



Development of Integrated Teaching Materials Articulate Storyline with PBL Model to Improve Students' Statistical Literacy

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Abstract

The rapid development of technology in the 21st century requires students to possess statistical literacy skills in understanding and interpreting data-based information. However, students' statistical literacy skills are still relatively low, so innovative learning approaches are needed to support more active and meaningful learning. This study aimed to develop teaching materials integrated with Articulate Storyline and the Problem Based Learning (PBL) model to improve students' statistical literacy skills. The study used the Research and Development (R&D) method with the 4D development model consisting of define, design, develop, and disseminate stages. The results showed that the developed teaching materials were valid, had a good readability level, and were effective in improving students' statistical literacy skills. The implementation of the PBL model encouraged students to understand, analyze, present, interpret, and conclude data through contextual problem-solving activities. In addition, the integration of Articulate Storyline created a more interactive learning environment through the use of various learning media. Therefore, the developed teaching materials are feasible to support the improvement of students' statistical literacy skills.

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INTRODUCTION

The transformation of education in the 21st century demands human resources capable of critical thinking and creativity, as well as the ability to utilize technology in everyday life. Education is a crucial aspect in preparing a competitive and adaptive generation to current developments. According to Siregar et al. (2024), education can produce skilled and competitive human resources, thus playing a vital role in the development process. Therefore, the learning process needs to be designed innovatively to improve the quality of human resources.

Mathematics is a subject that plays a crucial role in developing students' thinking skills. In addition to numeracy, mathematics also fosters logical, critical, and systematic thinking, as well as problem-solving skills. Saputra (2024) states that mathematics is the primary foundation of various academic disciplines. Furthermore, mathematics learning in the current era emphasizes the development of 21st-century skills, such as critical thinking, communication, collaboration, and creativity (Lestari, V.A., 2023). One mathematical skill relevant to these demands is statistical literacy.

Khasanah et al. (2023) define statistical literacy as an individual's ability to understand, process, analyze, and interpret statistical data to solve a problem. This ability is important because various information in everyday life is often presented in the form of tables, diagrams, and graphs. However, the statistical literacy skills of students in Indonesia are still relatively low. Based on the results of initial observations at SMP Negeri 1 Pucakwangi, students' statistical literacy skills are still relatively low. Students have actually been introduced to statistical literacy-based problem solving, but their ability to implement these concepts is still low. The results of a preliminary study showed that the average statistical literacy skills of seventh-grade students at SMP Negeri 1 Pucakwangi only reached 51.37 out of a maximum score of 100. In addition, Sari et al. (2022) revealed that students still experience difficulties in understanding questions, reading

data, and applying statistical concepts in problem solving.

One way to improve students' statistical literacy skills is through engaging and interactive learning innovations that can increase student motivation. One such innovation is improving the learning tools used, such as teaching materials. Husada (2020) states that teaching materials are a set of learning materials systematically arranged to support the learning process. Developing teaching materials tailored to students' needs can create more effective learning (Yati & Amini, 2020).

One learning model that can be applied to help improve students' statistical literacy through innovative teaching materials is Problem-Based Learning (PBL). According to Maulana et al. (2020), PBL is a learning model that exposes students to real-world problems, thereby developing problem-solving and critical thinking skills. Through this model, students are trained to understand, process, present, interpret, and draw conclusions from data, which are part of statistical literacy skills.

The implementation of the PBL model can be combined with the integration of learning technology, one of which is through Articulate Storyline. Husna & Fajar (2022) explain that Articulate Storyline is software capable of integrating text, images, audio, video, animation, and interactive quizzes in learning. The integration of Articulate Storyline in PBL-based teaching materials allows for the presentation of contextual problems in a more engaging and systematic manner, thereby helping students understand, analyze, present, interpret, and draw conclusions from data. Furthermore, research by Mukarromah (2025) shows that visual and interactive learning media are effective in improving students' statistical literacy skills. Thus, the integration of Articulate Storyline in PBL-based teaching materials has the potential to help improve students' statistical literacy skills.

The development of integrated teaching materials using Articulate Storyline with the PBL model for statistics has not been widely implemented, especially to improve the statistical literacy skills of junior high school students.

Therefore, this study aims to develop integrated teaching materials using Articulate Storyline with the PBL model that meet the criteria of feasibility, readability, and effectiveness to improve students' statistical literacy skills.

METHOD

This study used the Research and Development (R&D) method. According to Muqdamien et al. (2021), the Research and Development method is a research method used to develop, refine, and test the feasibility and effectiveness of a product. The product developed in this study was an integrated teaching material, Articulate Storyline, with a PBL model to improve students' statistical literacy skills. The study was conducted at SMP Negeri 1 Pucakwangi, Pati Regency, Central Java, with 27 class VII A students as subjects.

The development model used is the 4D model proposed by Thiagarajan (1974), which includes the define, design, develop, and disseminate stages. The define stage is conducted through preliminary studies and field surveys to identify problems and learning needs. The design stage aims to draft an initial draft of the developed teaching materials. Next, the develop stage includes expert validation, product revision, and a trial of the teaching materials, consisting of feasibility testing, readability testing, effectiveness testing, and student response testing.

The feasibility test of the teaching materials was conducted by two mathematics lecturers and two mathematics teachers through a validation questionnaire. The readability test was conducted on 10 eighth-grade students of SMP Negeri 1 Pucakwangi using a readability questionnaire. Meanwhile, the effectiveness test was conducted through a pretest and posttest of students' statistical literacy skills which were analyzed using the average completeness test, the proportion completeness test, and the difference test of two means. In addition, at the end of the learning, students were also given a response questionnaire to determine their responses to the use of the developed teaching materials. Finally,

the dissemination stage was carried out through the dissemination of the developed products to specific users or target groups.

RESULTS AND DISCUSSIONS

The product innovation developed in this research is an integrated teaching material using Articulate Storyline with a PBL model to improve students' statistical literacy skills. The developed teaching material contains statistical material, specifically data and diagrams, where the solutions are adjusted to the stages or indicators of statistical literacy skills. Thus, students are expected to practice and develop statistical literacy skills in solving each given problem. The development of this teaching material was carried out by following the stages in the 4D model, with the following results.

The define stage is the initial stage in the 4D development model, which aims to identify learning needs and problems as the basis for product development. This stage involves needs analysis, student analysis, material analysis, and the formulation of learning objectives (Thiagarajan et al., 1974). The define stage in this study was conducted at SMP Negeri 1 Pucakwangi through interviews and a preliminary study.

A needs analysis was conducted to determine the current state of mathematics learning, particularly in statistics. Interviews with teachers revealed that the learning resources used were limited to government textbooks and did not utilize technology-based interactive learning media such as Articulate Storyline. Furthermore, students' statistical literacy skills were still relatively low, particularly in understanding, interpreting, and summarizing data. This finding is supported by preliminary studies showing that the average statistical literacy skill of seventh-grade students was only 51,37 out of a maximum score of 100.

Student analysis shows that students tend to be less interested in learning mathematics because the material is perceived as difficult and there are too many formulas to understand. Students also experience difficulty solving

contextual problems related to everyday life. Furthermore, limited learning resources lead to students being less active and less accustomed to conducting independent data analysis.

Student analysis shows that students tend to be less interested in learning mathematics due to perceived difficulty in the material and the numerous formulas required to understand. Students also experience difficulty solving contextual problems related to everyday life. Furthermore, limited learning resources result in students being less active and less accustomed to conducting independent data analysis.

Based on the analysis, learning innovation is needed in the form of developing integrated teaching materials using Articulate Storyline with the Problem-Based Learning (PBL) model. The development of teaching materials focuses on statistical data and diagrams for seventh-grade junior high school students. The teaching materials are designed to help students understand statistical concepts through contextual problem presentation, problem-solving activities, and the integration of interactive media. This is expected to create more engaging learning and support the improvement of students' statistical literacy skills.

The design stage is the initial product development stage based on the analysis results from the define stage. This stage involves developing test instruments, selecting media, selecting teaching material formats, and developing an initial product draft. The test instrument is designed to measure students' statistical literacy skills through pretests and posttests that refer to statistical literacy indicators: understanding, analyzing, presenting, interpreting, and summarizing data. The questions are also tailored to the learning objectives of the statistical data and diagram material for grade VII junior high school.

The selection of learning media was based on the results of a needs analysis, which indicated that students' learning resources were still limited and they were not utilizing technology-based interactive learning media. Therefore, teaching materials were developed in printed form integrated with Articulate Storyline as an

interactive learning support medium. Articulate Storyline integration was carried out through the presentation of contextual problems, interactive quizzes, and various learning media such as text, images, audio, video, and animation, which students could access through barcodes on the teaching materials.

In addition, the design stage also includes selecting the format of the teaching materials, including the display design, font type, layout, and systematic arrangement of the teaching materials to make them more attractive and easier for students to understand. The teaching materials are structured according to the syntax of the Problem Based Learning (PBL) model and consist of an introduction, content, and conclusion. The content section includes learning activities on data and diagram statistics material presented through contextual problems and statistical literacy-based activities.

The final result of the design phase is an initial draft of the integrated teaching materials Articulate Storyline with a PBL model. This initial draft is designed to help students understand statistical concepts through interactive, systematic problem-solving activities that align with statistical literacy indicators. The initial draft can be seen in Figure 1 below.

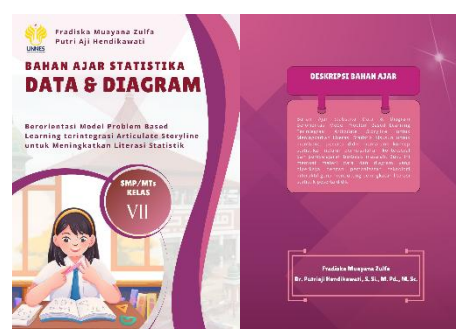


Figure. 1 Initial draft of teaching materials

The development stage is the development and refinement of the product developed in the design stage. This stage involves feasibility testing, readability testing, effectiveness testing, and student response testing. The goal of this stage is to produce teaching materials that are suitable, easy to understand, and effective for use

in learning to improve students' statistical literacy skills.

The results of the feasibility test carried out by the validator can be seen in Table 1 below.

Table 1. Summary of Final Results of the Teaching Materials Feasibility Test

Appraiser	Feasibility (%)			
	Content	Dish	Language	Results
V01	94.79	96.67	91.07	94.34
V02	91.60	96.60	91.07	92.92
V03	92.70	93.33	87.50	91.50
V04	93.75	91.60	85.71	91.04

The feasibility test results show that the integrated teaching materials Articulate Storyline with the PBL model obtained an average percentage of 92.45% with very feasible criteria. In the aspect of content feasibility, the average obtained was 93.21%, the presentation aspect was 94.55%, and the linguistic aspect was 88.84%, all of which were included in the very feasible category.

The validator also provided several suggestions for improvement, such as refining the writing of learning objectives, improving the presentation of tables and figures, and refining the instructions for the Problem-Based Learning learning steps. All of these suggestions were used as the basis for revisions to refine the teaching materials before the next testing phase. Here is one example of the improvements made to the teaching materials.



Setelah menyelesaikan permasalahan yang telah disebutkan pada masalah inti, buatlah laporan yang merangkum seluruh proses penyelesaian masalah tersebut. Susun laporan ini mengikuti langkah-langkah penyelesaian yang diberikan pada contoh soal. Laporan ini akan digunakan untuk persiapan presentasi hasil karya.

Figure 2. Teaching materials before improvement



Setelah menyelesaikan permasalahan yang telah disebutkan pada masalah inti, buatlah laporan yang merangkum seluruh proses penyelesaian masalah tersebut. Susun laporan ini mengikuti langkah-langkah penyelesaian yang diberikan pada contoh soal yang meliputi: memahami data, menganalisis data, menyajikan data, menginterpretasikan data dan menyimpulkan data. Laporan ini akan digunakan untuk persiapan presentasi hasil karya.

Figure 3. Teaching materials after improvements in the sentence structure section in the fourth step of the PBL model.

After going through the feasibility test, the teaching materials were then tested for readability to determine how easily they were understood by students. The results of the readability test are presented in Figure 4.

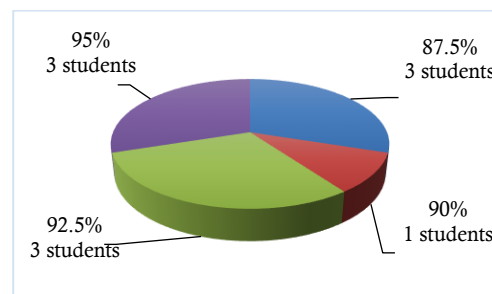


Figure 4. Results of the Readability Test of Teaching Materials

The readability test results showed that the integrated teaching materials, Articulate Storyline, with the PBL model, achieved a score of 91.25%, meeting the criteria of being easy to understand. These results demonstrate that the developed teaching materials meet the readability criteria, including the use of clear language, systematic presentation of the material, attractive presentation, and the use of illustrations that support student understanding (Ardiansyah et al., 2021). Furthermore, the integration of Articulate Storyline through images, animations, and interactive media helps increase student interest in participating in the learning process.

After passing the readability test stage, the teaching materials were then tested for effectiveness to determine the effectiveness of the integrated teaching materials Articulate Storyline with the PBL model in improving students' statistical literacy skills. The effectiveness test was conducted on seventh-grade students of SMP Negeri 1 Pucakwangi through the administration of a pretest and posttest of statistical literacy skills. The effectiveness test was carried out through three hypothesis tests, namely the average completeness test, the proportion completeness test, and the average difference test of the pretest and posttest.

Before conducting the hypothesis test, a normality test was performed on the pretest and posttest scores to determine whether the data came from a normally distributed population.

The normality test was performed using the Kolmogorov-Smirnov test using SPSS.

Based on the results of the normality test, a significance value of 0.200 was obtained in the pretest data and 0.095 in the posttest data of students' statistical literacy abilities, which indicates that the pretest and posttest data of students' statistical literacy abilities come from a normally distributed population.

In the first hypothesis, an average completeness test was carried out to determine whether the average post-test score of students' statistical literacy skills had reached the Actual Completeness Limit (BTA), which was 72. The calculation results can be seen in Table 2 below.

Table 2. Average Completion Test Results

	$\bar{x}$	μ_0	n	s	t_{count}	t_{table}
Posttest	78.7	72	27	7.64	4.539	1.705

Based on the results of the completeness test, the average t_{count} value was obtained at 4.539, while the t_{table} value at a significance level of 5% was 1.705. Because $t_{count} > t_{table}$, H_0 was rejected and H_1 was accepted. This shows that the average posttest score of students' statistical literacy abilities after using the Articulate Storyline integrated teaching materials with the PBL model had reached the Actual Completion Limit, which was 72.

Next, for the second hypothesis, a proportion completeness test was conducted to determine whether the percentage of students achieving learning completeness was more than 75%. The calculation results can be seen in Table 3 below.

Table 3. Results of the Proportional Completeness Test

	π_0	x	n	z_{count}	z_{table}
Posttest	0.75	25	27	2.138	1.64

Based on the results of the proportion completeness test, the z_{count} value was obtained at 2.138, while the z_{table} value at a significance level of 5% was 1.64. Because $z_{count} > z_{table}$, H_0 was rejected and H_1 was accepted. This shows that the percentage of students who achieved

completeness in statistical literacy skills after using the integrated teaching materials Articulate Storyline with the PBL model was more than 75%, so that classical completeness had been achieved.

In the third hypothesis, a mean difference test was conducted to determine whether there was an increase in students' statistical literacy skills before and after using the developed teaching materials. The calculation results are presented in Table 4 below.

Table 4. Results of the Test of Differences between Two Means

	n	$\bar{B}$	SB	t_{count}	t_{table}
Pretest	27	47.593	5.639	43.855	1.705
Posttest	27				

Based on the results of the two-average difference test, the value obtained was 43.855, while the t_{table} value was 1.705. Because $t_{count} > t_{table}$, H_0 is rejected and H_1 is accepted. This shows that the average posttest score of students' statistical literacy skills is higher than the average pretest score after using the Articulate Storyline integrated teaching materials with the PBL model. The increase in students' statistical literacy skills was also strengthened by the results of the N-Gain test which obtained a score of 0.698 with moderate criteria. These results indicate that the use of the developed teaching materials is able to provide an increase in students' statistical literacy skills.

Based on the results of the effectiveness test, it can be concluded that the integrated statistical data and diagram teaching materials Articulate Storyline with the PBL model are effective in improving students' statistical literacy skills. The effectiveness of this teaching material is supported by the implementation of the Problem Based Learning model which encourages students to be active in solving contextual problems, analyzing data, and drawing conclusions based on the data obtained. In addition, the integration of Articulate Storyline helps create more interactive and engaging learning through the presentation of text, images, animations, audio, and interactive

activities so that students more easily understand the statistical material.

The results of this study align with Maryati (2021) research, which demonstrated that developing statistical teaching materials effectively improves students' statistical literacy. Furthermore, research by Daris Salamah et al. (2024) also demonstrated that the application of Problem-Based Learning can improve statistical literacy skills through contextual problem-solving activities. Another study by Mukarromah (2025) demonstrated that the use of interactive visual-based learning media is effective in helping students understand and interpret data, thus supporting improved statistical literacy skills.

The student response test was conducted after the teaching materials were declared effective in improving students' statistical literacy skills. This test aimed to determine students' responses to the use of Articulate Storyline's integrated teaching materials with the PBL model during the learning process. The results of the student response test are presented in Figure 5 below.

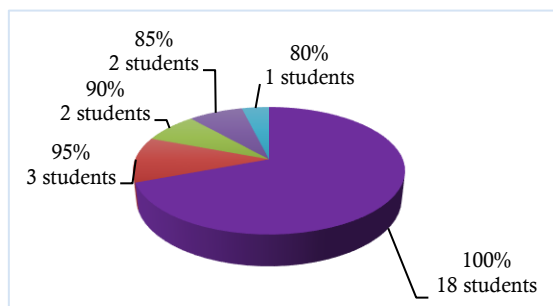


Figure 5. Results of Student Response Test

Based on the results of the student response test, the developed teaching materials achieved a 97% rating, with a very positive criterion. These results indicate that the teaching materials are able to attract student interest and provide a good learning experience during the lesson. Students assessed that the teaching materials have an attractive presentation, easy-to-understand material, and help them be more active in understanding statistical concepts and solving contextual problems. Furthermore, the integration of Articulate Storyline through the

use of interactive media such as images, animation, audio, and quizzes also makes learning more interesting and less boring.

The positive student responses indicate that the developed teaching materials have met the aspects of presentation, readability, and ease of use in learning. This is in line with the opinion of Sugianto et al. (2018) who stated that good teaching materials can help students understand the material, increase learning engagement, and adapt to student learning needs. Thus, teaching materials integrated with the PBL model are declared suitable for use as learning resources to support the improvement of students' statistical literacy skills.

The results of this study are also supported by previous research. Dwindi et al. (2024) stated that the development of interactive teaching materials received a positive response from students because it was able to increase interest in learning. In addition, research by Gea et al. (2025) showed that teaching materials based on Problem Based Learning received a very good response because it made it easier for students to understand the material through problem-solving activities. Research by Rajab et al. (2024) also showed that the use of Articulate Storyline in learning is included in the practical and interesting category for use in the learning process.

The dissemination stage is the final stage in the 4D development model, which involves disseminating teaching materials that have been deemed feasible, easy to understand, effective, and have received positive responses from students. At this stage, the teaching materials were printed on a limited scale and distributed to SMP Negeri 1 Pucakwangi and mathematics teachers as additional learning resources for data and diagram statistics. The dissemination of teaching materials was intended to enable them to be utilized in the learning process to help improve students' statistical literacy skills.

CONCLUSION

Based on the results of research and development that has been done, the integrated

teaching material Articulate Storyline with PBL model was obtained to improve students' statistical literacy skills. The developed teaching material obtained an average feasibility percentage of 92.45% with very feasible criteria, a readability percentage of 91.25% with easy to understand criteria, and a student response of 97% with very positive criteria. In addition, the results of the effectiveness test showed that the teaching material was effective in improving students' statistical literacy skills, indicated by the achievement of average completeness, classical completeness, and an increase in statistical literacy skills based on the results of the pretest and posttest which was strengthened by an N-Gain score of 0.698 in the moderate criteria. Thus, the developed teaching material meets the criteria of feasibility, readability, and effectiveness of teaching materials, so it is suitable for use as a learning resource on data and diagram statistics materials to support the improvement of students' statistical literacy skills.

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