The Impact of ICT-Based Contextual Mathematics Learning on Students' Problem-Solving Ability

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ABSTRACT

Mathematics is a topic in excessive school that is difficult to understand. The contextual teaching and learning (CTL) model assisted by Information and Communications Technology (ICT) can overcome this. The purpose of this research was to determine students' mathematical problem-solving abilities through ICT- assisted CTL learning. This is a quasi-experimental research with a total population of 1083 students of SMA N 2 Padang. A sample of 100 students who were selected through a simple random sampling technique, each of which was fifty students for the experimental group and the control group. The studies device changed into a take a look at of mathematical problem-fixing abilities. Data have been analyzed the use of covariance analysis. The result of this research is that high school students who are taught with ICT-assisted contextual learning models are able to solve problems correctly. Meanwhile, students who learn through conventional models have difficulty solving mathematical problems. The conclusion of this research is the ability of students to solve mathematical problems who learn through ICT-assisted CTL learning is better than students who are taught through conventional learning.

Keywords: Problem-Solving, ICT, Contextual Mathematics Learning.

1. INTRODUCTION

Mathematics is a obligatory issue in high school. However, the fact is that students' math skills are still very low [1][2]. Several studies have found that students still experience many mathematical errors, such as procedural, conceptual, interpretation and careless errors. [3]. Many students have difficulty understanding two different symbolic concepts for a concept, as well as sketching a graph of the function of two variables in 3 dimensions [4]. The concept of function is a mathematical concept that is difficult for students to understand. It continues through to college students. Learning the concept of function is often not treated comprehensively. Function learning is taught implicitly, even though functions can be developed in different contexts. Also, the concept of function is widely studied in mathematics education [5].

Educators should understand cognitive constraints before implementing learning.

Cognitive constraints in mathematics learning that students face must be overcome through practicing different thinking activities, using prior knowledge and experience in completing certain task groups, and developing various mathematical cognitive micro-structures. [6].

The concept of function is a mathematical object that is widely used in problem-solving. One of these things is about quadratic equations. The majority of students fail to understand the concepts in problem-solving involving quadratic equations. Students have difficulty understanding the concept of equations, additive inversion, square roots. Also, the difficulty of understanding integer addition, multiplication, algebraic expressions, distribution and division laws. It was a conceptual mistake made by the students [3].

Various errors and problems of college students in information the concept of function are a concern in this paper. Function is a concept that is widely used in solving problems. Problem- solving is one of the most important math skills. Solving problems is a major means of accomplishing mathematics goals, and not just the goals of learning mathematics itself. It is an integral part of mathematics. Students must accept common possibilities to formulate, grapple with, and remedy complicated problems [7].

The main objective of learning mathematical problem-solving is to enable students to think for themselves, and to equip them with a set of mathematical thinking skills and processes. They are flexible, independent thinking skills and processes [8]. Students should be advocated to mirror on their thoughts during the problem-fixing process. It targets so that college students can follow and adapt the strategies they increase for different issues and in different contexts. Learning arithmetic through fixing math issues, college students collect a way of thinking, conduct of endurance and curiosity. Also, self-assurance in conditions is unique out of doors of math class [7]. Self-self-assurance impacts math capabilities. Mathematical capabilities have a superb direct impact on problem-fixing capabilities. There is a superb direct impact of mathematical capabilities on self-efficacy. There is a superb direct impact of self-efficacy on problem-fixing capabilities [9].

Actually, diverse tries to overcome the weaknesses of arithmetic gaining knowledge of have been made however the arithmetic gaining knowledge of method could be very mechanistic and conventional. The gaining knowledge of system handiest specializes in gaining knowledge of targets and gaining knowledge of consequences, at the same time as the system to arrive at gaining knowledge of consequences is ignored. Most of the gaining knowledge of targets handiest focus on remembering facts, principles and other computational aspects. Also, changes and improvements in arithmetic gaining knowledge of do not clear up problems [10]. One of the innovations in mathematics learning to overcome the mistakes and difficulties of students in understanding mathematics, especially the concept of function is contextual learning assisted by ICT (Information and Communications Technology) [11].

Implementation of ICT is a planned part of comprehensive teaching. It has clear objectives, a teaching plan, teaching materials, supporting technical resources. Also for teacher training and development. The increase in the use of ICTs in education can be viewed from a broader increase in the educational environment. It's not just a single technology [12]. To make it easier for students to understand the concept of function, it takes a learning trajectory that is close to the students' thoughts. It is realistic learning [10]. In realistic learning, the starting point of learning is a contextual problem. Therefore, contextual teaching and learning strategy is the right choice of learning [13]. Mathematics learning with the CTL approach is effective for improving the mathematics skills of high school students [14]. The CTL approach in discovery-based mathematics learning is designed to present real-world problems in the learning process, designing learning strategies. The application of this learning improves students' problem-solving abilities using differential equations [13]. These studies show that the

CTL approach contributes to improving the ability to understand mathematics, especially the concepts and principles of function.

The ability of students to understand mathematical concepts using contextual / realistic mathematics learning tools is higher than students who learn conventionally. Contextual mathematics learning tools can replace conventional learning [15]. The results of different research imply that there's an effect of contextual gaining knowledge of (connected mathematics) with a nearby cultural technique at the capacity to apprehend the idea of mathematics. The capacity to apprehend mathematical concepts in college students taught with contextual gaining knowledge of is better than college students who're taught using traditional gaining knowledge of models [16].

The capacity to understand mathematical standards of college students who're taught the use of contextual (realistic) mathematics learning procedures is better than college students who are taught the use of direct learning, after controlling for their preliminary abilities. [17]. There is a positive direct effect of cognitive structure on the ability to understand mathematical concepts [18]. The cognitive structure is one of the schemes that are in students' initial knowledge. Initial knowledge is a prerequisite for students to understand mathematical concepts [18]. It becomes an illustration that the initial ability in contextual mathematics learning is a prerequisite for learning mathematics, especially the concept of function.

The idea of characteristic is certainly considered one among the basic standards in arithmetic which could be very useful for know-how deeper arithmetic learning, inclusive of calculus. However, calculus is also a difficult one. Students experience misconceptions and principles in calculus. Misconceptions and calculus principles that many students experience are limit functions [19]. That is one end result of the low level of college students knowledge the idea of feature. The idea of feature is likewise a basic idea for college students so one can resolve math problems. The problem-solving ability of students who learn with contextual problems (based on local culture) and assisted with ICT (in this case youtube) is higher than students who learn not oriented to local culture after controlling for students' initial abilities. Also, there is an interaction effect between contextual learning factors based on local culture and mathematics material on problem-solving abilities [20][21]. This shows that ICT-assisted contextual learning in mathematics learning can have a positive effect on problem-solving abilities. Based on the description, it can be hypothesized that learning mathematics with the ICT-assisted CTL approach can improve mathematical problem- solving abilities. Therefore, the aim of this study is to determine how the

ICT-assisted CTL approach affects the mathematics problem- solving abilities of high school students.

2. METHOD

Based on the problem, this research is quasi-experimental research, this is the final part of developing an ICT-assisted contextual learning model. The design of this study was a nonequivalent control group design (see Figure 1).

$$\text{O1 \quad X \quad O2}$$

$$\text{O3 \qquad O4}$$

Figure 1 Research Design

Figure 1 represents that O1 and O3 are pre-tests, O2 and O4 are post-tests where X is an ICT-assisted contextual learning model.

The study population was all students of SMA Negeri 2 Padang as many as 1083. This study was focused on class X students, with the sample selected by a simple random sampling technique. The number of samples is 100 students with details of 50 students for the experimental group (action: ICT-assisted contextual learning model) and 50 students for the control group.

The research instrument is a test of mathematical problem-solving abilities related to the concepts and principles of function. The instrument has been validated by experts, and tested with a high level of validity and reliability. Pre-tests are given for O1 and O3, and post-tests for O2 and O4. Data were analyzed using statistics, namely Analysis of Covariance (ANCOVA).

3. RESULT AND DISCUSSION

Inferential analysis of data on mathematical problem-solving abilities is used to test the proposed hypothesis as well as to answer the formulation of this research problem. The covariate variable in this study was the students 'initial ability obtained from the students' pretest scores, while the dependent variable was the mathematics problem-solving ability obtained from the post-test scores.

Before presenting the results of inferential data analysis, we present the results of solving mathematical problems on paper. Students through ICT-assisted contextual learning are able to solve problems correctly. Figure 2 is a paper and pencil solving student problem.
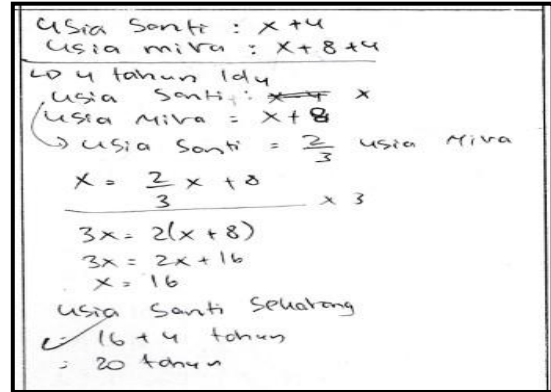

Figure 2 Problem Solving by S1 Students

Figure 2 shows that the students' ability in solving mathematical problems. Undergraduate students are ready to perceive the problem, they can identify what is known and asked about the problem, then make a mathematical model according to the problem given. Finally, he is able to solve the problem using the model and return the solution to the real problem. On the other hand, students who are taught through conventional learning have difficulty in solving problems. For example, S2 students experience errors as shown in Figure 3.
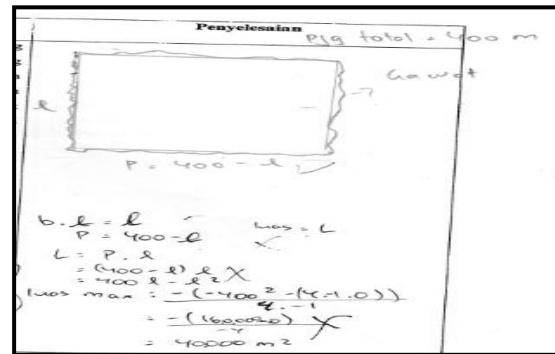

Figure 3 Problem Solving by Students S2

Based on Figure 3, S2 college students aren't capable of recognize the trouble, and can't clear up the trouble given. Furthermore, to determine the ratio of problem-solving abilities of students who learn through the ICT-based CTL learning model and conventional learning.

Experimental data were analyzed using ANCOVA test (covariance analysis). The two groups are one experimental group. This group is students who learn mathematics through contextual learning with ICT assistance. This group of 50 students. The control group is 50 other students who learn through conventional learning.

The statistical test begins with testing the normality of the control group data. That is to find out whether the population data of the two variables are normally distributed or not. The test used is the Kolmogorov

Smirnov test (KS). The data on students' problem-solving abilities in the control group showed Dn = 0.188 and KS Table = 0.192 The results of the analysis mean that Dn = 0.176 < KS-table = 1.92. It shows that the data on the problem-solving ability of students in the control group come from populations that are normally distributed. Furthermore, the data on students' problem-solving abilities in the experimental group showed that Dn = 0.182 and KS Table = 0.192. It means that the problem-solving ability of students in the experimental group comes from a population that is normally distributed. After the data was normal, then the homogeneity test of the two groups was using the Levene test of variance similarity.

Table 1 Levene's Test

F	df1	df2	Sig.
2,73	2	98	1,86

Table 1 shows that F = 2.73 > 1.86 = F table. It can be conclude that the two groups of sample data have the equal variance / homogeneous. The next test is data linearity testing. The test results can be seen in Table 2.

Table 2 Linearity Test of Experimental Group

Source of Variance	SS	Df	MS	F*
Lack of Fit	236,57	6	39,43	1,50
Pure Error	2536,87	43	59,00	

Based on Table 2, with a significant level of α = 5% it is obtained F table = 2.32, which means F* = 1.50 <2.32 = F table, then the regression model of the experimental group is linear. This means that the relationship between students 'initial abilities and students' mathematical problem-solving abilities in the experimental institution is linear. the regression equation for the experimental group is y = 76.55 + 0.37x. Linearity analysis of the control group regression model, summarized in Table 3.

Table 4 Control Group Linearity Test

Source of Variance	SS	Df	MS	F*
Lack of Fit	256,72	6	42,79	1,50
Pure Error	2189,58	43	50,92	

Table 3 shows that F* = 1.19 and F table = 2.32 for the significant level α = 5%. That means that F* <F table, and the control group regression model is linear. Thus, the regression for students 'initial ability data with students' mathematics problem-solving abilities from the control group was linear. The control group regression equation is y = 50.34 + 0.53x.

Based on the results of data analysis, the similarity of the two regression models for the experimental group and the control group, the combined data linear regression model is obtained, see Table 4.

Table 4 Summary of the Similarity Analysis of the Regression Model

A	b	F*	Ft
-4,56	12,79	15,57	3,16

Based on Table 4, the combined regression model is Y = -428.27 + 21.30X, with F* = 15.57. This test is to determine whether the two linear regression equations of the experimental and control groups coincide or not. With a significant level α = 5%, it is obtained F-table = 3.16 <F*, then Ho is rejected. This means that the linear regression model of the experimental group and the control group is not the same. Thus, the two linear regression equations do not coincide.

To determine whether there are differences in students' problem-solving abilities in mathematics between students taught with ICT- based CTL learning and conventional learning. Because the two regression models are not the same, it will be continued by testing the alignment of the regression coefficients. Based on the results of the calculation of the parallelity test of the regression model of the experimental group and the control group, the following analysis results were obtained.

Table 5 Summary of the Analysis of Two Regression Alignments

F*	Ft	Ho
1,23	2,19	accepted

Based on Table 5, using a significant level α = 5% obtained F (0.95; 1; 96) = 4.00 which means F* = 1.97 <F (0.95; 1; 86), then Ho is accepted. This means that the linear regression model of the experimental group and the control group are parallel.

Because all the analysis of variance has been fulfilled and the two regression models are parallel, it could be concluded that there are variations withinside the mathematical problem-fixing capabilities of students in the experimental group who were given learning by treating mathematics learning with ICT-based CTL learning, with the control group's mathematical problem-solving abilities being given mathematics learning conventional.

The regression lines for the experimental group and the control group are parallel, with the regression equation being (1) The regression equation for the experimental group is y = 74.79 + 0.43x. (2) The regression equation for the control group is y = 50.34 +

0.53x. Since the two regression equations are parallel, to determine which one is better, we just need to determine the constant size of the two regressions. Because the regression line constants for the experimental group are greater than the regression line constants for the control group, namely 74.79 and 50.34, there is a big distinction in the problem-solving talents of college students who're taught through ICT- assisted CTL approach and conventional. Geometrically, the regression line for the experimental group is above the control group's regression line, this means that that the arithmetic problem-fixing cappotential of the experimental institution given ICT-assisted CTL approach is higher than the arithmetic problem- fixing cappotential of the manipulate institution given traditional arithmetic learning. This is supported by the t-test for the two means of the two groups, namely t count = 19.347 greater than t table = 1.67 at the 5% significance level. This proves that the mathematics problem- solving ability of the group of students who learn through ICT-assisted CTL learning is better than college students who're taught thru traditional learning.

The effects of this examine help preceding research, that the contextual learning approach has a large impact on the mathematical ability [22][23] and self-confidence of students [24]. It is a learning that can improve higher order mathematical thinking skills [25]. Also improves mathematical skills [26][27][28]. However, there may be no full-size interplay among contextual and expository learning with students 'initial mathematical abilities on mathematical connection abilities and students' self-confidence [24]. Thus, we believe that ICT- assisted CTL learning has a positive effect on the ability to solve mathematical problems, especially the concept of function.

4. CONCLUSION

High school students who are taught with ICT-assisted contextual learning models are able to solve problems correctly. Conversely, students who learn through conventional models have difficulty solving math problems. Finally, we can conclude that the mathematics problem- solving ability of the group of students who learn through ICT-assisted CTL learning is better than students taught through conventional learning.

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REFERENCES

[1] [D. Herawaty, W. Widada, F. Herdian, and K. U. Z. Nugroho, "The cognitive process of extended trans students in understanding the real number system," IOP Conf. Ser. J. Phys. Conf. Ser. 1470 012070 doi10.1088/1742- 6596/1470/1/012070, vol. 1470, pp. 1–6, 2020.

[2] W. Widada, D. Herawaty, R. Jumri, and H. Wulandari, "Students of the extended abstract in proving Lobachevsky's parallel lines theorem," IOP Conf. Ser. J. Phys. Conf. Ser. 1470 012098 doi10.1088/1742- 6596/1470/1/012098, vol. 1470, pp. 1–10, 2020.

[3] J. P. Makonye and O. Matuku, "Exploring Learner Errors in Solving Quadratic Equations," Int. J. Sci. Educ., vol. 12, no. 1, pp. 7–15, 2016.

[4] H. Kashefi, Z. Ismail, and Y. M. Yusof, "Obstacles in the learning of two-variable functions through mathematical thinking approach," Procedia - Soc. Behav. Sci., vol. 8, no. 5, pp. 173–180, 2010.

[5] O. Viirman, "The function concept and university mathematics teaching," Diss. Fac. Heal. Sci. Technol. Dep. Math. Comput. Sci. Karlstad Univ., 2014.

[6] R. Antonijević, "Cognitive activities in solving mathematical tasks: The role of a cognitive obstacle," Eurasia J. Math. Sci. Technol. Educ., vol. 12, no. 9, pp. 2503–2515, 2016.

[7] NCTM, "Principles and Standards for School Mathematics Overview," National Council of Teachers of Mathematics. pp. 1–6, 2010.

[8] C. M. Laterell, "What Is Problem-solving Ability ?," LATM J., vol. 1, no. 1, pp. 1–12, 2013.

[9] S. Amri and W. Widada, "The Role of self- efficacy and mathematics ability in the problem solving mathematics," Adv. Soc. Sci. Educ. Humanit. Res. Vol. 295, vol. 295, no. ICETeP 2018, pp. 70–73, 2019.

A. Fauzan, "Applying Realistic Mathematics Education (RME) In Teaching Geometry In Indonesian Primary Schools," University of Twente, 2002.

[10] K. Ruthven, ICT in mathematics education: the future and the realities, no. 11. 2016.

[11] K. Morgan, M. Morgan, L. Johansson, and E. Ruud, A systematic mapping of the effects of ICT on learning outcomes. 2016.

[12] R. P. Khotimah and M. Masduki, "Improving Teaching Quality and Problem Solving Ability

Through Contextual Teaching and Learning in Differential Equations: A Lesson Study Approach," JRAMathEdu (Journal Res. Adv. Math. Educ., vol. 1, no. 1, pp. 1–13, 2016.

[13] S. Syamsuddin and E. Istiyono, "The effectiveness of mathematics learning through contextual teaching and learning approach in Junior High School," AIP Conf. Proc., vol. 2014, no. September, 2018.

[14] N. Syafriafdi, A. Fauzan, I. M. Arnawa, S. Anwar, and W. Widada, "The Tools of Mathematics Learning Based on Realistic Mathematics Education Approach in Elementary School to Improve Math Abilities," Univers. J. Educ. Res., vol. 7, no. 7, pp. 1532–1536, 2019.

[15] D. Andriani et al., "Understanding the number concepts through learning Connected Mathematics (CM): A local cultural approach," Univers. J. Educ. Res., vol. 8, no. 3, pp. 1055–1061, 2020.

[16] D. Herawaty, W. Widada, K. Umam, Z. Nugroho, A. Falaq, and D. Anggoro, "The Improvement of the Understanding of Mathematical Concepts through the Implementation of Realistic Mathematics Learning and Ethnomathematics," Adv. Soc. Sci. Educ. Humanit. Res. Vol. 295, vol. 295, no. ICETeP 2018, pp. 21–25, 2019.

[17] S. Suharto and W. Widada, "The Cognitive Structure of Students in Understanding Mathematical Concepts," Adv. Soc. Sci. Educ. Humanit. Res. Vol. 295, vol. 295, no. ICETeP 2018, pp. 65–69, 2019.

[18] W. Widada and D. Herawaty, "Dekomposisi Genetik tentang Hambatan Mahasiswa dalam Menerapkan Sifat-sifat Turunan," J. Didakt. Mat., vol. 4, no. 2, pp. 136–151, 2017.

[19] K. U. Z. Nugroho, W. Widada, and D. Herawaty, "The Ability To Solve Mathematical Problems Through Youtube Based Ethnomathematics Learning," Int. J. Sci. Technol. Res., vol. 8, no. 10, pp. 1232–1237, 2019.

[20] W. Widada, D. Herawaty, K. U. Z. Nugroho, and A. F. D. Anggoro, "The Scheme Characteristics for Students at the Level of Trans in Understanding Mathematics During Etno-Mathematics Learning," 3rd Asian Educ. Symp., vol. 8, no. Aes 2018, 2019.

[21] W. Widada, S. Efendi, D. Herawaty, and K. U. Z. Nugroho, "The genetic decomposition of students about infinite series through the ethnomathematics of Bengkulu , Indonesia," IOP Conf. Ser. J. Phys. Conf. Ser. 1470 012078

doi10.1088/1742-6596/1470/1/012078, vol. 1470, pp. 1–9, 2020.

[22] W. Widada and D. Herawaty, "The Effects of the Extended Triad Model and Cognitive Style on the Abilities of Mathematical Representation and Proving of Theorem," Adv. Soc. Sci. Educ. Humanit. Res., vol. 218, no. ICoMSE 2017, pp. 89–95, 2018.

[23] Rusmini and E. Surya, "The Effect of Contextual Learning Approach to Mathematical Connection Ability and Student Self- Confidence Grade Viii Smp Negeri 8 Medan," Int. J. Sci. Basic Appl. Res. (IJSBAR, vol. 35, no. 2, pp. 249–262, 2017.

[24] Hobri, I. Septiawati, and A. C. Prihandoko, "High-order thinking skill in contextual teaching and learning of mathematics based on lesson study for learning community," Int. J. Eng. Technol., vol. 7, no. 3, pp. 1576–1580, 2018.

[25] W. Widada, "Sintaks Model Pembelajaran Matematika Berdasarkan Perkembangan Kognitif Peserta Didik," J. Pendidik. Mat. Raflesia, vol. 1, no. 2, pp. 163–172, 2016.

[26] D. Selvianiresa and S. Prabawanto, "Contextual Teaching and Learning Approach of Mathematics in Primary Schools," J. Phys. Conf. Ser., vol. 895, no. 1, 2017.

[27] W. Widada, "The Existence Of Students In Trans Extended Cognitive Development On Learning Of Graph Theory," J. Math Educ. Nusant., vol. 1, no. 1, pp. 1–20, 2015.