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SPACED REPETITION CONCEPT DESIGN WITH FUZZY MULTI CRITERIA ANALYSIS AS A MEDIA TO IMPROVE NUMERACY LEARNING FOR ELEMENTARY SCHOOL STUDENTS

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ABSTRACT

Numeracy Learning activities after the Covid-19 Pandemic have been a decline in the quality of learning in a number of elementary school students. This research is limited to learning numeracy for low-grade students, namely grades 1, 2, and 3 because the basic concept of numeration begins with low grades. There are several factors that make it difficult for students to understand numeracy. The students often forget about the concepts that have been taught before. An Effective way of memorizing with the conventional way is memorizing with repeat pronunciations. To improve the quality of education, learning concepts that were previously carried out conventionally must be developed in a modern way using applications. The purpose of this research is to improve the numeracy learning concept of low-grade students in primary school after the Covid-19 pandemic, which is more fun and modern, by using the concept of spaced repetition based on Android flashcards. The analysis of 135 students' assessments is based on criteria such as tangible, reliability, empathy, Responsive, and assurance. The decision support system using Fuzzy Multi-Criteria Methods (MCDM) is also used to determine the weighting of the criteria and the effectiveness of learning using spaced repetition concept and its application. The result of the weighting using fuzzy multi-criteria is obtained defuzzification that tangible 65.18, reliability 56.54, responsive 46.17, assurance 49.13, and empathy 29.62. Tangible has the highest results in this test, which means that the students prefer modern learning with Android applications with an attractive experience. The correlation test obtained the result of 0.76, which is a high value in decision-making and could be accepted.

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1. INTRODUCTION

In learning basic numeracy, especially for low-grade students, namely grades 1, 2, and 3, numeration is very important to learn, and the basic concept must be well understood by children. Counting in numeracy is more than just mastering math material at school; but also involves the ability to relate it to various situations outside of school, which also requires problem-solving, critical thinking, and understanding in non-mathematical contexts [1]. The Covid-19 pandemic has had a negative impact on numeracy skills in low-grade elementary school children. Students are not able to understand the mathematical concepts used to solve problems in the real world. This ability include awareness of the relationship between numbers, understanding symbols and number of vocabulary, the ability to carry out systematic calculations, awareness to compare various number quantities, symbols and number patterns, as well as simple mathematical calculations [2]. One of the factors for improving numeracy skills is that the role of parents is needed in this case so that children can practice counting because children's numeracy skills will be better if done with hands-on practice [3]. The implementation of numeracy learning at the elementary school level has several obstacles, namely the low interest of students in learning related to mathematics, the ability of students to understand problems is still low, and the numeracy learning system is still conventional and monotonous [4]. Indonesia got a math score of 387 out of an average score of 490, while in TIMSS, Indonesia got a math score of 395 out of an average score of 500. Based on these results, Indonesia still occupies a lower position than the small country Vietnam [5]. In the research conducted by [5]. In the research that has been conducted by [6], one of the contributing factors is that students often forget the material they have learned even though various methods, such as taking notes, summarizing, and working on questions, have been done.

Based on the results of several literature studies, some of the problems found in low grades, especially grades1 to grade 3, in terms of numeracy (counting) are described as follows: 1) some students do not know numbers, 2) some students cannot write numbers correctly true, 3) students find it difficult to learn numeracy manually, 4) students feel bored with manual and conventional techniques being taught. The traditional way that is used effectively to memorize a multiplication number or a mathematical formula is to repeat it periodically and practice directly through the questions. Spaced Repetition Learning is used to memorize something by providing varying pauses for each repetition. This approach resembles the traditional way that has been done before, but it is done in a modern way using a flashcard-based android with an attractive appearance and easily understood by low-grade students. Previously, this research was also studied in terms of literacy by Hanks and Zhan with the title "The Forgetting Curve and Learning Algorithms" [7]. In addition, [8] in a paper entitled "Vocabulary Trainer Using an Online Flashcards Site," used the Leiter method. From the research that had been previously developed, the analysis used was in program design, and in the research that would be carried out, the analysis using fuzzy Mamdani was used after the use of the flashcard-based Android application, which was applied to low-grade elementary school students.

Based on the background described above, the problem to be solved in this research are how to design Spaced Repetition concept based on Flashcard android to improve numeracy learning for low-grade class students. Spaced repetition learning application is a learning media application that applies the spaced repetition technique, which is a technique for memorizing with repetition, which was developed in 1960 [9]. The technique provides a time lag that will continue to increase when reviewing previously known information [10]. After the space repetition concept is done, trough the effectiveness will count using Fuzzy Multi-Criteria criteria and take the criteria among tangible, Reliability, responsive, assurance, and empathy. Fuzzy logic is an approach to computing based on the degree of truth, which is usually stated with true 1 and false 0. Fuzzy logic is a methodology of counting with variable words as a substitute for counting with numbers [11].

2. RESEARCH METHODS

System design is an important part of a system or application. System design is intended to provide an overview of the methods. This research is a descriptive-analytic study using a questionnaire with a cross-sectional design [12]. The quality of the space repetition concept application is taken from 5 (five) aspects consisting of tangible, Reliability, responsive, assurance, and empathy factors. This research uses a sample of 45 students in each grade who have tried the application. The students were randomly selected in SD Muhammadiyah 2 Waru Sidoarjo, and the sampling was also carried out by 45 of the student assistants at each grade, who were taken randomly after trying the application. The total sample of both studies is 135

respondents who were given a questionnaire to fill in according to the filling instructions. The stage of this research included:

1. Data collection stage
   Data collection is done by taking primary and secondary data. Primary data were obtained from experiments conducted directly at the time of the study, while secondary data was obtained from data generated from journals and ministry websites.
2. Observation and model design
   This activity is carried out to synchronize the primary data that has been obtained with secondary data by making direct observations in the field to ensure that the data obtained is valid.
3. Multi-Criteria Decision-Making Step
   At this stage, data processing is carried out using the Fuzzy Multi-Criteria method. Data obtained from the results of filling out the questionnaire (field) is processed by the fuzzy method for getting the criterion weight. The steps in the fuzzy method in weighting criteria are as follows:
   a. Define the alternatives to be considered and the problem formula (mathematical model)
   b. Determine the criteria that will be used as the basis for evaluating and modelling the preferences of decision makers for each criterion.
   c. Determine the fuzzy number membership function of each assessor by doing a recapitulation of assessment scores from linguistic and numerical rating scales obtained from questionnaire filling. As well as determining the middle value of the fuzzy number by means of adding up all the values that appear at each level of the linguistic scale and dividing the results of the sum. The formula below [13]:

$$\boldsymbol{a_t} = \frac{\sum_{i=1}^{k}\sum_{j=1}^{l} \boldsymbol{T_{ij}}}{\sum_{i=1}^{k} \boldsymbol{n_i}} \quad (1)$$

   The formula included the following:
   $\boldsymbol{a_t}$ is the mean value of the fuzzy number for the linguistic assessment level
   $\boldsymbol{T}$ is rating levels such as not satisfied, dissatisfied, quite satisfied, satisfied, and very satisfied.
   $\boldsymbol{j}$ is number of criteria $\boldsymbol{1, 2, 3, \cdots l}$
   $\boldsymbol{k}$ is a number of alternatives
   $\boldsymbol{n_i}$ is sum of criteria from the linguistic scale $\boldsymbol{T}$ for alternative $\boldsymbol{i}$
   $\boldsymbol{T_{ij}}$ is numeric number from linguistic scale $\boldsymbol{T}$ for alternative $\boldsymbol{i}$ from criteria $\boldsymbol{j}$
   d. Determine the weight of the fuzzy assessment of the criteria of each assessor.
   e. Make tabulation of the results of the assessment that has been done before to get the aggregation weight value for each criterion. The aggregation process is carried out by finding the aggregation value of each lower limit, middle value, and upper limit value, which can be formulated as follows:

$$\boldsymbol{c_t} = \frac{\sum_{j=1}^{n} \boldsymbol{c_{tj}}}{\boldsymbol{n}} \quad (2)$$

$$\boldsymbol{a_t} = \frac{\sum_{j=1}^{n} \boldsymbol{a_{tj}}}{\boldsymbol{n}} \quad (3)$$

$$\boldsymbol{b_t} = \frac{\sum_{j=1}^{n} \boldsymbol{b_{tj}}}{\boldsymbol{n}} \quad (4)$$

   With
   $\boldsymbol{c_{tj}}$ is the lower limit value of the subjective criterion to$-\boldsymbol{t}$ by the decision make to$-\boldsymbol{j}$
   $\boldsymbol{a_{tj}}$ is the middle limit value of the subjective criterion to$-\boldsymbol{t}$ by the decision make to$-\boldsymbol{j}$
   $\boldsymbol{b_{tj}}$ is the upper limit value of the subjective criterion to$-\boldsymbol{t}$ by the decision make to$-\boldsymbol{j}$
   $\boldsymbol{n}$ is the number of decision maker
   $\boldsymbol{N_t} = (\boldsymbol{c_t}, \boldsymbol{a_t}, \boldsymbol{b_t})$ is average weight rating criterion
   f. Calculate a single value by defuzzification models "center of gravity" [14]

$$\boldsymbol{x} = \frac{\int \boldsymbol{\mu}\, \boldsymbol{c}(\boldsymbol{x})\boldsymbol{x}\, \boldsymbol{dx}}{\int \boldsymbol{\mu}\, \boldsymbol{c}(\boldsymbol{x})\, \boldsymbol{dx}} \quad (5)$$

$$\boldsymbol{defuzzification} = \frac{\int_{ct}^{at} \frac{x-ct}{at-ct} x\, dx + \int_{at}^{bt} \frac{x-bt}{at-bt} x\, dx}{\int_{ct}^{at} \frac{x-ct}{at-ct}\, dx + \int_{at}^{bt} \frac{x-bt}{at-bt}\, dx} \quad (6)$$

   And normalize the results so that the value obtained between 0 and 1, $\boldsymbol{w}$ is weight, $\boldsymbol{c_{ij}}$ is score each criterion, with the following formula

$$\boldsymbol{w} = \frac{\boldsymbol{c_{ij}}}{\sum \boldsymbol{c_{ij}}} \quad (7)$$

4. Data Processing with TOPSIS (Technique for Order Preference by Similarity to Ideal Solution)
   The Procedure of TOPSIS [15] as follows
   a. Create an un-processes matrix, which contains criteria, alternative, and weighs, as follows [16]:

$$D = \begin{matrix} - \\ A_1 \\ A_2 \\ \vdots \\ A_m \end{matrix} \begin{matrix} C_1 & C_2 & \cdots & C_n \end{matrix} \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1n} \\ x_{21} & x_{22} & \cdots & x_{2n} \\ \vdots & \vdots & \vdots & \vdots \\ x_{m1} & x_{m2} & \cdots & x_{mn} \end{bmatrix} \quad (8)$$

   $C_i = C_n =$ criterion
   $A_j = A_m =$ Alternative
   $W =$ Weight
   $x_{ij} = x_{mn}$
   b. Create the decision matrix $(\boldsymbol{r_{ij}})$ as follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}}, \quad (9)$$

   with $i = 1,2, \ldots m$, and $j = 1,2, \ldots, n$
   c. Create the decision matrix $(\boldsymbol{y_{ij}})$ as follows:

$$y_{ij} = w_i r_{ij} \quad (10)$$

3. RESULTS AND DISCUSSION

Spaced repetition concept design is used so that students can easily memorize numeracy using gadgets. Students will not be spared from playing gadgets. This makes learning numeracy requires a fun concept through gadgets so that students are interested. The ranking stage is carried out so that results can be drawn from comparisons between modern and conventional methods as follows:

1. Determine the criteria that will be used as a reference in decision making, namely C_i where the analysis of 135 student's assessment is based on criteria such as tangible, Reliability, empathy, Responsive, and assurance.
2. Create a decision matrix based on sub-criteria (C_i) where the criteria are quality of product, product reliability, design capability, user capability, effective learning evaluation, and evaluation time.
3. The result is obtained from the ranking process, namely the sum of the normalized multiplication R with the weight vector so that the largest value is selected as the best alternative (A_j) solution.
4. Correlation testing to show the level of validation using the formula [17]:

$$r_{xy} = \frac{N\sum XY - (\sum X)(\sum Y)}{\sqrt{(N\sum X^2 - (\sum X)^2)(N\sum Y^2 - (\sum Y)^2)}} \quad (11)$$

The collected data is recapitulated based on the results of the assessment of the linguistic scale and the numeric scale. The decision maker assesses each criterion using a linguistic and numerical scale, namely each respondent evaluates each criterion (5 criteria) using a linguistic and numerical scale such as: Very dissatisfied (1), Not Satisfied (2), fairly satisfied (3), Satisfied (4), Very Satisfied (5). The following in **Table 1** is a summary of the frequency distribution of the characteristics of the respondents from the android based numerical flashcard design which is applied to the low class, namely class 1, class 2, and class 3. **Table 1** is the result of a questionnaire consisting of 135 respondents consisting of classes 1, 2, and 3, with a male and female sampling. In this questionnaire, experiment conducted at an elementary school (SD Muhammadiyah 2 Waru Sidoarjo), there were more female students than male students. The respondents are students who use the application of android-based numerical flashcards for the period of December 2022 until January 2023 as a student's user. **Table 2** is a recapitulation of the resulting questionnaire consisting of 135 respondents, consisting of the parents or guard of elementary school students who has tried the application of an android-based numerical flashcard for a period of December 2022 until January 2023 called Guard's User.

Table 1. Frequency Distribution of Respondent Characteristics Of Android Based Numerical Flashcard Design For Period December 2022-January 2023 (Student's Users)

Category of Students	Male		Female	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Class 1	15	11.1	30	22.2
Class 2	23	17	22	16.3
Class 3	22	16.3	23	17.1

Table 2. Frequency Distribution of Respondent Characteristics of Android Based Numerical Flashcard Design for Period December 2022-January 2023 (Guard Users)

Category of Guards	Male		Female	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Class 1	22	16.3	23	17.03
Class 2	11	8.14	34	25.18
Class 3	10	7.41	35	25.94

From the data in **Table 1** and **Table 2,** respondents were given some questionnaires with the question in five criteria such as tangible, reliability, responsive, assurance, and empathy. Each criterion has some sub-criteria. The sub-criteria has 3 questions which can be seen in **Table 3.**

Table 3. Frequency Distribution of Respondent Characteristics at SD Muhammadiyah 2 Waru Sidoarjo (Student's Users)

Numerical Scale	Criteria														
	Tangible (%)			Reliability (%)			Responsive (%)			Assurance (%)			Emphaty (%)		
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
1	5.92	7.41	3.70	2.22	1.48	2.96	6.67	4.44	3.7	2.22	5.19	7.41	1.48	0	0
2	3.7	9.62	7.4	12.6	8.89	6.67	10.37	13.3	11.85	8.15	9.63	5.18	3.7	2.2	0
3	18.51	25.9	16.2	20.7	20	22.2	22.22	30.3	26.67	14.1	17.8	22.2	30.4	11.1	21.5
4	48.15	29.6	17	15.5	25.9	14.8	10.37	14	18.5	40.7	22.9	17	11.1	28.1	31.8
5	23.7	27.4	55.5	48.9	43.7	53.3	50.37	37.8	39.25	34.8	44.4	48.1	53.3	58.5	46.7

Table 3 shows the frequency distribution of Respondent Characteristics at SD Muhammadiyah 2 Waru Sidoarjo. In **Table 3**, the decision maker assesses each criterion using a linguistic and numerical scale, namely each respondent evaluates each criterion (5 criteria) using a linguistic and numerical scale such as: Very dissatisfied (1), Not Satisfied (2), fairly satisfied (3), Satisfied (4), Very Satisfied (5). Each Criterion has sub-Criteria namely $X_1, X_2, X_3, X_4, X_5, X_6, X_7, X_8, X_9, X_{10}, X_{11}, X_{12}, X_{13}, X_{14}$, and X_{15}. In Tangible, there are 3 sub criteria such as appearance (X_1), facility (X_2) and Physical Means (X_3). In Reliability, there are 3 criteria namely ability (X_4), convenience (X_5), and Provision (X_6). Responsive have three sub-criteria namely respond (X_7), speed (X_8), and willingness (X_9). Assurance has three sub criteria also namely skills (X_{10}), knowledge (X_{11}), and guarantee (X_{12}). Emphaty covers sub criteria understand (X_{13}), applicable (X_{14}), and easy to use (X_{15}). **Table 3** shows that the percentage of criteria while student user using the application covers five criteria and sub-criteria. **Table 4** shows the frequency distribution of respondent characteristics at SD Muhammadiyah 2 Waru Sidoarjo. The respondents in **Table 4** are the parents or the guards of students at SD Muhammadiyah 2 Waru Sidoarjo.

Table 4. Frequency Distribution of respondent characteristics at SD Muhammadiyah 2 Waru Sidoarjo (Guards Users)

Numerical Scale	Criteria														
	Tangible (%)			Reliability (%)			Responsive (%)			Assurance (%)			Emphaty (%)		
	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15
1	2.22	1.48	2.96	3.7	1.48	8.15	6.67	2.96	3.7	4.44	8.9	2.22	0	0	2.22
2	3.7	5.18	6.67	2.96	9.62	12.6	10.4	8.15	6.67	5.92	3	8.9	7.4	5.18	5.93
3	23.7	19.3	21.5	23	13.3	22.2	22.2	23.7	14	12.6	14	21.5	13.3	25.2	27.4
4	8.15	5.18	4.44	7.4	14.8	11.1	10.4	20.7	20	17.8	23.7	29.6	37	44.4	43
5	62.2	68.9	64.4	63	60.7	45.9	50.4	44.4	55.5	59.3	50.4	37.8	42.2	25.18	21.48

After the linguistic value is obtained, the next step is to find the boundary value, namely the lower limit, the middle limit, and the upper limit as the value of the characteristic. **Table 5** shows the data recapitulation of lower boundary, mid value, and upper boundary values as the result of the assessment to get the aggregation weight value for each criterion.

Table 5. Data Recapitulation of Lower Boundary, Mid Value, and Upper Boundary Values

Criteria	Linguistic Level														
	Very Dissatisfied (STP)			Not Satisfied (ST)			Fairly Satisfied (CP)			Satisfied (P)			Very Satisfied (SP)		
	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b
Tangible	0	3	4	3	5	10	5	11.5	13	11.5	17	23	17	21	25
Reliability	0	5	9	5	9	10	9	15	18	15	17.4	24	17.4	19	24
Responsive	0	7	8	7	12	14	12	14	15	14	17	19	17	19	21
Assurance	0	4	7	4	7	13	7	15	20	15	17.6	21	17.6	20	22
Empathy	0	3	6	3	10	17	10	14	17.5	14	18.5	22	18.5	21	25

Table 6 is the result of the assessment that has been done before to get the aggregation weight value for each criterion. The aggregation process is carried out by finding the aggregation value of each lower limit, middle value, and upper limit value with suitable formulas (2), (3), dan (4).

Table 6. Triangular Fuzzy Membership Function Students and Guard's User

Criteria in Membership Function															
Tangible			Reliability			Responsive			Assurance			Empathy		
ct	at	bt	ct	at	bt	ct	at	bt	ct	at	bt	ct	at	bt
7.3	11.5	15	9.28	13.08	17	9.8	12.6	15.2	10.92	12.72	16.6	9.1	13.3	17.4
6.84	9.04	11.8	8.92	11.32	13.3	12.04	13.64	15.4	7.5	11.1	14.14	7	10.22	13.8

From the table above, the aggregate value determination is formed to form a fuzzy triangular membership function for student's user and parent users. From the membership function table, the aggregation process is carried out by finding the average for the data value lower limit (ct), middle value (at), and upper limit (bt). The method of obtaining is calculated by adding all linguistic levels on each criterion and then dividing it by the total linguistic variable that has been determined. **Table 7** shows the recapitulation of criteria interest level weight for student's user and guard levels. Five criteria in **Table 7** get the result more than 0-1, so the defuzzification normalizes so that the value obtained between 0 and 1 as a formula (7).

Table 7. Recapitulation of Criteria Interest Level Weight

Criteria	Students User		Guards User	
	Defuzzification	Weight	Defuzzification	Weight
Tangible	11.80	0.176682	9.74	0.165916
Reliability	13.78	0.206433	11.48	0.195556
Responsive	12.95	0.19396	14.00	0.238527
Assurance	14.30	0.214121	12.51	0.213136
Empathy	13.94	0.208804	10.97	0.186865

The following **Figure 2** is a membership function for each criterion from tangible, reliability, Responsive, assurance, and empathy. The membership function in **Figure 2** shows the criteria of tangible and reliability. Tangible shows the optimal value with the maximum satisfaction value obtained with a maximum value.

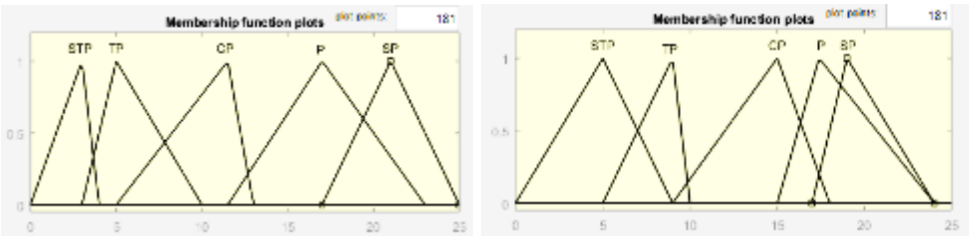

Figure 2. Membership Function for criteria *Tangible* dan *Reliability*

Figure 3. shows the membership function from criteria responsive, assurance, and empathy. Among these 3 criteria, assurance occupies the second position after tangible criteria. Assurance shows the understanding that the trust given to the application is quite high.

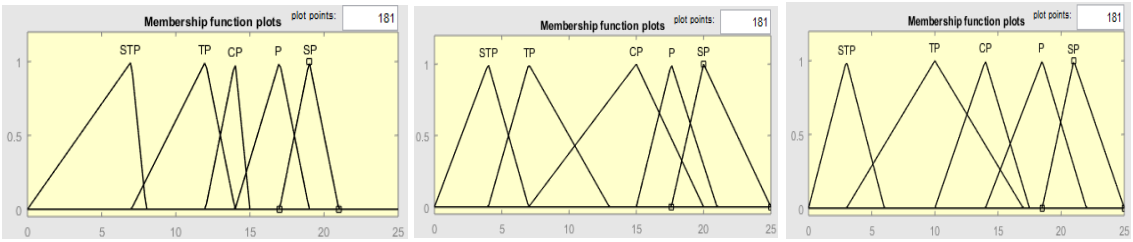

Figure 3. Membership Function for criteria *Responsive, Assurance* dan *Empathy*

Table 8. Criteria Importance Level Value (all users)

Numerical Scale	Criteria of Linguistic Level for All User (%)				
	Tangible	Reliability	Assurance	Responsive	Empathy
1	2.222222	4.444444	5.185185	2.962962	0.74074
2	5.185185	8.395062	5.925926	7.901235	6.17284
3	21.48148	19.50617	16.04938	16.79012	21.97531
4	5.925926	11.11111	23.7037	20.98765	41.48148
5	65.18519	56.54321	49.1358	46.17284	29.62963

Table 8 shows the total percentage of the numerical scale criteria for the satisfaction level of all users from a score of 1-5. Tangible has the highest score of user satisfaction, with a number of 65.18%. Then reliability is the second position of linguistic level of user satisfaction with a number of 56.54%. With the formula (11), the data in Table 8 has obtained a correlation coefficient of 0.762014 for student users. According to the definition in the validity test, the number 0.762014 is a high number that is valid in the decision variable so that it can be used as data in research. Testing data from the guard's user obtained a correlation coefficient of 0.991. According to the definition in the validity test, the number is very high in testing for making the decision. The following is a definition of the correlation coefficient in decision's making, namely on a scale of Likert **[18]**, between 0,8 to 1 is very high, between 0.6 to 0.8 is high, between 0.4 to 0.6 is enough, between 0.2 to 0.4 is low, between 0 to 0.2 is very low.

4. CONCLUSIONS

Based on the result obtained, an analysis of 135 students' assessments based on five criteria such as tangible, reliability, empathy, responsive, and assurance. By using Fuzzy Multi-Criteria Methods (MCDM), the value of weighting on the criteria and the effectiveness of learning using spaced repetition concept were obtained. The result of the weighting using fuzzy multi-criteria is obtained by defuzzification that each criterion sorted by TOPSIS ranking as follows tangible 65.18, reliability 56.54, assurance 49.13, responsive 46.17, and empathy 29.62. Tangible has the highest results in this assessment, which means that the students prefer modern learning with Android applications as a gadget as one of the media for learning numeration. Tangible is a real form of application, including appearance and facility, its means that with a nice and attractive appearance, students enjoy learning numeration as if they were playing a fun game. Reliability took second place in this assessment. This criterion included ability, convenience, and provision. The assessment took assurance as the third criterion, which means that the application concept provides additional knowledge and experience for students in skills and knowledge. Responsive and empathy are the low-value criteria according to the assessment level, considering this application is still new and requires a lot of development. The correlation test of the student's user obtained the result of 0.76, which is a high value in decision-making, and the correlation test of the guard's user obtained the result of 0.991, which is a very high value in decision-making. From this research, it can be concluded that the concept can be developed in accordance with the assessment that has been done before. Applications can be used as useful media to support numeracy learning at school and for students learning at home with parental assistance.

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REFERENCES

[1] D. T. D. Maya Nur Janah, "Literasi Numerasi dalam Pembelajaran Tematik," *J. Muallimuna*, vol. 7, pp. 87–98, 2022.
[2] R. dan T. Kementrian Pendidikan, Kebudayaan, "Modul Literasi Numerasi Di Sekolah Dasar," *Modul Literasi Numer. Di Sekol. Dasar*, vol. 1, p. 22, 2021, [Online]. Available: http://ditpsd.kemdikbud.go.id/upload/filemanager/2021/06/2 Modul Literasi Numerasi.pdf
[3] N. Z. Salvia, F. P. Sabrina, and I. Maula, "Analisis Kemampuan Literasi Numerasi Peserta Didik Ditinjau Dari Kecemasan Matematika," *ProSANDIKA UNIKAL …*, no. 2019, 2022, [Online]. Available: https://www.proceeding.unikal.ac.id/index.php/sandika/article/view/890
[4] D. W. Adinda and I. Oktaviyanti, "Profil Kemampuan Numerasi Dasar Siswa Sekolah Dasar Di SDN Mentokan," vol. 7, pp. 1066–1070, 2022.
[5] F. T. P. Pangesti, "Menumbuhkembangkan Literasi Numerasi Pada Pembelajaran Matematika Dengan Soal Hots," *Indones. Digit. J. Math. Educ.*, vol. 5, no. 9, pp. 566–575, 2018, [Online]. Available: http://idealmathedu.p4tkmatematika.org
[6] U. Umar and A. Widodo, "Analisis Faktor Penyebab Rendahnya Kemampuan Akademik Siswa Sekolah Dasar di Daerah Pinggiran," *J. Educ. FKIP UNMA*, vol. 8, no. 2, pp. 458–465, 2022, doi: 10.31949/educatio.v8i2.2131.
[7] J. Hanks and P. Zhan, "The Forgetting Curve and Learning Algorithms," pp. 53–60, 2012.
[8] J. Kumamoto, "Vocabulary Trainer Using an Online Flashcard Site," pp. 1–8, 1972.
[9] A. Hidayat and N. M. S. Iswari, "Rancang Bangun Spaced Repetition Software untuk Menghafal Huruf Jepang Menggunakan Algoritma Supermemo 2 Berbasis IOS," *J. Ultim. InfoSys*, vol. 9, no. 1, pp. 32–36, 2018, doi: 10.31937/si.v9i1.846.
[10] C. C. Astuti and R. S. Untari, "Applied Hierarchical Cluster Analysis with Average Linkage Algoritm," vol. 5, no. November, pp. 1–7, 2017.
[11] L. Santya, M. Miftah, V. Mandala, S. Saepudin, and D. Gustian, "Penerapan Metode Fuzzy Mamdani untuk Pendukung Keputusan Penentuan Jumlah Produksi Lantak Si Jimat," *J. Rekayasa Teknol. Nusa Putra*, vol. 7, no. 1, pp. 35–41, 2019.
[12] N. L. Azizah, B. H. Prasojo, and C. S. Rini, "Analisis Tingkat Kepuasan Publik Terhadap Pelayanan Rumah Sakit Berdasarkan Metode Fuzzy Topsis Mcdm," *J. Ilm. Soulmath J. Edukasi Pendidik. Mat.*, vol. 7, no. 1, pp. 63–74, 2019, doi: 10.25139/smj.v7i1.1429.
[13] M. K. Hidayat and S. Natalia, "Fuzzy Multi Atribute Decision Making Dengan Metode Simple Additive Weighted Untuk Penilaian Siswa Terbaik di TK Harapan Mulia Bekasi," *IJCIT (Indonesian J. Comput. Inf. Technol.*, vol. 3, no. 1, Mei , ISSN: 2527-449X, E-ISSN: 2549-7421, pp. 55–62, 2018.
[14] N. Febriany, "BAB III Metode Fuzzy Mamdani," 2016.
[15] Sanusi and J. Husna, "Sistem Pengambilan Keputusan Menggunakan Topsis Fuzzy Mcdm Untuk Pemilihan Tempat Wisata Berbasis Web," *J. Ilm. Rekayasa dan Manaj. Sist. Inf.*, vol. 4, no. 1, pp. 26–35, 2018, [Online]. Available: http://ejournal.uin-suska.ac.id/index.php/RMSI/article/view/4889/2965
[16] I. K. Putri, "Aplikasi Metode Fuzzy Min-Max (Mamdani) Dalam Menentukan Jumlah Produksi Perusahaan," *J. Ilm. d'Computare*, vol. 9, pp. 30–38, 2019.
[17] J. M. Adnan.K, Afandi F, "Hubungan Kemampuan Literasi Numerasi dengan Hasil Belajar Matematika Siswa Kelas V SD Gugus II," pp. 423–430, 2021.
[18] T. Nempung, T. Setiyaningsih, and N. Syamsiah, "Otomatisasi Metode Penelitian Skala Likert Berbasis Web," no. November, pp. 1–8, 2015.