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Interactive Matrix Website: Facilitating Discovery Learning to Improve Students' Mathematical Literacy Skills

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Abstract: This research is motivated by the low mathematical literacy skills of students in Indonesia, which is an important skill for the application of mathematics in daily life. The purpose of this study is to develop an interactive website based on google sites to improve students' mathematical literacy skills, especially in matrix materials. The method used in this study is the ADDIE (Analysis, Design, Development, Implementation, Evaluation) model, which involves students of grade XI social studies in Yogyakarta as participants. Data is collected through tests (pre-test and post-test) and non-tests (questionnaires and observations) to get a comprehensive picture of the effectiveness of the website developed. Data analysis is carried out qualitatively and quantitatively to assess the validity, practicality, and effectiveness of the product. The results of the study showed that the website developed met the validity criteria of material and media experts, and was considered very practical by teachers and students, with an average learning implementation of 90.25%. The effectiveness test using the paired sample t-test showed a significant increase between the pre-test and post-test scores, with the average post-test reaching 84.84, which exceeded the minimum completeness criteria (KKTP) set. In addition, more than 75% of students have successfully achieved KKTP. The implication of this study is that the interactive website developed can be an effective tool in improving students' mathematical literacy skills, so it is expected to help students better understand mathematical concepts and apply them in daily life. This research makes a positive contribution to efforts to improve the quality of mathematics education in Indonesia.
Keywords: literacy mathematics; matrix; website; ADDIE; interactive

INTRODUCTION

Mathematical literacy skills is an important ability that allows a person to identify, understand, and apply mathematics in a real-life context (Oktiningrum & Hartono, 2016). Student training related to mathematical literacy skills is needed to achieve the demands of the Industrial Revolution 4.0 era which refers to the capacity to develop and apply reasoning in solving problems of daily life (Espinosa, 2021). Unfortunately, the mathematical literacy skills of students in Indonesia is still relatively low. This is reflected in the results of the Programme for International Student Assessment (PISA) which shows a decline in the mathematics scores of Indonesian students in 2018 and 2022. Other research, such as those conducted by Atsnan et al.

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(2018) and Masfufah & Afriansyah (2021), also shows that many students have difficulty in solving math problems, especially those related to real-world contexts. Maysarah et al. (2023) also found that students' lack of involvement and activeness in the classroom is an indication of the cause of students' low mathematical literacy skills.

Maralova (2024) explains that improving mathematical literacy skills requires a comprehensive approach, combining effective teaching strategies, curriculum design, and continuous assessment to meet the diverse needs of students. Teachers can use various efforts, one of which is the development of websites such as modules, LKPD and related learning media. An interactive learning atmosphere (between teachers and students as well as students and students), quick feedback from technology teachers and mathematics content are factors that shape students' mathematical dispositions (Ulia & Kusmaryono, 2021). One of the efforts to improve students' mathematical literacy is to utilize technology, especially interactive websites. Technological developments encourage the world of education to continue to adapt and develop, both for teachers and students, in order to achieve optimal learning goals. Said et al. (2023) stated that learning is no longer limited by space and time, because technology allows the teaching and learning process to be carried out flexibly, one of which is through websites. Websites can present interesting and interactive learning materials, as well as provide quick feedback to students. Several studies, such as those conducted by Syahdela et al. (2023), show that the use of interactive websites, such as quizizz, can improve students' mathematical literacy skills and learning motivation. Lestari & Utami (2022), added that interactive media such as websites can help students understand abstract concepts better through observing, touching, and using tools. Rezeki et al., (2023) also support that web-based learning not only makes it easier for students to understand the material but also actively involves them in the learning process.

In this study, the development of an interactive website will use the google sites platform. Google sites are a practical way to learn because they provide learning information quickly and can be accessed anywhere and anytime (Rosiyana, 2021). Setiawan et al. (2019) added that Google Sites has provided various features, including templates with elegant designs. Maskar et al. (2021) stated that the use of google sites can be used as a solution in providing easy access to information. Research conducted by Saputra & Octaria (2022) regarding the use of google sites on derivative materials concluded that the use of these websites increases students' enthusiasm and activeness in asking questions. In line with that, research by Islanda & Darmawan (2023) on the use of google sites to improve physics learning achievement of grade XI students also showed a positive response from students as users of learning media. This is evidenced by a significant increase in students' pre-test and post-test scores. In addition, the discovery learning model, according to Farib et al. (2019), can be applied in interactive websites to increase student involvement in the learning process. In discovery learning, students are required to be actively involved in discovering concepts or principles for themselves (Yerizon & Sarti, 2021).

In the context of matrix learning, this material is often considered abstract and difficult for students to understand. Therefore, the development of an interactive website specifically designed for matrix materials using google sites is expected to help students better understand matrix concepts and improve their mathematical literacy skills. Uleng et al. (2023) in their research related to the development of learning media using web google sites with the help of educational games obtained student learning test results of 75.8% which were in the category of good assessment. Therefore, the development of a google sites-based matrix interactive website with a discovery learning approach is expected to be an alternative to improve students' mathematical literacy skills.

The existing research gap is the lack of focus on how specific learning approaches such as discovery learning can be integrated into the Google Sites platform for matrix materials to improve mathematical literacy in more depth. Therefore, the development of an interactive website specifically for matrix materials based on Google Sites with a discovery learning approach is expected to address this gap by providing a platform that not only presents materials but also facilitates students to actively discover matrix concepts independently, so that it can help students better understand matrix concepts and improve their mathematical literacy skills. The development of an interactive matrix website based on Google Sites with a discovery learning approach is expected to be an alternative to improve students' mathematical literacy skills.

METHOD

This research is a development study (Research & Development) aimed at producing a valid, practical, and effective interactive matrix website product. The development procedure employs the ADDIE model, which consists of the stages of analysis, design, development, implementation, and evaluation. The subjects for this research trial are students from class XI IPS at one of the State Senior High Schools located in the province of Yogyakarta for the academic year 2024/2025. The data in this study were collected using a combination of test and non-test methods. Test data were obtained from the scores of mathematical literacy skills assessments, including pre-test and post-test scores. Meanwhile, non-test data were collected through questionnaires and observation sheets of the implementation of learning. The stages of development are as follows.

1. Analysis
   The analysis stage includes: (a) analysis of student characteristics, (b) analysis of school needs and situations, (c) analysis of the curriculum and learning outcomes that must be achieved.
2. Design
   The design stage includes several steps, including: (a) establishing learning objectives, (b) organizing the structure and flow of website use, (c) gathering and designing learning content, (d) creating user interactions, and (e) designing

3. Development
   The steps to be used in this stage include: (a) product development and (b) product validation.
4. Implementation
   The implementation stage consists of two trials, including a limited trial involving 15 students, and a large-scale trial involving 36 students simultaneously serving as research subjects in this study.
5. Evaluation
   The evaluation stage is the last stage used to re-evaluate the use of websites in the classroom which is used to improve mathematical literacy skills

Data Analysis Techniques

1. Qualitative Data Analysis
   The qualitative data of this research consists of suggestions and input from validators, practitioners, and students.
2. Quantitative Data Analysis
   a. Validity Analysis
   Validity is analyzed based on the questionnaire data filled out by the validators. The questionnaire data is then calculated and converted into the following Table 1.

Table 1. Validity Classification

Score Intervals	Validity Categories
$S_{min} + 4JI \leq V < S_{max}$	Very Valid
$S_{min} + 3JI \leq V < S_{min} + 4JI$	Valid
$S_{min} + 2JI \leq V < S_{min} + 3JI$	Sufficiently Valid
$S_{min} + JI \leq V < S_{min} + 2JI$	Less Valid
$S_{min} \leq V < S_{min} + JI$	Invalid

(Widoyoko, 2017)

Information:
JI: Interval Distance
S_{min} : Ideal Minimum Score
S_{max} : Ideal Maximum Score

Based on Table 1, a validity category is then made by material experts and media experts shown in Table 3 by first recapsing the data on the number of assessment items, maximum score, minimum score, and interval distance presented in Table 2.

Table 2. Recap of scoring items, maximum score, minimum score, and interval distance

Instrument	Scoring Item	Maximum Score	Minimum Score	Interval Distance
Validation by material experts	14	56	14	8,4
Validation by media experts	16	64	16	9,6

Table 3. Validity categories by subject matter experts and media experts

Interval		Category
Validation by material experts	Validation by media experts	
$47{,}6 \leq V < 56$	$54{,}4 \leq V < 64$	Very Valid
$39{,}2 \leq V < 47{,}6$	$44{,}8 \leq V < 54{,}4$	Valid
$30{,}8 \leq V < 39{,}2$	$35{,}2 \leq V < 44{,}8$	Sufficiently Valid
$22{,}4 \leq V < 30{,}8$	$25{,}6 \leq V < 35{,}2$	Less Valid
$14 \leq V < 22{,}4$	$16 \leq V < 25{,}6$	Invalid

The description is as follows: V = Total score of the validator's assessment.

The learning device is declared valid if the validator concludes that the learning device is suitable for use and the score assigned reaches at least the "good" category.

b. Analysis of Practicality

The analysis of practicality is obtained from the practical assessments by students and teachers, as well as the percentage of learning implementation sheets. Data on the number of assessment items, maximum score, minimum score, and interval distance are presented in Table 4.

Table 4. Recap of scoring items, maximum score, minimum score, and interval distance

Instrument	Scoring Item	Maximum Score	Minimum Score	Interval Distance
Practicality by Teachers and Students	15	60	15	9

Practical data processing can be converted with Table 5.

Table 5. Practicality categories by teachers and students

Score Intervals	Practicality Categories
$51 \leq P < 60$	Very Practical
$42 \leq P < 51$	Practical
$33 \leq P < 42$	Fairly Practical
$24 \leq P < 33$	Less Practical
$15 \leq P < 24$	Impractical

The percentage of learning implementation sheets will be obtained using the following percentage results.

$$Learning\ Implementation = \frac{Activities\ Carried\ Out}{Total\ Aktivities} \times 100\%$$

The website product is declared practical if the percentage of learning implementation achieved is more than 75% and the practicality score obtained reaches the minimum practical category based on practicality assessments by teachers and students.

c. The effectiveness analysis

The effectiveness analysis was obtained from the results of the students' mathematical literacy skills test using several tests and assisted by R studio software, including:

1. The Normality Test, was carried out to find out whether the population selected in this study was normally distributed or not.
2. The Hypothesis Test, is carried out to test the hypothesis that the average score of the student's mathematical literacy skills test is equal to or greater than the predetermined (KKTP), which is 75.
3. The Proportion Test, was carried out to test the hypothesis that the percentage of students who achieved classical completeness, namely obtaining KKTP (75) ≥ 75%.
4. The Paired Sample T-test is carried out to find out if there is an average difference before and after learning using an interactive website that was developed. This test will use pre-test and post-test data.

RESULTS AND DISCUSSION

Website Product Validity

Expert validation is carried out with the aim of assessing the validity of the product. Expert validation was carried out by two expert lecturers from the UNY mathematics education master's study program. Two expert lecturers assess the validity of the developed product, and provide suggestions and input to researchers to improve the developed product before being tested. A recapitulation of website assessment by material and media experts is presented in the following table 6.

Table 6. Expert Website Rating Recapitulation

Validator	Maximum Score	Score Acquistion	Validity Category
Matter Expert	56	46	Valid
Media Expert	64	50	Valid

Based on table 6 above, it is concluded that the website products developed meet the valid category.

Website Product Practicality

The practicality of the website product was obtained from the acquisition of practicality scores by teachers and 15 students as small test subjects and learning implementation sheets. A recapitulation of the practicality assessment by teachers and students is presented in the following table 7. Meanwhile, the percentage of learning implementation is presented in the following table 8.

Table 7. Recapitulation of practicality assessments by teachers and students

Instrument	Maxsimum Score	Score Acquistion	Category
The Assessment of teachers	60	60	Very practical
The Assessment of students	60	52,2	Very practical

Table 8. Percentage of Learning Implementation

Meeting Score	Teacher Activity Score	Student Activity Score	Presentage
1	23	22	100%
2	20	19	84%
3	21	20	88,5%
4	21	20	88,5%
Average			90,25%

Based on Table 7 and Table 8, it was obtained that the developed product met the practical criteria.

Website Product Effectiveness

The effectiveness of the website product was carried out in a large trial class involving 36 students, where there were 12 male students and 14 female students. Based on the results of the post-test, information was obtained that there were 3 students who obtained post-test scores below the specified KKTP, namely 36. The results of the analysis of the effectiveness of using website products in the classroom will be described as follows.

Normality Test

Table 9. Normality Test

Univariate Normality		
Variable	*p-value*	*Normality*
Pre-Literasi Matematis	0.0607	YES
Pos-Literasi Matematis	0.1176	YES

Based on the results of the analysis, it was obtained that the pre-test and post-test of mathematical literacy skills were distributed normally and could be continued for the next test.

Hypothesis Test

Table 10. Hypothesis Test

$t_{0.05(35)}$	$t.test$	*p-value*	*Mean post-test*	α	Keputusan
1.6896	8.1935	1.182e-09	84.8428	0.05	H_0 ditolak

Based on the results of the hypothesis test, it was obtained that the average post-test score was 84.8428. The average obtained > the specified KKTP is 75.

Proportions Test

Based on the results of the calculation with a significance of 0.05, the value of $Z = 2.3105 > Z_\alpha = 1{,}65$was obtained. Thus, it was concluded that H_0 was rejected, the proportion of mathematical literacy skills test results that reached the KKTP (75) was greater than 75%.

Uji Paired Sample T-Test

Based on the results of the paired sample t-test, it was found that there was a significant average difference between the pre-test and post-test scores of students' mathematical literacy skills.

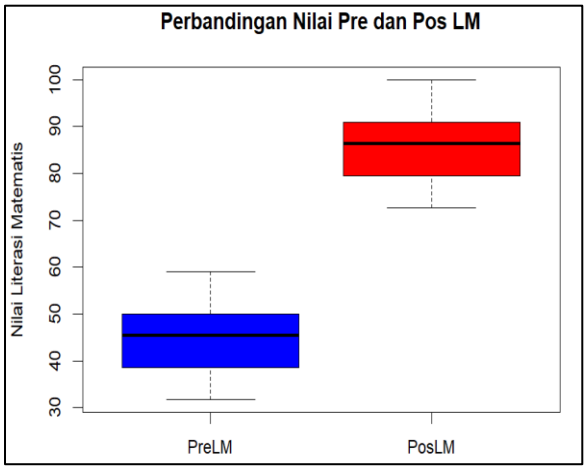

Figure 1. Comparison of Pre and Post Mathematical literacy skills Scores

Based on the results of the boxplot visualization above, it can be seen that the pre-test score of mathematical literacy skills is lower than the post-test score of mathematical literacy skills, so this shows a difference. Therefore, this interval has a positive value, therefore, it can be concluded that the average post-test of mathematical literacy skills is higher than the average of pre-test mathematical literacy skills. In other words, there is an increase in mathematical literacy skills after the use of interactive websites.

Discussion of Website Product Validity

The validation results by material experts (score 46) and media experts (score 50) indicate that the interactive website based on discovery learning that was developed is included in the valid category and is suitable for use in learning. Assessment and validation by experts are essential stages in the development of technology-based learning media to ensure the quality, feasibility, and suitability of the media before being implemented (Saputri et al., 2023). The valid score obtained indicates that fundamentally, this website has met the basic criteria as a learning

medium. However, input from both validators is very important for improvement. The material expert's suggestion to vary the problems with real environmental contexts (for example, billboards) is in line with the principles of contextual learning which aim to increase the relevance of the material for students (Amalia et al., 2024). Alignment of learning objectives and materials with reference books, as well as the addition of mathematical literacy skills indicators, is also crucial to ensure curriculum coherence and content depth. From the media aspect, recommendations for maintaining visual consistency (fonts, colors), increasing contrast, providing markers between sections, standardizing navigation, and arranging learning flows sequentially are key elements in instructional design and user experience (UX). These principles aim to ensure usability and facilitate the user's cognitive process in following the learning flow effectively on the digital platform (Nasrina et al., 2021). Implementing these suggestions will optimize the quality and potential of the website as an effective and attractive learning tool.

Discussion of Website Product Practicality

The results of the limited trial on 15 students and 1 teacher showed a very high level of practicality for the interactive website developed. The observation score of learning implementation (90.25%), practicality assessment by teachers (score 60), and average student assessment (score 52.2) consistently confirmed the category of "very practical". Practicality assessment from the perspective of end users (teachers and students) through direct trials in the classroom is very important to ensure that learning media are relevant and can be implemented effectively in real contexts (Rahmawati et al., 2022). This high practicality is supported by teachers' positive assessments of the aspects of ease of use, time efficiency, attractiveness, ease of understanding, and usefulness of the website. Students' positive perceptions of interest and presentation of materials also strengthen these findings, indicating that the website is considered interesting and easy to use by its target users (Sodiq et al., 2021). These criteria are key factors in the acceptance and adoption of educational technology in the school environment (Faradayanti et al., 2020). The input from students to add an answer key feature is constructive feedback. This suggestion indicates a need or desire for students to be able to conduct independent self-evaluation after studying the material. The addition of a feature that allows students to check their own answers can support the self-regulated learning process and provide direct formative feedback. The implementation of this feature can be considered for further development to increase the potential of the website in facilitating student understanding independently.

Discussion of Website Product Effectiveness

The effectiveness assessment of this interactive website aims to measure its impact on improving students' mathematical literacy skills, using a pre-test and post-test design. This approach is a standard method in educational research to evaluate changes in student abilities as a result of an intervention (Banuwa & Susanti, 2022). Product effectiveness is determined based on the fulfillment of three specific, complementary criteria. First, the average post-test

score of students' mathematical literacy skills must reach or exceed the Learning Objective Achievement Criteria (KKTP) set, which is 75. This criterion ensures that students generally achieve the minimum competency target after using the website (Bito et al., 2024). Second, the percentage of students who successfully achieve a score above KKTP (75) must be at least 75%. This classical completion criterion is important to show that the website is effective for the majority of students, not just a small portion (Panjaitan et al., 2020). Third, there must be a statistically significant difference between the average mathematical literacy skills scores before (pre-test) and after (post-test) the use of the website. This difference, which is often analyzed using a t-test or N-Gain, indicates an increase in ability that can be attributed to the website intervention (Hadiana, 2023). The fulfillment of these three criteria simultaneously becomes the basis for concluding the effectiveness of the website in improving students' mathematical literacy skills.

CONCLUSION

Interactive website products based on discovery learning for mathematical literacy skills and disposition are validated (score 49-50) and very practical (implementation 90.25%, teacher score 60, students 52.2). The effectiveness test showed a significant increase in mathematical literacy skills, reaching KKTP and high criteria in more than 75% of students, and there was a difference in the average before and after use. Therefore, it is recommended that this website be integrated more widely in mathematics learning, supported by teacher training, and its features and materials continue to be developed. Recommendations include further studies on long-term impacts and adaptations for various student characteristics. Theoretical Implications are that this study strengthens the theory of discovery learning in a digital context to improve mathematical literacy skills and disposition. It shows that discovery learning syntax is effective in facilitating understanding and positive attitudes towards mathematics through interactive media. Practical Implications are that this website can be a very effective tool for teachers to implement active learning. The results of the study support further development of digital learning resources based on a constructivist approach in schools. Finally, the Open Problem is "To what extent do students' interactions with specific elements in the discovery learning syntax on the website contribute individually to changes in their mathematical dispositions?"

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