(1), 327–333. https://doi.org/10.31004/basicedu.v5i1.684

Pratiwi, T. A., Wardana, M. Y. S., & Purnamasari, I. (2023). Keefektifan Model Project Based Learning Berbantu Media Replika Sistem Pencernaan Manusia Terhadap High Order Thinking Skills Siswa Kelas V SD Negeri 1 Ngasem Jepara. *Pena Edukasia,* *1*(2), 135-144. Retrieved from https://journal.cvsupernova.com/index.php/pe

Putri, O. D., Nevrita, N., & Hindrasti, N. E. K. (2019). Pengembangan Instrumen Penilaian Keterampilan Berpikir Kritis Siswa Sma Pada Materi Sistem Pencernaan. *BIOEDUKASI (Jurnal Pendidikan Biologi)*, *10*(1), 14. https://doi.org/10.24127/bioedukasi.v10i1.2004

Rachmawati, N. Y., & Rosy, B. (2020). Pengaruh Model Pembelajaran Problem Based Learning (PBL) terhadap Kemampuan Berpikir Kritis dan Pemecahan Masalah pada Mata Pelajaran Administrasi Umum Kelas X OTKP di SMK Negeri 10 Surabaya. *Jurnal Pendidikan Administrasi Perkantoran (JPAP)*, *9*(2), 246–259. https://doi.org/10.26740/jpap.v9n2.p246-259

Rati, Rohiat, S., & Elvinawati, E. (2022). Pengembangan Multimedia Pembelajaran Interaktif Berbasis Problem Based Learning (Pbl) Menggunakan Aplikasi Articulate Storyline Pada Materi Ikatan Kimia. *Alotrop*, *6*(1), 70–79. https://doi.org/10.33369/alo.v6i1.21799

Rawa, N. R. (2020). Pengembangan Lembar Kegiatan

Siswa (LKS) Matematika Berbasis Pendekatan Scientific pada Materi Aritmatika Sosial bagi Siswa SMP. *Jurnal Kependidikan: Jurnal Hasil Penelitian Dan Kajian Kepustakaan Di Bidang Pendidikan, Pengajaran Dan Pembelajaran*, *6*(2), 319. https://doi.org/10.33394/jk.v6i2.2620

Rohmaini, L., Netriwati, N., Komarudin, K., Nendra, F., & Qiftiyah, M. (2020). Pengembangan Modul Pembelajaran Matematika Berbasis Etnomatematika Berbantuan Wingeom Berdasarkan Langkah Borg and Gall. *Teorema: Teori Dan Riset Matematika*, *5*(2), 176. https://doi.org/10.25157/teorema.v5i2.3649

Rosdianto, H., & Murdani, E. (2017). Implementasi Model Pembelajaran POE (Predict Observe Explain) Untuk Meningkatkan Pemahaman Konsep Siswa Pada Materi Hukum Newton. *Jurnal Pendidikan Fisika*, *6*(1), 55. Retrieved from http://jurnal.unimed.ac.id/2012/index.php/jpf

Rudianti, R., Rudianti, A., & Muhtadi, D. (2021). Proses Berpikir Kritis Matematis Siswa Ditinjau Dari Tipe Kepribadian Ekstrovert dan Introvert. *Mosharafa: Jurnal Pendidikan Matematika*, *10*(3), 437–448. https://doi.org/10.31980/mosharafa.v10i3.675

Sofyan, A. & Hidayat, A. (2022). Dampak Perkembangan Teknologi Peningkatan Kualitas Pendidikan. *Satya Informatika*, *7*(2), 16–25. Retrieved from https://teknik.usni.ac.id/jurnal/ade sofyan-amin hidayar -stkip babunnajah-uin-smhb.pdf

Suhailah, F., Muttaqin, M., Suhada, I., Jamaluddin, D., & Paujiah, E. (2021). Articulate Storyline: Sebuah Pengembangan Media Pembelajaran Interaktif Pada Materi Sel. *Pedagonal : Jurnal Ilmiah Pendidikan*, *5*(1), 19–25. https://doi.org/10.33751/pedagonal.v5i1.3208

Sundari, A., Windyariani, S., & Ramdhan, B. (2023). Profil Kemampuan Berpikir Kreatif Melalui PjBL Berbasis Pop Up Book Pada Siswa SMP. *Jurnal Pendidikan Biologi*, *12*(2), 156–165. Retrieved from https://jurnal.stkipbima.ac.id/index.php/OZ/article/view/1301

Tamara, M. F., Tulenan, V., & Paturusi, S. (2019). Aplikasi Pembelajaran Interaktif Sistem Pencernaan Manusia untuk Siswa SD. *Jurnal Teknik Informatika*, *14*(3), 377–386. https://doi.org/10.35793/jti.v14i3.27132

Wahyuni, S., Ridlo, Z. R., & Rina, D. N. (2022). Pengembangan Media Pembelajaran Interaktif Berbasis Articulate Storyline Terhadap Kemampuan Berpikir Kritis Siswa SMP pada Materi Tata Surya. *Jurnal IPA & Pembelajaran IPA*, *6*(2), 99–110. https://doi.org/10.24815/jipi.v6i2.24624

Yasin, A. N., & Ducha, N. (2017). Kelayakan Teoritis Multimedia Interaktif Berbasis Articulate Storyline Materi Sistem Reproduksi Manusia Kelas Xi Sma. *BioEdu*, *6*(2), 169–174. Retrieved from http://ejournal.unesa.ac.id/index.php/bioedu