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Research Article

Effectiveness of loci method to increase mathematics learning achievement of grade 5th elementary school students

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Abstract

Mathematics learning achievement of elementary school students is determined by the learning method used by the teacher. The learning method needed is a method that can help maximize student memory so that students can remember the material well. The Loci method connects certain objects with specific locations so that the individual may easily recall them. The purpose of this study was to empirically test the effectiveness of the loci method on mathematics learning achievement for elementary school students. This experimental research used a quasi-experimental design, with a one-group research design. Six elementary school students participated in this study. Pretest-posttest design with mathematics achievement test and the loci method treatment module were utilized as instruments. Data were analyzed by the paired sample t-test. The results of data analysis found that there is a difference between pre-test and post-test and that the loci approach helps enhance mathematics achievement. The Cohen's d Effect Size test resulted in a score of 77.4%, indicating that the Loci Method is highly effective in boosting mathematics learning achievement for students in elementary school. The implication of this research is that schools are expected to train mathematics teachers to use the loci method to improve students' mathematics learning achievement.

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Introduction

Understanding mathematics is strongly related to numeracy skills. This determines the direction and technique of studying mathematics to make it more contextually (Rowan-Kenyon et al., 2012). The Indonesian Ministry of Education has created a national assessment for students in Indonesia on literacy and numeracy components (Zubaidah, 2021). This National Assessment is an evaluation program to improve the quality of education which consists of a minimum competency assessment in literacy and numeracy, a character survey and a survey of the learning environment. The National Assessment is carried out with the aim of improving students' critical thinking and reasoning skills in literacy and numeracy aspects which are expected to later increase the Program for International Student Assessment (PISA) scores and Trends in International Mathematical and Science Study (TIMSS) scores (Sriyatun, 2020). Students of Indonesia were placed 44th out of 49 countries based on the latest data from TIMSS, which was followed by Indonesia in 2015, for the assessment of learning achievement in mathematics and science for students from various areas of the

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world. According to the most recent PISA 2018 data, which tests students' science, reading, and math skills around the world, Indonesia's maths score ranks 73rd out of 78 countries (Dian, 2022).

The results of the National Assessment carried out in 2021, when evaluated through the lens of minimum competency assessment, demonstrate that 1 in 2 students throughout Indonesia have not attained the requisite literacy competence, and 2 out of 3 students throughout Indonesia have not reached the minimum numeracy competence (Rosa, 2022). According to Swasty (2022), among the several levels: elementary school, junior high school, and senior high school, the elementary school has the highest percentage of education units that require special intervention, particularly in the field of numeracy. This can be concluded that the mathematical ability of elementary school students in Indonesia is relatively low, which can be seen in their numeracy abilities.

Mathematical achievement, specially for numeracy abilities must be developed. According to Retnoningsih (2015) and Binkley et al. (2012), strengthening mathematical abilities can boost the ability to think rationally, analytically, systematically, critically, and creatively, allowing individuals to access, manage, and use knowledge to deal with dynamic situations. The numeracy skills are important to improve because if they are not improved, it will have a negative impact on society's survival, including the difficulty of continuing education, low competitiveness, and being easily duped by hoaxes circulating in the community (Rosa, 2022).

The capacity to perceive mathematical information as well as employ arithmetic operations and numbers that surround persons in everyday life is referred to as numeration (Sternberg, 2012). The capacity to conceptualize utilizing mathematical principles to solve daily situations is referred to as numeration (Papadopoulos, 2013). In reality, numeracy entails being able to apply the notion of counting to a variety of circumstances in the world (Cohen, 2016).

The concept of numeracy is similar to the loci method, which relates knowledge about specific items with specific locations in the expectation that the subject would recall the information more easily (Solso et al, 2008). According to Riccomini (2015), concerning mathematics achievement, the mnemonic method (which consists of the loci method, dependent word system method, keyword method, acronym method, and acrostic method) is a way that can help maximize student memory so that students can remember the formulas used in mathematics and use them appropriately. According to Willingham (2021), memory is required for recycling knowledge since it is utilized to obtain new knowledge or answer problems.

Students will be able to improve their learning results by being given a method that addresses the issue of low achievement in mathematics. Additionally, this method may have a positive effect on teachers as well as students, making it easier for them to carry out their educational duties and helping students develop critical thinking and social skills (McLean & Connor, 2015).

The loci method is successfully applied, and Qureshi's (2014) research demonstrates that interactive learning utilizing the loci method can improve student performance as evidenced by an increase in the percentage of correct answers provided by students when compared to independent study sessions that use assessments through regular worksheets. Additionally, studies by Syanthi et al. (2016) demonstrate that applying the Loci Method on 54 students of scientific courses can help you retain information more effectively than just reading it aloud. Similarly, Retnoningsih (2015) demonstrated in her study that the Loci Method had an impact on how students yunior high school associated items with geometric formulae. Peek (2016) conducted previous research on the Loci Method, which is used in learning French verbs for high school students, and it is known that the loci method is effective in learning French verbs. Based on the explanation above, the authors are interested in conducting experimental research on how the effectiveness of the loci method to improve mathematics learning achievement of elementary school students

Mathematics Learning Achievement

Learning achievement is referred to as the provision of value as a result of student learning after the examination (Khalalia, 2015). Learning achievement, according to Zimmerman (2013), is a learning result that cannot be isolated from learning activities, where learning activities are a process and learning achievement is a learning process. the

outcomes of the learning procedure So, based on the words of the two scholars above, it is possible to conclude that learning achievement is the outcome obtained by students after engaging in learning activities.

Mathematics achievement is the outcome obtained by students after participating in mathematics lessons, which results in changes in students' self in the form of new mastery and skills as evidenced by grades (Andersson & Palm, 2017). According to Huang et al. (2012), mathematics achievement is the outcome obtained by students after completing the entire series in the mathematics learning process. Thus, based on these two perspectives, it is possible to conclude that mathematics achievement is the outcome gained by students after engaging in mathematical learning activities, resulting in certain changes in students in the form of grades.

According to several researchers, several factors influence student achievement. According to Kauffman (2015), the factors that affect student learning achievement include 1) internal factors that come from within students, 2) external factors that come from the environment, and 3) student learning approaches, which include strategies and methods of learning that students use. Han et al. (2015) also discusses the following aspects that influence learning achievement: internal factors and external factors.

- internal factors consisting of:
    - physiological factors, namely the health of the body and the five senses
    - psychological factors, namely intelligence, attitude, motivation,
- external factors consisting of:
    - family environmental factors, namely family socioeconomic, parental education, parental attention, and the atmosphere of family relationships,
    - school environmental factors, namely infrastructure, teacher and student competencies, curriculum and teaching methods
    - community environmental factors, namely socio-cultural, and participation in education.

The 2013 curriculum aims to make changes in character education that are integrated by emphasizing the cognitive, affective, and psychomotor aspects to improve student learning achievement that is more directed at practice than just material, and is also capable of bringing out student creativity through the skills (Salim & Mujtahidah, 2020). The three aspects of student achievement correspond to the three aspects of learner achievement identified by Mirzeoglu (2016), which are cognitive, affective, and psychomotor. According to Stoet and Geary (2018), each aspect of mathematics learning achievement is explained as follows:

- Cognitive aspects are learning achievements related to the ability to think, which includes the ability to comprehend, memorize, apply, analyze, synthesize, and evaluate.
- The affective aspect is a learning achievement whose achievement is related to feelings and emotions consisting of interests, attitudes, self-concepts, and values in attitude to overcome problems that are around.
- The psychomotor aspect is a learning achievement whose achievement is related to the muscle skills and physical strength of the individual.

The objective of assessing in this study is limited to learning achievement in mathematics, with the aspects used being cognitive. The material used to assess students' mathematical learning achievement is following the mathematics teacher's manual, with fractions material and velocity and discharge material.

Table 1. Fractions, Velocity, and Discharge Indicators

Material	Indicator
1. Fraction	1.1 Identifying the forms of fractions and calculating the addition and subtraction of fractions with different denominators.
	1.2 Solving problems involving addition and subtraction of two fractions with different denominators

	1.3 Multiplication and division of fractions with different denominators
	1.4 Solving problems related to multiplication and division of fractions
2. Speed and Discharge	2.1 Identifying the comparison of two different quantities (velocity as a comparison of distance with time, discharge as a comparison of volume and time)
	2.2 Solving problems related to the comparison of two different quantities (velocity, discharge)

Loci Method

The mnemonic approach includes the loci method. The mnemonic approach is a method of memorizing (Pressley et al., 2016). The mnemonic approach, as defined by McCabe (2015), is a technique that employs familiar associations to improve the storage and retrieval of information in memory. According to Solso et al (2008), the loci approach is defined as follows: 1) employing easy-to-understand correlations or relationships, 2) storing or coding information to the brain, and 3) memorizing stored knowledge by retrieving the information.

The Loci method connects certain objects with specific locations so that the individual may easily recall them (Solso et al, 2008). The Loci (location) method is used to help people memorize specific types of information (Bower in Solso et al, 2008). When people struggle to remember specific types of information, the Loci approach is used to help them. According to Dalgleish et al. (2013), the loci method can use visual imagery to connect things from the list that have just been studied with real locations that people are familiar with. As a result, by repeating activities to recall information using the loci method while visiting predefined sites, the memory of information will be sharper.

According to Li et al. (2021), the success of the loci method is dependent on the creation of a familiar environment that is used as a landmark (something that stands out or is easily seen as a pointer) or location paired with one or more items to remember when coding, as well as the mental ability to remember items. The loci approach helps aid the transition of abstract knowledge into concrete information, which is then more easily processed by the neurological system associated with memory.

The stages of implementing the loci method according to Stine (in Anshorulloh, 2008), include:

- select a place or location that is always remembered,
- select a fact or several information or items to be remembered,
- select elements or things associated with the locations utilized in remembering information,
- make visual representations that tie information to characteristics of the area or location, and
- show the visuals numerous times a day for three or four days.

As stated by Kaplan and Wolf (2017), the loci method necessitates a clear reference to the location of the things to facilitate their discovery. According to Tilley (2016), there are several rules to remember using the loci method, including 1) not using the same two objects, 2) not putting objects in a zigzag manner, and 3) having confidence in one's ability to visualize familiar locations can make it easier to remember using the loci method.

Li et al (2021) used two groups in their experimental study of the loci method: the experimental group and the control group. The experimental group was assessed with four different types of cognitive tasks that lasted two hours for the pretest and posttest, whereas the training session lasted 20 days, four consecutive weeks, and five days per week. Spend 30 minutes every day in the training session performing working memory training utilizing the loci method. Meanwhile, the control group received no training during the 20 days. He divided the 20 days into two sessions, each lasting 10 days, in their experiment. The first ten days were spent introducing participants to the loci method and guiding them to recall the route of the place with some landmarks (hints), after which they were trained to remember items randomly related to these landmarks (hints). Landmarks can be serial numbers associated with each piece in the remembered object. Each route inside the place is learned and skilfully linked by participants based on individual experience, which is more likely to be remembered by oneself.

Furthermore, for the second session, each participant was directed to remember random items, wherein the first stage, participants were directed to remember 5 items for 90 seconds, and the items were immediately recorded on paper, then in the second stage, items that needed to be remembered were added again. 5 items became 10 items, and the duration used was also increased by 90 seconds to 180 seconds, and so on until all items were able to be remembered by participants well. If the participant can remember these items at a certain stage, then he can continue at the next stage, but if he has not been able to remember correctly, then he must complete the memorization of the items at the current stage.

Effectiveness of Loci Method to Improve Mathematics Learning Achievement

According to the findings of a study conducted by Retnoningsih (2015), the loci method affects the connection of items with geometric formulas for students of senior high school. This study is a real experimental design study with a pretest-posttest control group design. Research conducted by Ardika (2016) also showed that the mnemonic method proved effective for trigonometry learning in terms of memory and mathematics learning achievement on senior high school. Where from the results of his research also mentions that the mnemonic method can be used to increase student interest in learning and creativity when students make donkey bridges. And from the research, it was found that by giving treatment using the loci method, the overall memory of students increases and was included in the high category, and students' mathematics achievement was able to achieve scores above the minimum.

The loci method was used by repeatedly linking information (in the form of visual images) containing fraction material, velocity material, and discharge material in 37 pieces of material (items) in the form of posters connected to certain objects (which are different from each other) so that individuals can easily remember and understand the information and thus improve their mathematics achievement. More specifically, the loci method will improve mathematics achievement because students can understand information and remember information from each material in the poster and involve numeracy skills (interpreting mathematical numbers for problem-solving) in its implementation.

Problem of Study and Hypothesis

From the preceding information, the following research question can be derived: How effective the loci method was at improving mathematics learning achievement for elementary school students?. Therefore, the research hypothesis is: The loci method have a significant impact to improving mathematics learning achievement for elementary school students.

Method

Research Design

This research used an experimental research type, with the research design namely quasi-experimental design. Quasi-experimental research is an experimental research method that is not so strict in controlling the variables (Thyer, 2021). The sample in this quasi-experimental research was not determined randomly (Handley et al., 2018). In this quasi-experimental design, the researcher chose the form of the research, namely the one group pretest-posttest design. This research design was chosen to examine the causal relationship between the independent variable and the dependent variable by comparing pretest and posttest scores before and after treatment. The loci method variable is the independent variable in this study, and the mathematics achievement variable is the dependent variable. This study's design employed a single group of subjects with no comparison group. The research design is as follows (Knapp, 2016):

Table 2. One group pretest-posttest design

Pre-Test		Treatment		*Post-Test*
O_1	$\longrightarrow$	X	$\longrightarrow$	O_2

Where:

O_1 = *Pre-Test* (measurement of students mathematics achievement before being given treatment)

X = Treatment (giving treatment in the form of the Loci Method)

O_2 = *Post-Test* (measurement of students mathematics achievement after being given treatment)

Participants

The subjects in this study were students elementary school of grade 5th , totaling six students who were selected by non-random sampling, namely by taking research subjects that had conformity with predetermined characteristics. The criteria for selecting this subject include 1) Elementary school students in grade 5th, 2) having mathematics achievement that is included in the low classification based on the measurement results of the mathematics learning achievement test instrument for grade 5th , 3) willing to be involved in a series of experimental processes using the method loci. The research location is State Elementary School Krenceng 4 Kediri District, with the experimental room used, namely the library room of State Elementary School Kerenceng 4.

Data Collection Tool

Mathematics Learning Achievement Test

The data collection method in this study used the test method. The instruments used in this study were the mathematics learning achievement test instrument and the loci method treatment module instrument. The mathematics learning achievement test in this study uses a multiple choice question model where students choose one of 4 answer choices that are considered correct to answer the given math problem. Where in its manufacture the researchers were guided by the Package Book "Mathematics: For grade 5th" by Indrianti et al by Intan Pariwara Publisher and from the Book "Mathematics Teaching Materials" with Usaha Makmur Solo Publisher. The validity of the instrument was tested against four expert judgments, including two lecturers who were mathematicians and as well as two elementary school mathematicians.

In addition to the mathematics learning achievement test, the researcher also uses a research instrument in the form of the loci method treatment module which in its preparation is based on the theory and implementation procedures of the loci method from Solso et al (2008) and Li et al (2021). The instrument of the Loci Method Treatment Module is entitled "Loci Method Treatment Module to Improve Mathematics Learning Achievement grade 5th at state elementary school". The validity of the module was tested by an expert judgment expert in psychology with a specialization in education.

The researcher performed the content validity test to evaluate the instrument's validity. The Aiken V coefficient of 0.75 - 0.94 indicates that the grade 5th elementary school mathematics achievement test instrument has high validity based on the results of the content validity test of the fifth-grade mathematics learning achievement test instrument with calculations using the Aiken V index. Then, to test the content validity of the loci method treatment module with calculations using the Aiken V Index, the Aiken V coefficient of 0.67 - 1.00 means that the loci method treatment module instrument has high validity. In testing the reliability of the mathematics achievement test instrument, the researcher used the Split Half Spearman-Brown Formula. From 18 valid items, the results of the split half Spearman-Brown reliability calculation were 0.796.

The classification was utilized to categorize mathematics achievement scores on research subjects as high or low. The researcher's classification was based on the average score of mathematics achievement. The following are the findings of a descriptive analysis of the fifth-grade mathematics learning achievement test scores.

Table 3. Descriptive Statistics of Mathematics Learning Achievement Score

	N	Minimum	Maximum	Mean	Std. Deviation
Score of Mathematics Learning Achievement	22	3,00	16,00	9,23	3,74
Valid N (listwise)	22				

The average score on the mathematics achievement test is 9.23, according to the table above. The lowest and highest scores are 3 and 16, respectively. The standard deviation is also reported to be 3.74. The group norm is used to categorize mathematics accomplishment scores based on standard deviation and the average total score is shown below.

Table 4. Mathematics Learning Achievement Norms

Formula	Score Range	Classification
$X < 9.23$	3 – 9	Low
$9.23 \leq X$	10 – 16	High

According to the results of the mathematics learning achievement test instrument try-out of 22 students, 11 subjects have low learning achievement in mathematics, whereas 11 other subjects have high learning achievement.

Based on the difficulty level of each item calculated from the try-out results of the mathematics learning success test instrument, it was discovered that 9 items had a high or tough item difficulty level and 9 other items had a low or easy item difficulty level. In terms of item discrimination, there are 0 poor items, 10 unsatisfactory products, 4 quite good items, and 4 very good items. As a result, the 18 items on the mathematics achievement exam can be used in field data gathering.

The loci method theory proposed by Stine in Anshorulloh (2008), Halim (2012), and Li et al. was the foundation for the experimental design (2021). This trial design included six sessions over six days, with each treatment session lasting 120 minutes (two hours).

The normality and homogeneity tests were employed as precursor tests, as well as the paired sample t-test and Cohen's d effect size test as hypothesis tests. Because there were 50 subjects, the researcher utilized the Shapiro-Wilk normality test. The researcher was aided in conducting the Shapiro-Wilk normality test. In the Cohen's d effect size test, the size of the effect is expressed as a percentage. For Effect Size score classification, the following is a score classification table for the One Group Pretest Posttest according to Cohan in Dini, et al (2017).

Table 5. Cohen's d Effect Size Classification Score

Size	Interpretation
0 – 0,20	Weak effect
0,21 – 0,50	Modest effect
0,51 – 1,00	Moderate effect
>1,00	Strong effect

Furthermore, the classification in the form of percent according to Cohen in Becker (2000) is as follows.

Table 6. Classification of Cohen's d Effect Size Score in percent

Cohen Standard	***Effect Size***	**Percentage**
Big	2,0	81,1%
	1,9	79,4%
	1,8	77,4%
	1,7	75,4%
	1,6	73,1%
	1,5	70,7%
	1,4	68,1%
	1,3	65,3%
	1,2	62,2%
	1,1	58,9%
	1,0	55,4%
	0,9	51,6%
	0,8	47,4%
Medium	0,7	43,0%
	0,6	38,2%
	0,5	33,0%
	0,4	27,4%
	0,3	21,3%
Small	0,2	14,7%
	0,1	7,7%
	0,0	0%

Results

Description of the Loci Method Implementation

There are 6 subjects in this study, including MA, MI, MR, AR, SN, and VM. Based on the questionnaire given to all subjects, the subjects found it difficult with mathematics because it was difficult to remember mathematical material, especially the formulas and how to solve the problems. Before the experiment, all subjects had agreed to be the subject of the experiment by filling out the informed consent form. The implementation of the loci method was carried out in 6 sessions, including:

The First Session includes an introduction to the loci method, beginning with its knowledge, execution, and restrictions that each subject must follow when carrying out tasks utilizing the loci method later. All volunteers are willing and ready to participate in a series of experiments and follow all existing regulations. The subjects in this initial

session paid close attention to the presentation and were certain that they would be pleased with the loci method. They believe that the loci method will help them remember mathematical formulas and material and improve their mathematics learning achievement based on the explanation provided. According to the MA subject, using the loci method can make learning and remembering mathematical formulas easier. The MI participant also stated that the loci approach can recall previously forgotten facts. Similarly, the topic of SN stated that the loci approach can help in remembering mathematical content and working on questions.

The Second Session includes activities to recall 13 items and their objects, the contents of which are to grasp and apply explanations relevant to implementation methods. The subjects performed admirably during this second session. Many subjects were quite eager in carrying out the exercises, especially understanding the material on the poster, but one subject fell asleep when explaining the material and several others joked about it. Researchers investigate these issues and attempt to revive activities by urging them to pay attention to the material's content, providing advice to help them recall the material, and conducting questions and answers to examine the material's content. In addition, the subject was still unable to build their visual picture so they still needed help from the researcher to provide ideas about the visual picture of the ongoing material. The subject was still hesitant to answer questions after the second session.

The Third Session contains activities to remember the 12 items and their objects which are a continuation of the previous item, the contents of which are to understand explanations related to the implementation procedures and apply what has been explained. In this third session, the subjects have started to memorize the flow of the activities, where they just need to continue the next 12 items from the 13 items that have been memorized previously. In this third session, several subjects started to dare to answer questions and create visual image ideas of the ongoing material. The subjects were very enthusiastic about exploring the material in the poster and it was rare to joke with their friends.

The Fourth Session includes activities to recall 12 items and their objects, which are a continuation of the preceding item, the contents of which are to comprehend and apply explanations related to implementation methods. The subjects were more comfortable with the flow of activities during the fourth session, and they became more passionate about carrying them out. In comparison to the previous session, all participants were able to answer questions confidently in this fourth session, however, some individuals were sluggish to respond. All individuals were allowed to offer their visual description of what was going on at the moment.

The Fifth Session includes activities that require students to recall random items of fractional content and record them on the given sheet. The length of memorizing all elements on the poster was shortened from 11 minutes to 8 minutes and then back to 5 minutes in this fifth session. This was done since the remaining time was spent remembering by joking and playing alone. So that when the length is shortened, all participants may implement the loci approach diligently and passionately. Some subjects were able to carry out activities to remember fractional items at random and record them correctly in this fifth session, but others were still constrained in carrying out activities where there was a miscommunication in writing random items and not fast enough in writing remembered items on the paper provided. Thus, in these circumstances, the researcher provided further instructions and advice on how to change the time limit. So that the topic can compensate for other subjects in the following step. In this fifth session, all subjects were, on average, able to complete three stages of remembering random items from the five previously planned stages. Although the whole subject has not been able to complete up to stage five, all items in the fractional material have been able to be remembered by the subject.

The Sixth Session includes activities to recall random items of velocity and discharge material and report these items on the given page. Because the flow of activities in the sixth session was the same as the flow in the fifth session, the subjects had already learned it. The distinction is that the subject to memorize is speed and discharge, and the sixth session concludes with a quiz session. All subjects were able to carry out tasks easily, and all were able to complete all phases of memorizing, specifically three stages of memorizing random items of speed and discharge.

Analysis of Data

The following is an explanation of the data on mathematics achievement scores before and after being given treatment using the loci method for six students. The presentation of the data can be seen in the following.

Table 7. Scores of Pre-test and Post-test Results of Grade 5th Mathematics Achievement

No.	Initial	*Pre-test*	Category	*Post-test*	Category
1.	MA	9	Low	12	High
2.	MR	8	Low	10	High
3.	MI	7	Low	8	Low
4.	AR	7	Low	12	High
5.	SN	9	Low	14	High
6.	VM	8	Low	13	High

According to Table 7, the six participants received a pretest score ranging from 7 to 9, with the overall category score being the lowest. Following treatment with the loci method methodology, the results obtained from six participants ranged from 8 to 14, with subjects MA, MR, AR, SN, and VM scoring in the high category, but MI subjects scoring in the low category.

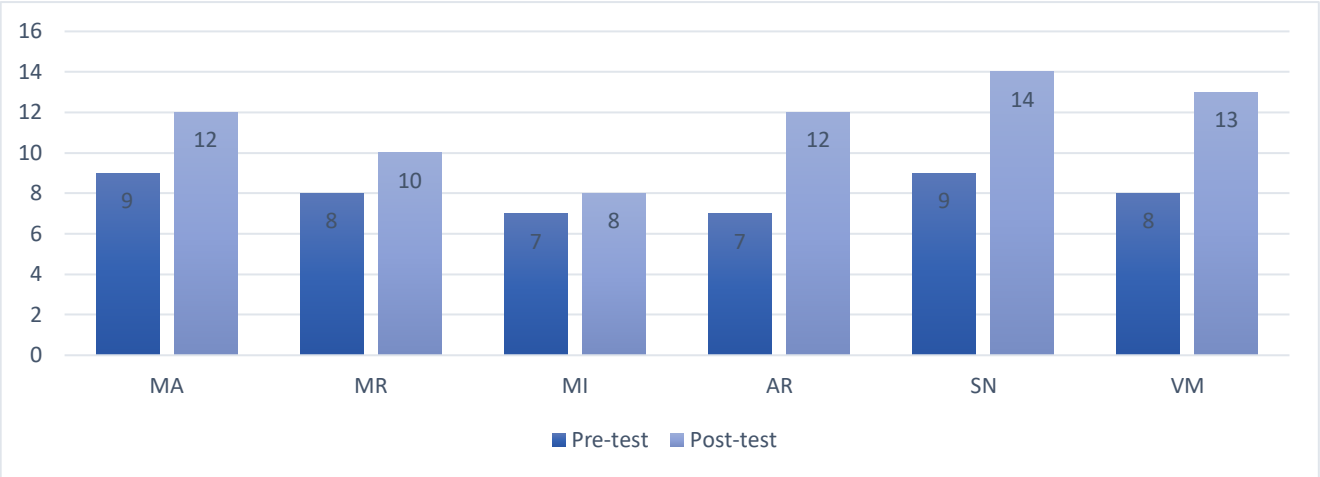

Figure 1. Bar Chart of Pre-test and Post-test Scores of Class V Mathematics Learning Achievement

Based on Figure 1 above, it is known that there is an increase between the pretest score and the posttest score with a different increase in each subject.

Table 8. Changes in Mathematics Learning Achievement Score

No.	Name Initial	*Pretest*	*Posttest*	Change	Percentage (%)
1.	MA	9	12	+3	33,33
2.	MR	8	10	+2	25,00
3.	MI	7	8	+1	14,29
4.	AR	7	12	+5	71,43
5.	SN	9	14	+5	55,56
6.	VM	8	13	+5	62,50

The pretest and posttest scores for each subject are provided in the table above, along with the percentage change in each subject's score and the amount by which the score increased between the pretest and posttest.

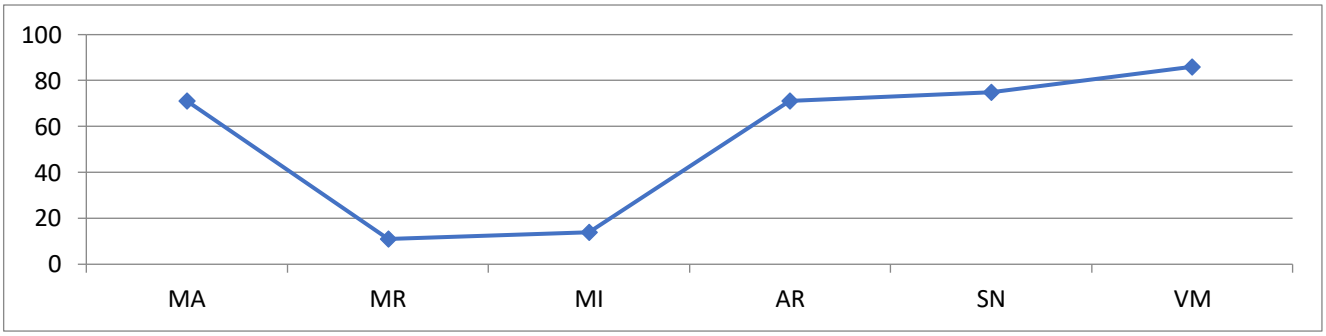

Figure 2. Line Diagram of Changes in Mathematics Learning Achievement Scores (in Percentage)

The picture above is a graph of the percentage change score in each subject. It is known that the percentage is very different from one subject to another.

Hypothesis Testing

Before testing the hypothesis, the pretest and post test data will be checked whether they have normality distribution and homogeneity.

Table 9. Significance of Normality Test

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Pre Test	,202	6	,200*	,853	6	,167
Post Test	,258	6	,200*	,940	6	,659

According to the calculations shown in the above table, the pretest data have a significance of 0.167, where the p-value > 0.05. The pretest results for grade 5th mathematics achievement can thus be interpreted as having a normal distribution. And for post-test data with a p-value of 0.659 > 0.05. Therefore, it can be inferred that the post-test results on grade 5th students' math achievement are similarly normally distributed. Thus, the two data can be used to test the paired sample t-test.

Table 10. Significance of Homogeneity Test

Test of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Skor Test	Based on Mean	3,673	1	10	,084
	Based on Median	1,623	1	10	,231
	Based on Median and with adjusted df	1,623	1	6,144	,249
	Based on trimmed mean	3,379	1	10	,096

Based on the results of the homogeneity test above, it is known that the variation of the two samples has a significance of 0.096 > 0.05, it can be concluded that the variance of the two samples in the pretest and post-test scores of class V mathematics learning achievement is homogeneous or the same.

Hypothesis testing using paired sample t-test. The paired sample t-test can be used to see if there is a difference in the sample mean between the two conditions before and after treatment. The paired sample t-test calculation yielded the following results.

Table 11. Standard Deviation Calculation Results

Paired Samples Statistics					
		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	Pretest	7,5000	6	,83666	,34157
	Posttest	11,5000	6	2,16795	,88506

In the table above, it is known that the average value of 6 subjects in the pretest is 7.5 while the average value of the post-test is 11.5. Then it is also known that the standard deviation of the pretest is 0.34 while the standard deviation of the posttest is 0.89.

Table 12. Correlation Significance of Pretest & Posttest

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	Pretest & Posttest	6	-,055	,917

The correlation between pretest and posttest has a reasonably significant correlation of 0.917 in the table above, with the opposite direction of the relationship.

Table 13. The Significance of the Paired Sample t-test

Paired Samples Test									
		Paired Differences					t	df	Sig.
		Mean	Std. Deviation	Std. Error Mean	95%				
					Lower	Upper			
Pair 1	Pretest - Posttest	-4,00000	2,36643	,96609	-6,48342	-1,51658	-4,140	5	,009

Based on the foregoing calculations, a significance of 0.009 was found where the p-value (0.009) = 0.05. As can be observed, there is a distinction between the pretest and the posttest. As a result, the best effective way to increase the mathematics learning success of primary school students in class V can be inferred.

The Test of Cohen's d Effect Size

Based on the classification of Effect Size scores (Cohen, 1992), it was found that the use of the loci method technique in improving mathematics learning achievement for fifth-grade elementary school students at State Elementary School Krenceng 4 had a high effect (Strong effect) of 1.84 or 77, 4%.

Discussion and Conclusion

The loci method has high efficacy in enhancing mathematics learning achievement of fifth-grade elementary school students at State Elementary School Krenceng 4, Kediri District, according to the study's findings. In this study, the researcher administered a pretest and a posttest before and after treatment to determine the difference in grade 5th mathematics achievement scores, which could be used to determine the effectiveness of the loci method on fifth-grade students' mathematics achievement.

Before using the loci method, the mathematics learning achievement of the fifth-grade subjects at State Elementary School Krenceng 4 was still relatively low. This can be seen from the results of the pre-test on six subjects, namely MA, MR, MI, AR, SN, and VM subjects. The subjects had been given learning by the researchers using the usual method used by the teachers before the researchers gave the subjects a pretest mathematics learning achievement test. After being given a mathematics achievement test, it was found that all six participants received scores in the low category with an average score of 7.5.

The subjects claimed that the pretest was difficult to complete since it was difficult to remember the mathematical formulas and understand the material provided during class learning. According to Grootenboer and Marshman (2015), mathematics is frequently regarded as a difficult and boring subject. According to Sun et al (2018), mathematics material was difficult to understand and formulas were difficult to memorize. Meanwhile, the ability to recall is affected by the method chosen (Mukherji & Albon, 2018).

The subjects' learning method has been limited to listening to the teacher explain the topic in front of them, with no alternative methods employed to supplement or enhance existing learning methods. The subjects thought that the previous strategy had failed to make them happy about mathematics and improve their mathematics learning achievement. Pupils might be glad to learn well when the learning approach utilized is entertaining and tailored to their needs, since this can later assist students to concentrate and understand the material provided (Dempo & Seli, 2016). Nganji (2018) also believes in his theory that when students build their knowledge, it is better than when the knowledge is handed to them in a ready-made shape by their teacher. In other words, when students build their knowledge, they will be better able to understand it. According to Hmelo-Silver (2012), memory is required in recycling knowledge because it is used to obtain new knowledge or answer difficulties. So that when kids learn mathematical content, it is easier for them to memorize formulas, allowing them to thrive in mathematics (Su et al., 2016)

The loci method improved the mathematics achievement of fifth-grade subjects at State Elementary School Krenceng 4. This is evident from the post-test findings of six subjects: MA, MR, MI, AR, SN, and VM. Five of the six subjects scored in the high range, while one scored in the low range. The subject's mathematics learning achievement increased from 7.5 (low category) to 11.5 (high category). According to Ni and Hasan (2019), the mnemonic method (which includes the loci method, dependent word system method, keyword method, acronym method, and acrostic method) can assist students to maximize their memory so that they can recall the formulas utilized in mathematics appropriately.

Following treatment with the loci method, the subjects were enthusiastic about employing the loci method and believed that doing so would improve their mathematics achievement. The subjects in this study thought mathematics was tough, but after being treated with the loci method, they claimed they could understand the content extremely

well since the loci approach helped students' memory in retaining even difficult material. According to Solso et al. (2008), the loci technique relates information on specific things with specific locations with the hope that the respondent will recall the information more easily.

This is as influential as the research conducted by Ardika (2016) that the memory and mathematics learning outcomes of high school students experienced improvement after using the mnemonic method (which consists of the loci method, dependent word system method, keyword method, acronym method, and acrostic method), which is indicated by a change in scores on student learning outcomes tests and student memory questionnaire data scores before and after the treatment. According to the study's findings, 24 students from all subjects met the high criteria, 1 student met the very high criteria, and 3 students met the sufficient criteria. The learning outcomes of the subjects in the study after participating in learning using the mnemonic method revealed that all students succeeded well, where the mnemonic method was effectively applied, as evidenced by the completion of 89.29% of students in fulfilling the minimum score determined by the school is 78, with an average score of 87.32. The survey also revealed that all subjects were enthusiastic about taking part in the experiment and actively participated in the discussion by asking questions.

The loci method is a successful strategy for increasing primary school students' mathematics learning achievement in grade 5th. In the Cohen's d effect size test, the results were 1.84, the score belongs to the category that has a strong effect of 77.4%. This is consistent with Solso et al. (2008)'s theory that the loci method produces adequate outcomes for serial learning. In this study's implementation of the loci method, a material contained in a poster affixed to the first object will be continued to the material on the poster in the next object with a certain serial number until the subjects have known and remembered the entire material in the poster in the experimental room. Serial learning is a type of learning that systematically provides linguistic features from one sequence to another to memorize and remember (Jones & Macken, 2015).

Furthermore, McCabe (2015) claims that of the entire mnemonic way of remembering methods, the loci method is the oldest and most successful method of remembering, because only the loci method is used by linking specific items or information with things in place around the individual. According to Cozolino (2017), the Loci method is closely related to the use of the cortex in the left and right hemispheres, where the loci method combines the power of imagination and sensuality with the accurate ordering of places, where imagination and sensuality is a right brain function and accurate ordering of places is a left brain function.

This loci method is used frequently for people to recall certain information more readily (Solso et al, 2008). This is also related to the theory of memory, where he stated that certain information that is processed repeatedly can last longer in the cerebrum and stay in Long Term Memory (LTM) compared to information without being given repetition will only be in Short Term Memory and will be more easily replaced by other incoming information. Similarly, Williams et al. (2021) stated that the loci approach is superior for remembering since it uses a brain ability, specifically the hippocampus, which allows memories to be remembered stronger and last longer.

A mathematics achievement that requires comprehension will be able to grow if the concept of numeracy is used in its implementation, which is consistent with the concept of the loci method itself. Whereas boosting mathematics learning achievement necessitates the use of memory to access information or reuse knowledge stored in the brain connected to the content asked in the questions on learning achievement exams. According to Zull (2012), memory is required for recycling knowledge since it is utilized to obtain new knowledge or address difficulties. Moreover, the loci method can help to improve and develop this memory.

As stated by Qureshi et al. (2014), the loci method is used more effectively than other mnemonic methods because it encourages the subject to present an image of an object that will be remembered in his mind, and the loci method is used effectively in remembering related information and can be used in remembering faces, numbers, and lists of words. According to Brancucci (2012), the effectiveness of the loci technique is due to the usage of brains connected to spatial learning rather than brain anatomy and intellect. According to Palvio (2014) explanation, students of varied intelligence and brain architectures can employ the loci method together. According to Gross et al. (2016), the loci method is the best mnemonic strategy for word recall.

Previous research by Retnoningsih (2015), found that the loci method had an influence on the association of spatial formula objects in mathematical topics. The findings of hypothesis testing show that the difference in mean in the experimental group is 13.667, whereas the difference in mean in the control group is just 1.0. As a result, the average value of the association of mathematical geometrical formula objects for students taught using the loci approach was

greater than the average of the associations for students not taught using the loci method. In other words, the loci technique may be inferred to be a successful strategy for improving mathematics learning achievement.

The study's findings show that the loci method is highly successful in enhancing mathematics learning achievement in fifth-grade elementary school students. However, several flaws were discovered in this study, where it was felt that the research subjects did not pay attention to the situation and conditions in the field because the duration of two hours in each treatment session had not been adjusted to the normal and normal conditions of elementary school students in grade 5th in learning. Additionally, the time allotted needs to be modified to account for how long each instructor typically spends teaching math to children.

In addition to the length of the treatment, the offered posters could be more suited to the age of the participants, who are in grade 5th of an elementary school and prefer pictures of certain cartoon characters. To get more trustworthy data, direct interviews with the individuals are required to supplement difficulties in the field. The results would also be more accurate and the study would utilize more individuals if it were performed utilizing a research method that allowed for the inclusion of a control group as a comparison. This can provide data for future research.

Recommendations

Based on the research that has been done, The researcher's suggestions to educators can add or modify existing learning methods with the loci method; it is hoped that the loci method technique module can be used to help students improve their mathematics achievement. It is advised that the school conduct mathematics training utilizing the loci method, the implementation methods for which are specified in a module that is tailored to the context and conditions in the field. The researcher suggests several things for future research, including 1) Using the loci method with a daily duration that is adjusted to students at a certain level and a longer treatment period as in previous long-term studies, 2) the use of poster media or other learning media must be adjusted to the attractiveness of students, for example, by providing pictures of their favorite cartoon characters, 3) can further deepen the problem data in the field through direct interviews with the subjects, 4) lastly, future researchers can opt to conduct a study that includes a control group as a comparison to ensure more reliable results, as well as subjects that are also replicated.

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