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Development Of A Microlearning-Based LUMI E-Module To Improve Mathematical Literacy Skills On Circle Material For Eleventh-Grade Students Of Senior High Schools In Surakarta City

Ahmad Fatkhul Alim[1], Ira Kurniawati[2*], Yuli Bangun Nursanti[3]

[a,b,c] Mathematics Education, Sebelas Maret University, Indonesia
* irakurniawati@staff.uns.ac.id

Keyword: LUMI E-Module, Microlearning, Mathematical Literacy, Circle, ADDIE.

Abstract

This study aimed to develop a microlearning-based LUMI E-Module on circle material to improve the mathematical literacy of eleventh-grade students in Surakarta City. The research was conducted at SMA Negeri 7 Surakarta involving 35 students. Utilizing the Research and Development (R&D) method with the ADDIE development model, data were collected through interviews, observations, validation questionnaires, practicality questionnaires, and mathematical literacy tests. Results showed that the LUMI E-Module achieved an average validity score of 0.978 from the material expert and 0.958 from the media expert, categorizing it as having very high validity. Practicality tests conducted by the teacher and students yielded percentages of 95.31% and 89.58% respectively, indicating it as very practical. The effectiveness test demonstrated an increase in the average pre-test score from 48.57 to 87.74 in the posttest, with an average N-Gain score of 0.77 (high category). Therefore, the developed E-Module was valid, very practical, and effective in enhancing mathematical literacy.

1. INTRODUCTION

The development of 21st-century education demands students to possess logical, critical, creative, and adaptive thinking skills in facing various problems. In mathematics learning, these skills are closely related to mathematical literacy. Mathematical literacy is not only related to the ability to perform calculations but also includes the ability to reason mathematically, formulate problems, apply mathematical concepts, and interpret the results of solutions in real-life contexts. OECD (2023) defines mathematical literacy as an

individual's capacity to reason mathematically and to formulate, employ, and interpret mathematics in a variety of real-world contexts.

However, students' mathematical literacy skills still need to be improved. Students are often able to solve routine problems but experience difficulties when faced with problems that require context understanding, reasoning, and interpretation. These difficulties can arise because mathematics learning still tends to be oriented toward procedures and the use of formulas. Consequently, students are not accustomed to understanding the meaning of concepts deeply and applying these concepts to solve contextual problems.

This problem was also found in eleventh-grade mathematics learning at SMA Negeri 7 Surakarta. Based on the results of preliminary observations and interviews, students still experienced difficulties in understanding circle material, especially in the sub-materials of arc length, central angles, inscribed angles, and the relationship between central angles and inscribed angles. Students tended to memorize formulas but still had trouble when they had to determine the appropriate concept in contextual problems. In addition, the learning resources used were still dominated by textbooks, student worksheets (LKS), and teacher explanations, while the use of interactive digital teaching materials had not been optimally utilized.

Circle material is one of the geometry topics that require visualization and an understanding of the relationships between concepts. In this material, students not only need to know formulas but also need to understand the connection between circle elements, arc length, central angles, and inscribed angles. Therefore, the teaching materials used need to present the material systematically, visually, and in a way that is easy to understand. Furthermore, the teaching materials also need to include context-based practice questions so that students can practice their mathematical literacy skills.

One approach that can be used to support this learning is microlearning. Microlearning is a learning approach that presents material in small, focused units that are easy to learn in a short time. This approach is suitable for mathematics material because students can learn one concept first before moving on to the next. Thus, complex material can be presented more lightly, gradually, and easily understood (Monib, Qazi, & Apong, 2025)

The microlearning approach can be integrated into interactive digital teaching materials, one of which is through the LUMI E-Module. Lumi Education, (n.d.) supports the creation of H5P-based interactive content, such as multimedia presentations, interactive videos, multiple-choice quizzes, short fill-in-the-blanks, and true-false questions. These features allow researchers to compile teaching materials that are more interactive and easily accessible to students.

Previous studies have shown that interactive E-Modules can serve as alternative teaching materials that support mathematics learning and have the potential to improve students' mathematical literacy. Aulia and Prahmana (2022) developed an interactive E-Module based on the Realistic Mathematics Education approach and found that the developed E-Module was valid, practical, and had the potential to improve students' mathematical literacy skills. These findings indicate that the development of interactive E-Modules is relevant to supporting literacy-based mathematics learning.

Based on this description, this study aims to develop a microlearning-based LUMI E-Module on circle material that is valid, practical, and effective in improving the mathematical literacy skills of eleventh-grade students at public senior high schools in Surakarta City, with the research implementation at SMA Negeri 7 Surakarta. The novelty of this research lies in the integration of the microlearning approach within the LUMI E-Module, specifically designed to support mathematical literacy skills through a concise, gradual, visual,

interactive, and contextual presentation of circle material.

2. METHOD

This study employed a Research and Development (R&D) method using the ADDIE development model. The ADDIE model consists of five stages: analysis, design, development, implementation, and evaluation. Branch (2009) explains that ADDIE is a systematic instructional design approach consisting of analysis, design, development, implementation, and evaluation stages. This model was chosen because it is suitable for developing digital teaching materials gradually, starting from needs analysis to product quality evaluation. The research was conducted at SMA Negeri 7 Surakarta during the even semester of the 2025/2026 academic year.

The research subjects consisted of material experts, media experts, mathematics teachers, and 35 eleventh-grade students at SMA Negeri 7 Surakarta. The developed product was a microlearning-based LUMI E-Module on circle material. The material in the E-Module included the definition of a circle, elements of a circle, arcs, arc length, central angles, inscribed angles, and the relationship between central and inscribed angles.

Data collection techniques were carried out through observations, interviews, validation questionnaires, practicality questionnaires, and mathematical literacy tests. Observations and interviews were used to obtain initial data regarding learning needs. Validation questionnaires were used to determine the product's validity level from material and media experts. Practicality questionnaires were given to teachers and students to ascertain the ease of using the product.

The criteria for content validation according to Budiyono (2017) are as follows: (1) The suitability of the questionnaire items with the indicators; (2) The statements are clearly formulated; (3) Statements do not cause multiple interpretations; (4) Statements use Indonesian language rules properly and correctly.

The validity of the E-Module was tested using questionnaires with four answer options on a Likert scale: Very Good (4), Good (3), Less Good (2), and Very Less Good (1). The validity test consists of media expert validation and material expert validation. The product validity analysis used the Aiken's V index (Aiken, 1985), which can be used to determine expert agreement (Retnawati, 2016), with the following formula:

$$V = \frac{\sum(r - l_0)}{[n(c-1)]}$$

Description:
V = Aiken Index / average total validity score from all validators
r = Score given by validator
l_0 = Lowest score
c = Highest score category (which is 4)
n = Total validators

The results of these calculations are then converted based on the validity categories by Guilford & Fruchter in Puspitasari & Febrinita (2021) as listed in Table 1.

Table 1. Validation Categories

Interval	Category
$\mathbf{0,00 \leq V < 0,20}$	Very Low Validity
$\mathbf{0,20 \leq V < 0,40}$	Low Validity
$\mathbf{0,40 \leq V < 0,60}$	Medium Validity
$\mathbf{0,60 \leq V < 0,80}$	High Validity
$\mathbf{0,80 \leq V \leq 1,00}$	Very High Validity

The practicality test of the developed E-Module was analyzed using a response questionnaire from teachers and students. The questionnaire was prepared with four answer options on a Likert scale: Very Good (4), Good (3), Less Good (2), and Very Less Good (1). Scoring was done using a Likert scale for each statement item (Sugiyono, 2017). Based on the scores obtained, the percentage of the number of respondents' answers will be calculated using the following formula (Sugiyono, 2017) :

$$P = \frac{\text{Total score obtained}}{\text{Maximum number of scores}} \times 100\%$$

The average practicality score from all respondents is calculated using the formula:

$$\bar{x} = \frac{\sum P}{n}$$

The average score obtained will be converted based on the practicality assessment categories proposed by Budiyono (2020) and Akbar (2013), as shown in Table 2.

Table 2. Practicality Assessment Categories

Interval (%)	Category
$\mathbf{0 \leq P < 20}$	Not Practical
$\mathbf{20 \leq P < 40}$	Less Practical
$\mathbf{40 \leq P < 60}$	Quite Practical
$\mathbf{60 \leq P < 80}$	Practical
$\mathbf{80 \leq P \leq 100}$	Very Practical

Based on Table 2, the developed learning media will be considered practical if it achieves a minimum percentage of 60%.

The effectiveness of the product in improving student learning outcomes is measured using the Gain Normality Test based on the pre-test and post-test results. According to Meltzer (2002), normalized gain is a test used to estimate the extent to which a treatment is effective in increasing concept understanding. The formula for calculating the normalized gain value is as follows (Hake, 1998):

$$Ngain = \frac{S_{post} - S_{pre}}{100 - S_{pre}}$$

The interpretation of the N-Gain value in this study refers to the interpreotation of the N-Gain results described by Hake (1998), as shown in Table 3.

Table 3. N-Gain Interpretation

Interval	Category
$\mathbf{0.70 \leq N < 100}$	High Improvement
$\mathbf{0.30 \leq N < 0.70}$	Medium Improvement
$\mathbf{0 \leq N < 0.30}$	Low Improvement

3. RESULTS AND DISCUSSION

This research resulted in a product in the form of a microlearning-based LUMI E-Module on circle material to improve the mathematical literacy skills of eleventh-grade students at SMA Negeri 7 Surakarta. The product was developed using the ADDIE model, which includes the analysis, design, development, implementation, and evaluation stages. The E-Module was developed using Lumi Education with its main Interactive Book feature and was supported by Canva for designing covers and visual elements. Inside the E-Module, researchers utilized several features, namely Course Presentation, video, Multiple Choice, True/False Question, Fill in the Blanks, and Text or Advanced Text.

In the analysis stage, researchers conducted curriculum analysis, student characteristic analysis, and material analysis. The analysis results indicated that SMA Negeri 7 Surakarta had implemented the Merdeka Curriculum, but mathematics learning still required more interactive digital teaching materials. Students experienced difficulties in understanding circle material, especially in connecting the concepts of arc length, central angles, inscribed angles, and the relationship between the two angles. Students also tended to memorize formulas without understanding their application in problem contexts. Therefore, the development of a microlearning-based LUMI E-Module was deemed appropriate to help students learn the material gradually and contextually.

In the design stage, researchers prepared the initial design of the E-Module. The product design included the formulation of learning objectives, mathematical literacy indicators, the content structure of the E-Module, the selection of Lumi features, layout design, and the design of quizzes and literacy-based mathematics questions. The E-Module was designed into several sections, namely the preliminary section, circle material, arc material, central and inscribed angles material, glossary, and references. The material was presented in small units so that students could understand the concepts gradually. The questions in the E-Module were arranged in contextual forms so that students would not only use formulas but also understand situations, determine

concepts, perform calculations, and interpret solution results.

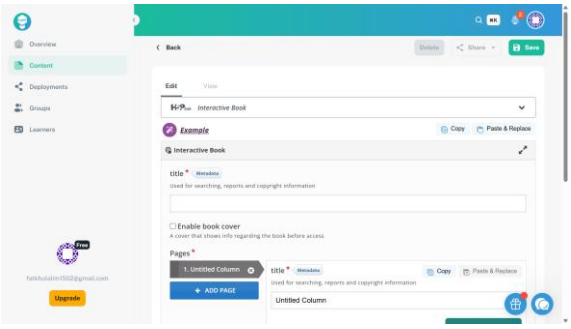


Figure 1. Display of LUMI E-Module Structure

Figure 1 shows the structure of the LUMI E-Module developed using the Interactive Book feature. This structure displays the division of material into several small sections, starting from the introduction, circle material, arcs, central and inscribed angles, to the closing section. This display demonstrates that the E-Module is designed according to microlearning principles, namely presenting material gradually and with focus.

In the development stage, the product design was developed into an initial product. The initial product was then validated by material experts and media experts. Material expert validation was conducted to assess content feasibility, language, and presentation. Media expert validation was conducted to assess screen design layout, ease of use, consistency, graphics, and media usefulness. The summary of the validation results is presented in Table 4.

Table 4. LUMI E-Module Validation Results

Validator	Average Validity Score	Category
Material Expert	0,978	Very High Validity
Media Expert	0,958	Very High Validity

Based on Table 4, the material expert validation results obtained an average validity score of 0.978 with a very high validity category. The assessed aspects included content feasibility, language feasibility, and presentation feasibility. These results indicate that the material in the E-Module is in accordance with the learning objectives, student characteristics, and mathematical literacy indicators. In addition, the material presentation was deemed systematic and suitable for use in learning.

The media expert validation results obtained an average validity score of 0.958 with a very high validity category. The assessed aspects included screen design layout, ease of use, consistency, graphics, and usefulness. These results indicate that the LUMI E-Module has a good appearance, is easy to use, consistent, and useful for supporting mathematics learning. Thus, the product was declared valid and feasible to use after revisions were made according to the validators' suggestions. Suggestions from the material expert included adding introductory material or a brief history of circles, adding literacy-based mathematics practice questions, and refining question wording.

Suggestions from the media expert included adding a concept map, adding the author's biography, and adjusting the layout to be more sequential and consistent. After revisions were made, the product was used in the implementation stage.

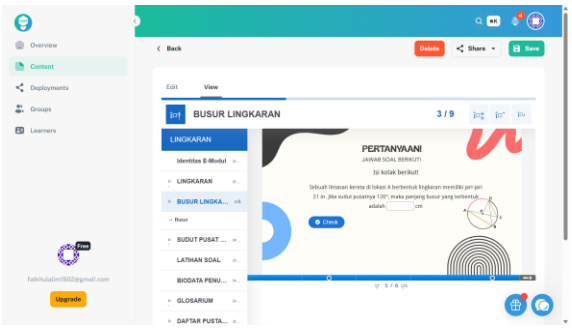


Figure 2. Display of Mathematical Literacy Questions

Figure 2 shows an example of a mathematical literacy-based question found in the LUMI E-Module. The question is presented in a specific context so that students do not only use formulas but also understand the information in the problem, determine the appropriate mathematical concept, perform calculations, and interpret

the solution results. This display serves as evidence that the E-Module not only presents material but also contains activities that support mathematical literacy.

In the implementation stage, the LUMI E-Module was used in mathematics learning in class XI of SMA Negeri 7 Surakarta. Students used the E-Module to study circle material, watch trigger videos, read materials, take interactive quizzes, and solve mathematical literacy-based questions. The practicality of the product was assessed through teacher and student response questionnaires. The summary of the practicality test results is presented in Table 5.

Table 5. LUMI E-Module Practicality Test Results

Respondent	Practicality Percentage	Kategori
Teacher	95,31%	Very Practical
Student	89,58%	Very Practical

Based on Table 5, the practicality test results by the teacher obtained a percentage of 95.31% with a very practical category. These results indicate that the teacher considered the E-Module easy to use, suitable for learning, visually appealing, and helpful in presenting circle material. The practicality test results by students obtained a percentage of 89.58% with a very practical category. Students considered the E-Module easy to understand, engaging, and helpful for them to learn the material gradually. Thus, the microlearning-based LUMI E-Module was declared very practical for use in mathematics learning.

The product's effectiveness was analyzed based on the pre-test and post-test results of the students' mathematical literacy skills. The summary of the effectiveness test results is presented in Table 6.

Table 6. Summary of Effectiveness Test Results

Component	Result
Numben of student	35
Average pre-test	48,57
Average post-test	87,74
Average N-Gain	0,77
N-Gain (%)	77,14%
Category N-Gain	High
Student in high category	26 students (74,29%)
Student in moderate category	9 students (25,71%)
Student in low category	0 students (0 %)

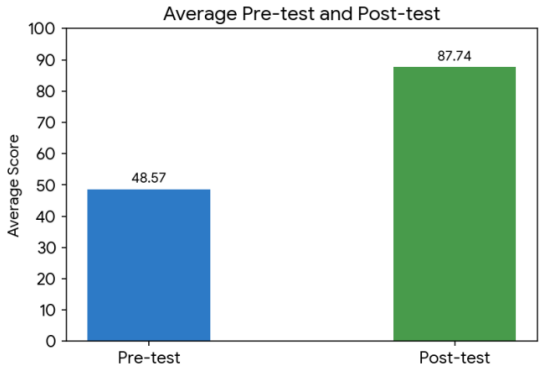


Figure 3. Graph of Average Pre-test and Post-test Scores

Based on Table 6 and Figure 3, the students' mathematical literacy skills experienced an increase after using the microlearning-based LUMI E-Module. The N-Gain calculation results obtained an average of 0.77 or 77.14%, thus falling into the high category. Out of 35 students, 26 students or 74.29% were in the high improvement category, and 9 students or 25.71% were in the moderate improvement category. There were no students in the low improvement category.

This improvement in mathematical literacy skills occurred because the LUMI E-Module presents material gradually through microlearning principles. The material presented in small parts helps students understand one concept before moving on to the next concept. In addition, the use of visual illustrations, trigger videos, interactive quizzes, and contextual questions helps students understand the concept of circles more concretely. Students are also trained to understand information in questions, determine the right concepts, perform

calculations, and interpret answer results based on the problem context.

In the evaluation stage, researchers evaluated the final quality of the product based on the validation, practicality, and effectiveness results, as well as notes during implementation. The evaluation results showed that the microlearning-based LUMI E-Module had met the criteria of being valid, very practical, and effective. Nevertheless, the use of the E-Module still requires digital devices and an adequate internet connection, especially when students access videos or certain interactive features. Therefore, teachers still need to provide guidance at the beginning of use so that students understand the learning flow within the E-Module.

Overall, the results of this study indicate that the microlearning-based LUMI E-Module can be an alternative digital teaching material in mathematics learning. This product supports more active, independent, visual, and contextual learning. The results of this study are also in line with the research of Aulia and Prahmana (2022), which showed that interactive E-Modules can be valid, practical alternative teaching materials with the potential to improve students' mathematical literacy skills.

4. CONCLUSION

Based on the results of the research and development that have been conducted, it can be concluded that the microlearning-based LUMI E-Module on circle material was successfully developed using the ADDIE model, which includes the analysis, design, development, implementation, and evaluation stages. The developed product contains material on the definition of a circle, elements of a circle, arcs, arc length, central angles, inscribed angles, and the relationship between central and inscribed angles. The material is presented gradually, visually, interactively, and contextually to support the mathematical literacy skills of eleventh-grade students at public senior high schools in Surakarta City.

The research results indicate that the microlearning-based LUMI E-Module has a very high level of validity based on the validation results from material experts and media experts. The practicality test results also indicate that the E-Module falls into the very practical category based on teacher and student assessments. Furthermore, the effectiveness test results show an improvement in students' mathematical literacy skills with an average N-Gain score of 0.77 or 77.14% in the high category. Thus, the microlearning-based LUMI E-Module is declared valid, very practical, and effective in improving students' mathematical literacy skills on circle material.

Theoretically, this research contributes to the development of microlearning-based digital learning media in mathematics education. The novelty of this research lies in the integration of the microlearning approach into the LUMI E-Module, which is specifically designed to support mathematical literacy skills through a brief, gradual, visual, interactive, and contextual presentation of material. Practically, the LUMI E-Module can be used as an alternative digital teaching material by teachers and students in eleventh-grade mathematics learning, particularly on circle material.

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REFERENCES

Aiken, L. R. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement*, *45*(1), 131–142. https://doi.org/10.1177/0013164485451012

Akbar, S. (2013). *Instrumen perangkat pembelajaran*. PT Remaja Rosdakarya.

Aulia, E. T., & Prahmana, R. C. I. (2022). Developing interactive E-Module based on realistic mathematics education approach and mathematical literacy ability. *Jurnal Elemen*, *8*(1), 231–249. https://doi.org/10.29408/jel.v8i1.4569

Branch, R. M. (2009). *Instructional Design: The ADDIE Approach*. Springer US. https://books.google.co.id/books?id=mHSwJPE099EC

Budiyono. (2017). *Statistika untuk penelitian pendidikan*. UNS Press.

Budiyono. (2020). *Statistika Dasar untuk Penelitian*. UNS Press.

Education, L. (n.d.). *Create H5P and host your content in Lumi*. https://lumi.education/

Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American Journal of Physics*, *66*(1), 64–74.

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. *American Journal of Physics*, *70*(12), 1259–1268.

Monib, W. K., Qazi, A., & Apong, R. A. (2025). Microlearning beyond boundaries: A systematic review and a novel framework for improving learning outcomes. *Heliyon*, *11*(2), e41413. https://doi.org/10.1016/j.heliyon.2024.e41413

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

Puspitasari, A., & Febrinita, F. (2021). Uji validitas dan praktikalitas bahan ajar. *Jurnal Evaluasi Pendidikan*, *8*(2), 200–210.

Retnawati, H. (2016). *Analisis kuantitatif instrumen penelitian (Panduan peneliti, mahasiswa, dan psikometrian)*. Parama Publishing.

Sugiyono. (2017). *Metode Penelitian Kuantitatif, Kualitatif, dan R&D*. Alfabeta.