# Effectiveness of the Joyful Learning Model with Scratch-Assisted Learning Media on Students' Mathematical Literacy

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# Effectiveness of the Joyful Learning Model with Scratch-Assisted Learning Media on Students' Mathematical Literacy

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## ABSTRACT

This study was motivated by students' mathematical literacy levels that have not yet met expected learning standards and by the limited use of interactive learning media in schools. In addition, studies that combine learning models and digital media to improve students' mathematical literacy remain limited. This study aimed to examine the effectiveness of a joyful learning model supported by Scratch-based learning media in improving students' mathematical literacy, as well as to describe students' mathematical literacy performance, learning activities, and responses during the implementation. The study employed a one-shot case study experimental design. The population comprised all seventh-grade students at SMP Negeri 10 Tasikmalaya, and the sample was Class VII K (n = 32), selected through simple random sampling. Data were collected using a mathematical literacy test, a learning activity observation sheet, and a student response questionnaire. The data were analyzed using a binomial (proportion) test. The results indicated that the joyful learning model supported by Scratch-based media was effective for students' mathematical literacy, with students' mathematical literacy categorized as moderate (71.9%). Student learning activities were classified as very good, and students' responses to the learning were very positive.

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## Introduction

In the world of education, there is one field of study that plays a very significant role, namely mathematics. Mathematics helps individuals solve various types of problems, and even though not all problems are mathematical in nature, mathematics still plays a significant role in solving problems in real life (Sholihah & Mahmudi, 2015). Solving real-life problems is what is referred to as mathematical literacy (Lindawati, 2018). Mathematical literacy helps students develop the ability to formulate, apply, and interpret mathematics in various contexts. The contexts referred to are real-world situations. According to Dewi & Maulida (2023) the

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development of mathematical literacy is very important as part of the 21st century competency requirements, namely critical and problem solving, communication and collaboration, as well as creativity and innovation. Thus, mathematical literacy is a must for students.

The importance of mathematical literacy in the 21st century has not been matched by the mathematics learning achievements of students in Indonesia. Currently, students' mathematics learning achievements are still relatively low, which is thought to be due to their low mathematical literacy skills (Suprapto et al., 2023). Based on the results of the Programme for International Student Assessment (PISA) in 2022, which were announced on December 5, 2023, Indonesia experienced a decline in mathematical literacy scores compared to the PISA results in 2018. The mathematical literacy score in 2018 was 379, while in 2022 it dropped to 366. Therefore, the main objective of mathematics education at the school level is to develop mathematical literacy skills (Putri et al., 2024).

Based on the 2024 Education Report of SMPN 10 Tasikmalaya, the maximum score achieved in mathematical literacy competency was 64.59% in the geometry domain. This result has not reached the specified learning completeness of 75. Therefore, competency in the geometry domain needs to be optimized. Information from one of the mathematics teachers at SMP Negeri 10 Tasikmalaya indicates that students at the school are still not proficient in reasoning and analyzing problems in the context of everyday life. Students are also still unable to identify and apply mathematical concepts and procedures in solving these problems. In practice, learning at SMP Negeri 10 Tasikmalaya already uses the independent curriculum. In mathematics learning itself, several learning models are used, including the traditional model and problem-based learning. The learning media used are also not yet interactive. The use of these learning models and media has not been able to develop mathematical literacy and tends to make students less interested and bored in learning.

Many previous studies have focused on developing mathematical literacy through the application of learning models, including research by Tasman (2022) which produced a reading to learn learning model that was quite effective for mathematical literacy, due to the active involvement of students in learning activities, so that they enjoyed the process of understanding concepts and the stages of solving literacy-based problems. Other research was conducted by Handari (2024) that implementation of the project-based learning model can improve mathematical literacy due to several factors, including the active, innovative, and creative involvement of students in completing projects. This makes learning student-centered and allows them to gain real-world experience while building their understanding. In addition, research conducted Amalia (2018) also stated that the implementation of a problem based learning model combined with team games tournaments can increase students' learning motivation and mathematical literacy due to the emergence of a fun atmosphere during the learning process.

Referring to previous learning and research conditions, learning that stimulates students to be active, innovative, and creative in a joyful atmosphere that develops their mathematical literacy is needed. One relevant alternative is the joyful learning model. The joyful learning model is a learning process that takes place in a pleasant atmosphere, free from coercion or pressure, so that students feel calm while participating in the learning process. The joyful learning model emphasizes elements of play in the learning process that are easily accepted by students and can increase interest and learning achievement (He et al., 2017). This situation is able to attract attention and reduce boredom among students during the learning process. The integration of appropriate, interesting, and enjoyable learning media can also stimulate students to be active during learning, which can also increase motivation and feelings of enjoyment during learning (Anggoro et al., 2024). One platform that can be utilized is Scratch. Using

Scratch provides a different experience for students. Its attractive design and interactive technology make learning more enjoyable and far from boring.

Based on the description above, no research has been found that discusses combining models and learning media for students' mathematical literacy. One example is the use of the joyful learning model by integrating Scratch-assisted learning media for mathematical literacy, particularly in indicators using mathematical concepts, facts, procedures, and reasoning. As a follow-up to the issues raised, this study was conducted to determine the effectiveness of the joyful learning model with Scratch-assisted learning media on students' mathematical literacy. Learning is considered effective if the test results show that at least 75% of students meet the minimum competency standard of 75 (Mulyasa, 2017).

## Method

### Research Design, Population and Sample

The method used was a pre-experimental design method of the one-shot case study type. In this design, there is only a group that receives treatment without a control group. The research design was adopted from Gay & Airasian (2000). This design was chosen because the effectiveness of a treatment on a specific outcome can be determined directly on one group of subjects without a comparison group. The researchers determined the research population to be seventh-grade students at SMP Negeri 10 Tasikmalaya. The sampling technique used was simple random sampling using a paper lottery. The sample obtained was class VII K with 32 students.

### Instruments

The instruments used were mathematical literacy test questions, observation sheets of student learning activities, and questionnaires on student responses to learning. First, mathematical literacy test questions serve to measure students' mathematical literacy. The test questions consist of complex multiple-choice and matching questions. Each question contains one of the mathematical literacy indicators according to the OECD (2023) namely using mathematical concepts, facts, procedures, and reasoning. The validity and reliability of these test questions were first assessed by an expert, who is a mathematics education lecturer, and the instruments were tested on students outside the population group. The validity of the test results was examined using the correlation product moment, and reliability was examined using *Alpha Cornbach* (Arikunto, 2018). After being declared valid and reliable, these test questions were distributed to students after the learning process was completed.

Second, observation of student learning activities is conducted to assess student engagement during learning activities. This observation is based on aspects of student learning activities according to Sardiman (2018) namely visual, verbal, listening, writing, drawing, motor, mental, and emotional activities. Observations were conducted by an observer who is a mathematics teacher at SMPN 10 Tasikmalaya, and the results were recorded in an observation sheet. Third, the student response questionnaire was used to obtain information about students' responses to learning using the joyful learning model with Scratch-assisted learning media. The student response questionnaire was based on indicators according to Hairina (2021) namely interest, motivation, satisfaction, assessment, and response.

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## Data Collection and Analysis

Data collection was conducted by observing learning activities carried out by observers during the learning process. After the learning material had been fully delivered, students were given a mathematical literacy test and a questionnaire to be completed individually. After the data was collected, data analysis was conducted, including mathematical literacy test results. The data was processed to obtain scores for each student. The following scoring guidelines were used:

**Table 1.** Test Question Scoring Guidelines

| Question Type | Response to Question | Score |
|---|---|---|
| Complex multiple choice questions | Selecting incorrect statements | 0 |
| | Selecting the correct statement | 1 |
| The Question of Matchmaking | Wrong answer | 0 |
| | Correct answer | 1 |

(Pusmenjar, 2020)

The results of the mathematical literacy test were then analyzed using descriptive statistics were performed to determine the statistical measures of the data, including the number of data points (n), largest data (max), smallest data (min), mean ($\bar{x}$), and standard deviation (s). To calculate mathematical literacy categories using categories according to Arikunto (2019):

**Table 2.** Mathematical Literacy Category

| Value | Category |
|---|---|
| $X \geq (\bar{X} + SD)$ | High |
| $(\bar{X} - SD) > X < (\bar{X} + SD)$ | Medium |
| $X \leq (\bar{X} - SD)$ | Low |

The research hypothesis was tested using a proportion test (binomial). This test was used to determine whether the joyful learning model with Scratch-assisted learning media was effective in improving students' mathematical literacy.

The results of observations and questionnaires were processed to obtain the percentage of student activities and responses. The following scoring guidelines were used:

**Table 3** Learning Activity Observation Sheet Scoring Guidelines

| Learning Activities | Score |
|---|---|
| Activity descriptor not visible | 0 |
| Activity descriptor visible | 1 |

(Totok Yulianto et al., 2023)

**Table 4.** Guidelines for Scoring Student Response Questionnaires on Learning

| Criteria | Score |
|---|---|
| No | 0 |
| Yes | 1 |

(Sugiyono, 2021)

The formula for processing the observation and questionnaire data uses the following formula (Sudjana, 2017):

$$P = \frac{f}{N} \times 100\%$$

Explanation:
$P$ : Percentage
$f$ : Total score
$N$ : Maximum score

Overall Students

$$Pk = \frac{fk}{S} \times 100\%$$

Explanation:
$Pk$ : Overall percentage
$fk$ : Total percentage value
$S$ : Number of students

Calculation of learning activity categories using categories according to Masyhud & Tasmin (2014) modified:

Table 5. Categories of Student Learning Activities

| Percentage Value | Category |
|---|---|
| $81\% - 100\%$ | Very Good |
| $61\% - 80\%$ | Good |
| $41\% - 60\%$ | Fair |
| $21\% - 40\%$ | Not Good |
| $0\% - 20\%$ | Bad |

To calculate the response categories of students, we use the categories according to Arikunto (2019) which are as follows:

Table 6 Categories of Student Responses

| Percentage Value | Category |
|---|---|
| $80\% < X \leq 100\%$ | Very Positive |
| $60\% < X \leq 80\%$ | Positive |
| $40\% < X \leq 60\%$ | Somewhat Positive |
| $20\% < X \leq 40\%$ | Less Positive |
| $0\% < X \leq 20\%$ | Very Less Positive |

**Research Findings**

Based on mathematical literacy tests, observations, and questionnaires regarding student responses to learning, the following results were obtained. Mathematical literacy test results are based on mathematical literacy test scoring guidelines.

Table 7. Descriptive Statistics Results of Mathematical Literacy Tests

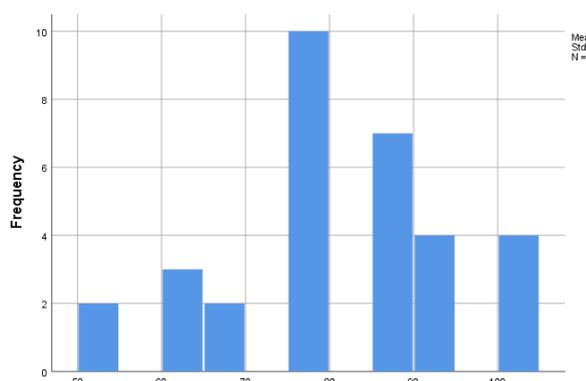| Description | Results |
|---|---|
| Number of data ($n$) | 32 |
| Largest data ($max$) | 100 |
| Smallest data ($min$) | 54 |
| Mean ($\bar{x}$) | 80.16 |
| Standard deviation ($s$) | 12.7 |

**Figure 1.** Mathematical Literacy Results Histogram

The mathematical literacy test was taken by 32 students, with the highest score obtained by a student being 100 and the lowest being 54. The average score for the mathematical literacy test was 80.16, with a standard deviation of 12.7.

**Table 8.** Results of Students' Mathematical Literacy Category

| Value | Category | Frequency | Percentage |
|-------|----------|-----------|------------|
| $X \geq 92.9$ | High | 4 | 12,.5% |
| $67.4 < X < 92.9$ | Medium | 23 | 71.9% |
| $X \leq 67.4$ | Low | 5 | 15.6% |

The results of the mathematical literacy category analysis in the Table 8 show that there are three groups, namely: the high group consisting of 4 students, which is 12.5% of the total sample; the medium group consisting of 23 students, which is 71.9% of the total sample; and the low group consisting of 5 students, which is 15.6% of the total sample. From the distribution of results, it is known that the majority of students are in the moderate category, with a percentage of more than 50% of the total sample. Therefore, it can be concluded that the mathematical literacy level of students who use the joyful learning model with Scratch-assisted learning media is in the moderate category.

Hypothesis testing using proportion testing (binomial testing) to determine the effectiveness of the joyful learning model with Scratch-assisted learning media on mathematical literacy. Learning is considered effective if more than 75% of the total number of students achieve learning completeness, which is 75. The binomial test, which is a non-parametric method, does not require the assumption of normal distribution. In this study, one-sided proportion testing was conducted with a significance level of 5%.

**Table 9.** Proportion Test Results

| Variable | Group | Category | N | Observed Proportion | Test Proportion | Exact Sig. (1-tailed) |
|----------|-------|----------|---|---------------------|-----------------|----------------------|
| Mathematical Literacy Test Result | Group 1 | $\leq 75$ | 7 | 0.22 | 0.75 | 0.000 |
| Mathematical Literacy Test Result | Group 2 | $> 75$ | 25 | 0.78 | 0.25 | |
| Mathematical Literacy Test Result | Total | | 32 | 1.00 | | |

*Note:* The alternative hypothesis states that the proportion of cases in Group 1 is < 0.75.

Based on the test results, the sig. value obtained was $0.000^a$. According to Field (2018) the value $0,000^a$ indicates a very small value $< 0,001$. So the exact sig value is *exact sig* $<$

0,05, meaning $H_0$ is rejected and $H_1$ is accepted. In conclusion, the use of the joyful learning model with Scratch-assisted learning media is effective for students' mathematical literacy.

The results of the observations have been analyzed and are shown in the following Table 10

**Table 10.** Results of Learning Activity Observations

| Meeting No. | Percentage |
|---|---|
| 1st | 81% |
| 2nd | 85% |
| 3rd | 82% |
| 4th | 78% |
| 5th | 81% |
| 6th | 79% |
| **Overall percentage** | **81%** |

The results show that the percentage of student learning activity in each consecutive meeting was: 81% in the first meeting, 85% in the second meeting, 82% in the third meeting, 78% in the fourth meeting, 81% in the fifth meeting, and 79% in the sixth meeting. The overall average of the results shows that 81% of students were active during the learning process, which, if categorized, falls into the very good category.

**Table 9.** Results of Student Response Questionnaire on Learning

| Indicator | Percentage |
|---|---|
| Interest | 95% |
| Motivation | 95% |
| Satisfaction | 88% |
| Assessment | 86% |
| Response | 97% |
| **Overall percentage** | **92%** |

Based on the calculations, the results obtained were percentages based on the indicators, namely interest at 95%, motivation at 95%, satisfaction at 88%, assessment at 86%, and response at 97%. When averaged, the results showed that 92% of students gave positive responses, which when categorized, fell into the very positive category.

**Discussion**

**Mathematical literacy test results**

Based on statistical analysis, the students' mathematical literacy was obtained with an average score of 80.06. After conducting a proportion test to determine the effectiveness of the joyful learning model with Scratch-assisted learning media on students' mathematical literacy, the result was a sig. value of $0,000^a$ which means the $exact\ sig < 0,05$, so $H_1$ is accepted that the use of the joyful learning model with Scratch-assisted learning media is effective for students' mathematical literacy. This shows that the use of the joyful learning model with Scratch-assisted learning media contributes to encouraging students to achieve learning completeness, which indicates a change in students' abilities to reason, analyze, identify, and apply mathematical concepts and procedures when solving mathematical problems in everyday contexts. The contributing factor is the use of the joyful learning model, which helps students understand the basic concepts of the material. In line with Ardiani et al. (2023) that the joyful learning model can develop thinking skills and build learning material concepts.

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In this study, the application of the joyful learning model focuses on meaningful learning experiences and active participation that involve interaction with the environment and other people, which is in line with Vygotsky's constructivism theory (1978) which emphasizes that students construct their own knowledge through social interaction and their own experiences, enabling them to discover the meaning of the material being studied and understand it more deeply. This is in line with Utaminingtyas (2024) Learning through the joyful learning approach can create meaningful learning experiences by connecting teaching materials to the real experiences of students, thereby encouraging increased understanding and active participation in the learning process.

The use of Scratch-based learning media also plays a role in encouraging students to achieve learning completeness. The use of Scratch learning media aims to make learning interesting for students and encourage them to be active during the learning process. This is implemented through the use of interactive learning media that stimulates students to actively engage in learning, in line with behaviorist theory, which emphasizes that providing stimuli influences student behavior. In addition, these media are capable of providing new learning experiences, thereby stimulating interest and curiosity about the learning material. In line with Eviota & Liangco (2020), that implementation of Scratch-assisted learning media has been proven to improve students' mathematical literacy. This improvement is driven by attractive and interactive material packaging, as well as visual and auditory support elements that motivate students and make them enthusiastic about learning activities.

## Results of Observation of Student Learning Activities

Based on the observation results, it was found that 81% of students were active during the learning process, which can be categorized as very good. These results indicate that the use of the joyful learning model assisted by Scratch media successfully created a learning atmosphere that encouraged active student participation and indicated enthusiasm and good cooperation among most students during the learning process. This condition occurs because the application of the joyful learning model supported by Scratch media is able to create a learning environment that is fun, relevant to the context of life, meaningful, and encourages active participation and interaction among students. This atmosphere also facilitates the emotional and cognitive involvement of students. In line with Hanani (2023), implementation of joyful learning can increase student participation and enthusiasm during learning because this type of learning is fun, meaningful, and connected to students' daily experiences, thereby prioritizing child development psychology. In addition, the use of Scratch-assisted learning media facilitates students to actively participate in learning activities, because this media emphasizes direct interaction between students and the learning media itself. In line with Assulamy (2023) the use of Scratch-assisted learning media can foster students' interest in learning while encouraging their active participation in the learning process.

## Results of Student Response Questionnaire on Learning

Based on the observation results, it was found that 92% of students gave positive responses, which, if categorized, fell into the very positive category. These results indicate that the use of the joyful learning model supported by Scratch learning media can create an interesting, motivating, and enjoyable learning process, as well as facilitate understanding of the material. This is because the joyful learning model is based on a constructivist approach, in which students are actively involved through activities such as creating projects and counting real objects, so that they build understanding directly through concrete learning experiences. In

line with Hill in Suparlan (2019) The constructivism theory is about how to generate knowledge from what is done and practiced in everyday life. The use of Scratch learning media also makes students interested in participating in learning because it is supported by visualization and interactivity.

**Table 10.** Correlation of Each Component's Results

| Component | Result | Correlation |
|---|---|---|
| Mathematical Literacy | Moderate category | Describing the changes in students' mathematical literacy as gradual and influenced by other factors, such as the complexity of the material, the relatively limited duration of the intervention, and the varying basic abilities of the students. |
| Learning Activities | Very good category | Learning activities support the development of initial understanding, but improving literacy takes longer than increasing activity. |
| Student Responses | Very positive category | Positive responses become affective capital that strengthens readiness to learn, although they are not directly proportional to literacy achievement because literacy requires a deep cognitive process. |
| The Correlation Between the Three Components | | The combination of both strengthens the foundation of learning, but current literacy results show that literacy development is a gradual process that requires more time and practice. |

Based on these findings, the joyful learning model with Scratch-assisted learning media is effective for mathematical literacy, as evidenced by the average scores and significant proportion tests. The integration of these two elements creates enjoyable learning and encourages active student participation. In addition, learning media also reinforces conceptual understanding through visualization, simulation, and interactive representation. Conceptually, this study contributes to changes in students' mathematical literacy, particularly in terms of changes in their ability to reason, analyze, identify, and apply mathematical concepts and procedures when solving mathematical problems in everyday contexts with the help of technology and the integration of meaningful, interactive learning experiences and emotional involvement.

However, despite the high level of activity and response from students, they were still unable to achieve a high level of mathematical literacy. This shows that changes in students' mathematical literacy occur gradually and are influenced by other factors, such as the complexity of the material, the relatively limited duration of the intervention, and the varying basic abilities of the students. In this context, high activity and response levels are an important foundation for stronger mathematical literacy changes in subsequent learning, so that teachers can utilize these learning models and media as constructivist learning that supports students' mathematical literacy, such as using games or projects in learning to explore concepts, and using learning media as concept visualization.

In addition, this study also has limitations such as the use of a research design that does not use a pretest or control class, so that the effectiveness of the joyful learning model with Scratch learning media can only be concluded based on the posttest results. This means that the changes in mathematical literacy found may not solely originate from the treatment, but other factors such as educators, new teaching interventions, and learning environment support must also be considered.

## Conclusion

The use of the joyful learning model with Scratch-assisted learning media is effective for students' mathematical literacy, and students' mathematical literacy using the joyful learning model with Scratch-assisted learning media is in the moderate group. The learning activities of students in the learning process showed a very good level of activity, namely 81%, and the students' response to learning showed a very positive response rate of 92%. These results indicate that the use of the joyful learning model with Scratch-assisted learning media can strengthen students' mathematical literacy. Recommendations for future researchers to investigate the effect or improvement of mathematical literacy using the joyful learning model with Scratch-assisted learning media and other methodological designs such as quasi-experimental designs to test the stronger and more measurable effects of this learning model and media while expanding the contribution of research on mathematical literacy to be more comprehensive.

## Conflict of Interest

The author declares no conflict of interest.

## Authors' Contributions

N.P.A.A.R was directly involved in all stages of the research process, including study implementation, data collection, instrument development, manuscript drafting, discussion of findings, and refinement of the manuscript to its final version. E.N. and D.S. contributed to the formulation of the main research ideas, strengthening of the theoretical framework, methodological design, data management and analysis, interpretation of results, and approval of the final manuscript. All authors have reviewed and approved the final version of this article. The respective contributions to conceptualization, writing, and manuscript revision were 40% for N.P.A.A.R.: 40%, E.N.: 30% and D.S.: 30%

## Data Availability Statement

The authors declare that data sharing is not applicable, as no new data were created or analyzed in this study.

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