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DEVELOPMENT OF E-LEARNING OF MATHEMATICS NUMERACY TO IMPROVE STUDENTS' NUMERACY ABILITY

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Abstract

When compared to reading and science skills, Indonesian students' numeracy skills always receive the lowest average scores. On the PISA test, 71% of students do not meet the minimum numeracy competency level. Because education and technological advancement are inseparable, a technology-based initiative that can improve students' numeracy skills is required. The creation of an e-learning numeracy application known as "E-learningNumeration," which is anticipated to offer a substitute for enhancing students' numeracy abilities. The purpose of this study is to ascertain whether the developed E-learningNumeration application is reliable, efficient, and applicable for assisting students in developing their mathematical numeracy skills. The students in class VIII at SMP IT Najib Rasyid served as the study's subjects. In this study, one type of R&D research method is the Software Development Life Cycle with a prototyping approach model. The Independent Samples Test analysis reveals that the E-learningNumeration application is effective in improving students' mathematical numeracy, as evidenced by the sig. value (2-tailed) Equal variances assumed to be 0.016 0.05. The developed application is deemed valid and usable. With an average score of 77.50 on the student questionnaire, the E-learning Numeracy application is also said to be useful. This study suggests that the E-learning Numeracy application should assist students in improving their numeracy skills.

Keywords: E-learning; E-learningNumerasi; Mathematical Numeracy; prototype; R&D; SDLC.

Abstrak

Kemampuan berhitung siswa Indonesia secara konsisten memperoleh hasil rata-rata terendah jika dibandingkan dengan kemampuan membaca dan sains mereka. Sekitar 71% siswa gagal memenuhi tingkat kemahiran minimal dalam berhitung sebagaimana dinilai oleh ujian PISA. Korelasi antara pendidikan dan kemajuan teknologi tidak dapat disangkal. Oleh karena itu, sangat penting untuk menggunakan pendekatan berbasis teknologi untuk meningkatkan kemahiran berhitung siswa. Tujuannya adalah untuk membuat aplikasi e-learning berhitung yang disebut "E-learningNumeration" yang akan berfungsi sebagai metode alternatif untuk meningkatkan kemampuan berhitung siswa. Tujuan dari penelitian ini adalah untuk menilai validitas, efikasi, dan kepraktisan aplikasi E-learningNumeration dalam meningkatkan kemampuan berhitung matematika siswa. Partisipan dalam penelitian ini terdiri dari siswa kelas delapan di SMP IT Najib Rasyid. Penelitian ini memanfaatkan Software Development Life Cycle dengan model pendekatan prototyping, yang merupakan teknik penelitian di bidang R&D. Program E-learningNumeration yang dirancang dinilai valid dan praktis untuk digunakan. Lebih jauh lagi, terbukti berhasil meningkatkan kemampuan berhitung matematika siswa, sebagaimana ditunjukkan oleh hasil analisis Independent Samples Test, di mana nilai signifikansi terlihat. (Bilatera1) Asumsi varians yang sama terpenuhi pada tingkat signifikansi 0,016, yang lebih rendah dari ambang batas 0,05. Aplikasi E-learning Numeracy dinilai praktis, sebagaimana ditunjukkan oleh skor rata-rata 77,50 yang diperoleh dari evaluasi kuesioner siswa. Penelitian menunjukkan bahwa aplikasi E-learning Numeracy kemungkinan dapat meningkatkan kemampuan berhitung siswa.

Kata kunci: E-learning*; E-learningNumerasi; Numerasi Matematika; prototype; R&D; SDLC.*

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INTRODUCTION

Education is crucial not only for the development of our children and younger siblings, but also for the advancement of our nation and state in the future. It serves as a key indication of a country's growth. Developing early numeracy abilities is crucial for acquiring mathematical knowledge in later stages of education (Hellstrand et al., 2020; Cahyadi et al., 2023). Chan's study emphasizes the significance of numeracy abilities in enhancing kids' early mathematical development and boosting their academic performance (Chan & Scalise, 2022; Kementerian Pendidikan dan Kebudayaan, 2017). Numeracy abilities consistently get the lowest average scores in comparison to reading and scientific skills. Approximately 71% of pupils fail to acquire the basic level of numeracy proficiency (Hadi & Abduh Moch., 2022). This is evident from the lowest average score achieved in PISA 2003, which was 360. The highest mean score was attained in the PISA 2006 assessment, with a score of 391 points. According to the OECD (2019), Indonesian students achieved an average score of 379 in the PISA 2018 assessment. The Indonesian government, namely the Ministry of Education, has implemented many measures to enhance the proficiency of Indonesian students. These measures include the National Assessment, which encompasses basic competence assessments, character surveys, and work environment surveys (Kemendikbud, 2021; Hastuti & Setyaningrum, 2023). Strong numeracy abilities are crucial for the future of the Indonesian country to effectively compete with other nations (Wiyata & Suwartini, 2022; Kertayasa & Herman, 2023).

Considering the widespread use of smartphones among junior high school students, e-learning may serve as a viable method to facilitate their learning. Information and communication technology (ICT) has become a crucial aspect of our everyday life, including the development of mathematical literacy or numeracy skills (Hong et al., 2020; Alyoussef, 2023). E-learning is believed to provide a potential answer for enhancing numeracy abilities. Mononen et al. (2014) suggest that different learning design characteristics, such as computer-assisted learning or e-learning, may effectively contribute to the improvement of numeracy skills. E-learning facilitates students' learning by eliminating the constraints of place and time. It allows students to access relevant information, hence enhancing the learning process in a more convenient and efficient manner. (Masfingatin et al., 2021; Firdaus, 2021).

E-learning is a technology that instructors may use to teach numeracy to students. With e-learning, students have the flexibility to study from anywhere. Aunio's study findings indicate that students who received instructor assistance throughout the learning process had greater improvement in their numeracy abilities compared to other groups (Aunio et al., 2021). E-learning media serves as a tool to encourage and enable interactive learning (Farman & Chairuddin, 2020). The creation of this junior high school Numeracy E-Learning application is an extension of the progress made in developing the mathematics numeracy application (NuMet) for elementary schools (Zaenal et al., 2022).
Based on various research and expert explanations, researchers are focused on creating e-learning numeracy tools specifically designed for junior high

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school students. This project is a progression from the creation of numeracy apps for elementary schools that the researchers have previously undertaken. The ongoing development of e-learning numeracy is anticipated to enhance the numeracy proficiency of junior high school pupils. The application is called "E-learningNumerasi".

The current advancement in this subject involves the creation of E-learning programs specifically designed to enhance students' numeracy skills. These applications are unique and there is a need for an update to improve their functionality. The innovation of this research results in the development of an E-learning numeracy application, which enables students to learn numeracy conveniently and flexibly, regardless of time and location. Several research have examined numeracy abilities and competences related to e-learning. However, none of these studies specifically consider numeracy as an application, instead seeing e-learning as a supplementary tool for acquiring mathematical numeracy. The purpose of this study is to create an e-learning numeracy application that facilitates students' acquisition of numeracy skills. The primary aim of this project is to develop an E-learning application specifically designed for numeracy education. This program is compatible with Android devices, laptops, and PCs, allowing students to use it at any location and time for learning purposes. The significance of this study is evident in the inadequate numeracy skills exhibited by junior high school students. Additionally, the current learning media being utilized is ineffective. Therefore, there is a need for a novel and engaging medium, such as "E-learningNumeration," to facilitate enjoyable learning experiences and enhance students' numeracy skills.

METHODS

The Research and Development (R&D) technique involves the ongoing testing of products as part of the research process. The R&D methodology used utilizes the program Development Life Cycle (SDLC) with a prototyping approach. This involves developing a program that serves as an early representation of a product concept, often referred to as a prototype. The SDLC development paradigm using the prototyping model has six distinct stages: analysis, prototyping, evaluation, development, testing, and deployment. During the needs analysis stage, several aspects are examined, including the needs of students, instructors, school environment, curriculum, teaching materials, and mathematics. In this analysis, the researcher conducted interviews with teachers and numerous students to gather data for the research study. During the prototype stage, a preliminary description of the model plan is created based on the analysis findings, specifically for Numeracy e-learning. The next step is the assessment phase, during which the produced Numeracy e-learning Design is assessed via validation by subject matter experts, media experts, and potential users, namely students and instructors, in order to get feedback. Once the assessment is over, the process proceeds to the development step, when code is written using a programming language to produce a numeracy e-learning application. Following that, the testing or implementation phase involves conducting system-level tests. Additionally, the completed application is deployed on students in the experimental class. Upon completion of

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the testing phase, if the findings indicate that the application is fully functional and appropriate for usage, the numeracy e-learning application will be disseminated on a larger scale. The research population included only of pupils enrolled at Najib Rasyid Integrated Islamic Middle School. The sample for this research consisted of all pupils enrolled in grades 8-A and 8-B. The study was carried out during the first semester of the 2023/2024 academic year. The data gathering methods used in this research included both tests and non-tests. The final exam questions were used to assess the numeracy skills of students who were taught using both the newly built numeracy e-learning application and traditional methods. The non-test data gathering strategies used included field observations, structured interviews, and questionnaires. The data analysis approach used in this research included a comprehensive investigation of both qualitative and quantitative data. Quantitative data analysis was conducted to assess the validity, feasibility, and efficacy of both the data and models. The validity of Numeracy E-Learning is assessed via rigorous evaluation by subject matter experts and media professionals. Consequently, the practicality of numeracy e-learning is determined by analyzing the outcomes of student surveys specifically related to numeracy e-learning. Table 1 displays the factors used for making decisions. The effectiveness analysis is conducted by examining the improvement in numeracy skills through the comparison of test scores between the experimental class and control class using the Independent Samples Test. This test is used to determine the average difference between the two groups.

Table 1. Validity and Practicality Criteria

Score Interval (%)	Category
85-100	Very Valid/ Practical
84-70	Valid/ Practical
0-69	Less Valid/ Practical

RESULTS AND DISCUSSION

This text will describe and explain the outcomes of the research and development of the "E-learning Numeracy" application. The description and explanation will be based on the phases of the Software Development Life Cycle (SDLC) model, using a prototyping approach model.

Analysis

In the initial phase of this study, the researcher performed a needs analysis by interviewing teachers and multiple students to gather data for the research. Additionally, an analysis of the curriculum and teaching materials, as well as an assessment of the school environment, were conducted. Najib Rasyid Integrated Islamic Middle School continues to use the KTSP curriculum for grades VIII and IX in its curriculum analysis. Subsequent interviews conducted with teachers and students revealed that students continue to struggle with atypical math problems, now referred to as numeracy problems. Consequently, there is a need for media or teaching materials that can assist and support students in their mathematical numeracy education, as the current resources available to students are limited to textbooks. Consequently, the researcher endeavored to provide alternative educational resources for students by building and constructing an

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E-learning application called "E-learning Numeracy" to facilitate their acquisition of numeracy skills. This application has been designed to cater to the specific requirements of students, providing them with comprehensive resources such as materials, example questions, and practice questions. Furthermore, this program may be accessed on both laptops and cellphones as software. The creation of this e-learning was prompted by the findings of interviews conducted with students, revealing that 90% of them had personal cellphones, which are used on a near-daily basis. The creation of this numeracy application aims to enhance students' engagement in learning by enabling them to access educational content on their cellphones from any location.

Prototyping

A prototype was created based on the findings of a requirements analysis conducted with instructors and students. This prototype serves as an early demonstration of the "Numeracy E-learning" concept. Numeracy e-learning is specifically created to enhance students' numeracy skills by providing them with the opportunity to study mathematics anytime and anywhere. It is anticipated that this application will contribute to the improvement of students' mathematical numeracy abilities. Utilizing educational media may enhance the efficiency of learning and facilitate students' comprehension of the subject matter (Winarni et al., 2021). The prototype of Numeracy E-learning is shown in Figure 1, Figure 2, and Figure 3.

Figure 1. Initial Display Prototype of Numeracy E-learning

Figure 2. Prototype of Numeracy E-learning Content Display

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Figure 3. Prototype of Numeracy E-learning Cover Display

Evaluation

The generated apps will undergo validation by media experts, material experts, and users, namely instructors and students, in order to get feedback. The input provided by the validator might serve as valuable information for assessment or enhancement in application development. In addition, the numeracy e-learning prototype undergoes first validation by two subject matter experts and two media experts. The two validators are experts in the field of materials, namely mathematics. One is a mathematics teacher at a junior high school, while the other is a mathematics professor. The validation evaluation findings from media and material specialists may be seen in Table 2 and Table 3.

Table 2. E-learning Numeracy Validation Assessment by Material Experts

Assessment Indicaor	**Assessment Score**	**Assessment Score Validator 1**	**Assessment Score Validator 2**
Material	Compliance with Curriculum	90	85
	Compliance of media content with the material being taught.	86	84
	Clarity of media usage instructions.	86	87
	Compliance of achievement indicators with Basic Competencies.	92	83
	Compliance of media content with constructivist learning characteristics	88	82
Language	Effectiveness of sentences used in media usage instructions.	90	84
	Standardization of terms used.	82	78
	Compliance of language use with students' level of knowledge development.	84	81
	Total	698	664
	Average	87,25	83
	Category Validity	**Very Valid**	**Very Valid**

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Table 3. Validation Assessment of E-learning Numeracy by Media Experts

Assessment Indicaor	Assessment Score	Assessment Score Validator 1	Assessment Score Validator 2
Appearance	Suitability of writing sentences	82	80
	Suitability of size and type of letters	84	82
	Suitability of color selection	78	75
	Suitability of backgorund	79	77
	Suitability of image selection	80	74
Media Content	Suitability of instructions to use of media	82	80
	Suitability of theory to the composition of learning media	81	82
	Total	566	550
	Average	80,86	78,57
	Category Validity	**Valid**	**Valid**

Table 4. Suggestions for Revision and Improvement of Numeracy E-Learning

No	Revision Suggestions
1	For language and terms in the material and questions, use language and terms that are easy for students to understand
2	Use more attractive colors and not too busy
3	Use more attractive backgrounds and icons according to the mathematics material
4	For questions, it is better to increase them with different types
5	The arrangement of media in the application is not well connected

The Numeracy E-learning prototype as the beginning of the Numeracy E-learning application development process was assessed by material and media experts. From the results of the validation of the material experts, an average value of 87.25 and 83 was obtained with a very valid category with several notes, this shows that in terms of material, this Numeracy E-learning application has been valid and feasible in terms of material even with several notes. Furthermore, the average validation assessment from media experts was 80.86 and 78.57 with a valid category, this shows that this Numeracy E-learning application is valid and feasible when viewed from the media indicators, with several notes that need to be improved. The suggestions from the material validator and experts that will be improved at the final development stage, as can be seen in Table 4.

Developing

Developing is the stage of writing code in creating an application using a programming language. The programming languages used are CSS, Javascript, PHP which are supported by the MySQL Database. The use of the MySQL Database is because the application created is based on a Web Application.

Based on suggestions for improvement to the Numeracy E-learning application from material and media experts, then the Numeracy E-learning application Prototype that was previously created was improved according to suggestions from material and media experts. There are five revision suggestions, namely two

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suggestions from material experts and three suggestions from media experts. The results of the improvements to the Numeracy E-learning application that were developed will then be tested on students. The Numeracy E-learning that has been developed consists of several parts. The first part is the cover or initial display of Numeracy E-learning, where in the initial display a brief explanation of Mathematical Numeracy is explained, as seen in Figure 4.

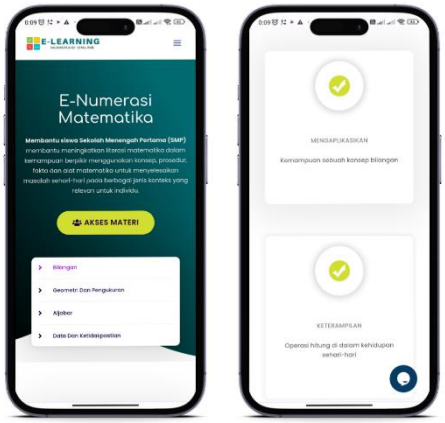

Figure 4. Initial View of the Numeracy E-learning Application

The content area of the Numeracy E-learning program is divided into four chapters: Numbers, Geometry/Measurement, Algebra, and Statistics or Uncertainty Data. These chapters are listed under the section called "List of Materials". The content includes a concise overview of the topic, along with supplementary example questions and practice questions that have been tailored to align with the curriculum used in junior high schools. For examples and practice questions are made in three categories based on the level of cognitive ability, the three categories are understanding, application (application) and the most difficult is reasoning. The cognitive level in numeracy has been adjusted to the curriculum that has been published by the government. That way, teachers will find it easier to measure students' mathematical numeracy abilities based on the level of questions in the Numeracy E-learning application. For more details, see Figure 5 and Figure 6.

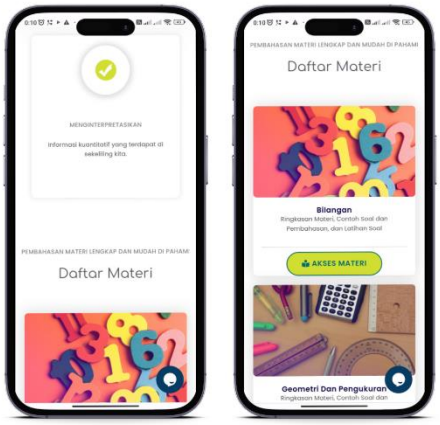

Figure 5. Display of the contents of the Numeracy E-learning Application

Figure 6. Display of Numeracy E-learning Application Material Contents

Next, the third part is the closing or ending, this part is the final part of the Numeracy E-learning application, in this part there is a special part, namely the direct consultation section, for students who are still confused about the material in the Numeracy E-learning application, they can ask directly via the telephone number listed in the application, as in Figure 7.

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Figure 7. Closing View of Numeracy E-learning Application

For further details, the Numeracy E-learning application that has been developed can be opened at the link https://e-learningnumerasi.online/, This application can be accessed via smartphone, laptop or PC which can be accessed anywhere and anytime.

Testing or Implementation

This phase is the system-level testing phase, which is followed by extensive testing on users of varying scales. System testing is conducted to verify the correct operation of a product or program by verifying its functionality. If the application is operating correctly, both mini and big scale testing are conducted. During this limited-scale evaluation, people are requested to provide input, which is essentially a user acceptability test. Following the completion of small-scale testing, the subsequent phase involves conducting large-scale testing. This testing entails using the application for numeracy learning inside the experimental class. A pilot study was conducted on a cohort of 22 students, who were instructed to use the Numeracy E-learning program for a duration of one week. Subsequently, the students were requested to provide feedback by completing a questionnaire. The mean score of the questionnaire evaluation provided by the students was 77.50. Therefore, it may be inferred that the Numeracy E-learning application, which has been created, is deemed suitable for use in classroom activities to support student learning.
In addition, researchers administered the Numeracy E-learning program directly in the classroom for large-scale testing. During the implementation stage, an experiment was conducted in class VIII A with 22 students, while class VIII B served as the control group with 24 students. In the experimental class, the learning process involves the use of the Numeracy E-learning program, while in the control class, learning is only based on the students' own books. During this experimental phase, a total of 5 sessions were conducted, focusing on the subject matter of numbers. During the implementation stage, the instructor used the Numeracy E-learning program to directly offer numerical information to the experimental class in the first to fourth sessions. The instructor provided a comprehensive explanation of the subject matter, including illustrative instances of inquiries that required cognitive abilities such as comprehension, application, and logical thinking. Subsequently, pupils were instructed to engage in independent study at home with the Numeracy E-learning tool. Additionally, students were assigned practice tasks that required completion at home, with the questions already embedded into the Numeracy E-learning program. In the control class, the instructor supplied instructional materials and sample questions sourced from reference books. The learning approach used in the control class followed a traditional instructional style.

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During the sixth and final session, pupils were administered a comprehensive examination, after four prior instructional sessions. The exam was administered to two groups, an experimental group and a control group, all of whom were given the identical set of essay test questions consisting of a total of 4 questions. The experimental class had an average value of 83, while the control class had an average value of 79, as shown by the results of the final exam. In order to assess the effectiveness of the Numeracy E-learning application in enhancing students' mathematical numeracy skills, a statistical analysis called the Independent Samples Test will be conducted. This test, presented in Table 5, aims to determine the disparity in the mean scores between the experimental and control groups. Prior to doing the t-test, we perform a normality test as a requirement for the Independent Samples Test. The results of the normality precursor test may be seen in Table 5.

Table 5. Tests of Normality

Class	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Exsperiment	.125	22	.200*	.917	22	.066
Control	.141	24	.200*	.927	24	.084

According to the table, the Sig. value for the experimental class is 0.066, which is greater than the significance level of 0.05. Similarly, the Sig. value for the control class is 0.084, also greater than 0.05. Therefore, based on the decision-making criteria of the Shapiro Wilk test, it can be concluded that the numeracy test data for both the experimental and control classes follow a normal distribution. Since both datasets meet the specified criteria of normality, we will proceed with a t-test. The results of the t-test may be seen in Table 6.

Tabel 6. Hasil Independent Samples Test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Tes Numerasi	Equal variances assumed	.806	.374	2.497	44	.016	3.7917	1.5184	.7315	6.8519
	Equal variances not assumed			2.473	40.193	.018	3.7917	1.5334	.6929	6.8904

According to the table 6 provided, the significance value (2-tailed) assuming equal variances is 0.016, which is less than 0.05. Therefore, based on this information, we may infer that the null hypothesis (Ho) is rejected and the alternative hypothesis (Ha) is accepted in the independent sample t-test. Therefore, it may be inferred that there is a substantial disparity in the average numeracy learning results of students in the experimental and control classrooms. The experimental class refers to a group of students who get instruction utilizing the Numeracy E-learning program. The efficacy of the Numeracy E-learning program in enhancing students' arithmetic numeracy abilities may be inferred. These findings align with several studies completed by earlier

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researchers, indicating that ICT-assisted learning or E-learning has a beneficial effect. Putra et al's study findings indicate that the use of learning videos in mathematics education has a beneficial effect on the development of numeracy literacy abilities in junior high school students (Putra & Mukhtar, 2022). According to Cahyadi et al. (2023), the creation of ebook module apps has the potential to greatly enhance students' numeracy abilities. The study conducted by Sutarna et al. (2021) highlights the effectiveness of e-learning as a learning alternative for enhancing students' numeracy abilities. E-learning media may be used as a substitute to cultivate students' self-reliance in mathematics education (Lu'luilmaknun & Wutsqa Urwatul, 2018). According to Ameer & Singh (2013), there is a notable disparity in numeracy abilities across different grade levels when exposed to various interventions. Valerio and Ferrara (2022) observed that numeracy has generally progressed from tangible number notions to abstract number concepts. There is no text provided. This Numeracy E-learning program aims to enhance instructors' ability to enhance students' mathematical numeracy skills in educational institutions.

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Deployment.

If the test results indicate that the application is comprehensive, it is deemed to be genuine, functional, and efficient. The last step involves disseminating it to all junior high school instructors and pupils who need it.

CONCLUSION AND SUGGESTIONS

The Numeracy E-Learning application has been deemed legitimate and viable for use in student learning, as determined by the evaluation of subject matter and media specialists. According to the questionnaire evaluation ratings provided by students, Numeracy E-Learning is deemed suitable for usage by junior high school students. Moreover, the Numeracy E-Learning program has been deemed beneficial for enhancing pupils' arithmetic numeracy abilities. The researcher acknowledges that there are several deficiencies in the construction of this Numeracy E-Learning program that need to be addressed via more study. We eagerly anticipate valuable recommendations and feedback from readers to enhance the development of the Numeracy E-Learning program.

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