EDUMATSAINS
JURNAL PENDIDIKAN MATEMATIKA DAN SAINS
E-ISSN:2527-7235
Volume 10 Issue. 3, January 2026, pp 29-37
http://ejournal.uki.ac.id/index.php/edumatsains

Development of Learning Styles based Mathematics E-module to Enhance Student's Numeracy Skills

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Article Info

Article history:
Received: October 24th, 2025
Revised: January 26th, 2026
Accepted: January 27th, 2026
Available online: January 31st, 2026

https://doi.org/10.33541/edumatsains.v10i3.7483

Abstract

This research's purpose is to develop an e-module based on students learning style to increase the numeracy skills of students. The research method used is Research and Development (RnD) method. The RnD model used in this research is ADDIE model. The result of this research is an e-module based on student's learning style and validated with material validation mean score of 3,770 within very valid category, media validation mean score of 3,631 within very valid category, and language validation mean score of 3,167 within valid category. The validated module is then implemented and is tested based on effectivity and the N-gain score of 0,44 is gotten with the increase category of medium. Hence, it is concluded that the e-module based on students learning style can increase student's numeracy skills.

Keywords: Research and Development, e-module, Learning Styles, Numeracy skills

1. Introduction

Numeracy encompasses the knowledge, abilities, and habits that individuals require to effectively utilize mathematics in diverse situations (Forgasz, 2017). French (2014) delineates five dimensions of numeracy: practical, professional, recreational, civic, and cultural. Numeracy skills serve as a foundation across these dimensions, enabling individuals to compreh end, explain, and anticipate various life phenomena.

The Programme for International Student Assessment (PISA) serves as a benchmark for evaluating numeracy proficiency among students (OECD, 2023). While Indonesia's performance in PISA 2022 exhibited a slight improvement compared to 2018, the overall mathematics score remained the lowest among participating countries, dropping from 379 to 366 (Kemendikbud, 2023).

This indicates a persistent need to enhance numeracy skills among Indonesian students. Conventional and monotonous teaching methods often fail to align with diverse learning styles, hindering students' grasp of mathematical concepts (Anderha, 2021). These shortcomings contribute to low numeracy levels, as ineffective instruction impedes students' ability to apply mathematical concepts to real-world scenarios and hinders their problem-solving and reasoning skills (Wahyuni, 2022).

Desi (2023) explained that differentiated instruction tailored to individual learning styles emerges as a promising approach to address numeracy deficiencies. In his studies, Suaib (2017) concluded that The VAK (Visual, Auditory, Kinesthetic) learning style model, widely employed in education, categorizes individuals based on their preferred information processing modes. Visual learners excel when presented with visual aids such as diagrams or graphs, while auditory learners benefit from verbal explanations (Amrullah et al, 2024). Kinesthetic learners thrive through hands-on activities. Studies by Valle (2023) and Idris (2024) establish a significant link between phonological awareness and numeracy development, emphasizing the role of auditory processing in numeracy acquisition. Chen (2019) further highlights the unique impact of each learning style on academic performance, suggesting that integrating all three approaches can enhance student outcomes.

Adapting teaching practices to align with modern educational trends is crucial for effective learning (Costa et al, 2023). Sindiq and Suhendro (2021) recent studies about the incorporation of electronic modules (e-modules) represents an innovative approach that aligns with contemporary education trends. Asrial (2019) demonstrates the effectiveness of e-modules as a multimedia 4.0 innovation, showcasing their significant advantage over conventional teaching methods. E-modules hold immense potential as vehicles for delivering quality education.

In light of the aforementioned challenges, e-modules tailored to individual learning styles present a viable solution to combat low numeracy levels among students (Hussain, 2024). By incorporating modern educational trends and catering to diverse learning styles, these e-modules can effectively enhance numeracy skills.

This research aims to develop e-modules based on learning styles to enhance numeracy skills among students. Additionally, the study will investigate the differential impact of these e-modules on students with visual, auditory, and kinesthetic learning styles. The developed e-modules can be adopted by schools seeking to implement differentiated instruction approaches to promote numeracy development among their students.

2. Methods

This research resulted in an electronic learning module based on learning styles to enhance students' numeracy skills. The research method used was research and development (RnD) and employed the Analysis, Design, Development, Implementation, Evaluation (ADDIE) model. The sample in this study was students of class VIII H at SMPN 80 Jakarta, consisting of 36 students. Data collection techniques were carried out by filling out questionnaires on the modules developed by expert validators in the aspects assessed and implementing pre-test and post-test on the students. The research data consisted of validation data and pre-test-post-test data of the students.

Validation data was obtained by filling out validation questionnaires in the aspects of material, media, and language using a 4-point Likert scale with the following indicators:

Tabel 1.

Material validity questionnaire indicators

No.	Criteria	Number of statements
1.	Content Feasibility Aspect	12
2.	Media Feasibility Aspect	8
3.	Contextual Assessment Aspect	9

Table 2.

Media validity questionnaire indicators

No.	Criteria	Number of Statements
1.	Content Size	2
2.	Cover Design	7
3.	Content Quality	18
4.	Multimedia Aspects	10

Table 3.
Language validity questionnaire indicators

No.	Criteria	Number of Statements
1.	Adherence to Language Dictionary	3
2.	Communicative and Interactive Language	3

The validity results are then tabulated to then be averaged for each aspect with the formula below.

$$\overline{X} = \frac{1}{n_{val}} . \frac{\sum X}{n}$$

Where:
$\overline{X}$ = Average
n_{val} = number of validitators
$\sum X$ = total score
n = number of questionnaires

The average results for the validitators will be matched with the product validity conversion as seen below.

Table 4.
Validity Conversion

Category	Score Range
Very Valid	$X > 3{,}4$
Valid	$2{,}8 < X \leq 3{,}4$
Somewhat Valid	$2{,}2 < X \leq 2{,}8$
Less Valid	$1{,}6 < X \leq 2{,}2$
Not Valid	$X \leq 1{,}6$

Pretest and Posttest scores are processed with N-gain analysis. The result is shown with the formula below

$$N\ Gain\ (g) = \frac{Posttest\ score - Pretest\ score}{Ideal\ score - Pretest\ score}$$

N-gain calculation is then categorized with the Meltzer criteria shown with the table below

Table 5.
N-Gain Criteria

N-gain	Criteria
$\geq 0{,}7$	High
$0{,}3 \leq N - Gain < 0{,}7$	Medium
$< 0{,}3$	Low

3. Result and Discussion

3.1. Result

Analysis Results

The analysis results indicate that only 13.89% of students have learning outcomes above the school's Minimum Competency Score (KKM), which is 78. Summative assessment data for 3 months shows a consistent pattern where students with good summative results tend to consistently perform well in the second and third summative assessments, as well as students with low summative results. Students have different learning preferences and teachers find it difficult to adapt learning to each individual, and there are limitations to conventional learning such as writing on the whiteboard that is not visible, the teacher's voice is not audible, and the books used are not effective in explaining a material.

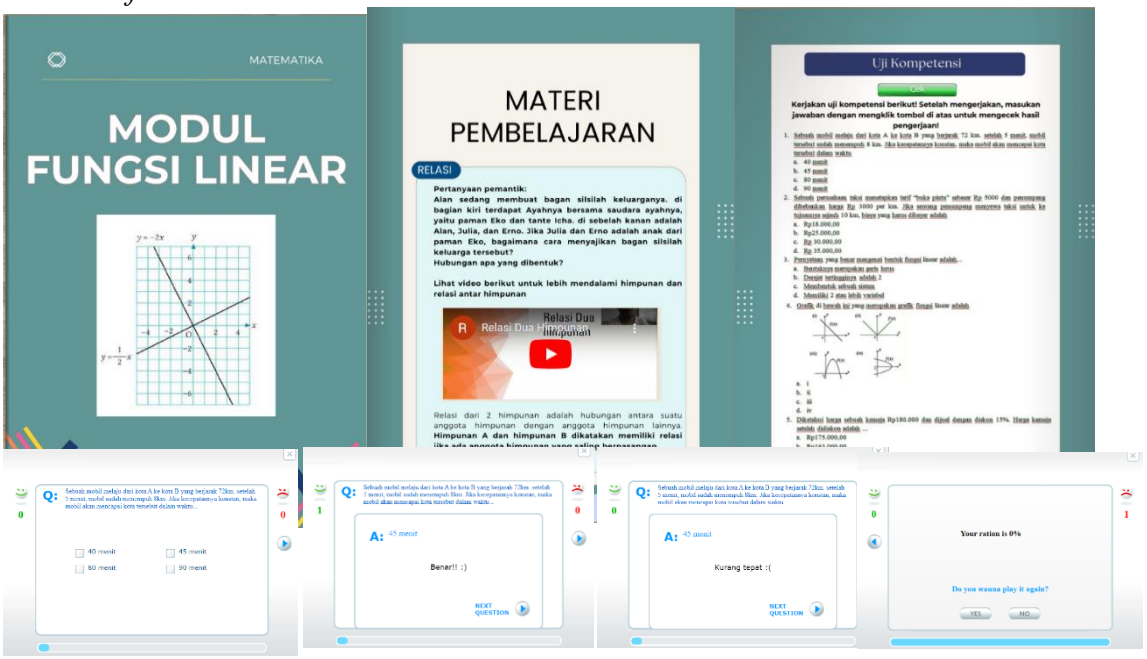
Design Results

The design results produced an electronic module framework, reference selection and module feature planning, and the creation of pre-test and post-test questions. The module framework is made with a cover, preface, introduction, module success indicators, module usage instructions, basic competency mapping, learning materials, summaries, evaluations, and a bibliography. The module's features are video and audio learning that are inserted into the module using the Flip PDF Professional program.

Development Results

Development phase resulted in an e-module with features that enhances learning for visual, auditory, and kinesthetic learners by adding audio-visual media, activities for kinesthetic learners, and evaluations to test the level of knowledge obtained from the learning process. The module and features are shown with the figure below.

Figure 1.
e-module features



The developed e-module is then tested for validity. The validity aspect is based on the material, media, and language. The results are shown below.

Tabel 6
e-module validity result

Aspect	Number of Validators	Average score
Material	3	3,770
Media	3	3,631
Language	2	3,167

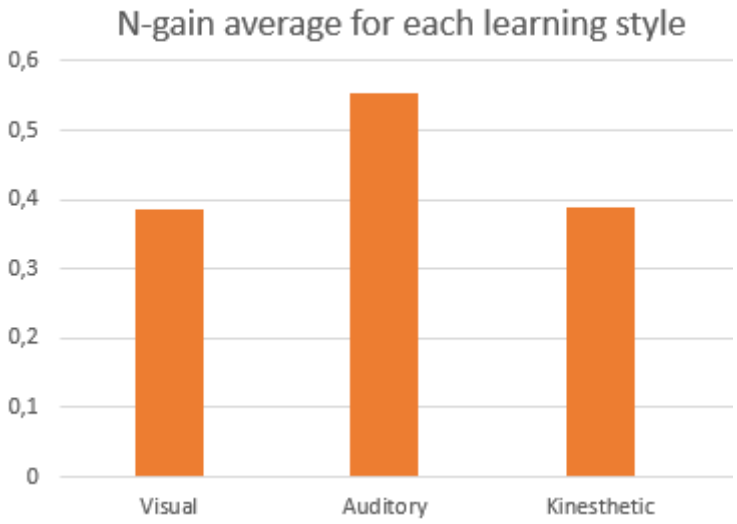
Implementation Results

The implementation results involved applying the module to students in the classroom. Before distributing the module, a pre-test was conducted to determine the students' numeracy skills. The questions used were 8 questions that had been validated through pilot testing and analysis, which represent the indicators of numeracy skills in the linear function material, namely being able to operate numbers, being able to understand the concept and use it to solve problems, and being able to interpret information to determine the results before and after an event.
After the students completed the pre-test, the researcher distributed the link to the electronic module for students to use and study. Students were also given instructions on how to use the module, how to access learning videos, how to digitally annotate the module, and how to use interactive quizzes for learning. Students also filled out a questionnaire to determine their learning styles to identify their preferred learning styles.

Evaluation Results

The evaluation result is from the pretest-posttest results which is then processed with the N-gain formula. Students are given questionnaire to determine their learning style before the test and the results of the description of the N-gain calculation for each learning style can be seen in figure below.

Figure 2.
Average N-gain score for each learning style



Change data

3.2. Discussion

The developed e-module has the validity score of 3.770 for Material and 3.6310 for Media which is in “Very Valid” Category. The module also has the validity score of 3.167 for language which is in “Valid” category. This means that the module can be used in a classroom. Researcher gave students a pretest before disseminating the module by link and after the students learn through the module, they were given a posttest. Students with auditory learning styles have the highest average N-gain score with 0.554 in the medium category, which means that the module is most effective on auditory learners. This is due to the module having 3 videos which enhances learning through auditory means. Students with kinesthetic learning styles have average N-gain score with 0.388 which is still in the medium category. which means that the module is also moderately effective on kinesthetic learners. This is due to the module having activities between each sub-material which enhances learning through kinesthetic means. Students with visual learning styles have average N-gain score with 0.385. Although it is the lowest of the 3-learning style, it is still in the medium category. which means that the module is also moderately effective on visual learners. Visual learners struggle with the module due to the audio-visual features rely more heavily on the audio than the visual.

4. Conclusion

The developed electronic modules based on learning styles for enhancing numeracy skills among students demonstrated satisfactory validity. The average validity score for the content was 3.770, categorized as "Very Valid," while the average validity scores for media and language were 3.630 and 3.167, respectively, both categorized as "Valid." These results indicate the modules' suitability for implementation. The N-gain result is 0.44 in the medium category which means that the e-module is able to improve student’s numeracy skills.

Based on the research findings, discussion, and conclusions above, Teachers who implement learning style-based modules should be able to increase student interest so that they have the willingness and initiative to learn independently. More time should also be allocated to improve numeracy skills so that students' foundational skills can be in the high category before moving on to the next material, making it easier to learn the subsequent material. For future researchers, it is recommended to deepen the research by using more materials and implementing the use of modules for one semester to make the improvement graph more visible.

5. Aknowledgments

The researchers would like to thank SMPN 80 Jakarta for providing the place, teachers and the students for the research. Researchers would also like to thank the validitators for the evaluation and input for the e-module. Last but not least, the researchers would also like to thank Pendidikan Matematika FKIP UKI for the opportunity for the research.

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