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Mnemonic on the logarithm of the form of creativity from 21st century skills

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Abstract. One of the methods that can facilitates students to remember the formulas and terms in math easily is mnemonic technique. This study aims to determine whether there are differences in the effect of applying mnemonic techniques as a form of creativity in 21st century skills and conventional learning to learning outcomes. This research was conducted at Vocational High School and used the experimental method. The experimental class is treated mnemonic techniques as a form of creativity in 21st century skills and the control class is given conventional learning. Methods of data collection in this study using the method of documentation and test methods. The data analysis used t-test. Data obtained from experiment class and control class. The result of this study showed there are differences in the effect of applying mnemonic techniques as a form of creativity in 21st century skills and conventional learning to learning outcomes. Classes with mnemonic techniques as a form of creativity in 21st century skills give better learning outcomes than the ones in conventional learning classes. This happens because the application of mnemonic techniques can improve students' memory.

1. Introduction

The word mnemonic comes from the name of the Greek memory goddess Mnemosyne, the embodiment of the ability to remember the Greeks seen in offerings to the gods [1]. Mnemonics device is a learning method that develops specific ways to encode any given information for easier and efficient storage and retrieval [2]. Mnemonics are methods for encoding information to make it more memorable, mnemonics give the chance to concetrate on relevan features of material more deeply than by simply rehearsing it [3]. Mnemonics are strategies that improve memory by encoding information with associations between new and previously learned information in long-term memory [4]. Memonic help regulate information that reaches memory that works in a pattern known so that information is more easily adapted to schematic patterns in long-term memory [5]. Mnemonic is a technique that increases the storage and retrieval of information in memory [6]. Mnemonic techniques which could be easily incorporated in the regular classroom teaching methodology for enhancing mathematical skills and performance [7]. Mnemonics method of teaching is superior to lecture method of teaching.It also helps to reduce the difficulty of students in learning mathematics..Hence this strategy can be effectively used in our present classroom set up and the package is relevant and significant. It can make the students motivated and the classroom more interesting [8]. Wang, Thomas and collagues have show that the initial benefits of using the key word mnemonic (an imagery-based-tecnhnique designed to foster cued recall of paired associates are not very durable over time when retention interval is manipulated as a between participants variable) [9]. Some mnemonic techniques according to Joyce that can be used to remember

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are, (1) loci technique is a technic that involves visual memory areas to remember everything which is in the place and then connect each part so that it becomes a single unit / combined intact,(2) mnemonic acronym system is the use of each first letter of a group of words (sentences) into a new word, for example ASTC is an abbreviation of the names of the angle that is positive in each quadrant (A: All / all is positive in the quadrant I, S: sin which is positive in quadrant II, T means the tan and C means Cos which is positive in the next quadrant), (3) mnemonic acrostic system is the use of each first letter of a group words and abbreviations in syllables thus make a sentence. However, acrostic does not always use the first letter and also does not always produce stands in the form of syllabe or phrase, for example *sindemi, cossami, tandesa* which stands for comparison of trigonometry in a right triangle; another example is the abbreviation of *intersimin* (integral sin worth min), (4) technic of keywords, where the alive imagination put on pronouns [10]. Mnemonics work by utilizing some well-known principles of psychology : a retrieval plan is developed during encoding, and mental imagery both visual and verbal is used [11].

Logarithm is one of the material that is considered difficult by students in class X SMK. The basic competencies that will be achieved in the material of logarithms is that students determine the results of logarithms and resolve contextual problems related to logarithms. The ability of students to determine the results of logarithms and solve contextual problems related to logarithms is still relatively low, this can be seen from the results of the PAMER UN, of 158,778 students in Central Java, only 52,492 students were able to simplify the form of logarithms and their results, while 106,286 students have difficulty in simplifying the logarithm form and results. Therefore, It is important to apply learning that can enhance students' ability to remember and call on existing memory. According to Mojeed Kolawole and Akinsola, mnemonic and prior knowledge instructional strategies were more effective at improving the students' achievement mathematics. The results revealed that mnemonic instruction had the higher mean score than both the prior knowledge and the conventional teaching method [12].

Along with the development of the era, the 21st century is a century marked by the rapid development of science and technology. This condition should be followed by learning that can meet the demands of the times. The teaching of the 21st century is expected to produce human resources that can master various forms of 21st century skills. The Educational Testing Service (ETS) in its publication, *Digital Transformation: A Literacy Framework for ICT Literacy* (2007), defies 21st century learning skills as the ability to a) collect and/or retrieve information, b) organize and manage information, c) evaluate the quality, relevance, and usefulness of information, and d) generate accurate information through the use of existing resources [13]. The skills have been grouped into three main areas,(1) Learning and innovation skills: critical thinking and problem solving, communications and collaboration, creativity and innovation, (2) Digital literacy skills: information literacy, media literacy, Information and communication technologies (ICT) literacy, (3) Career and life skills: flexibility and adaptability, initiative and self-direction, social and cross-cultural interaction, productivity and accountability [14].

The Partnership for 21st Century Skills identifies 21st century skills as critical thinking and problem solving, communication, collaboration, and creativity and innovation- more commonly known as the 4C skills [7]. From 4C, the research used is creativity and innovation. Creativity is one's ability to generate new ideas from existing ideas. Creativity depends on one's creative thinking, the process of thinking to create new ideas that lead to new discoveries and often called innovation. Characteristics Creativity and Innovation Skills,(1) develop, apply and convey new ideas to others new invention and often called innovation, (2) open and responsive in viewing new and different views, (3) using technology to make decisions, solve problems, and create new ideas [15].

Based on the characteristics of creativity and types of mnemonic techniques, In this study, mnemonic techniques used in logarithms as a form of creativity in 21st century skills are very relevant because students can apply and convey new ideas and can store new knowledge in long-term memory. The teacher guides students to be able to create acrostic techniques on logarithmic material, so as to improve student learning outcomes. The following are some acrostic techniques on logarithms as a form of student creativity, (1) ${}^{a}\log 1 = 0$ (satnol = satu nol) that means if the numerus is 1 then the result is logarithm of 0, (2) ${}^{a}\log a = 1$ (samsat = sama satu) that means if the principal number and numerus are

the same then the result is logarithm 1, (3) $^{a}\log (b.c) = {}^{a}\log b + {}^{a}\log c$ (kalimbah = kali ditambah), (4) $^{a}\log (b:c) = {}^{a}\log b - {}^{a}\log c$ (bagikur = bagi dikurangi), dan (5) $^{a}\log b^{n} = n.\ {}^{a}\log b$ (pangkali = pangkat dikali). With the use of this acrostic technique, it is expected to be able to improve students' mathematics learning achievement results in logarithmic material.

Some result studies using mnemonics techniques include: (1) the students' mathematical understanding of sinus and cosinus addition are in very good category [5], (2) mnemonics provide immediate access to relevant knowledge of complex concepts [16], (3) mnemonics help students recall information by encoding and organizing data in a fashion that makes information readily accesible, thus reducing stress and supporting the cognitive resources necessary for Hot'S [17], mnemonics will not revolutionize education but given the variety of techniques, their compatibility with other learning strategies, and effectiveness with certain materials, it seems that students would benefit from being familiar with them and knowing when and how to use them [18], analysis of the students pre and post instruction asessments revealed significant interaction effects between types of instruction provided and instruction phase, indicating better perfomance in letter-sound association as a consequence of the inclusion of both mnemonics and explicits sound contrasting [19]. The difference between this research and the previous one is that this study applies the mnemonic technique to logarithms, whereas previous studies applied the mnemonic technique to trigonometry. From the results of the above research, it turns out that no one has applied the mnemonics technique to logarithms.

2. Method

Type of research used in this study is the experimental method. This research was conducted at Vocational High School 2 Surakarta. In this study, two classes were selected as experimental classes and control classes. Sample of this research is 32 students class X Computer and Networking Engineering (TKJ) A of SMK Negeri 2 Surakarta chosen by random sampling as experimental classes and 32 students class X (Software Engineering) RPL A of SMK Negeri 2 Surakarta chosen by random sampling as control classes. Experimental classes were treated with mnemonic tecnique and control classes were given conventional learning treatment. Methods of data collection in this study using documentation method and test method. Documentation method used as initial data. The test method is used as the final test. The test method with logaritma material is used as the final test. The instrument consisting 20 items is validated by two mathematics teachers who have obtained master's degrees in mathematics education and mathematics lecturers from Veteran Bangun Nusantara University. This is then tested in class X Computer and Networking Engineering (TKJ) C of SMK Negeri 2 Surakarta and analyzed. Instrument analysis consist of discrimination power (DP), difficulty level (D), and reliability test with Kuder-Richardson – 20 (KR-20). An item is said to be good if it has a discrimination power of more than or equal to 0.30 ($DP \geq 0.30$), difficulty level $0.30 \leq D \leq 0.70$ and reliability index greater than or equal to 0.70 ($r_{11} \geq 0.70$). The results of the instrument analysis are 20 items were obtained to qualify for discrimination power and difficulty. The reliability value of the 20 items, $r_{11} = 0.7158$. Reliability value used describe the usefulness of an item in measurement. It means that the result of measurement having a reliability index 0.70 or more then instrument can be used to measurement. The data analysis used in this research is t-test by taking significance level $\alpha = 5\%$ which is to compare two models of learning. Alpha (α) level is the probability of rejecting the null hypothesis given that it is true. As a matter of good scientific practice, a significance level is chosen before data collection and is usually set to 0.05 (5%). Other significance levels (e.g., 0.01) may be used, depending on the field of study [20].

3. Results and Discussion

3.1. Preliminary data analysis

This section, we present the initial data analysis. Preliminary data is taken from final exam score of the national exam at junior high school. Table 1 shows the result of normality test with Liliefors method on experimental and control classes. Test were tested with Excell.

Table 1. Normality test in the experimental and control class preliminary data

Class	$L_{\text{-value}}$	N	$L_{0,05;32}$
Experimental	0.0869	32	0.1566
Control	0.0921	32	0.1566

Based on Table 1, in the experimental class obtained $L_{\text{-value}}$ = 0.0869 and in the control class $L_{\text{-value}}$ = 0.0921. L.value is obtained from the national exam at junior high school each class is sorted from the smallest value to the largest value, then tested with Liliefors method. In experimental classes obtained the maximum value of $L_{\text{-value}}$ = 0.0869 and control classes obtained the maximum value of $L_{\text{-value}}$ = 0.0921. $L_{0,05;\ 32}$ = 0.1566; C = {L | L > 0.1566}, because the L-value in each class is not included in C then data of two classes are said to be normally distributed.

The t-test can be used in data for two independent samples, a random sample of normal distribution, and only 1 dependent variable. Table 2. Describe the t- test result with Excell to find uot whether there are differences in the experimental class and control class.

Table 2. t- test on initial ability of experimental and control class

Class	N	Mean	SD	t-value	$t_{0,025;62}$
Experimental	32	75.7031	15.6606	0.2201	1.998
Control	32	74.9531	11.2403		

The result of t- test, obtained t-value = 0.2201, it is smaller than $t_{0,025;62}$= 1,998. It can be said there is no differences in both classes. Both classes have the same initial capability. Furthermore, for experimental classes using mnemonic tecnique of the form of creativity from 21st century skills and for control classes with conventional learning.

3.2 Analysis of final data

Table 3 present normality test of experimental and control classes final test. Data obtained from the final test scores of exponents and logarithms material in the experimental classes and control classes.

Table 3. Normality test in the experimental and control classes final test

Class	$L_{\text{-value}}$	N	$L_{0,05;32}$
Experimental	0.1052	32	0.1566
Control	0.1209	32	0.1566

Result in Table 3 shows L-value in experimental classes and control classes less than $L_{0.05;32}$, then it is said the final test data is normally distributed

Table 4 shows the result of t- test on the final test of experimental and control classes with Excell. Data obtained from the final test scores of exponents and logarithms material in the experimental classes and control classes.

Table 4. t- test after experimental

Class	N	Mean	SD	t-value	$t_{0,025;62}$
Experimental	32	70.7813	16.5641	2.0628	1.998
Control	32	61.8750	17.9493		

It was obtained from the data analysis that t-value = 2.0628 and $t_{0,025;62}$= 1.998. t-value is higher than $t_{0,025;62}$ so it is said there was a difference in the final test of experimental and control classes. Based on the result of the analysis, it can be concluded that there are differences in the effect of applying mnemonic tecnique of the form of creativity from 21st century skills and conventional learning to learning outcomes. Learning using mnemonic tecnique of the form of creativity from 21st century skills provides better learning outcomes than conventional learning. This condition can occur because there are differences in characteristics in conventional learning and mnemonic techniques of the form of creativity from 21st century skills.

Table 5. Table of conventional learning characteristics and mnemonic tecniques of the form of creativity from 21st century skills.

Conventional learning	Mnemonic tecnique of the form of creativity from 21st century skills.
Learning Center	
Teacher centered and teachers is a source of learning.	Student centered, students can find learning resources not only from the teacher. Teacher as a facilitator and motivator.
Classroom environment	
Students work individually	Students learn in groups and with the guidance of teachers express their ideas to apply mnemonic techniques.

Table 5 shows that the character difference in both learning influences students' reponse during classroom learning. In conventional learning, students wait for teacher and passive explanation, students do not want to ask when they do not understand, that it can cause boredom. Students do not motivate each other, students easily give up when experiencing difficulties because there is no discussion friend. Students' creativity is not built and students do not built communication skills. On the contrary, in learning with mnemonic tecniques of the form of creativity from 21st century skills students can develop their creativity and ideas so they are not passive. Students are accustomed to collaborate, respect each other, accept the advantages and disadvantages of others.

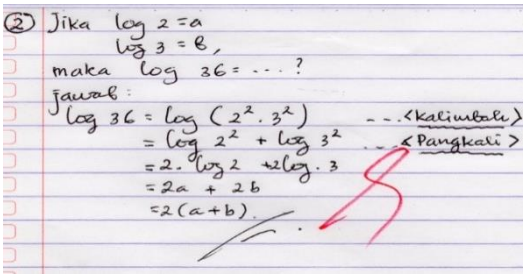


Figure 1. Students use mnemonic techniques

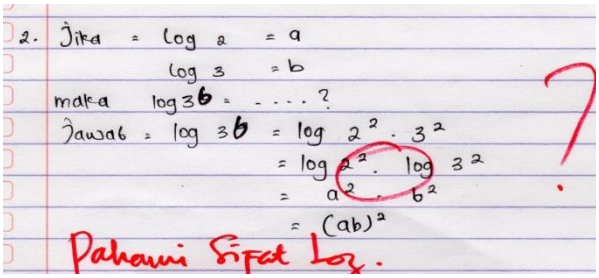


Figure 2. Students do not use mnemonic techniques.

From the results of the students' work from Figure 1 and Figure 2, shows that students using mnemonic techniques are able to do the questions well and correctly compared to students who work without using mnemonic techniques. Students who use mnemonic techniques are able to do well. Properties that exist in logarithms, are used correctly like log $(2^2. 3^2)$ = log 2^2 + log 3^2 (kalimbah). Furthermore, log 2^2 + log 3^2 = 2. log 2 + 2. log 3 (pangkali), finally the answer is correct. Unlike the results of the work of students who do not apply the mnemonic technique, there is an error, log $(2^2.3^2)$ = log 2^2 . log 3^2, it should use log 2^2 + log 3^2 (kalimbah). When students work on problems about logarithms, the teacher can simply remind students about the properties of logarithms through mnemonic techniques including satnol, samsat, kalimbah, bagikur, and pangkali. Thus, students are able to do well and are able to store it on long-term memory.

4. Conclusion

Learning with mnemonic tecniques of the form of creativity from 21st century skills can provide better learning outcomes than conventional learning. This learning causes students feel not bored because can put forward new ideas using mnemonic techniques. Students also become more courageous to express opinions because there is mutual respect. Based on the research findings, the author suggested that Learning with mnemonic tecniques of the form of creativity from 21st century skills can applied in the learning of exponents and logarithms. Suggestion for further research is the researcher using technology to integrate 21st century skills in mnemonic tecniques.

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