26 (1), 2025, 20-35

Jurnal Pendidikan MIPA

e-ISSN: 2685-5488 | p-ISSN: 1411-2531

http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

Development of Scratch Learning Multimedia to Improve Mathematical Literacy Skills on Statistics Material

Arinda Hikma Wati[1], Megita Dwi Pamungkas[1,*], Dita Aldila Krisma[1], & Jovenil Bacatan[2]

[1]Department of Mathematics Education, Universitas Tidar, Indonesia

[2]UM Penaplata College, Island Garden City of Samal, Philippines

Abstract: This study aims to analyse the validity, practicality, and effectiveness of Scratch learning multimedia in improving students' mathematical literacy skills. This research method is Research and Development (R&D) with ADDIE development model (Analyze, Design, Development, Implementation, and Evaluation). The sample of this research was VIII C students of SMP Negeri 1 Tegalrejo as many as 32 students. The sampling technique used purposive sampling. The data collection techniques were interviews, questionnaires, observation sheets, and tests. The results showed that Scratch learning multimedia was in the very valid category with the acquisition of 80% material validity and 83.56% media validity. Scratch learning multimedia is classified as a very practical category with a percentage of 81.87% based on student responses and 98.33% teacher responses. In addition, this multimedia is effective for improving mathematical literacy skills as evidenced by the difference in pre-test and post-test scores, with an N-Gain value of 0.43 including the moderate category. It can be concluded that the development of Scratch learning multimedia is valid, practical, and effective to improve students' mathematical literacy skills.

Keywords: mathematical literacy, scratch multimedia, statistics.

▪ INTRODUCTION

Today's important element of mathematics learning is developing students' mathematical literacy skills. Mathematical literacy is a notion used to define the competencies required to meet the demands of life in modern society (Bolstad, 2023). Mathematical literacy is an ability that refers to formulating, applying, and interpreting mathematics in various contexts. Mathematical literacy is one of the educational competencies emphasised by the Organisation for Economic Cooperation and Development (OECD). Mathematical literacy is the ability to use mathematical knowledge in real-life situations, making it an essential component of education because of its importance in solving everyday problems (Muhaimin et al., 2024). Mathematical literacy is largely related to the use of mathematics in everyday life (Sikko, 2023). Mathematical literacy is critical for students to understand mathematics, not just mastering the material, but also using mathematical reasoning, concepts, facts, and tools to solve everyday problems, students must use mathematics to communicate and explain the problems they face by using mathematical concepts (Fatwa, Septian, & Inayah, 2019).

Indonesia in the international arena is considered unable to contribute to a generation that has good literacy skills (Sitompul, Budayasa, & Masriyah, 2019). This can be seen in the 2018 PISA assessment where the mathematical literacy skills of Indonesian students are still below the average compared to other countries, which is in the 73rd position out of 79 countries with a score of 379 (OECD, 2023). In 2022 Indonesia's ranking rose to 69th, but the score obtained was lower than in 2018, namely 379 with a difference of 13.

Megita Dwi Pamungkas
*Email: megitadwip@untidar.ac.id

DOI: http://dx.doi.org/10.23960/jpmipa/v26i1.pp20-35
Received: 26 November 2024
Accepted: 23 December 2024
Published: 05 February 2025

The facts in the field show that the mathematical literacy skills of students in class VIII C SMP N 1 Tegalrejo are still on the scale and interval of 41-65 according to the learning objectives completeness criteria, where on this scale they still have not reached completeness and need partial remedial. The average mathematical literacy ability of students in the initial test results that have been carried out reaches 54,68. These results fall into the low category, which is in the X≤70 interval.

The low results of students' mathematical literacy skills can be caused by various factors. Factors that influence the low mathematical literacy of students include, among others, teachers not accustoming students to work on mathematical literacy problems in the learning process (Haara et al., 2021). Students are accustomed to following the teacher's example in solving problems so when faced with a problem pattern that is not the same as what they have been taught, students will experience difficulties (Pamungkas et al., 2024). Based on the interview results, not every meeting was given questions related to mathematical literacy. This was reinforced by the observation that the teacher did not give problems related to mathematical literacy. In fact, teachers must be trained on how to improve students' mathematical literacy, as well as integrate teaching activities into the curriculum (Demir, 2023).

The material that can be associated with mathematical literacy skills is statistics. Based on the content aspects that exist in mathematical literacy, statistics material is included in the uncertainty and data content. Statistics is a broad mathematical discipline that deals with techniques for collecting, analyzing, interpreting, and presenting numerical data (Larson, 2006). Statistics material is material that also requires the ability to interpret data in the form of tables and diagrams. Students in junior high school still struggle with statistical content, particularly when it comes to interpreting and understanding data presented in the form of tables, graphs, or diagrams. The measure of mean and median is another aspect of statistical material that students find challenging since they continue to make mistakes when completing it.

Based on the results of the interview, the statistical material in the story problem section has not shown any improvement in the work. Students still do not understand what is instructed in the problem so student work is not optimal. Mathematics learning in statistics material is also not yet supported by learning multimedia that helps the learning process. The students need to relate certain mathematical knowledge and tools to a specific context. Students reflect on a situation in which they, their parents, or someone they know needs to solve a math problem (Bolstad, 2023). Therefore, multimedia is needed during mathematics learning. There needs to be an action to improve this so that students' mathematical literacy skills increase.

The way that can be taken to deal with problems related to mathematical literacy skills that are still lacking, namely in learning using media. The learning process must be able to facilitate students to improve their mathematical literacy skills (Pamungkas et al., 2021). One way to help students understand the material is to use interactive multimedia content (Pradana et al., 2020). Interactive multimedia includes images, animation, and sound in software that can interact directly with students. Based on the needs analysis questionnaire, 90.63% of students stated that multimedia makes students feel happy and interested in learning mathematics. As many as 78.13% of students felt that multimedia would help them in learning mathematics. This was obtained from the results of the student needs analysis questionnaire. One of the multimedia that can be used is Scratch

learning multimedia. Scratch, a software tool, is the evolution of text-based programming into a visual coding environment (Fidai et al., 2020). Several studies show that Scratch can provide benefits for math learning especially for problem-solving (Benton et al., 2017; Calao et al., 2015; Hughes et al., 2016) and computational thinking (Fagerlund et al., 2021; Perez-Marin et al., 2020; Rodríguez-martínez et al., 2019).

Scratch can not only increase motivation, learning engagement, and fun, but also increase opportunities to learn other mathematical concepts (López, Gonzalez, & Cano, 2016). Scratch enables users to create their own projects like interactive stories, games, animations, simulations, etc (Marcelino et al., 2017). Scratch supports the development of skills and competencies for learning (Pérez-Jorge & Martínez-Murciano, 2022). Therefore, based on this description, it will be necessary to conduct research and development entitled 'Development of Scratch Learning Multimedia to Improve Mathematical Literacy Skills of Class VIII Students in Statistics'.

▪ METHOD

Participants

The population in this study were VIII-grade students of SMP Negeri 1 Tegalrejo, consisting of 7 classes. Class VIII C served as the sample. The sampling technique used purposive sampling. Purposive sampling is a technique that employs specific sampling methods to obtain a sample from a data source (Sugiyono, 2016).

Research Design and Procedures

The type of research used is Research and Development (RnD). The development model used is the ADDIE development model (Analyze, Design, Development, Implementation, Evaluation). The ADDIE development model is suitable for developing a learning product in the field of education (Branch, 2009). An overview of the ADDIE development design stages according to (Branch, 2009) shown in Figure 1.

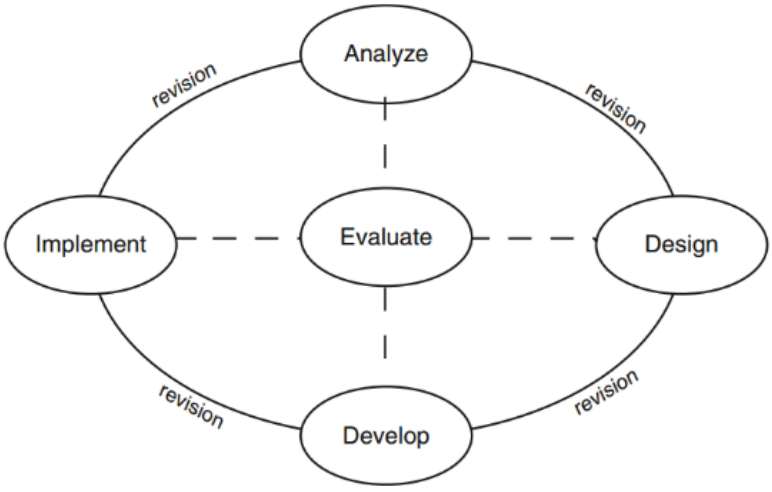

Figure 1. Stages of the ADDIE model

At the analysis stage, media needs were analyzed by distributing questionnaires to students. We also conducted a curriculum analysis to modify the development process according to the relevant curriculum standards. We also conducted an analysis of student

characteristics to identify and categorize their responses during the math learning process. We took several steps in the design stage, such as reviewing the research material and creating flowcharts and storyboards. We conducted a material review to select the appropriate materials for use. Another step involves creating a flowchart to clearly describe the product's manufacturing process and streamline the design process. Then, make a storyboard that contains the content that will be included in the multimedia. Creating a storyboard ensures a more structured approach to multimedia creation. We design the learning multimedia using Canva, PowerPoint, and Scratch applications. This research period takes approximately 2 months.

During the development stage, we create instruments in the form of questionnaires and test questions. Once we create the instrument, we proceed to design the multimedia and validate it with the help of media and material experts. Once the validity test process has been completed, the next step is the implementation stage. This stage involves implementing a lesson in the classroom through multimedia learning using Scratch. At this stage, we conducted pretests and posttests on statistics material to measure students' mathematical literacy skills. Additionally, we will distribute a practicality questionnaire based on responses from both students and teachers, to gauge their reactions to using Scratch for multimedia learning. The evaluation stage consists of two stages: formative evaluation, which occurs at every stage of development to enhance elements like content, animation, and images, and summative evaluation, which occurs after completing all previous stages to enhance the overall effectiveness of the teaching materials.

Instruments

The non-test instruments in this study used questionnaires, interview guidelines, and observation sheets, while the test instruments used pretest and posttest questions. The questionnaires used in this study include a media needs analysis questionnaire, an expert validation questionnaire, and a media practicability questionnaire. Students and teachers use the needs analysis questionnaire to identify their needs. Students and teachers can fill in the needs analysis questionnaire, which includes statements about the multimedia requirements for mathematics learning. The validation questionnaire in this study includes a test instrument validation questionnaire, a material expert validation questionnaire, and a media expert validation questionnaire. These three questionnaires use a Likert scale that contains a choice of five answers. The validation questionnaire of the test question instrument consists of aspects of material, clarity, content accuracy, and language. The media expert validation questionnaire is graded on how easy it is for users to use multimedia and how accurate the instructions are for using media. The material expert validation questionnaire, on the other hand, is graded on how language and content feasibility (which includes material and questions on multimedia) are used.

The practicality questionnaire consists of student and teacher response questionnaires. This response questionnaire contains aspects of display feasibility, including ease, attractiveness, menu clarity, image display, tables, and writing in multimedia. Additionally, the statements in this questionnaire address content feasibility, which encompasses the ease of operation of multimedia and the suitability of the material. The interview guide incorporates questions that were utilized during the initial data collection phase to assess the condition of the school, students, and teachers involved. This study utilizes two types of observation sheets: the first one for initial observations and the second for implementing learning through developed multimedia. The initial

observation sheet is used to observe learning activities in the classroom, as well as to understand the types of learning media used and all other aspects closely related to the classroom learning process. We use the learning implementation sheet to determine the learning activities in the classroom through the development of multimedia. The observer filled in this implementation sheet during the research.

The test instruments utilized were pretest and posttest questions, each consisting of three questions that covered five indicators of mathematical literacy skills. An expert in the field validated this instrument first. If the minimum validity index results fall into the high validity category, you can use the instrument; however, if they fall into the medium category, you need to review the instrument (Fajaruddin et al., 2021). If the validation analysis of the pretest and posttest questions yields results > 0.8, the index (V) falls into the high validity category, indicating the instrument's suitability. We also tested the reliability of the pretest and posttest questions using the Cronbach Alpha formula. iability. If the reliability coefficient index falls within the high category, we can consider the instrument reliable (Payadnya & Jayantika, 2018). High reliability indicates a small error in obtaining measurement results; the greater the reliability, the smaller the measurement error (Retnawati, 2016). According to the reliability test, the results for both the pretest and posttest questions fall into the high category, with scores exceeding 0.7 within the range of 0.6 to 0.8. Therefore, we can conclude that the question is reliable and suitable for use.

Data Analysis

The data analysis techniques used in this study include the validity test, practicality test, and effectiveness test. The purpose of the validity test is to assess a product's feasibility for use in research. Material and media experts assess the validity test. The validity test analysis was carried out by giving an answer score with the following criteria: Very Feasible (score 5), Feasible (score 4), Feasible Enough (score 3), Less Feasible (score 2), and Not Feasible (score 1). We use the practicality test to determine if using learning media with Scratch is practical for students. Students and teachers filled out a practicality questionnaire to obtain the results of the practicality test. We use a Likert scale in the practicality questionnaire to test the product's practicality, with five answer options: Strongly Agree (score 5), Agree (score 4), Undecided (score 3), Disagree (score 2), and Strongly Disagree (score 1) (Sugiyono, 2016). We carry out the effectiveness test by first testing normality, then applying the Liliefors test. Once we confirm the normality of the data, we proceed to calculate it using a parametric test, specifically the paired sample t-test. The paired sample t-test aims to determine whether there is a difference in mathematical literacy skills before and after treatment. Additionally, we conducted the n-gain test to assess the effectiveness of the Scratch learning multimedia product.

▪ RESULT AND DISSCUSSION

Analyze

The analysis stage in this study conducted interviews with teachers, administered needs questionnaires to students, and observed the learning process with the teacher. Students participate in a media needs analysis by completing questionnaires. We conducted this analysis to identify the appropriate media to apply to students. Learning that takes place usually uses lecture and group methods. Teaching materials that are often used by teachers are student worksheets. The use of technology in learning mathematics

is still rarely used because it adjusts the facilities and infrastructure at school. However, the teacher stated that with the presence of technological media, students understand the material better and it is easier to break it down. The use of technological media will create a new atmosphere and make students more interested. In accordance with the statement of Nugraha et al. (2023) that learning will be fun when it is supported by interesting learning media. In addition, students feel that the presence of technological media will be helpful in the learning process of mathematics.

We also conducted a curriculum analysis at SMP Negeri 1 Tegalrejo to understand the curriculum and materials used there. The curriculum applied at SMP Negeri 1 Tegalrejo is the Merdeka Curriculum. The materials in the Merdeka Curriculum include relations and functions, straight-line equations, and statistics. This material is taught in grade VIII in semester 2 in accordance with the Flow of Learning Objectives that is suitable for implementation at school. We conducted an analysis of student characteristics obtained during classroom observations, using this analysis to determine the appropriate learning process. Most students still find it difficult to learn mathematics. Many students are still confused about understanding the problems in story problems and how to determine the right strategy or steps in solving them. This can be seen from the students' pre-test results. Based on the observation of the implementation and activities of learning mathematics, students pay close attention when the teacher conveys related material. However, at the beginning of learning many students look sleepy. This, sparked the teacher to do an apperception or fun thing that makes students excited in learning mathematics. Thus, students can interact positively by still answering questions from the teacher and taking notes on what the teacher says related to the material being studied.

Design

During the design stage, the process of product design involves creating flowcharts and storyboards. We create a flowchart to clearly explain the product's manufacturing process and streamline the design process. Meanwhile, the storyboard provides an overview of the Scratch learning multimedia display under development. We also design this learning multimedia using Canva, PowerPoint, and Scratch applications. We use the Canva application to identify elements for our Scratch-based learning multimedia. This Canva application could be a tool for graphic design to form it simpler for users to design (Qomario et al., 2022). We use the PowerPoint application to input the content for the Scratch learning multimedia. Students can run the learning multimedia by coding its elements using the Scratch application. The material chosen in the Scratch learning multimedia is statistics. The learning objectives of statistics material are shown in Table 1.

Table 1. Learning objectives for statistics materials

No.	Learning Objectives
1.	Determine measures of data centrality (Mean/average, median, and mode)
2.	Determine measures of data distribution (range, quartiles, quartile range, and quartile deviation)
3.	Solve everyday problems related to measures of data concentration
4.	Solve everyday problems related to measures of data spread

Development

The development stage commences with the creation of both non-test and test instruments. The non-test instruments consist of a validation questionnaire for the test instrument, a validation questionnaire for material experts, a validation questionnaire for media experts, and a practical student response questionnaire. The test instrument validation questionnaire contains five aspects, including clarity, content accuracy, relevance, content validity, and language accuracy, along with 10 statements. The material expert validation questionnaire contains two aspects, including content and language feasibility, with 10 statements. The media expert validation questionnaire contains two aspects, including multimedia engineering and visual communication, with 15 statements. The student response questionnaire, which focuses on practicality, includes 12 statements that guide students' responses to the use of Scratch learning multimedia.

The test instruments take the form of pretest and posttest questions, which are based on mathematical literacy skills. We base the pretest and posttest questions on indicators of mathematical literacy skills. There are five indicators of mathematical literacy skills: students' ability to identify statements and questions mathematically, their ability to present objects resulting from identification, including interpretation through tables, diagrams, or images, their ability to create mathematical models based on problems, their ability to apply these mathematical models to solve problems, and their ability to provide reasons for drawing conclusions. Expert validation results include high-validity pretest and posttest questions, enabling testing to determine construct validity, differentiation, reliability, and difficulty level. The results of the construct validity of the pretest and posttest question instruments show that all items—both pretest and posttest—are in the valid category. The reliability analysis places the pretest and posttest questions in the high reliability category. As for the difficulty level of pretest questions, two questions fall into the difficult category and 3 questions fall into the moderate category; for the difficulty level of posttest questions, one question falls into the easy category and 4 others fall into the moderate category. Differentiating power on pretest questions 4 questions fall into the sufficient category, and one question falls into the bad category. On posttest questions, 3 questions fall into the sufficient category, and 2 others fall into the bad category. Based on the results of this analysis, of the five questions tested, only three are suitable for use in research. The next stage is product creation. We designed the product using Canva and PowerPoint.

Next, we place the completed design on Scratch and arrange it accordingly. This Scratch-based learning multimedia includes material features, sample questions, practice questions, and concluding notes. Students can access this Scratch-based learning multimedia through a link. The following link can be accessed by students: https://bit.ly/MulmedScratchStatistikaVIII?r=qr . The example questions and practice questions contain features that can enhance the development of mathematical literacy skills through multimedia. The display will be shown in Figure 2 and Figure 3.

Before field testing, the developed learning multimedia must undergo validation. Experts in material and media carried out this validation. The validators carry out the validation by administering a validation questionnaire. The purpose of validation by material experts is to validate the material in the learning multimedia using Scratch. The material experts' validation results confirm the validity and suitability of the Scratch-

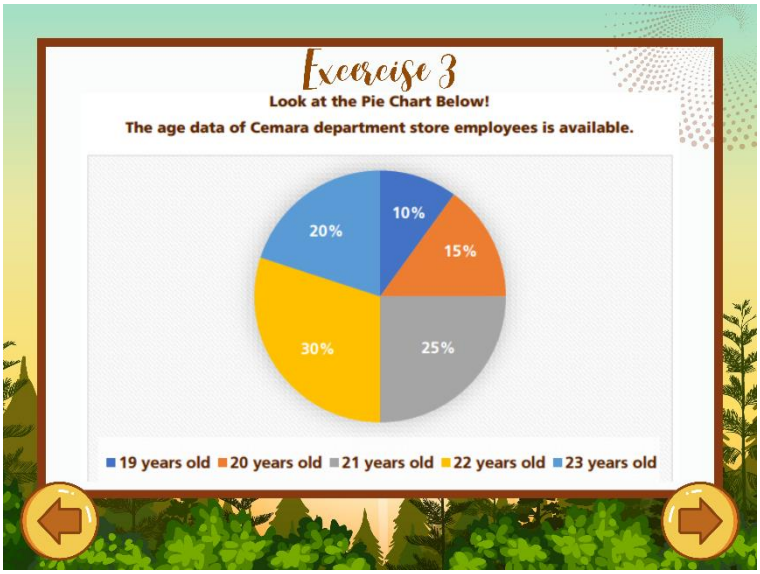

Figure 2. Display page exercise questions

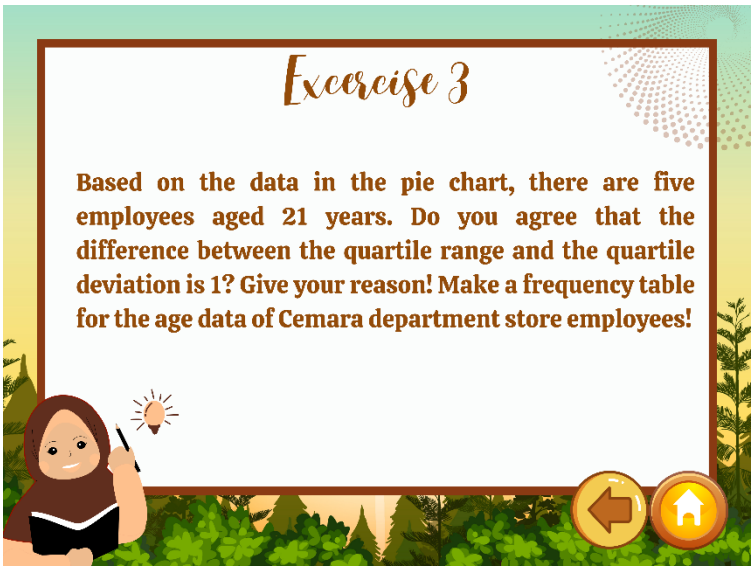

Figure 3. Display of the problem exercise page

based learning multimedia material for the learning process. The validity is obtained from the suitability of the material with learning outcomes and learning objectives, systematic material, as well as sample problems and exercises related to mathematical literacy; the language used is also straightforward, communicative, and understandable. However, the validators provided several suggestions for improving this multimedia before testing it on students. The experts' suggestions and input led to the improvement of the multimedia.

This multimedia not only received validation from material experts, but also from media experts. The purpose of validation by media experts is to validate learning multimedia using Scratch. Media expert validation is essential in the multimedia development process to assess its feasibility based on the designed quality, ensuring it is suitable for student use (Panggabean et al., 2022). The validation results place this

multimedia in a highly valid category, indicating that learning multimedia using Scratch is both feasible and applicable to mathematics education. Overall, the things assessed by media expert validators include, multimedia operation, multimedia benefits in helping explain material to students, content, and multimedia design. Multimedia technology positively affects both the methods teachers use to deliver knowledge and the ways students understand subject material (Abdulrahaman et al., 2020). In addition, Yaftian & Barghamadi (2022) state that using multimedia in teaching makes mathematics lessons more engaging, encouraging students to develop greater interest and motivation in learning the subject. One of the validators stated that the program is good, but there is still a little improvement in the audio part. The validity of multimedia stems from its ease of use, its ability to effectively convey material to students, and its appropriate design, which includes the appropriate use of colors, fonts, and other elements. However, before use, this multimedia needs to be improved based on suggestions from the validators to make it even better.

Implementation

The validators have made improvements, and now the classroom is ready to implement multimedia using Scratch. At this point, the experimental class, specifically class VIII C SMP Negeri 1 Tegalrejo, is incorporating Scratch-based multimedia learning into the mathematics statistics curriculum. We carried out the implementation five times in detail; the first meeting served as a pretest, meetings 2-4 involved multimedia learning using Scratch, and the final meeting served as a posttest. Learning with Scratch multimedia incorporates direct learning methods. There are five phases in the application of direct learning. The first phase involves conveying learning objectives and preparing students; the second phase involves demonstrating knowledge and skills; the third phase involves guided practice; the fourth phase involves checking understanding and providing feedback; and the fifth phase involves providing opportunities for further practice and applicatOne student from Tidar University observed the learning implementation at meetings 2-4, and the teacher also participated as an observer at one of the meetings. We conducted this to assess the effectiveness of implementing multimedia learning through Scratch.

This phase is about implementing what we have planed. The researchers make sure that the students got information about the learning such as how many meetings will be, when the learing will be, what tools or device is necessery, what material will be learned. According to Aldoobie (2015), in implementation phase, one of the step is prepare the learners. For preparing the learners to join the course using technology will start to make sure that the learners are familiar with the information about this course such as when and where the course will be, how many credits this class accounts for, what software is necessary, etc. Beside that, the researchers need to make sure that the classroom and the computer include the Scratch program is working.

Students implement pretest questions during the first meeting, which lasts for two hours. The purpose of this work is to assess the students' proficiency in solving problems based on mathematical literacy. The second meeting involved using Scratch to learn multimedia in the computer laboratory. This second meeting discussed how to use multimedia and the components in it. After that, enter into a discussion of the material. During the third meeting, we conducted in-class learning using each student's cellphone.

The discussion of the material continued during the third meeting. This third lesson followed the same methodology as the second meeting. Individually, students studied the material and worked on the sample problems. During the fourth meeting, students practice problems in groups and review the material they learned in the previous meeting. Prior to working on the posttest questions in the fifth meeting, students are required to complete a practicality questionnaire, which takes the form of student responses while engaging in multimedia learning using Scratch. After completing the questionnaire, students immediately began working on the posttest questions.

The results of the pretest and posttest data analysis showed that the average student scores obtained were 56 and 76 out of 32 students, respectively. This indicates a significant increase in test results both before and after the implementation of multimedia learning using Scratch. Additionally, we can observe a rise in the proportion of each mathematical literacy indicator. The achievement of each indicator of mathematical literacy is shown in Figure 4.

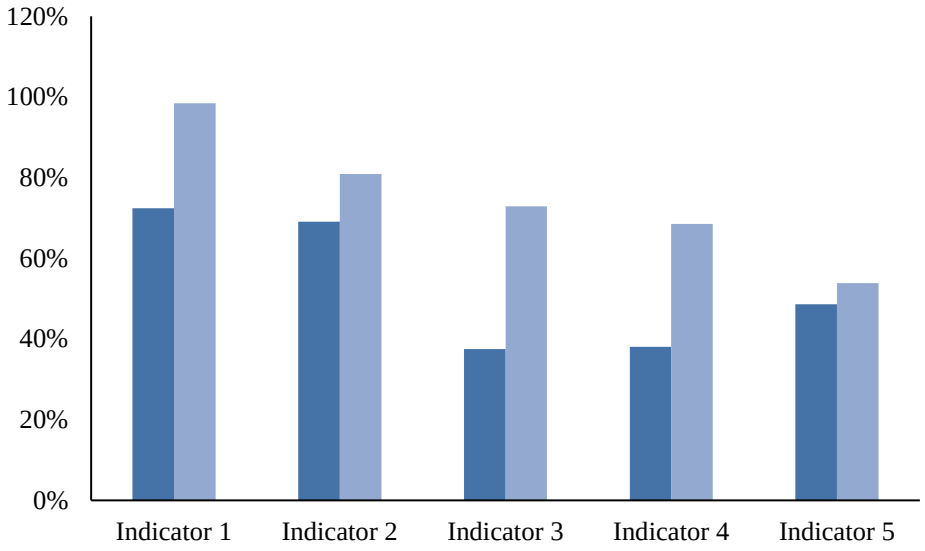

Figure 4. Percentage achievement of mathematical literacy indicator

Indicator 1, which measures communication and mathematization based on Figure 4, achieved a score of 72.39% on the pretest question and a score of 98.44% on the posttest question. The increase in indicator 1 reached 26.04%. Indicator 2, which measures representation in the pretest question, achieved a result of 69.09%, while the posttest question yielded a result of 80.90%. The increase in indicator 2 was 11.80%. Indicator 3, which reads the use of mathematical language in the pretest question, gets a result of 37.5%, and the posttest question gets a result of 72.92%. The increase in Indicator 3 reached 35.42%. Indicator 4, which reads planning problem-solving strategies in the pretest question, gets a result of 38.02%, and in the posttest question, it gets a result of 68.49%. The increase in Indicator 4 reached 30.47%. Indicator 5, which reads argumentation in the pretest question, gets a result of 48.61%, and in the posttest question, it gets a result of 53.82%. The increase in indicator 5 amounted to 5.21%.

Figure 4 shows that each mathematical literacy indicator's percentage score increased after learning multimedia with Scratch. Additionally, we conducted tests on both the pretest and posttest data. However, we first conducted a normality test to ascertain the data's normality. Based on the calculation results using the Liliefors test, the pretest and posttest data are smaller than the Liliefors table, so $H0$ is accepted, which means that the pretest data and posttest data are normally distributed. Given the normal distribution of both data, we employed a parametric hypothesis test. We conducted this hypothesis test to determine the average difference in mathematical literacy skills before and after using Scratch for multimedia learning. The paired sample t-test serves as the parametric hypothesis test in this study. The calculation results show that the t-count value exceeds the t-table value, leading to the rejection of test decision H0. This suggests a significant difference in the mathematical literacy skills of students before and after the implementation of multimedia learning using Scratch. We also analyzed the pretest and posttest data using the N-Gain test. We conducted the N-Gain test to visualize the growth in students' mathematical literacy skills before and after using Scratch for multimedia learning.

The N-Gain test results indicate an increase in students' mathematical literacy skills. We can conclude that learning multimedia using Scratch effectively improves students' mathematical literacy skills, based on the results of hypothesis testing and the N-Gain test. Therefore, the use of Scratch learning multimedia in learning to improve student learning outcomes especially in solving mathematics problems. This is consistent with the findings of Fitrianingsih et al. (2024) that Scratch can enhance students' mathematics learning outcomes. Correspondingly, Aminah et al. (2023) stated that the Scratch has been contributing significantly to the ability of solving problems in mathematics. When students use Scratch, one of the activities is to practice solving problems in groups. In this activity, each student worked together to contribute in solving problems related to mathematical literacy. The completion of this practice problem led students to communicate and collaborate with each other so that they could find the solution.

The practicality assessment is derived from the results of student and teacher response questionnaires administered in class VIII C following the implementation of Scratch-based multimedia learning in mathematics. We administered this response questionnaire to gather students' and teachers' reactions to Scratch-based multimedia learning, and to assess the practicality of this approach. The responses of students and teachers demonstrate the practicality of learning media. Overall, the questionnaire statements cover multimedia symbol and icon readability, benefits, and design attractiveness. Multimedia can foster student interest and attention to learning. The importance of using multimedia in learning is an effort to develop an interesting learning process and help students capture information more easily (Mayer & Moreno, 2002). Students and teachers can see the assessment results by filling out a questionnaire and then calculating the percentage. Students' questionnaires yielded an assessment of 81.87%. This indicates that learning mathematics through multimedia using Scratch is highly practical. The teacher's questionnaire yielded an assessment of 98.33%. This indicates that learning mathematics through multimedia using Scratch is highly practical.

In relation to communication in the use of Scratch, Calder (2018) stated that the communication and competencies that emerged in the use of Scratch showed appropriate aspects in mathematical problem solving. While, about collaboration, like the findings of

Taley et al. (2024), Scratch facilitated student collaboration and information sharing. Moreover, the use of Scracth provides a learning experience using interactive and interesting media for students so that they are more motivated to learn the material provided. Developing math materials presented using Scratch media makes students more active and interactive (Bernard & Setiawan, 2020). The interactivity of Scratch is shown by the existence of buttons that are easily accessible to select the menu to be learned, the part that provides opportunities for students to input answers, and ease of access. Things that are interesting when using Scratch media include the appearance of an appropriate layout, appropriate color composition, illustrations that fit the context, there are sounds that explain or interactive sentences, material that is easy to understand, and varied exercises. Therefore, the use of media in learning supports the students to keep focused and understand the material. The uses of media that facilitate visual or graphic media to help students' focus, making the learning more engaging, meaningful, and effective in understanding the material (Sholehah et al., 2024).

Evaluation

Each stage of development involves two stages of evaluation, known as formative evaluation, which focuses on improving elements such as content, animation, and images to enhance their attractiveness. We carry out this evaluation during product development, enhancing the multimedia based on suggestions and input from the validators. We conduct summative evaluation following the completion of all previous stages, aiming to enhance the overall effectiveness of the teaching materials. In line with the statement of Aldoobie (2015), there are two types of evaluation, which are formative evaluation and summative evaluation. We conduct the evaluation to ensure the suitability of the multimedia for use. The development of instructional materials should follow a cyclical and iterative process, as incorporating experts' feedback plays a crucial role in creating high-quality materials (Tolentino et al., 2023). The evaluation results show that the teacher and student responses have met the criteria of being very practical, and there are no improvements to the learning multimedia using Scratch. Experts have declared this multimedia effective in enhancing students' mathematical literacy skills. Therefore, students can effectively utilize Scratch to learn multimedia in mathematics, particularly in statistics. Accordingly, Kobsiripat (2015) state that Sractch is an interactive media that provides interesting and promote creative learning experience (Rosydiana et al., 2023). Students are enthusiasted and motivated in the learning process. Students are enthusiated and motivated in the learning process when they use Scratch, an interactive media that offers an interactive and effective learning experience.

▪ CONCLUSION

Multimedia using Scratch has proven to be valid, practical, and effective in improving students' mathematical literacy skills in statistics. This is due to Sratch's ability to present material, example problems, and practice problems in an easy-to-understand and interactive manner, thereby increasing students' interest and motivation to learn. Teachers can use Scratch's multimedia as a reference to prepare tasks that focus on mathematical literacy skills. Additionally, teachers and students can use this multimedia as learning media for statistics.

This research shows that technology such as Scratch has enormous potential to improve the quality of mathematics learning. Particularly, it enhances the mathematical literacy abilities of junior high school pupils. However, the limitations of this multimedia include its inability to automatically summarize student grades, necessitating a manual review process for each student individually. In addition, the activities are also still not varied due to limitations in processing coding. This research suggests that researchers should conduct similar studies to enhance their understanding of the Scratch application, ensuring a high-quality and diverse final product.

▪ REFERENCES

Abdulrahaman, M. D., Faruk, N., Oloyede, A. A., Surajudeen-Bakinde, N. T., Olawoyin, L. A., Mejabi, O. V., Imam-Fulani, Y. O., Fahm, A. O., & Azeez, A. L. (2020). Multimedia tools in the teaching and learning processes: A systematic review. *Heliyon*, *6*(11), e05312. https://doi.org/10.1016/j.heliyon.2020.e05312

Aldoobie, N. (2015). ADDIE Model. *American International Journal of Contemporary Research ADDIE*, *5*(6), 68–72.

Aminah, N., Sukestiyarno, Y. L., Cahyono, A. N., & Maat, S. M. (2023). Student activities in solving mathematics problems with a computational thinking using Scratch. *International Journal of Evaluation and Research in Education*, *12*(2), 613–621. https://doi.org/10.11591/ijere.v12i2.23308

Benton, L., Hoyles, C., Kalas, I., & Noss, R. (2017). Bridging primary programming and mathematics : some findings of design research in england. *Digital Experiences in Mathematics Education*, *3*, 115–138. https://doi.org/10.1007/s40751-017-0028-x

Bernard, M., & Setiawan, W. (2020). Developing math games media using scratch language. *Journal of Physics: Conference Series*, *1657*(012064), 1–10. https://doi.org/10.1088/1742-6596/1657/1/012064

Bolstad, O. H. (2023). Lower secondary students' encounters with mathematical literacy. *Mathematics Education Research Journal*, *35*(1), 237–253. https://doi.org/10.1007/s13394-021-00386-7

Branch, R. M. (2009). Instructional Design: The ADDIE Approach. Springer.

Calao, L. A., Moreno-Leon, J., Correa, H. E., & Robles, G. (2015). Developing mathematical thinking with scratch an experiment with 6th grade students. *Lecture Notes in Computer Science*, *September*. https://doi.org/10.1007/978-3-319-24258-3

Calder, N. (2018). Using scratch to facilitate mathematical thinking. *Waikato Journal of Education*, *23*(2), 43–58. https://doi.org/10.15663/wje.v23i2.654.To

Demir, F. (2023). A correlational evaluation between students mathematics literacy and high school entrance exam results. *Journal of Pedagogical Sociology and Psychology*, *5*(3). https://doi.org/10.33902/jpsp.202323579

Fagerlund, J., Häkkinen, P., Vesisenaho, M., & Viiri, J. (2021). Computational thinking in programming with Scratch in primary schools: A systematic review. *Computer Applications in Engineering Education*, *29*(1), 12–28. https://doi.org/10.1002/cae.22255

Fajaruddin, S., Retnawati, H., Wijaya, T. T., Ramadhan, S., & Prihatni, Y. (2021). *Alhamdulillah, butir pengembangan instrumen penilaian artikel jurnal ilmiah dikatakan valid oleh para rater. Measurement in Educational Research*, *1*(2), 89–

96.

Fatwa, V. C., Septian, A., & Inayah, S. (2019). *Kemampuan literasi matematis siswa melalui model pembelajaran problem based instruction. Mosharafa: Jurnal Pendidikan Matematika*, *8*(3), 389–398. https://doi.org/10.31980/mosharafa.v8i3.535

Fidai, A., Capraro, M. M., & Capraro, R. M. (2020). "Scratch"-ing computational thinking with Arduino: A meta-analysis. *Thinking Skills and Creativity*, *38*, 100726. https://doi.org/10.1016/j.tsc.2020.100726

Fitrianingsih, A. N. A., Rosjanuardi, R., & Sudihartinih, E. (2024). Super geo-bros game: a scratch-based mathematics game for learning geometric transformations to improve learning outcomes. *Jurnal Pendidikan MIPA*, *25*(2), 792–802.

Haara, F. O., Bolstad, O. H., & Jenssen, E. S. (2021). Research on mathematical literacy in schools - Aim, approach and attention. *European Journal of Science and Mathematics Education*, *5*(3), 285–313. https://doi.org/10.30935/scimath/9512

Hughes, J., Gadanidis, G., & Yiu, C. (2016). Digital making in elementary mathematics education. *Digital Experiences in Mathematics Education*, *3*, 139–153. https://doi.org/10.1007/s40751-016-0020-x

Kobsiripat, W. (2015). Effects of the media to promote the scratch programming capabilities creativity of elementary school students. *Procedia - Social and Behavioral Sciences*, *174*, 227–232. https://doi.org/10.1016/j.sbspro.2015.01.651

Larson, M. G. (2006). Descriptive statistics and graphical displays. *Circulation*, *114*(1), 76–81. https://doi.org/10.1161/CIRCULATIONAHA.105.584474

Marcelino, M. J., Pessoa, T., Vieira, C., Salvador, T., & Mendes, A. J. (2017). Learning computational thinking and scratch at distance. *Computers in Human Behavior*, *80*, 470–477. https://doi.org/10.1016/j.chb.2017.09.025

Mayer, R. E., & Moreno, R. (2002). Aids to computer-based multimedia learning. *Learning and Instruction*, *12*(1), 107–119. https://doi.org/10.1016/S0959-4752(01)00018-4

Muhaimin, L. H., Sholikhakh, R. A., Yulianti, S., Ardani, Hendriyanto, A., & Sahara, S. (2024). Unlocking the secrets of students' mathematical literacy to solve mathematical problems: A systematic literature review. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(4), em2428. https://doi.org/10.29333/ejmste/14404

Nugraha, F., Edy Mulyono, S., & Wahyudin, A. (2023). The effectiveness of infographic learning media in increasing learning interest, visual spatial intelligence and student learning outcomes in gugus ahmad yani KEC. Kuningan. *International Journal of Research and Review*, *10*(5), 383–390. https://doi.org/10.52403/ijrr.20230545

OECD. (2023). PISA 2022 assessment and analytical framework. PISA, OECD Publishing. https://doi.org/10.1787/dfe0bf9c-en

Pamungkas, M. D., Rahmawati, F., & Apriliyani, M. N. (2021). Teaching spatial geometry with geogebra: Can it improve the problem-solving skills of prospective mathematics teachers? *Journal of Physics: Conference Series*, *1918*(4), 042082. https://doi.org/10.1088/1742-6596/1918/4/042082

Pamungkas, M. D., Waluya, S. B., Mariani, S., Isnarto, I., Rahmawati, F., Noor Kholid, M., & Laksmiwati, P. A. (2024). Enhancing complex problem-solving skills through stem-based spatial geometry e-modules. *Qubahan Academic Journal*, *4*(3),

541–556. https://doi.org/10.48161/qaj.v4n3a794

Panggabean, D. D., Sinuraya, J., Harahap, M. H., & Goni, F. P. K. (2022). The feasibility and practicality of learning multimedia based on whiteboard animation of momentum and impulse towards first grade of senior high school student learning motivation. *International Journal of Current Science Research and Review*, *05*(11), 4216–4225. https://doi.org/10.47191/ijcsrr/v5-i11-19

Payadnya, I. P. A. A., & Jayantika, I. G. A. N. T. (2018). *Panduan penelitian eksperimen beserta analisis statistik dengan SPSS*. Deepublish.

Pérez-Jorge, D., & Martínez-Murciano, M. C. (2022). Gamification with scratch or app inventor in higher education: a systematic review. *Future Internet*, *14*(374). https://doi.org/10.3390/fi14120374

Perez-Marin, D., Hijon-Neira, R., Bacelo, A., & Pizarro, C. (2020). Can computational thinking be improved by using a methodology based on metaphors and Scratch to teach computer programming to children? *Computers in Human Behavior*, *105*, 105849. https://doi.org/10.1016/j.chb.2018.12.027

Pradana, L. N., Sholikhah, O. H., Maharani, S., & Kholid, M. N. (2020). Virtual mathematics kits (VMK): Connecting digital media to mathematical literacy. *International Journal of Emerging Technologies in Learning*, *15*(3), 234–241. https://doi.org/10.3991/ijet.v15i03.11674

Qomario, Q., Tohir, A., & Prastyo, C. (2022). Math poster with augment reality to increase learning outcome of students' high school. *International Journal of Trends in Mathematics Education Research*, *5*(1), 69–73. https://doi.org/10.33122/ijtmer.v5i1.106

Retnawati, H. (2016). *Analisis kuantitatif instrumen penelitian*. Parama Publishing.

Rodríguez-martínez, J. A., González-calero, J. A., & Sáez-lópez, M. (2019). Computational thinking and mathematics using Scratch : an experiment with sixth-grade students. *Interactive Learning Environments*, *0*(0), 1–12. https://doi.org/10.1080/10494820.2019.1612448

Rosydiana, E. A., Sudjimat, D. A., & Utama, C. (2023). Effect of digital learning media using scratch game based learning on student problem solving skills. *Jurnal Penelitian Pendidikan IPA*, *9*(11), 10010–10015. https://doi.org/10.29303/jppipa.v9i11.4876

Sáez-López, J. M., Román-González, M., & Vázquez-Cano, E. (2016). Visual programming languages integrated across the curriculum in elementary school: A two year case study using "scratch" in five schools. *Computers and Education*, *97*, 129–141. https://doi.org/10.1016/j.compedu.2016.03.003

Sholehah, A. J. S., Cahyanti, K. N., Dini, N. A., & Hidayatussolehah, N. (2024). Analysis of the role of image media in the mathematics learning process amid technological development. *International Journal of Education and Teaching Zone*, *3*(2), 161–171. https://doi.org/10.57092/ijetz.v3i2.176

Sikko, S. A. (2023). What can we learn from the different understandings of mathematical literacy? *Numeracy*, *16*(1). https://doi.org/10.5038/1936-4660.16.1.1410

Sitompul, R. S. I., Budayasa, I. K., & Masriyah. (2019). Mathematics literacy of secondary students in solving simultanenous linear equations. *Journal of Physics: Conference Series*, *947*(1). https://doi.org/10.1088/1742-6596/947/1/012019

Sugiyono. (2016). *Metode penelitian kombinasi (mix methods)* (Sutopo (ed.)). Alfabeta.

Taley, I. B., Amponsah, A., & Kpai, H. (2024). Exploring the factors that influence students' interest in using Scratch to learn coordinate Geometry: An integrated model based on the Technology Acceptance Model. *Journal of ICT in Education, 2020*.

Tolentino, J. C. G., Danganan, C. G., David, A. A., & Peña, J. T. (2023). Development and validation of a booklet in educational research: a supplementary material for filipino teacher education students. *Multidisciplinary Journal for Education, Social and Technological Sciences*, *10*(2), 1–23. https://doi.org/10.4995/muse.2023.18678

Yaftian, N., & Barghamadi, S. (2022). The effect of teaching using multimedia on mathematical anxiety and motivation. *JRAMathEdu (Journal of Research and Advances in Mathematics Education)*, *7*(2), 55–63. https://doi.org/10.23917/jramathedu.v7i2.16141