Contents lists available at Universitas Muhammadiyah Lampung

Hipotenusa Journal of Research Mathematics Education

Journal homepage: https://journal.uml.ac.id/index.php/HT/index

Development of FILM statistic in improving the mathematical literacy skill of grade VIII students

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ARTICLEINFO

Keywords:
Mathematical literacy;
Film;
Statistics;
Development;
Improving

ABSTRACT

Mathematical literacy is one of the key competencies students must possess in 21st-century learning, as it helps them understand, analyze, and solve problems in everyday life. However, students' mathematical literacy remains relatively low. This is evidenced by the 2022 PISA score of 366, which falls into the "low" category, as well as a 6.7-point decline in numeracy achievement in the 2025 Education Report Card at Kedungadem Public Junior High School 1. Furthermore, the use of interactive learning media in mathematics instruction remains suboptimal, resulting in a gap between the demands of mathematics literacy-oriented learning and actual classroom practices. This study aims to develop FILM (Interactive Mathematical Literacy Flipbook) media for statistics material that is valid, practical, and effective in improving the mathematical literacy skills of eighth-grade students. This study uses the Research and Development (R&D) method with a 4D development model modified to 3D, namely define, design, and develop. The research subjects were eighth-grade students in Class H at SMP Negeri 1 Kedungadem. Research instruments included a validation sheet, a response questionnaire, interviews, and a mathematical literacy skills test. Data analysis was conducted using both quantitative and qualitative descriptive techniques. The results showed that the FILM medium was rated as "highly valid," with a validity score of 0.911 from the media expert and 0.933 from the content expert. The medium's practicality, as assessed by teacher responses, was rated at 92%, and by student responses at 82%, both falling into the "highly practical" category. The effectiveness test results showed an N-Gain value of 0.68, classified as moderate. Thus, the FILM medium was deemed valid, highly practical, and sufficiently effective, making it suitable for use as an alternative interactive learning medium to support the improvement of students' mathematical literacy in statistics. These findings contribute to the development of innovative, technology-based mathematics instruction aimed at enhancing students' mathematical literacy.

1.Introduction

Mathematics education plays a crucial role in developing students' logical, analytical, and systematic thinking skills to face the challenges of the 21st century [1]. One of the primary focuses of mathematics learning is mathematical literacy, which is the individual's ability to formulate, apply, and interpret mathematical concepts in various life contexts [2]. Mathematical literacy is highly relevant to the demands of 21st-century learning because it emphasizes higher-order thinking skills such as problem solving and critical reasoning. Therefore, mathematics learning is not only oriented toward mastering formulas but also toward the ability to connect concepts to real-life situations [3].

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https://doi.org/10.36269/hjrme.vxix.xxx
Received 23 June 2026; Received in revised form 20 July 2026; Accepted 21 July 2026
Available online 01 august 2026
2723-486X/Published by Universitas Muhammadiyah Lampung.

The 2022 Programme for International Student Assessment (PISA) results show that students' mathematical literacy remains low, with a score of 366 (OECD, 2023). This result indicates that students still experience difficulty applying mathematical concepts to contextual problems. This situation demonstrates a gap between the expectations of mathematics learning, which emphasize mathematical literacy, and the reality on the ground. This situation demonstrates the need for innovation in the learning process to optimally improve students' mathematical literacy [4,5].

This gap is also evident in the learning conditions at SMP Negeri 1 Kedungadem. Based on interviews with math teachers, the learning process is still dominated by conventional methods using whiteboards and printed textbooks. The use of technology-based learning media is also still limited due to teachers' limited ability todevelop interactive digital media [6]. Furthermore, the 2025 education report card shows a decline in student numeracy achievement of 6.7 points and many students still have not achieved the Minimum complection criteria particularly in statistics. These conditions indicate that learning has not full supported the strengthening of students' mathematical literacy.

These conditions highlight the need to develop instructional materials that can support the improvement of students' mathematical literacy. One relevant subject for developing these skills is statistics, as it relates to the ability to interpret, analyze, and present data in various everyday contexts [7]. Therefore, interactive and contextual learning media such as interactive flipbooks are needed to integrate various multimedia elements to help students understand statistical concepts and improve their mathematical literacy.

In line with these needs, various previous studies have shown that the use of technology-based learning media has the potential to improve the quality of mathematics learning. The development of interactive flipbooks and digital e-modules has been proven to enhance learning motivation, conceptual understanding, and student engagement in the learning process [8]. Furthermore, learning media that integrate aspects of mathematical literacy have also been shown to help students understand mathematical concepts in a more contextual manner [9]. In statistics, the use of digital media has been shown to support student learning by presenting concepts in a more engaging and easily understandable way.

Based on the above discussion, it is evident that previous research has contributed to the use of technology as a medium for teaching mathematics. However, most studies still focus on improving learning motivation, conceptual understanding, or general learning outcomes. The development of media that specifically integrates interactive flipbooks with mathematical literacy skills in statistics has not been widely explored, particularly at the junior high school level. The novelty of this study lies in the development of FILM (Interactive Mathematical Literacy Flipbook), which combines interactive flipbook technology with a mathematical literacy approach to statistics. Thus, this study aims to develop FILM as a valid, practical, and effective learning medium for statistics that enhances the mathematical literacy skills of eighth-grade junior high school students.

2. Method

This study uses the Research and Development (R&D) method with a 4D development model modified into 3D. According to [10], research and development is a research method that aims to produce a specific product and test its feasibility and effectiveness. The product developed in this study is FILM (Flipbook for Interactive Mathematical Literacy) on statistics material for grade VIII junior high school students. The development model used is the 4-D model from Thiagarajan modified into 3-D, namely define, design, and develop [11]. This approach was chosen because it allows the development of learning media to be carried out systematically, structured, and oriented to the needs of students in the field.

2.1. Research design

This study employed the Research and Development (R&D) method using a 4-D development model that was modified to a 3-D model. The development stages included define, design, and develop, while the disseminate stage was omitted due to time constraints. This model was chosen because it is capable of producing valid, practical, and effective learning products. The 4-D development model is designed systematically so that the product development process can be carried out in a structured manner, starting from needs analysis through to the product testing stage (Thiagarajan et al., 1974). With these systematic stages, the developed product is expected to optimally support the learning process. The 4-D development model is systematically designed so that the product development process can be carried out in a structured manner, starting from needs analysis to the product testing stage [12]. In addition, this model is widely used in learning media development research because it allows for gradual evaluation and revision to produce products that meet user needs [13]. With these systematic stages, the developed product is expected to be able to support the learning process optimally.

2.2. Research Setting and Participants

This research was conducted at SMP Negeri 1 Kedungadem in the 2025/2026 academic year. The location selection was based on the results of initial observations which showed that mathematics learning was still dominated by conventional methods and the use of interactive digital media was still limited. The population in this study were all students from grades VIII-A to VIII-I, totaling 260 students. The subjects of this study were 30 students from grade VIII-H. The sampling technique used was random cluster sampling. All eighth-grade classes were treated as clusters, and a random draw was then conducted. Based on the results of the draw, Class VIII-H was selected as the research sample, thereby representing the population, since each class had an equal chance of being selected.

2.3. Research Procedure

This research applies an approach and development by adapting the 4-D model introduced by Thiangarajaan. The 4-D model is one of the development research models used to develop various types of learning media. According to [14] the 4-D development model consists of four main stages that are mutually continuous, namely Define, Design, Develop, and Disseminate. The development process in this study was only carried out up to the Develop stage due to research time limitations. The following is an explanation of each stage.

1. Define Stage, the initial stage to determine and explain development needs as well as collecting various information related to the product to be created. Activities in the define stage include initial analysis, student analysis, task analysis, concept analysis, and analysis of learning objectives.
2. Design Stage, At this stage the researcher determines the product design to be developed. The design stage consists of four main steps, namely criterion-test construction, media selection, format selection, and initial design.
3. The development stage aims to produce a product ready for use through a validation and revision process. At this stage, validation is conducted by two subject matter experts and one media expert; the product is revised based on the validators' feedback; and a limited pilot test is conducted to assess the practicality and effectiveness of the developed media.

2.4. Instruments and Data Collection

The research instruments used include expert and media expert validation sheets, teacher and student response questionnaires, and pretest and posttest questions. The validation sheet was used to assess the feasibility of FILM (Flipbook for Interactive Mathematical Literacy) from the aspects of content, presentation, and media appearance. Teacher and student response questionnaires were used to obtain data on the practicality of the media after being used in the learning process. Meanwhile, pretest and posttest questions were used to measure students' mathematical literacy abilities before and after using the media [15]. Data collection techniques were carried out through tests and non-tests. Test techniques were carried out through pretests and posttest, while non-test techniques were carried out through unstructured interviews, response questionnaires, and documentation to obtain supporting data during the research process [16].

2.5. Data Analysis

Data analysis in this study utilized two techniques: qualitative data analysis and quantitative data analysis. Qualitative data analysis was conducted descriptively based on the results of observations, interviews, and suggestions and comments from validators, teachers, and students as a basis for product improvement. Quantitative data analysis was conducted to assess the quality of the product in accordance with the research objectives, namely validity, practicality, and effectiveness. Validity was analyzed based on the results of expert validation; practicality was analyzed based on the results of teacher and student response questionnaires; and effectiveness was analyzed based on the results of pre- and post-tests of students' mathematical literacy skills.

1. Product Validity Analysis

   Validity analysis was conducted to determine the feasibility level of FILM (Flipbook for Interactive Mathematical Literacy) media based on assessments by material experts and media experts. Data were obtained from the validation sheet using a Likert scale of 1–4, then analyzed using the Aiken's V index to measure content validity. The formula used was:

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

Description:

s : $r - I_0$
r : Score given for assessment
I_0 : Low validity assessment score (1)
n : Number of validators
c : Highest validity assessment score (4)

Next, to determine the level of product validity, use the criteria presented in the

following table.

Table 1
Validation Sheet Criteria

Value	Criteria
$V > 0{,}8$	Very Valid
$0{,}4 < V \leq 0{,}80$	Valid
$V < 0{,}4$	Less Valid

Source [17]

2. Product Practicality Analysis

The practicality analysis was conducted based on the results of teacher and student response questionnaires using a Likert scale of 1–5. The practicality percentage was calculated using the formula:

$$Response = \frac{Total\ score\ obtained}{Maximum\ score}\ x100\%$$

Then the average score determines the practicality of FILM (Interactive Mathematical Literacy Flipbook) with the help of the following table 3.5:

Table 2
Practicality Score Criteria

Percentage Score (%)	Criteria
81%-100%	Very Practical
61%-80%	Practical
41%-60%	Quite Practical
21%-40%	Less Practical
0%-20%	Not Practical

Source [18]

3. Effectiveness Analysis

The effectiveness analysis was conducted based on the results of the pre-test and post-test of students' mathematical literacy skills using the N-Gain test. The formula used is:

$$N - gain = \frac{Posttes\ Score - Pretest\ Score}{Max\ Score\ -\ Pretest\ Score} \times 100\%$$

This analysis was conducted to determine the effectiveness of FILM (Interactive Mathematical Literacy Flipbook) based on the following criteria:

Table 3
Effectiveness Criteria

Score Range	Criteria
$0{,}70 < N - gain$	High
$0{,}3 \leq N - gain \leq 0{,}7$	Medium
$N - gain < 0{,}3$	Low

Source [19]

3. Results and discussion

This research resulted in a FILM learning media for statistics material for grade VIII junior high school students that has been tested based on three main aspects: validity, practicality, and effectiveness. The research results were analyzed to determine the product's quality in supporting the improvement of students' mathematical literacy skills. The results of the analysis of each aspect are presented systematically in the following subsections to illustrate the quality of the developed product.

3.1. Analysis Stage

The product developed in this research is a FILM on statistics material for grade VIII junior high school. Mefia is developed as a digital interactive flipbook that combines text, images, learning videos, and mathematical literacy-based exercises. The material is presented interactively so that students can learn statistical concepts through more engaging and contextual activities. This media also includes questions that refer to mathematical literacy indicators, namely formulate, employ, and interpre.



Fig 1. FILM Statistics Cover

https://heyzine.com/flip-book/62be9c281a.html
Fig 2. Media Access Link and QR Code

The initial appearance of the FILM media was designed with attention to visual aspects, readability, and ease of navigation to suit the characteristics of junior high school students. The media design was made attractive through the use of a combination of colors, illustrations, and a structured layout so as to increase students' attention and learning motivation. The developed media appearance is presented in Fig. 1 and Fig. 2.

3.2 Validity of the Product

The validation results indicate that the FIILM media meets the eligibility criteria for use in mathematics learning. Material expert validation yielded an overall Aiken's V value of 0.911, which is categorized as very valid. The assessment covered four aspects, namely material relevance, concept and content accuracy, mathematical literacy integration, and language. Meanwhile, media expert validation resulted in an overall Aiken's V value of 0.933, also categorized as very valid, covering the aspects of visual design and appearance, ease of use, consistency of media elements, and language. The detailed results of the expert validation are presented in Table 4.

Table 4
Result of Material and Media Expert Validation

Validator	Assesmment Aspect	Aiken's V	Category
Material Expert	Material Relevance	0.833	Very Valid
	Concept and Content Accuracy	0.917	Very Valid
	Mathematical Literacy Integration	0.875	Very Valid
	Language	1.000	Very Valid
Average		0.911	Very Valid
Media Expert	Visual Design and Appearance	1.000	Very Valid
	Ease of Use	0,918	Very Valid
	Consistency of Media Elements	1.000	Very Valid
	Language	0.835	Very Valid
Average		0.933	Very Valid

The findings indicate that both the instructional content and the media design satisfy the required validity standards for learning media. The high validity scores demonstrate that the statistical content is relevant to the learning objectives and mathematical literacy indicators, while the visual design, navigation, consistency, and language support effective learning. These findings align with previous research [20], which states that digital media with a high level of validity can improve learning quality due to a more systematic and engaging presentation of material.

3.3. Prcticality of the Product

The practicality of the FILM media was evaluated through teacher and student response questionnaires after its implementation in the learning process. The teacher response questionnaire yielded an overall practicality score of 92.00%, indicating a very practical category, while the student response questionnaire obtained an overall score of 81.64%, which was also categorized as very practical. Among the teacher responses, the ease of use aspect received the highest score (100.00%), whereas learning efficiency obtained the lowest score (86.67%), although it remained within the very practical category. Similarly, the highest student response was found in the clarity of presentation aspect (83.00%), while learning efficiency received the lowest score (79.78%), which was categorized as practical. These findings indicate that the FILM media is easy to use, supports classroom learning, and provides an engaging learning experience for both teachers and students. Students also reported that the interactive and visual presentation of statistical concepts helped them understand the material more easily and increased their interest in learning. These findings are consistent with previous research [21], which shows that the use of interactive digital learning media can increase student engagement in the mathematics learning process.

3.4. Effectivevess of the Product

The effectiveness of FILM media was analyzed based on the results of the pretest and posttest of students' mathematical literacy skills. Furthermore, the test results were calculated using the N-Gain test to determine the increase in students' mathematical literacy skills after using the media. The results of the students' N-Gain calculations are presented in the following table.

Table 5
N-gain Test Result

Subject 1-30	Pretest	Posttest	Pretest-Posttest	Max Score Pretest	N-Gain score
Mean	30,23	77,37	47,13	69,77	0,68

Based on Table 5, the N-gain value was 0.68, which falls into the moderate category. This result indicates that the use of the FILM media was able to improve students' mathematical literacy at a reasonably good level. Although the improvement did not reach the high category, this may be because mathematical literacy skills require continuous practice and sustained learning experiences to develop optimally [12]. In addition, students needed time to adapt to the use of interactive digital media during the learning process. Nevertheless, the findings demonstrate that FILM effectively supported students in understanding statistical concepts and produced better learning outcomes than before the implementation of the media. Therefore, the FILM media can be considered effective in improving students' mathematical literacy, particularly in learning statistics.

3.5. Overall Discussion

Based on the analysis of the validity, practicality, and effectiveness aspects, the FILM media met the criteria for a feasible mathematics learning medium. The findings demonstrated that the developed media achieved a very high level of validity, was perceived as very practical by both teachers and students, and was effective in improving students' mathematical literacy skills, as indicated by a moderate N-gain score [22]. These results may be attributed to the integration of interactive features, contextual statistical problems, and visual learning materials, which supported students' conceptual understanding and engagement throughout the learning process. The findings are consistent with previous studies [12] which reported that interactive digital learning media can enhance students' participation, motivation, and learning outcomes in mathematics [23-29]. The implementation of FILM therefore has important implications for mathematics instruction, particularly in supporting technology-enhanced learning and promoting students' mathematical literacy through contextual and interactive activities [30-33]. Future studies are recommended to implement the media over a longer instructional period, involve a larger and more diverse sample, and further develop additional mathematical topics and interactive features to maximize its educational impact [34]. A summary of the research findings is presented in Table 6.

Table 6
Summary of Research Results

No	Aspects Assessed		Value	Criteria
1	Validation	Material	0,911	Very Valid
		Media	1,111	Very Valid
2	Response Questionnaire	Teacher	92%	Very Practical
		Students	82%	Very Practical
3	Effectiveness	Test Results	68%	Quite Effective

4. Conclusion

This study produced FILM media for statistics material for grade VIII junior high school which has been tested based on the aspects of validity, practicality, and effectiveness. The validation results show that FILM media is in the very valid category both from the material and media aspects. In the practicality aspect, the media obtained a very practical category based on teacher and student responses which showed that the media was easy to use and interesting in learning. Meanwhile, the results of the N-gain analysis showed an increase in students' mathematical literacy abilities with a moderate category after using the media. Thus, FILM media is declared suitable for use as a mathematics learning medium.

In general, the results of this study indicate that FILM media can support more meaningful mathematics learning by presenting statistical concepts in a visual, interactive, and contextual manner. This medium also encourages student engagement and can serve as an alternative learning tool to improve mathematical literacy skills at the junior high school level. Theoretically, this study provides empirical evidence that interactive flipbook-based media can support the development of students' mathematical literacy skills. However, this study is limited to a single school, a relatively small sample size, and statistics content. Therefore, future research is recommended to involve a larger and more diverse sample, extend the implementation period, and develop the FILM medium for other mathematics topics.

Based learning media such as FILM in mathematics teaching. This is because these media have proven practical and can help improve students' mathematical literacy skills. Future researchers are advised to develop these media for other mathematics materials or expand the research subject to obtain more general results. Furthermore, developing more varied interactive features can also be implemented to improve the quality of learning media in the future.

CRediT authorship contribution statement

Kharisma Yogik Nur Aini: Conceptualization, methodology, Data Collection, Formal Analysing, Writing – original draf. Ari Indriani: Supervision, Validation, Weiting – review & editing. Dwi Erna Novianti: Suvervision, Validation, Project adminnnistration, Writing- Review & editing.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Acknowledgment

The author would like to thank SMP Negeri 1 Kedungadem for granting permission and support during the implementation of this research. The author expresses gratitude to the supervising lecturer who provided direction, guidance, and input in the preparation. Furthermore, the author thanks the students of class VIII-H who participated as research subjects. The author also thanks friends for provided support, encouragement, and assistance throughout the research process. The support is very important in the smooth completion of this research.

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