



Development of Learning Media Using PMRI-Based Scratch Applications for Statistics Material for Class VIII Junior High School

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ABSTRACT

Purpose of the study: This study aims to develop interactive learning media using the Scratch application based on the Indonesian Realistic Mathematics Approach (PMRI) for Statistics material for eighth-grade junior high schools. It also examines the validity, practicality, and effectiveness of the developed media in mathematics learning..

Methodology: This study used the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) model to develop Scratch-based learning media based on the Indonesian Realistic Mathematics Education (PMRI) approach for Statistics. The instruments used consisted of expert validation sheets, teacher and student response questionnaires, and pretest-posttest learning achievement tests. Data were analyzed using descriptive quantitative methods with a five-point Likert scale.

Main Findings: The developed Scratch-based PMRI learning media on Statistics achieved a material expert validity score of 0.88, a media expert score of 0.90, and a language expert score of 0.83. Teacher and student responses indicated the media was highly practical. Pretest and posttest results showed improved student learning outcomes, indicating that the media was valid, practical, and potentially effective for mathematics learning.

Novelty/Originality of this study: The novelty of this research lies in the integration of the Scratch application with the PMRI approach in developing interactive learning media for Statistics. The developed media incorporates real-life contexts and student-centered learning activities, thereby supporting more meaningful and engaging mathematics learning and enhancing student engagement.

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1. INTRODUCTION

Education is a deliberate and responsible process aimed at fostering individuals' maturity and overall development. It plays a fundamental role in human life and serves as a key driver of national progress. Within a country, education functions as a primary element that significantly contributes to the advancement of the nation [1]. According to [2], in the current era of educational transformation, teachers are expected not only to act as providers of knowledge but also as facilitators of learning. They are required to create learning environments that

are active, creative, and engaging. Education is also a crucial factor in shaping Indonesia's future. One of its primary objectives is to improve the quality of human resources through the teaching and learning process in schools [3].

In today's era of educational transformation, teachers are not only required to convey information but also to facilitate learning. They must be able to create an active, creative, and enjoyable learning environment [4]. Mathematics is a crucial field of study for the advancement of science and technology. It serves as a tool in various other disciplines [5]. Mathematics is a compulsory subject taught at all levels of education [6]. Lack of interest and motivation can lead students to perceive this subject as difficult and uninteresting, making it boring [7]. Therefore, new methods are needed to make this subject more engaging and easier for students to understand. One approach is to utilize technology-based learning media [8].

Mathematics is a subject that requires media related to everyday life. This allows students to absorb the material provided in the learning process and provide hands-on experiences. This aligns with the characteristics of PMRI [9]. PMRI involves real-world concepts with relevant experiences for students. This approach is very suitable for application in mathematics learning, because learning mathematics requires not only knowledge and memorization, but also deep understanding and the ability to solve mathematical problems accurately and correctly. In the process, students use real objects from everyday life as learning experience materials [10].

One of the mathematics subjects that requires a tool to convey information based on PMRI is statistics. This is because statistics is closely related to everyday life, such as in collecting data, presenting information, and making decisions based on the data obtained [11]. Furthermore, the difficulty students face in understanding statistics material occurs because learning often focuses on calculations and formulas, such as mean, median, and mode, without connecting them to real-life contexts [12]. As a result, students only understand statistics as a set of calculation formulas without understanding the meaning of the data and the reasoning processes behind them. Therefore, PMRI-based learning media and approaches are needed that can link statistical concepts to contextual situations so that students can understand the concepts more meaningfully and deeply [13].

Many students experience difficulty visualizing concepts in statistics, particularly in understanding the relationships between data, tables, and various forms of data presentation such as bar charts, line charts, and pie charts [14]. The lack of effective use of visual media in statistics learning contributes to these difficulties, hindering students' ability to visualize data and apply statistical concepts in everyday life [15]. Through the use of learning media, teachers can utilize various media such as images, animations, videos, and interesting games, so that learning becomes more meaningful and students do not get bored easily [16]. The use of technology-based visual media has been proven to help students understand the relationship between data and the interpretation of statistical results more concretely, thereby increasing students' understanding of statistical concepts [17].

One of the media that can be used is scratch media in line with research [18] bahwa that scratch is able to display images, videos, music and animations that can attract students' attention. By using scratch, teachers can create media that is more realistic and suits students' way of thinking, thereby helping students understand the lesson material. Scratch is a medium that can be used to understand statistics [19]. With scratch, statistics can be displayed more realistically. Through this media, students can understand and prove that the average value (mean) is obtained from the sum of all data divided by the number of data, as well as understand the relationship between raw data and other measures of data concentration such as median and mode more concretely [20].

Although various studies have shown that the Indonesian Realistic Mathematics Education (PMRI) approach and Scratch-based learning media can improve students' understanding and engagement in mathematics learning, these studies generally focus on developing interactive media without fully integrating PMRI characteristics or applying them to different materials [21]. Furthermore, most studies only assess the validity and practicality of the media, while research on the potential effects of PMRI-based Scratch media on student learning outcomes in statistics is still limited [22].

Based on the observations and interviews conducted on Thursday, October 16, 2025, with Mrs. Merry Santi, M.Pd., a mathematics teacher at State Junior High School 3 Lubuk Linggau, it was found that the school has implemented the Merdeka Curriculum. In the learning process, teachers primarily use printed textbooks and teaching materials published by the Ministry of Education, Culture, Research, and Technology. Furthermore, she explained that the use of diverse instructional media at State Junior High School 3 Lubuk Linggau is still limited, making mathematics learning less engaging. The teaching method is predominantly lecture-based, with instruction centered on the teacher, while students mainly listen and take notes. In addition, based on the interview results, students' learning outcomes in statistics remain relatively low. This is reflected in the fact that most students' daily test scores are below the Minimum Mastery Criterion (MMC) of 70. This condition indicates that many students have not yet developed a solid understanding of statistical concepts. Moreover, teachers have not optimally utilized instructional media during the learning process, resulting in limited student engagement.

One possible solution to these learning problems is the use of effective instructional media. One such medium is the Scratch application. Scratch is a visual programming language that enables users to create interactive animations and educational games [23]. It can be used both online and offline, making it flexible for classroom

implementation. Furthermore, Scratch has considerable potential to increase students' interest, motivation, and attention in learning mathematics [24].

Based on this description, this study develops learning media using the PMRI-based Scratch application on statistics material for eighth-grade junior high school students. The novelty of this study lies in the integration of PMRI characteristics into Scratch-based learning media so that students can build statistical concepts through contextual, exploratory, and interactive activities. In addition, this study not only assesses the validity and practicality aspects of the media, but also examines the potential effects of the media on student learning outcomes. Thus, this study is expected to contribute to the development of more innovative, contextual, and effective mathematics learning media, while enriching studies on the integration of PMRI and Scratch in mathematics learning at the junior high school level.

2. RESEARCH METHOD

This research employed a Research and Development (R&D) approach using the ADDIE model, which consists of five stages: Analysis, Design, Development, Implementation, and Evaluation. During the Analysis stage, curriculum analysis, student characteristics analysis, and learning needs analysis were conducted to identify problems and determine the specifications of the learning media. The Design stage included designing the learning materials, developing PMRI-based learning activities, preparing the user interface layout, and designing the learning media using the Scratch application. In the Development stage, the learning media were developed and subsequently validated by three experts, consisting of one material expert, one media expert, and one language expert. After being declared valid, the media were revised and tested to determine their practicality through teacher and student response questionnaires.

The Implementation stage involved a limited field trial with eighth-grade students at State Junior High School 3 Lubuk Linggau, who were selected using purposive sampling because they had studied or were currently studying statistics and met the research objectives. Before the implementation, students completed a pretest to determine their initial mathematical understanding. After learning using the Scratch-based PMRI learning media, students completed a posttest to measure their learning outcomes and determine the potential effect of the developed media. Finally, the Evaluation stage was conducted throughout the development process by evaluating the results of validity, practicality, and effectiveness to improve the final product.

The data collection instruments consisted of expert validation sheets, teacher response questionnaires, student response questionnaires, and learning achievement tests. The expert validation sheets assessed the appropriateness of the learning content, media design, presentation, and language aspects. The teacher and student questionnaires evaluated the practicality of the media in terms of ease of use, attractiveness, clarity of presentation, and usefulness in learning. The learning achievement test consisted of pretest and posttest items designed to measure students' understanding of statistical concepts.

2.1 Validity Analysis

The expert validation questionnaire can provide data that will be used to determine product validity. The validity of this product is obtained from the analysis of the data in the expert questionnaire. This validation questionnaire consists of three types: linguists, material experts, and media experts, each with different questions. The data from the learning media product assessment questionnaire is analyzed using the following steps:

- a. The scratch assessment sheets for linguists, material experts, and media experts are filled out according to the provisions in Table 1

Table 1. Validation Instrument Assessment Scale Guidelines

No	Answer Choises	Score
1	Very Good	5
2	Good	4
3	Enough	3
4	Poor	2
5	Very Poor	1

Modification [25]

- b. Calculate the total score for each validator for each aspect assessed using the following formula

$$V = \frac{\sum S}{n(c - 1)}$$

[26]

Note:

V = Validation

$S = r - lo$

r = Score given by the validator

lo = Lowest validation score

c = Highest validation score

n = Number of questions

- c. Convert the total score into qualitative data based on the validity categories in table 1 as follows:

Table 2. Validation Categories	
Interval	Category
$0,80 < V \leq 1,00$	Very Valid
$0,60 < V \leq 0,80$	Valid
$0,40 < V \leq 0,60$	Fairly Valid
$0,20 < V \leq 0,40$	Less Valid
$0,00 < V \leq 0,20$	Not Valid

[27]

Based on Table 2, it can be concluded that mathematics learning media using the scratch application is valid if the average score obtained is $V > 0,60$.

2.2 Practicality Analysis

The practicality of the Scratch application was analyzed using the following steps:

- a. Determine the assessment of the student and teacher response questionnaire sheets according to the following provision:

Tabel 3. Practicality Test Assessment Scale Guidelines			
No	Question	Qualification	Assesment
1	Positive Statement	Yes	1
2		No	0
3	Negative Statement	Yes	0
4		No	1

[28]

- b. Calculate the average score or percentage for all aspects using the following formula:

$$P = \frac{\text{Total score from data collection}}{\text{Criteria Score}} \times 100\%$$

[29]

Note:

P = Percentage score

- c. Converting the average for all aspects into qualitative data:

Table 4. Practicality Criteria	
Percentage	Feasibility
81 – 100	Very Practical
61 – 80	Practical
41 – 60	Fairly Practical
21 – 40	Less Practical
0 – 20	Not Practical

[29]

Based on Table 4, it can be concluded that mathematics learning media using the scratch application is practical if the average score obtained is $P \geq 61$.

2.3 Potential Effect Analysis

Test result analysis was conducted after students completed the test. The data obtained from the questions were analyzed using the following steps:

- a. Calculating scores from student answers
- b. Determining the final student grades using the following formula:
- $$NA = \frac{\text{obtained score}}{\text{maximum score}} \times 100 \quad [30]$$
- c. Calculating the number of students who completed or reached the Minimum Completion Criteria (KKM), which is 70, according to the KKM at SMP Negeri 3 Lubuklinggau. The product developed is considered to have a positive potential effect on students if the average completion score reaches ≥ 70 according to the KKM.
- d. Calculating the classical percentage requirement using the following formula:

$$P = \frac{t}{n} \times 100\% [30]$$

e. Note:

P = Classical Completion Percentage

t = number of students who completed

n = number of students

f. Converting the classical completion percentage into a qualitative value as follows:

Table 5. Classical Completion Percentage Category

Interval (%)	Category
$p \geq 80$	Very Good
$70 \leq p \leq 80$	Good
$60 \leq p \leq 70$	Fairly Good
$50 \leq p \leq 60$	Poor
$p < 50$	Very Poor

[30]

Based on Table 5, it can be concluded that mathematics learning media using the scratch application can be considered quite good if, in terms of potential effects, it has a classical completion percentage of $P \geq 60\%$ with a Minimum Classical Completeness (KKM) for student learning outcomes of 63. Therefore, if a student achieves a learning outcome greater than 63, it can be categorized as complete, and if a student achieves a learning outcome less than 63, it can be categorized as incomplete.

3. RESULTS AND DISCUSSION

This research resulted in a Scratch-assisted learning media product based on PMRI. This media development was conducted using the ADDIE research and development method, which includes five stages: Analysis, Design, Development, Implementation, and Evaluation. The following are the steps in the ADDIE development model used.

3.1 Analysis

In the analysis stage, researchers conducted a needs analysis, curriculum analysis, and student characteristics analysis. The results of the needs analysis indicate that the mathematics learning process at State Junior High School 3 Lubuk Linggau is still dominated by textbooks and lecture methods, while technology-based interactive learning media has not been optimally utilized. This condition results in low student motivation and activeness in learning, particularly in Statistics material, which requires concrete and contextual presentation of concepts.

The results of the curriculum analysis indicate that the school implements the Independent Curriculum, with Statistics as one of the learning outcomes in grade VIII. This material requires students to be able to collect, present, analyze, and interpret data, making it suitable for development using PMRI-based learning media that connects mathematical concepts to everyday life contexts.

This finding is in line with research [31] which reports that PMRI-based learning can improve understanding of mathematical concepts because the material is presented through contexts close to students' lives. Furthermore, the results of the student characteristics analysis indicate that students have diverse abilities and are more interested in interactive, visual, and contextual learning. Therefore, the development of learning media using the PMRI-based Scratch application for Statistics material is considered appropriate to the learning needs, the applicable curriculum, and the characteristics of eighth-grade students at State Junior High School 3 Lubuk Linggau.

3.2 Design

After the analysis phase was completed, the next stage was the design phase. At this stage, researchers designed the display and menu structure of the learning media using the PMRI-based Scratch application and created a storyboard as a reference in the development process. The material developed was Statistics, compiled based on the Learning Outcomes of the Independent Curriculum, with reference to textbooks, teaching modules, and other learning resources. Furthermore, researchers designed animations, navigation, practice questions, and problem contexts that align with the PMRI approach and were implemented using the Scratch application. At this stage, research instruments were also developed, including validation sheets from material experts, media experts, and language experts, as well as teacher and student response questionnaires to measure the media's practicality. Furthermore, a media flowchart was prepared as a guideline for the systematic and structured development process.

3.2.1 Content Design

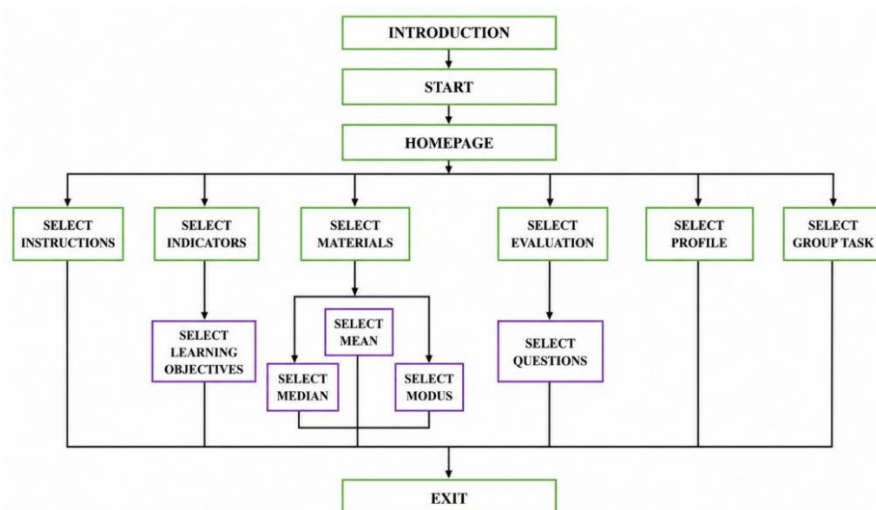


Figure 1. Flowchart of Learning Media Design

The product developed in this study is a Scratch-based learning media integrated with the Indonesian Realistic Mathematics Education (PMRI) approach for teaching statistics to eighth-grade junior high school students. The media consists of several main components, including the home page, learning objectives, contextual PMRI activities, learning materials, interactive exercises, and evaluation. The interface was designed to be simple, attractive, and easy to operate, enabling students to actively interact with the learning content. Figure 2 presents the overall appearance of the developed learning media.



Figure 2. Overview of the Scratch-Based PMRI Learning Media

The developed media begins with a home page that provides navigation to all learning menus. The learning activities are organized according to the PMRI approach, starting from contextual problems, concept discovery, and interactive practice. These features are expected to enhance students' engagement and understanding of statistical concepts through meaningful and interactive learning experiences.

3.2.2 Research instruments Design

Research instruments were developed to obtain data on the validity and practicality of the developed learning media. The instruments included validation sheets from subject matter experts, media experts, and linguists, as well as teacher and student response questionnaires. Before being used in data collection, all instruments were consulted with the supervising lecturer and validated by the instrument validator. Instruments that were declared valid were then used in the research data collection process.

a. Expert Validation Questionnaire

This questionnaire was used to obtain input and assessments from linguists, subject matter experts, and media experts. This instrument covered aspects such as: Language appropriateness and suitability of the material to core competencies; Accuracy and completeness of content; Clarity of language; Quality of visual display; Interactivity and navigation of the media. Each statement in the questionnaire was structured using a five-point Likert scale: Very Good (SB), Good (B), Sufficient (C), Poor (K), and Very Poor (SK).

b. Practicality Questionnaire

This instrument was used to determine student and teacher responses after using the learning media. This instrument covers several aspects assessed, including: ease of use of the media, attractiveness of the display, clarity of the content, and suitability to learning needs. The assessment scale also uses a positive and negative question scale with "Yes" or "No" answers. Furthermore, a suggestion column is provided to provide space for students and teachers to provide qualitative feedback.

c. Learning Evaluation Instrument

The researcher developed an evaluation instrument in the form of essay questions containing statistical material learned during the learning process using the Scratch learning media. This instrument was administered to students after they had used the learning media, with the aim of measuring potential effects, namely the extent to which the developed learning media can improve student learning outcomes and effectively assist in achieving learning objectives.

3.3 Development

3.3.1 Validity Test

During the development stage, the designed learning media was then validated by three competent validators to determine the media's suitability before implementation in the learning process. The validators consisted of a material expert, a media expert, and a linguist. The material expert in this study was Dr. Efuansyah, M.Pd., a lecturer in the Mathematics Education Study Program at PGRI Silampari University, who was tasked with assessing the suitability of the material content, the validity of the Statistics concepts, and the application of the PMRI approach in the learning media. The media expert was Dr. Dodik Mulyono, M.Pd., a lecturer at PGRI Silampari University, who assessed the design, appearance, navigation, interactivity, and ease of use of the scratch-based media. Meanwhile, the linguist was Dr. Dian Ramadan Lazuardi, M.Pd., a lecturer in the Indonesian Language and Literature Education Study Program at PGRI Silampari University, who assessed the language use, readability, and suitability of Indonesian language rules in the learning media.

The validation process was carried out using a validation sheet prepared during the design stage. Each validator assessed the aspects assessed and provided suggestions and input for improving the learning media. The validation results from the three validators were then used as the basis for revisions to ensure the learning media met the criteria for validity and was suitable for use in the learning process. Therefore, learning media using the PMRI-based Scratch application for Statistics material is expected to have good quality in terms of material, media, and language before being tested for practicality with teachers and students.

Table 6. Results of the Overall Validity Questionnaire Assessment

Average	Score	Category
Material Expert	0,88	Very Valid
Media Expert	0,90	Very Valid
Language Expert	0,83	Very Valid

Based on Table 6, the results of the expert validation questionnaire indicate that the PMRI-based Scratch learning media developed for statistics meets the criteria for being very valid. However, at the material expert stage, several criticisms and suggestions were received. One suggestion was the need to increase the time duration for the data text displayed in a problem. During the trial stage, several criticisms and suggestions were received from the media expert stage. One suggestion was to optimize the function of the next button on the learning display. During the trial stage, several criticisms and suggestions were received from the language expert stage, including adjusting sentences to EYD.

3.3.2 Practicality Test

Based on the results of the practicality test, the learning media using the PMRI-based Scratch application received a positive response from teachers and students. Assessment was conducted through a questionnaire administered after the media was used in the learning process. Teachers and students assessed that the developed media was easy to use, had an attractive appearance, presented the material clearly, and was able to increase student interest and engagement in Statistics learning.

The assessment results indicated that the developed learning media met the criteria of being very practical, making it suitable for use in the learning process. Therefore, the learning media using the PMRI-based Scratch application for Statistics can be used as a supporting medium for mathematics learning in eighth grade students at State Junior High School 3 Lubuk Linggau.

Table 7. Overall Practicality Questionnaire Assessment Results

Assesment	Maximum Score	Score Obtained	Percentage of Average Score	Category
<i>Small Group</i>	78	67	85,89%	Very Practical
Teacher Responses	13	12	92,30%	Very Practical
Total	91	79	86,81%	Very Practical

Based on Table 7, the overall practicality questionnaire assessment results by users, namely teachers and students, of the learning media using the PMRI-based Scratch application for statistics material demonstrated the criteria of being very practical. These results indicate that the developed learning media is easy to use, engaging, and supports the learning process, thus requiring no further revision. Teachers and students involved in the trial also responded positively to the use of this learning media.

3.4 Implementation

During the implementation phase, the learning media, which had been declared valid by material experts, media experts, and language experts and had been revised according to the validator's suggestions, was implemented with eighth grade students at State Junior High School 3 Lubuk Linggau. Before the learning using the media began, students were given a pretest to determine their initial abilities in Statistics. The learning process then proceeded using the interactive Scratch-based learning media with the PMRI approach. After all learning activities were completed, students were given a posttest to determine changes in learning outcomes after using the developed media.

In addition to the pretest and posttest, teachers and students were also asked to complete a response questionnaire to determine the practicality of the learning media. The pretest and posttest results were used to assess students' understanding of the Statistics material, while the response questionnaire results were used to determine the ease of use, attractiveness, and usefulness of the learning media in the learning process.

3.5 Evaluation

The evaluation phase is carried out continuously at each stage of the ADDIE model, from analysis, design, development, and implementation. Evaluation is conducted through providing feedback and revisions to the learning media based on suggestions from supervisors, subject matter experts, media experts, and language experts. Each input is used as a basis for refining the content, display, navigation, and language aspects of the media to align with learning objectives.

After the implementation phase was completed, the learning media was piloted with eighth-grade students at State Junior High School 3 Lubuk Linggau. Evaluation was conducted through analysis of pretest and posttest results to determine improvements in student understanding of Statistics material after using the Scratch-based learning media with the PMRI approach. In addition, teachers and students also completed a response questionnaire to assess the media's practicality in terms of ease of use, attractiveness of display, and usefulness in the learning process.

If the evaluation results indicate any shortcomings, either based on the pretest-posttest results or feedback from teachers and students, revisions and improvements are made to the learning media. Thus, the developed media is expected to meet the criteria of being valid, practical, and capable of supporting improved student understanding of Statistics material.

Table 8. Student Learning Outcomes

Score Range	Number of Students	Percentage	Category
>70	27	90%	Completed
<70	3	10%	Incomplete
Total	30	100%	

Based on Table 8, the test results given to 30 students in grade VIII.7 show that 27 students (90%) were in the complete category, while 3 students (10%) were incomplete. Therefore, it can be concluded that PMRI-based scratch-based learning media for statistics has a potential effect on student learning outcomes.

4. CONCLUSION

Based on the research and development results, the learning media using the Scratch application based on the Indonesian Realistic Mathematics Education Approach (PMRI) for statistics was declared valid, highly practical, and had a very positive potential impact on student learning outcomes. Validation results by material experts, media experts, and language experts yielded scores of 0.88, 0.90, and 0.83, respectively, declaring the media suitable for use. The practicality test showed a teacher response rate of 92.3%, a small group test of 85.89%, and an overall average of 86.81%, categorized as very practical. Furthermore, the potential effect test showed that 90% of students achieved the learning completion criteria (KKM), thus achieving the research objective of producing valid, practical, and effective learning media for statistics. The developed media has the potential to be applied to mathematics learning at the junior high school level and can be further developed for other mathematics materials or integrated with more interactive features to improve learning quality.

The implications of this research are the availability of interactive and contextual learning media that can assist teachers in delivering statistics material and increase student engagement and understanding during the learning process. This research still has limitations because the trial was only conducted in one school with a limited number of subjects and was only applied to statistics material. Therefore, future research is recommended to test the media in different schools with a larger sample size, apply it to other mathematics materials, and develop more innovative media features so that its effectiveness can be compared in broader learning contexts.

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