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Applying Contextual Teaching and Learning (CTL) with the Triangle Method in Mathematics Classes to Improve Students' Ability in Problem-Solving

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This study aims to find out the combination practice of Contextual Teaching and Learning (CTL) and the Triangle Method in improving the students' ability in problem-solving. The study used quasi-experiment with a quantitative approach. The population consisted of students in grade XII in Senior High School. The sampling technique used was simple random sampling. The samples were divided into two classes. The data were analysed by using t-test and two ways ANOVA. The result shows that the mean of the final test in the experiment class is higher than in the control class. Furthermore, CTL approach can be used in mathematics classes with another content. Besides that, it is not only for students grade XII but also for students grade XI and X. For the novelty of this study is the CTL approach can be adopted by the teacher to improve the students' ability in problem-solving for the real world problem.

Key words: *Mathematics learning, contextual teaching and learning, Triangle method, Prior knowledge, Problem solving skill*

Introduction

The goal of the study is to improve the ability to articulate problem solving by using a combination of *Contextual Teaching and Learning* (CTL) approach and *Triangle Method*. The previous study has examined this CTL approach in developing problem-solving of students (Khotimah, 2016; Surya et al., 2017). However, research shows that the CTL approach did not significantly impact on enhancing learners' ability (Curry et al., 2012). In other words, the CTL approach has no effect or satisfied results on increasing learners' ability. It is known that learners are still troubled by figuring out the significance of the given issue. Learners have

trouble in identifying the essence of the problem so that they cannot afford to solve it (Kopparla et al., 2019). Additionally, learners have difficulty finding keywords in problems and do not like a problem in an essay (a long word problem) (Phonapichat et al., 2014; Yerizon, Putra & Subhan, 2018).

The identification of a problem is of the utmost importance in finding appropriate solutions. Therefore, teachers can ask learners to write down difficult issues and look for precise solutions to each difficult item written on the worksheet, which is called the *Triangle Method*. This method may help learners to be more comfortable in understanding or identifying the underlying issues. The *Triangle Method* is a method the teacher can use in making it easier for learners to understand math problems. This method has been verified to help learners identify problems and find correct solutions (Podolak & Kawałek, 2016). Thus, this research tried to combine the CTL approach with the *Triangle Method* to strengthen the learner's problem ability to be improved significantly.

CTL is a learning approach that can accommodate knowledge and enhance learners' math skills (Tambelu, 2013). This approach requires teachers to relate teaching materials into learners' lives using real issues (Chen et al., 2019). The CTL is an approach of learning that has proven to enhance learners' problem-solving skills through critical and creative thinking processes through the presents of real-world problems (Selvianiresa & Prabawanto, 2017). Moreover, the CTL can also facilitate teachers to encourage learners' motivation for learning math primarily in solving real-world problems (Ekowati et al., 2015; Geduld, 2017). In other words, the CTL is an approach that views that learning must be based on learners' experiences by presenting a context of life in learning activities.

CTL is a concept of learning that helps teachers in involving lesson materials to context or situations that are relevant to learners. Ausubel theory by Babadoğan and Unal (2011); Kostiainen et al. (2018) says that the given material must be meaningful that is appropriate to the cognitive structure of learners. Therefore, lesson materials must be associated with earlier concepts of learners to be assimilated and well recognised by them. The concept of learning also emphasises the meaningful relevant actual situation with learners (Zhou & Brown, 2017). In other words, the CTL can facilitate learners to link new information with existing experience or knowledge that is turning more meaningful learning experience to them (Ren & Smith, 2018).

The *Triangle Method* is an additional method for the teacher to facilitate learners in understanding and identifying the problem. This method is used to help learners sort out problems into two parts which are the causes and solutions sides (Podolak & Kawałek, 2016). In this way, it can certainly help learners understand problems and plan appropriate solutions. The core of the problem-solving skill is how learners can find important information related to the problem so that they can be used as early information in finding the correct solution

(Nasution et al., 2018). The *Triangle Method* offers the facility to the learners in locating the core of the problem and then giving appropriate feedback. In other words, the *Triangle Method* has similarity with the *Theory of Creative Problem Solving* which have four stages in resolving a problem known as the *Creative Mental Process* which are *preparation, incubation, illumination, and verification* (Hsieh, 2018). Decision-making to find solutions is the result of the identification and resolution process of problems (Hamlen, 2018). The *Triangle Method* offers the learners space to identify the extent of the problem and to help them to make the right decisions to the problem. In other words, the combination between the CTL and the Triangle Method can help learners in math learning through having the same objective, which is the development of potential problem-solving capabilities. On top of this, it can also help teachers with the current issue to design with 21st century skills (Zhong & Xu, 2019).

The study also considers the prior knowledge aspect as an essential part of learners' knowledge of Mathematics. Lefa (2014) defines learning as a process in building cognitive structures through the process of absorbing new information (assimilation) and petitioning old information so that new information can come into the cognition structure of learners (accommodations). In other words, learners develop new knowledge and skills according to the initial knowledge already possessed. This indicates that prior knowledge took a particularly decisive measure for processing new information in the cognitive structure of learners. This early knowledge had a substantial effect on learners' ability to build new knowledge (Lee et al., 2019). To that end, teachers must pay attention to the extent of learning about the lesson materials to be given. Teachers obviously can connect new concepts with existing knowledge so they can go in and linger in the cognition structures of learners (Vallori, 2014).

This study was conducted to improve students' problem-solving skills in learning mathematics by paying attention to aspects of prior knowledge of students. Based on existing theories and some previous study results, the following hypothesis can be formulated as follows;

H1: Students 'problem solving ability using CTL with *Triangle Method* is better than students' problem solving ability without CTL
H2: There is an interaction between CTL and prior knowledge of students towards problem-solving skills

Methods

This type of study is *Quasy Experiment* research with *Randomised Control Group Only Design*. This study aims to determine the causality of the treatment given (Akhtar, 2016). The study was conducted at SMA 1 Bayang grade XII, in West Sumatra, Indonesia. The research sample was students of grade XII, SMA 1 Bayang, West Sumatra, Indonesia in the academic year of 2019-2020. Samples were taken randomly consisting of *the experimental class* by grade XII.1 (35 students) and *the control class* by grade XII.2 (34 students).

In this study, the tests given are *Prior Knowledge Test* and *Problem Solving Test*. *Prior Knowledge Tests* were given about 5 questions before conducting the study. This test aims to determine the students' initial knowledge about the prerequisite material from the subject matter to be given. The *Problem Solving Test* was given at the end of the study about 5 questions to find out the problem-solving ability after applying the *Contextual Teaching Learning* (CTL) approach with the help of the *Triangle Method*. *Problem Solving Tests* are designed based on indicators of problem-solving ability (Polya, 1945). All of the questions were given in the form of essays.

To find out the effectiveness of using this CTL approach, data on the results of *Problem Solving Tests* were tested using t-tests in both sample groups (*Experiment* and *control*). Besides, this study also examines the interaction of the CTL approach with students' initial knowledge of problem-solving abilities. The research design used can be seen in Table 1 showing that data taken in this study are (1) initial knowledge data obtained through the provision of initial tests. This data is used to divide students into high and low groups based on their initial knowledge, and (2) data on students' problem-solving abilities obtained through the provision of final tests. Before the test is used, the validity and reliability of the instrument are carried out. Based on the results of instrument analysis, it is known that *The Problem Solving Test* can be used as a data collection tool. Data that has been collected analysed using the t-test can be used to find out the problem solving ability of students after the application of CTL with the *Triangle Method* and the Two Ways ANOVA test to determine the effectiveness of using the CTL approach and the presence or absence of interaction between the approach with prior knowledge on the problem solving ability of participants students.

Table 1. Research Design

	Class	
Prior Knowledge	**Experiment**	**Control**
High	**CTL**	**Without CTL**
Low		
	Post-test	Post-test

Results and Discussion

Before analysing the data, testing of the requirements for using the t-test and two ways, ANOVA analysis need to be achieved. First, sample data is randomly selected, in this case, this requirement has been fulfilled because sampling has been done by simple random sampling (Random Sampling). Second, the data come from populations that are normally distributed. Data normality testing is done using the Kolmogorov-Smirnov test with the help of SPSS software. The test results show that in the experimental class, the value of sig. greater than alpha (0.121> 0.05) as well as the control class (0.200> 0.05). This means that the data of students' problem-solving ability of the experimental class and the control class are normally

distributed. Third, the data has a homogeneous variance. The Levene Test does the third requirement testing. The test results show that the value of sig> alpha value (0.352> 0.05). This means that both sample classes have homogeneous warranties. Based on the prerequisite test analysis results, it is known that the data obtained are normally distributed and homogeneous. Therefore, data can be analysed using t-test and two ways ANOVA (Kadir, 2016).

Problem Solving Skill of Students

To find out the effectiveness of using CTL in learning mathematics, a different test of problem-solving ability between the *experimental class* and *the control class* was carried out using the t-test. Table 2 shows that the sig value <alpha (0.000 <0.05) is obtained. This means that there are differences in students' problem-solving abilities in the *experimental class* and *the control class,* which are very significant. In other words, there is an effective use of the CTL approach in mathematics learning towards students' problem-solving abilities.

Table 2. Independent Samples Test

		Group	**N**	**Mean**	**Std. Deviation**	**Std. Error Mean**
Experiment and Control		**Experiment**	**35**	**75,74**	**7,402**	**1,251**
		Control	**34**	**67,26**	**8,277**	**1,419**

	Lavene's Test for Equality of Variance		t-test for Equality of Means						
	F	Sig.	t	df	Sig.(2-tailed)	Mean Difference	Std. error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Experiment and Cc Equal variance assumed	0,879	0,352	4,488	67	0,000	8,478	1,889	4,708	12,249
Equal variance not assumed			4,481	65,703	0,000	8,478	1,892	4,700	12,256

Interaction of Combination CTL and Triangle Method to Problem Solving Skill

Studying a learning approach, it cannot be separated from how a teacher pays attention to the characteristics of students in designing learning. In this case, the teacher should pay attention

to the readiness of students in receiving subject matter. The constructivist theory (J. Brunner) states that learning is a process that facilitates students in constructing their ideas based on past knowledge (Kamberelis, 2006). In other words, to design learning, it should pay attention to the condition of the students' initial knowledge in receiving new subject matter. Furthermore, this study found the presence or absence of interaction or the relationship of the CTL approach with students' initial knowledge in improving problem solving skills. Table 3 describes the results of the analysis. It shows that sig values> alpha values (0.467> 0.05) are obtained. It can be known that there is no interaction between the approaches of CTL with students' initial knowledge of problem-solving skills.

Table 3. Test of Between-Subjects Effects Dependent Variable: Problem Solving Skill

Source	Type III Sum of Squares	df	Mean square	F	Sig.
Corrected Model	1429,571[a]	3	476,524	7,875	0,000
Intercept	352448,681	1	352448,681	5824,286	0,000
Method	1232,177	1	1231,177	20,362	0,000
Prior_Knowledge	159,580	1	159,580	2,637	0,109
Method*Prior_ Knowledge	32,323	1	32,323	0,534	0,467
Error	3933,386	65	60,514		
Total	358752,000	69			
Corrected Total	5362,957	68			

[a] R Squared = 0,267 (Adjusted R Squared = 0,233)

The results of the analysis show significant differences in the problem-solving abilities of the students of the two sample classes. Based on these results, it can be said that *Contextual Teaching and Learning* (CTL) can improve students' problem-solving abilities when compared to *control classes* without CTL. This happens because the CTL approach facilitates learners learning based on real-world problems. Concepting the material begins by presenting real problems that are often encountered by students in their lives. This certainly can increase students' motivation to solve problems by collaborating in groups (Ekowati et al., 2015; Selvianiresa & Prabawanto, 2017). In other words, CTL is an approach that can motivate students to develop mathematical concepts according to their abilities. Students not only accept it but also discover for themselves the concepts of the material being studied (Hasani, 2016). In addition, CTL can also provide self-confidence to students in learning mathematics because the knowledge obtained is their discovery (Surya et al., 2017). Things like this can make learning mathematics more meaningful that is learning that can help students in constructing mathematical concepts with their abilities. Through the internalisation process, students can rebuild these mathematical concepts or principles.

During learning in class, students work together in solving problems helped with the given triangle poster (*Triangle Method*). It can be seen that students give a positive response to this *Triangle Method* by analysing difficult things in the problem and then finding the right solution. With this condition can certainly help students to focus and understand the problems given (Sun et al., 2020). It can be said that to solve the problem can be passed by identifying the problem, planning the right strategy and reviewing the results obtained (Brookhart, 2010).

CTL is an approach that can facilitate students with problems of daily life (meaningful problems) because each concept obtained is related to the real situation of students (Sinay & Nahornick, 2016; Suciati et al., 2019). By applying the seven components of CTL *(Constructivism, Inquiry, Questioning, Modeling, Reflection, Learning Community and Authentic Assessment)* in the classroom, teachers will certainly be able to maximise the potential of students in learning mathematics. CTL provides the opportunity for students to communicate their ideas to solve the problems given. This makes students view that mathematics is something that can be understood or makes sense (make sense of mathematics) because it is associated with real-life (Mousley, 2018; Rusdi et al., 2018). Thus, CTL can be meaningful to students by knowing that mathematics is a tool that they can use to solve problems in their lives.

The results of the study also provide information that there is no relationship between the CTL approach with the students' initial knowledge in improving problem-solving abilities. It can be interpreted that CTL can be used for students who have high or low initial knowledge in improving problem-solving skills. In other words, the *Contextual Teaching and Learning* approach can be used on various types of students' abilities in receiving learning material. This happens because the CTL approach can facilitate the various needs and conditions of students in learning mathematics (Pinwanna, 2015).

CTL is a learning approach that provides opportunities for students to collaborate and work together to solve mathematical problems (Riitaoja et al., 2019; Samo et al., 2017). In each group, students are given the opportunity to communicate their ideas in solving mathematical problems and students who have more ability can help friends who are weak in learning (Sudarman, Djuniadi, & Sutopo, 2017; Yoruk, 2016). Through CTL, students who have high or low initial knowledge will be helped in learning mathematics because they can share or work together in completing the given tasks. This can be seen when students fill in the triangle poster given. Students help each other in filling out the left and right parts of a triangle to reach an understanding of the given problem. This condition occurs because CTL with the help of the *Triangle Method* can facilitate students to learn actively and increase their initial knowledge based on information obtained during learning in the classroom (Hasani, 2016). In other words, the CTL approach can cover the weaknesses of each weak learner through collaboration and collaboration in groups so that the ability to solve mathematical problems can be improved properly (Albay, 2019).

Based on what has been stated, it is known that the combination of CTL and *Triangle Method* can increase the activeness and problem-solving abilities of students in using mathematical concepts, especially to solve real-world problems. This happens because CTL not only requires students to find concepts but can also link these concepts to their real-world situations. Besides, the *Triangle Method* also helps students in understanding and finding the right solution to the given problems. It is known that CTL can also facilitate students who have high or low initial knowledge of learning. This condition occurs because the CTL approach gives students the opportunity to learn according to their abilities. In other words, students who have low initial knowledge can be helped by the information they obtain during class learning.

Conclusion

Based on the results of the study, it can be concluded that the problem-solving ability of students who learn with *Contextual Teaching and Learning* (CTL) assisted by *Triangle Method* is better than students who learn without CTL. It is known that CTL can facilitate students in developing their potential to solve real-world problems. Besides, the results of the analysis also showed that there was no interaction between CTL and students' initial knowledge in influencing problem-solving abilities. In other words, CTL can meet every need of students both with low initial and prior knowledge in learning mathematics.

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