DOI: 10.56773/bj.v4i2.65
E-ISSN: 2809-8528

Brillo Journal
Volume 4, Issue 2, June 2025, pp. 77-95

STUDENTS' PROBLEM-SOLVING SKILLS THROUGH THE MODIFIED TRIANGLE METHOD WITH CONTEXTUAL TEACHING AND LEARNING

Dina Amsari*, Salmaini Safitri Syam, Fadila Suciana

Primary Teacher Education Study Program, Universitas Negeri Padang, Indonesia
Email: dinaamsari@fip.unp.ac.id

Abstract

This research was motivated by the low level of students' problem-solving ability in mathematics learning, especially based on real-world problems. The main cause is that students still have problems in understanding the meaning and finding the core of the given problem. The objectives of this study to determine the modified Triangle Method (TM) with Contextual Teaching and Learning (CTL) to improv students' ability in problem-solving and also its interaction with prior knowledge. This type of research is experimental design with a sample of 69 students grade VIII in West Sumatera, Indonesia. The data were obtained by giving the test, which was evaluated by *t*-test and two-way ANOVA. Based on the result test, obtained a *t*-value of 4.488 with the *Sig*.=0.000<0.05= α. It can be concluded that the modified of TM and CTL can improve students' problem-solving ability. Meanwhile, the interaction test obtained *Sig*.0.467>0.05=α. In other words, there is no interaction between CTL and students' prior knowledge of problem-solving skills. It means that TM and CTL can be used for students with high and low prior knowledge to improve students' problem-solving skills

Keywords: Modified triangle method, Contextual teaching and learning, Prior knowledge, Problem-solving skills, Mathematics education.

Abstrak

Penelitian ini dilatarbelakangi oleh rendahnya kemampuan pemecahan masalah siswa dalam pembelajaran matematika, khususnya yang berkaitan dengan masalah dunia nyata. Penyebab utamanya adalah siswa masih mengalami kesulitan dalam memahami makna dan menemukan inti dari permasalahan yang diberikan. Tujuan dari penelitian ini untuk mengetahui praktik modifikasi Triangle Method (TM) dengan pendekatan Contextual Teaching and Learning (CTL) dalam meningkatkan kemampuan siswa dalam pemecahan masalah dan juga interaksinya dengan pengetahuan awal siswa. Jenis penelitian ini adalah penelitian eksperimen dengan sampel 69 siswa kelas VIII di Sumatera Barat, Indonesia. Data diperoleh dengan memberikan tes, yang dievaluasi dengan uji-t dan anova dua arah. Berdasarkan hasil pengujian, diperoleh nilai t-value sebesar 4.488 dengan nilai Sig.=0.000<α=0.05. Hal ini dapat disimpulkan bahwa modifikasi TM dan CTL dapat meningkatkan kemampuan pemecahan kemampuan pemecahan masalah siswa. Sementara itu, uji interaksi diperoleh nilai sig > nilai alpha (0,467 > 0,05). Dengan kata lain, tidak terdapat tidak terdapat interaksi antara CTL dan pengetahuan awal siswa terhadap kemampuan terhadap kemampuan pemecahan masalah siswa. Hal ini berarti bahwa TM dan CTL dapat digunakan untuk siswa dengan pengetahuan awal tinggi dan rendah untuk meningkatkan kemampuan pemecahan masalah siswa

***Kata Kunci**: Kemampuan pemecahan masalah,Metode segitiga yang dimodifikasi, Pendekatan kontekstual, Pendidikan matematika, Pengetahuan awal.*

How to Cite: Amsari, D., Syam, S. S., & Suciana, F. (2024). Students' Problem-Solving Skills through the Modified Triangle Method with Contextual Teaching and Learning. *Brillo Journal*, *4*(2), 77-95.

INTRODUCTION

The purpose of the study is to improve the ability to articulate problem-solving by modifying the TM with CTL. Previous study has examined this CTL in developing students' problem-solving (Lestari et al., 2021; Pangemanan, 2020). However, research shows that the CTL did not have a significant effect in improving students' ability (Curry et al., 2012; Priyadi & Yumiati, 2021). In other words, the CTL approach has no effect or satisfactory results in improving students' ability. It is known that students still have difficulties in finding out the meaning of the given problem. Students have difficulty in identifying the essence of the problem or using mathematical terms and their related concepts, so they cannot afford to solve it (Aisy et al., 2022; Mulwa, 2015; Sibaen et al., 2023). In addition, students have difficulty finding keyword problems and do not like problems in essays (long word problems) (Putra et al., 2020; Siniguian, 2017).

Identifying a problem is of paramount importance in finding appropriate solutions. Therefore, teachers can ask students to write down difficult problems and look for precise solutions to each difficult item written on the worksheet called TM. This method can help students feel more comfortable in understanding or identifying the underlying problems. TM is a method that the teacher can use to make it easier for students to understand math problems. This method has been verified to help students identify problems and find the correct solutions (Podolak et al., 2016). Therefore, the research attempted to combine TM and CTL in order to strengthen students' problem-solving skills in order to significantly improve them.

CTL is a learning approach that can incorporate knowledge and improve students' mathematical skills. This approach requires teachers to relate instructional materials to students' lives using real-world problems (Silseth & Erstad, 2018; Yeh et al., 2019). CTL is a learning approach that has been shown to improve students' problem-solving skills through critical and creative thinking processes by presenting real-world problems (Lago & Cruz, 2021; Lestari et al., 2021; Nawas, 2018). In addition, CTL can also facilitate teachers to promote students' motivation to learn mathematics primarily by solving real-world problems (Geduld, 2017; Lago & Cruz, 2021; Nawas, 2018). In other words, the CTL is an approach that views learning must be based on students' experiences by presenting a context of life in learning activities.

CTL is a concept of learning that helps teachers to relate instructional materials to contexts or situations that are relevant to students. Ausubel's theory says that the given material must be meaningful that is appropriate to the cognitive structure of students (Kostiainen et al., 2018; Lago & Cruz, 2021). Therefore, instructional materials must be associated with students' previous concepts in order to be assimilated and well recognized by them. The concept of learning also emphasizes the meaningful relevant actual situation with students (Babakr et al., 2019; Univeren & Karakus, 2020; Zhou & Brown, 2017). In other words, CTL can facilitate students to connect new information with existing experience or knowledge, which turns into more meaningful learning experience for them (Hanfstingl et al., 2019; Swars et al., 2018; Takunyaci, 2021).

TM is an additional method for the teacher to help students understand and identify the problem. This method is used to help students divide problems into two parts, which are the causes and solutions sides (Podolak et al., 2016). In this way, it can certainly help students to understand problems and plan appropriate solutions. The core of problem-solving ability is how students can find important information related to the problem so that they can be used as early information in finding the correct solution (Kale & Akcaoglu, 2020; Nasution et al., 2018). TM provides a way for understudies to discover the center of the issue and after that give fitting criticism. In other words, TM has similitude with the hypothesis of imaginative problem-solving which has four stages in understanding a issue known as the inventive mental handle which are planning, hatching, light, and confirmation (Basadur et al., 2014; Hsieh, 2018; Soyadı, 2015). Decision making to find solutions is the result of the process of identifying and solving problems (Hamlen, 2018; Sousa et al., 2019). TM provides space for students to identify the scope of the problem and help them to make the right decisions regarding the problem. In other words, the modified of TM and CTL can help students in learning mathematics by having the same goal, which is to develop potential problem-solving skills. In addition, it can also help teachers with the current issue of designing with 21st century skills (Adeoye & Jimoh, 2023; Zhong & Xu, 2019).

TM was a method designed to help students solve the problem. The inverted triangle represents a problem solved by students with the left hand as the cause and the right hand as the solution to those causes. In other words, TM was about defining the problem and finding the right solution to the problem. As for the technical performance, teachers can divide students into groups and give them triangular posters. The teacher then presents a problem to each group and asks the students to write things that are considered difficult on the left side of the triangle and discuss solutions that could remove the left side by writing it on the right side, as shown in Figure 1.

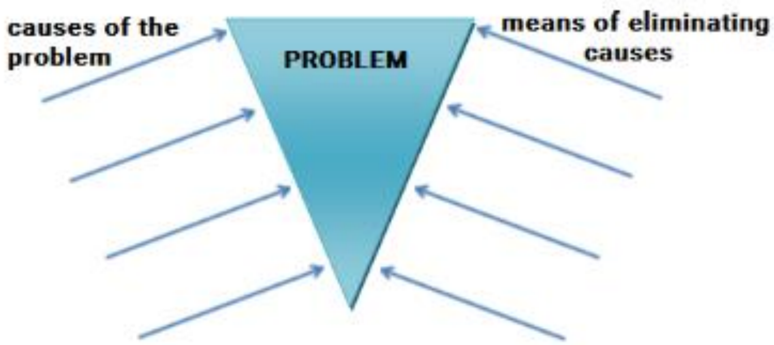

Figure 1. The triangle method (Podolak & Kawałek, 2016)

The integration of TM and CTL models in mathematics learning is done when students work in their groups to solve the given problems. First, the teacher gives a problem and a poster with an inverted triangle. Students work in groups to find the cause of the problem. This part is written by the students on the left side of the triangle. Meanwhile, on the right side of the triangle, students write the solution for each cause that arises. Through group discussions, students can work together and develop their ability to construct ideas and find the right solution to the given problem. Next, the results of the group discussion are presented to the class to get opinions or answers from other groups.

The study also considers the aspect of prior knowledge as an essential part of students' knowledge of mathematics. Piaget's theory defines learning as a process of building cognitive structures through the process of absorbing new information (assimilation) and petitioning old information so that new information can enter into the students' cognitive structure (accommodation) (Hanfstingl et al., 2019; Zhou & Brown, 2017). In other words, students develop new knowledge and skills according to the prior knowledge they already possess. This indicates that prior knowledge was a particularly important measure for processing new information in students' cognitive structure. This prior knowledge had a significant impact on students' ability to build new knowledge (Lee et al., 2019). To this end, teachers must pay attention to the extent of learning about the instructional materials to be given. Teachers can obviously connect new concepts with existing knowledge, so that they can enter and stay in students' cognitive structures

(Simonsmeier et al., 2022).

This study was conducted to improve students' problem-solving skills in learning mathematics by paying attention to aspects of students' prior knowledge. Based on existing theories and some previous study results, the following the research question can be formulated; (RQ1) Is students' problem-solving ability by modifying TM and CTL better than students' problem-solving ability without CTL?; (RQ2) Is there an interaction of the modified TM and CTL with students' prior knowledge towards problem-solving skills?

Hypothesis

(H1) Students' problem-solving ability by modifying TM and CTL is better than students' problem-solving ability without CTL; (H2) There is an interaction of the modified TM and CTL with students' prior knowledge towards problem-solving skills.

RESEARCH METHODS

This type of study is quasi-experimental research with a randomized control group only design. This study aims to determine the causality of the treatment given (Akhtar, 2016). The research population was students of grade VIII, SMPN 1 Bayang, West Sumatra, Indonesia in the academic year of 2023-2024 with details of class as shown in Table 1.

Table 1. Students in class VIII

Class	Students
VIII.1	35
VIII.2	34
VIII.3	34
VIII.4	33
Total	136

Sampling research using random sampling technique. Before selecting the sample, the requirements test was carried out, namely the homogeneity test and the similarity of the means using SPSS software. The following are the results of the requirements test (prerequisite test) analysis as shown in Table 2.

Based on the Kolmogorov-Smirnov test, each class has a *Sig*.$>\alpha=0.05$. In other words, the data of each member of the population is normally distributed.

Table 2. One-sample Kolmogorov-Smirnov test

		VIII.1	VIII.2	VIII.3	VIII.4
N		35	34	34	33
Normal Parameters	Mean	55.800	56.352	54.941	54.303
	Std. Deviation	11.180	9.607	8.431	8.153
Most Extreme Differences	Absolute	0.129	0.091	0.121	0.139
	Positive	0.129	0.058	0.121	0.139
	Negative	-0.079	-0.091	-0.078	-0.083
Test Statistic		0.129	0.091	0.121	0.139
Asymp. *Sig*. (2-tailed)		0.154	0.200	0.200	0.104

Furthermore, the homogeneity of variance test was carried out with the results as in Table 3.

Table 3. Test of Homogeneity of Variances

Levene Statistic	*df1*	*df2*	*Sig.*
1.794	3	132	0.151

Based on Table 3, *Sig*.=0.151>0.05=α. In other words, each member of the population has a homogeneous variance. The last test as a condition of random sampling is the mean similarity test with the results as in Table 4.

Table 4. One Way ANOVA

	Sum of Squares	*df*	Mean Square	*F*	*Sig*.
Between Groups	83.129	3	27.710	.311	.818
Within Groups	11768.217	132	89.153		
Total	11851.346	135			

Based on Table 4, *Sig*.=0.818>0.05=α. In other words, each member of the population has an average similarity.

Based on the prerequisite test, the sample can be randomly selected so that class VIII.1 is chosen as the experiment class and class VIII.2 as the control class. In the experimental class, learning was carried out using TM and CTL while the control class used conventional learning. Instructional strategies used in the TM and CTL approaches are the teacher divides students into 7 groups with one group consisting of 5 students. Each group was given a poster in the form of an inverted triangle in which there was one problem regarding the geometry of space material. Students in their respective groups are asked to analyse the factors or information related to the problem and write it on the left side of the triangle. Furthermore, students pay attention to ways to solve these factors and write them on the right side of the triangle. In addition, the teacher also distributed worksheets that were used to assist students in writing down the solutions they obtained. Then each group was asked to present their work in front of the class.

Instruments

In this study, the tests given are prior knowledge test and problem-solving test on the topic of space geometry. Prior knowledge test was given about 5 questions before conducting the study. This test aims to determine the students' prior knowledge about the prerequisite material of the subject 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 TM with CTL. All questions were given in the form of essays. Problem solving tests are designed based on indicators of problem-solving ability as shown in Table 5 (Guiñez & González, 2023; Sari et al., 2019).

Table 5. Guidance for Students Problem Solving Ability Tests

Indicator	Assessment	Score
Understanding the Problem	– Did not mention what was known and what was asked	0
	– Mention what is known without mentioning what was asked	1
	– Mention what is known and what is asked but is not right	2
	– Mention what is known and what is asked correctly	3
Arranging a Plan	– Not planning a problem solving at all	0
	– Planning a solution based on a problem but not right	1
	– Plan solutions based on problems correctly	2
Carrying Out a Plan	– There are no answers at all	0
	– Running the plan by writing down answers but wrong answers or only a small number of correct answers	1
	– Running the plan by writing half answers or most correct answers	2
	– Running the plan by writing answers completely and correctly	3
Re-Check	– Did not write a conclusion	0
	– Interpreting the results obtained by making conclusions but not right	1
	– Interpret the results obtained by making conclusions appropriately	2

Before the final test was given to students in both experimental and control classes, the validity and reliability of the test were tested. The validity test was carried out expertly by looking at the accuracy of the test made with the question grid and the level of cognition. The validity test was carried out by two experts in the field of mathematics with the decision that the test questions were suitable for testing. Furthermore, the questions were given to 30 students and then the difficulty index and differentiation index of the questions were calculated.

The test question difficulty index test was carried out with the help of SPPS using the Mean value of each question. The question is said to have a moderate level of difficulty if the mean value obtained is between 0.31–0.70.

The test of the differentiating power of the test questions was carried out by looking at the value of r count. With the criteria the question is said to be good if it has $r_{calc.}$>0.40. From the results of previous calculations, the value of r count is obtained as in Table 6.

Table 6. Differentiation index analysis results

Items	1	2	3	4	5
$r_{calc.}$	0.686	0.847	0.612	0.883	0.729

From Table 6, it is obtained that each item has a value of $r_{calc.}$>0.40 so that it is said that the question items have a good differentiating index.

Furthermore, the test reliability was tested using SPSS by looking at the Cronbach's Alpha. The Cronbach's alpha value is 0.803>0.60 so that the test is declared reliable.

Based on the validity test, difficulty index test, differentiator index and reliability test, the test questions are suitable to be used as instruments for collecting data on students' problem-solving skills.

Data analysis

In order to determine the effectiveness of using TM with CTL, data on problem-solving test scores were tested using *t*-tests in both sample groups (experimental and control). In addition, this study also examines the interaction of CTL with students' prior knowledge of problem-solving skills. The research design used is shown in Table 7.

Table 7. Research design

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

The data collected in this study are (1) prior knowledge data obtained by administering a pretest. This data is used to divide students into high and low groups based on their prior knowledge, and (2) data on students' problem-solving abilities obtained through the provision of final tests. Before the test is administered, the validity and reliability of the instrument are analyzed. Based on the results of the instrument analysis, it is known that the problem-solving test can be used as a data collection tool. The data collected, analyzed using the *t*-test can be used to find out the problem-solving ability of students after the application of TM with CTL and the two-way ANOVA test to determine the effectiveness of using TM with CTL and the presence or absence of interaction between the approach with prior knowledge on the problem-solving ability of the participants students.

RESULTS AND DISCUSSION

Before analyzing the data, it is necessary to check the requirements for using the *t*-test and two-way ANOVA analysis. First, the sample data are randomly selected; in this case, this requirement is met because the sampling was done by simple random sampling. Second, the data come from populations that are normally distributed. Data normality tests are performed using SPSS software as shown in Table 8.

Table 8. One-sample Kolmogorov-Smirnov test

		Experiment Group	Control Group
N		35	34
Normal Parameters	Mean	75.74	67.26
	Std. Deviation	7.402	8.277
Most Extreme Differences	Absolute	0.142	0.109
	Positive	0.106	0.079
	Negative	-0.142	-0.109
Test Statistic		0.142	0.109
Asymp. Sig. (2-tailed)		0.070	0.200

Table 8 shows that the experimental class has *Sig.*=0.070>0.05=α as well as the control class (*Sig.*=0.200>0.05=α). This means that the data on the problem-solving ability of experimental and control class students is normally distributed. Third, the data has a homogeneous variance. Testing the third requirement is done with the Levene Test. The results of the homogeneity test can be seen in Table 9.

Tabel 9. Test of Homogeneity of Variances

Levene Statistic	*df1*	*df2*	*Sig.*
0.879	1	67	.352

Table 9 shows that *Sig.*=0.352>0.05=α. This means that the two sample classes have homogeneous variance. Based on the results of the prerequisite test analysis, it is known that the data obtained are normally distributed and homogeneous. Therefore, the data can be analyzed using *t*-test and two-way ANOVA (Kadir, 2016).

Students' problem-solving ability

Data on students' problem-solving skills were obtained through the final test. The final test was given to both sample classes. The final test scores of students' problem-solving skills can be seen in Figure 2.

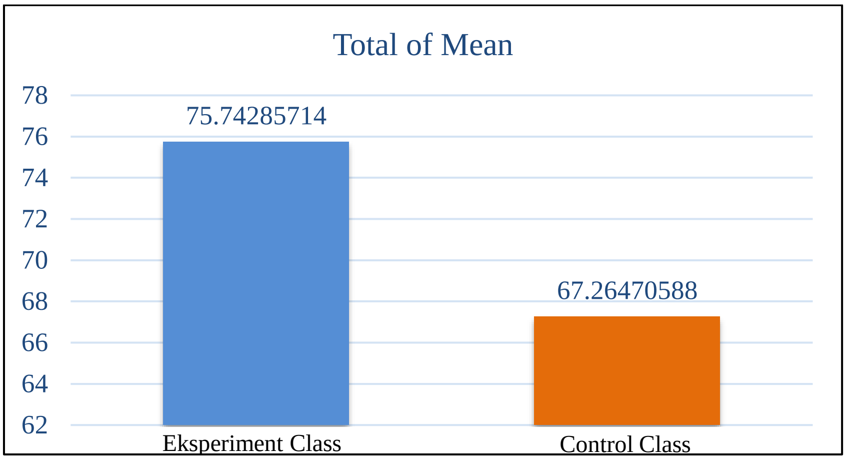

Figure 2. Graph of average problem-solving ability scores

In Figure 2, it can be seen that the average score of the experimental class is higher than the average score of the control class. In other words, students' problem solving ability using TM with CTL is better than without TM with CTL. To find out the effectiveness of using TM with CTL in learning mathematics, a difference test of problem-solving ability between the experimental class and the control class was carried out using the *t*-test. The results of the analysis are shown in Table 10.

Table 10. Levene's test and independent samples *t*-test result

Group	N	Mean	Std. Deviation	Std. Error Mean	Levene's test		*t*-test		
					F	*Sig.*	*t*	*df*	*Sig.*
Experiment	35	75.74	7.402	1.251	0.879	0.352	4.488	67	0.000
Control	34	67.26	8.277	1.419					

In Table 10, *Sig*.=0.000>0.05=α is obtained. This means that there are differences in students' problem-solving abilities in the experimental class and the control class that are very significant. In other words, there is an effective use of TM with CTL in mathematics learning on students' problem-solving ability.

Interaction of the learning and prior knowledge on problem-solving skills

Meanwhile, the average final test score of students' problem-solving ability based on prior knowledge can be seen in Figure 3.

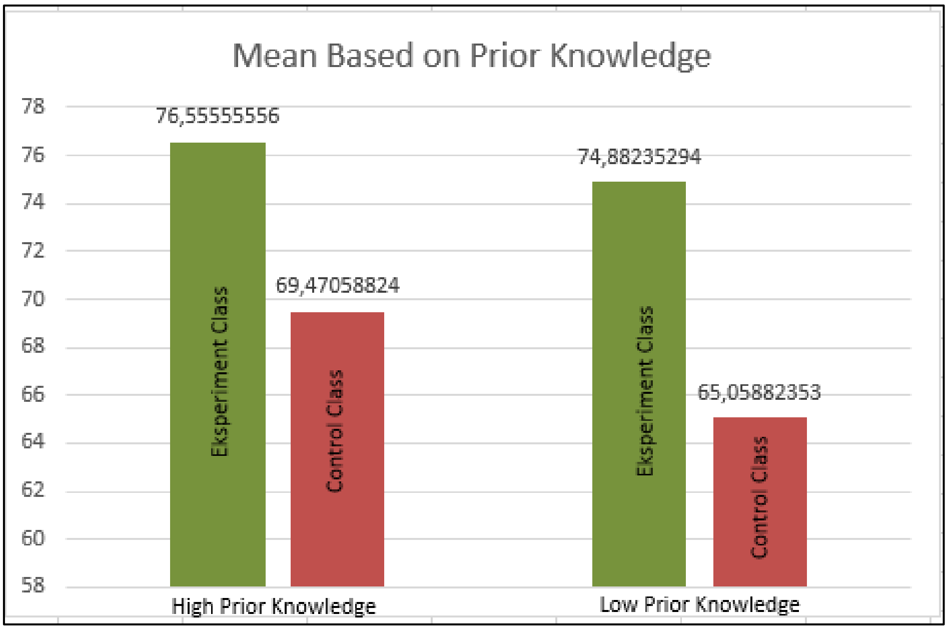

Figure 3. Graph of average problem-solving ability scores based on prior knowledge

In Figure 3, it can be seen that the average score of the experimental class is higher than the average score of the control class for both students with high prior knowledge and students with low prior knowledge. This happens because students already have the ability to analyze and understand the meaning of a problem and can provide ideas to solve the problem properly and correctly.

Studying about a learning approach, it cannot be separated from how a teacher pays attention to the characteristics of students in designing a learning. In this case, the teacher should pay attention to the students' readiness in receiving the subject matter. The constructivist theory by Brunner stated that learning is a process that facilitates students in constructing their ideas based on previous knowledge (Dimitriadis & Kamberelis, 2006). In other words, to design a learning, it should pay attention to the condition of students' prior knowledge in receiving new subject matter. Furthermore, this study found the presence or absence of interaction or relationship of TM with CTL with students' prior knowledge in improving problem solving skills. The results of the analysis are shown in Table 11.

Table 11. Test of two way ANOVA

Source	Type III Sum of Squares	*df*	Mean Square	*F*	*Sig.*
Corrected Model	1429.571	3	476.524	7.875	0.000
Intercept	352448.681	1	352448.681	5824.286	0.000
Method	1232.177	1	1232.177	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			
R Squared = 0.267 (Adjusted R Squared = 0.233)					

In Table 11, *Sig.*=0.467>0.05=α are obtained. It can be known that there is no interaction between CTL and students' prior knowledge of problem-solving skills.

Discussion of findings

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 TM and CTL can improve students' problem-solving abilities compared to control classes without TM and CTL. This is because TM and CTL facilitate students' learning based on real-world problems. In addition, the standard deviation of the experimental class is also lower than the control class. This means that students' problem-solving skills using TM and CTL are more uniform because in learning students work together in finding solutions to problems. By learning in groups, students who have low abilities can be helped by students who have high abilities.

The conceptualization of the material begins by presenting real problems that students often encounter in their lives. This can certainly increase students' motivation to solve problems by working in groups (Muhtarom et al., 2024; Selvianiresa & Prabawanto, 2017). In other words, TM and CTL is an approach that can motivate students to develop mathematical concepts according to their abilities. Students not only accept it, but also discover the concepts of the material being studied for themselves (Aguilar-Valdés et al., 2024; Hasani, 2016; Malvasi & Gil-Quintana, 2022). In addition, TM and CTL can also give students self-confidence in learning mathematics because the knowledge gained is their own discovery (Siregar et al., 2023; Surya et al., 2017). Such things can make learning mathematics more meaningful, that is, learning that can help students in constructing mathematical concepts with their own abilities. Through the process of internalization, students can reconstruct these mathematical concepts or principles.

During classroom learning, students work together to solve problems that are helped by the given triangle poster (in TM implementation). It can be seen that students give a positive response to this TM by analyzing difficult things in the problem and then finding the right solution. This condition can certainly help students to concentrate and understand the given problems (Hélie & Sun, 2010). It can be said that solving the problem can be done by identifying the problem, planning the right strategy and checking 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 maximize the potential of students in learning mathematics. CTL provides the opportunity for students to communicate their ideas to so lve the given problems. This makes students see mathematics as something that can be understood or makes sense (make sense of mathematics) because it is related to real life (Rusdi et al., 2018). Thus, CTL can be meaningful to students because they know that mathematics is a tool, they can use to solve problems in their lives.

The results of the study also provide information that there is no relationship between TM and CTL with students' prior knowledge in improving problem solving skills. It can be interpreted that CTL can be used for students who have high or low prior knowledge in improving problem solving skills. In other words, TM with CTL can be applied to different types of students' abilities in receiving learning material. This happens because the CTL approach can facilitate the different needs and conditions of students in learning mathematics (Lestari et al., 2021; Pinwanna, 2015). In addition, in learning students work together in their respective groups to provide ideas or opinions related to the solution of the problems discussed. This means that students who do not have high prior knowledge can understand the material with the help of their groupmates because each student is asked to be able to present the results of their discussion in front of the class.

CTL is a learning approach that provides opportunities for students to collaborate and work together to solve mathematical problems. 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 (Pangemanan, 2020; Sudarman et al., 2017). Through CTL, students solving skills in using mathematical concepts, especially to solve real-world problems. This happens because CTL not only requires students to find concepts, but also can link these concepts to their real-world situations. In addition, TM also helps students to understand and find the right solution to the given problems. It is known that CTL can also facilitate the learning of students with high or low knowledge. This condition occurs because the CTL approach gives students the opportunity to learn according to their abilities. In other words, students who have low knowledge can be helped by the information they receive during classroom learning.

It can be concluded that TM can enhance the use of CTL in learning because it is proven to improve students' math problem solving skills. The incorporation of TM should be able to help students in understanding the problem which has been one of the causes of students' difficulty in finding the right solution. This can certainly be the answer to the weaknesses of previous research which revealed that CTL has no impact or does not provide satisfactory results on improving students' abilities (Curry et al., 2012; Priyadi & Yumiati, 2021). The main problem is that students are still constrained in understanding the meaning of the problems given. Learners find it difficult to find the essence of the problem so they are unable to solve it (Kopparla et al., 2019). Thus, students' problem-solving skills are still weak even though they have used CTL. Based on the results of this study, the modified of TM and CTL can be used by teachers to facilitate students in understanding mathematical problems and has been proven to help them identify problems and find the right solution.

CONCLUSION

Based on the comes about of the ponder, it can be concluded that the problem-solving capacity of understudies who learn with alteration TM and CTL is superior than understudies who learn without CTL. It is known that CTL can offer assistance understudies to create their potential to illuminate genuine issues. In expansion, the comes about of the investigation moreover appeared that there was no interaction between CTL and students' beginning information in affecting problem-solving capacity. In other words, CTL can meet all the wants of understudies with both moo starting and earlier information in learning mathematics.

Based on the results of the research, it can be recommended that CTL can be used by teachers to improve students' math problem solving skills. Moreover, by combining CTL and TM, it can certainly cover students' weaknesses in understanding math problems. With the inverted triangle poster, it can make it easier for students to analyze one by one the factors that cause problems and try to find solutions to each of these causes. Thus, students can easily find solutions to problems because they have eliminated distracting factors that can make it difficult for them to understand the problem.

The novelty of our research is how to improve students' problem-solving skills. It is one of the 21st century skills that students need to have right now. This study is combination of CTL approach and TM, which is used to improve students' ability in problem solving to solve the real-world problem. Besides that, this study also talks about how the prior knowledge of students has interaction with CTL approach and TM in enhancing problem solving skill.

The limitations of this study only examine the condition of students based on their prior knowledge and also only examine one mathematical ability. In the future, it is hoped that other researchers can examine the learning styles of students using the CTL approach or other learning methods. In addition, future researchers can also examine how the CTL approach can affect other mathematical abilities such as reasoning, critical thinking and creativity by taking into account aspects of students' learning styles (auditory, visual, kinesthetic). In addition, CTL approach can be used in mathematics classes with another content. Besided that, it is not only for students grade VIII but also for students grade VII and IX. CTL approach can be adopted by teacher to improve the students’ ability in problem solving for the real world problem.

REFERENCES

Adeoye, M. A., & Jimoh, H. A. (2023). Problem-Solving Skills Among 21st-Century Learners Toward Creativity and Innovation Ideas. *Thinking Skills and Creativity*

Journal, *6*(1), 52–58. https://doi.org/10.23887/tscj.v6i1.62708

Aguilar-Valdés, M., Almonacid-Fierro, A., Valdebenito, K., & Sepúlveda-Vallejos, S. (2024). Epistemological beliefs and teaching practice: A systematic literature review 2011-2021. *International Journal of Evaluation and Research in Education (IJERE)*, *13*(2), 767–773. https://doi.org/10.11591/ijere.v13i2.26063

Aisy, N. M. R., Mulyono, M., & Walid, W. (2022). Analysis of students difficulties in mathematics problem-solving ability on number pattern material. *Jurnal Pijar MIPA*, *17*(6), 706–711. https://doi.org/10.29303/jpm.v17i6.4149

Akhtar, I. (2016). Research Design. *SSRN Electronic Journal*, 68–84. https://doi.org/10.2139/ssrn.2862445

Babakr, Z., Kakamad, K., & Mohamedamin, P. (2019). Piaget's Cognitive Developmental Theory: Critical Review. *Education Quarterly Reviews*, *2*(3). https://doi.org/10.31014/aior.1993.02.03.84

Basadur, M., Gelade, G., & Basadur, T. (2014). Creative Problem-Solving Process Styles, Cognitive Work Demands, and Organizational Adaptability. *Journal of Applied Behavioral Science*, *50*(1), 80–115. https://doi.org/10.1177/0021886313508433

Brookhart, S. M. (2010). *How to Asess Higher Order Thingking Skill in Your Classroom*. ASCD.

Curry, K., Wilson, E., Flowers, J., & Farin, C. (2012). Scientific Basis vs. Contextualized Teaching and Learning: The Effect on the Achievement of Postsecondary Students. *Journal of Agricultural Education*, *53*(1), 57–66. https://doi.org/10.5032/jae.2012.01057

Dimitriadis, G., & Kamberelis, G. (2006). *Theory for Education*. Routledge Taylor & Francis Group.

Guiñez, F., & González, D. (2023). The Impact of Real-World Mathematical Modelling Problems on Students' Beliefs About the Nature of Mathematics. In G. Kaiser & G. A. Stillman (Eds.), *International Perspectives on the Teaching and Learning of Mathematical Modelling* (pp. 93–109). Springer, Cham. https://doi.org/10.1007/978-3-031-27115-1_6

Hamlen, K. R. (2018). General Problem-Solving Styles and Problem-Solving Approaches in Video Games. *Journal of Educational Computing Research*, *56*(4), 467–484. https://doi.org/10.1177/0735633117729221

Hanfstingl, B., Benke, G., & Zhang, Y. (2019). Comparing variation theory with Piaget's theory of cognitive development: more similarities than differences? *Educational Action Research*, *27*(4), 511–526. https://doi.org/10.1080/09650792.2018.1564687

Hasani, A. (2016). Enhancing Argumentative Writing Skill through Contextual Teaching and Learning. *Educational Research and Reviews*, *11*(16), 1573–1578. https://doi.org/10.5897/ERR2016.2806

Hélie, S., & Sun, R. (2010). Incubation, insight, and creative problem solving: A unified theory and a connectionist model. *Psychological Review*, *117*(3), 994–1024. https://doi.org/10.1037/a0019532

Hsieh, C. Y. (2018). Developing Design through a Creative Problem-Solving Process: A Group Community Art Project. *International Journal of Art and Design Education*, *37*(3), 541–553. https://doi.org/10.1111/jade.12155

Kadir, K. (2016). *Statistika Terapan*. PT Rajagrafindo Persada.

Kale, U., & Akcaoglu, M. (2020). Problem Solving and Teaching How to Solve Problems in Technology-Rich Contexts. *Peabody Journal of Education*, *95*(2), 127–138. https://doi.org/10.1080/0161956X.2020.1745612

Kopparla, M., Bicer, A., Vela, K., Lee, Y., Bevan, D., Kwon, H., Caldwell, C., Capraro, M. M., & Capraro, R. M. (2019). The effects of problem-posing intervention types on elementary students' problem-solving. *Educational Studies*, *45*(6), 708–725. https://doi.org/10.1080/03055698.2018.1509785

Kostiainen, E., Ukskoski, T., Ruohotie-Lyhty, M., Kauppinen, M., Kainulainen, J., & Mäkinen, T. (2018). Meaningful learning in teacher education. *Teaching and Teacher Education*, *71*, 66–77. https://doi.org/10.1016/j.tate.2017.12.009

Lago, J. M. L., & Cruz, R. A. O. Dela. (2021). Linking to the real world: Contextual teaching and learning of statistical hypothesis testing. *Lumat General Issue*, *9*(1), 597–621. https://doi.org/10.31129/LUMAT.9.1.1571

Lee, J. Y., Donkers, J., Jarodzka, H., & van Merriënboer, J. J. G. (2019). How prior knowledge affects problem-solving performance in a medical simulation game: Using game-logs and eye-tracking. *Computers in Human Behavior*, *99*(April), 268–277. https://doi.org/10.1016/j.chb.2019.05.035

Lestari, F. P., Ahmadi, F., & Rochmad, R. (2021). The implementation of mathematics comic through contextual teaching and learning to improve critical thinking ability and character. *European Journal of Educational Research*, *10*(1), 497–508. https://doi.org/10.12973/EU-JER.10.1.497

Malvasi, V., & Gil-Quintana, J. (2022). Beliefs, performance, and applicability of mathematics in learning for life: The multi-case study at secondary education institutes in Italy. *Journal on Mathematics Education*, *13*(1), 51–68. https://doi.org/10.22342/jme.v13i1.pp51-68

Muhtarom, M., Sutrisno, S., Nizaruddin, N., & Murtianto, Y. H. (2024). Research on mathematical beliefs: systematic literature review. *International Journal of Evaluation and Research in Education*, *13*(2), 693–704. https://doi.org/10.11591/ijere.v13i2.25968

Mulwa, E. C. (2015). Difficulties Encountered by Students in the Learning and Usage of Mathematical Terminology: A Critical Literature. *Journal of Education and Practice*, *6*(13), 27–38.

Nasution, M. L., Yerizon, Y., & Gusmiyanti, R. (2018). Students' Mathematical Problem-Solving Abilities Through the Application of Learning Models Problem Based Learning. *IOP Conference Series: Materials Science and Engineering*, *335*(1), 0–5. https://doi.org/10.1088/1757-899X/335/1/012117

Nawas, A. (2018). Contextual Teaching and Learning (CTL) Approach Through REACT Strategies on Improving The Students' Critical Thinking in Writing. *International Journal of Management and Applied Science*, *4*(7), 46–49.

Pangemanan, A. (2020). Application of Contextual Teaching and Learning Approach on Statistics Material Against Student Results. *International Education Studies*, *13*(4), 1. https://doi.org/10.5539/ies.v13n4p1

Pinwanna, M. (2015). Using the Contextual Teaching and Learning Method in Mathematics to Enhance Learning Efficiency on Basic Statistics for High School Students. *The International Conference On Language, Education, Humanities & Innovation*, *21*(22), 58–63.

Podolak, M., Młynarska, M., Kawałek, A., Śnieżek, W., & Napiórkowska, G. (2016). *Modern Methods of Teaching – Learning Mathematicsand Related Subjects*. European Union under Erasmus+.

Priyadi, H. G., & Yumiati. (2021). The Effect of Contextual Teaching and Learning (CTL) Model With Outdoor Approach Towards the Students' Ability of

Mathematical Representation. *Education Quarterly Reviews*, *4*(3), 441–450. https://doi.org/10.31014/aior.1993.04.03.352

Putra, H. D., Setiawan, W., & Afrilianto, M. (2020). Indonesian high scholar difficulties in learning mathematics. *International Journal of Scientific and Technology Research*, *9*(1), 3466–3471.

Rusdi, R., Made Arnawa, I., Fauzan, A., & Lufri, L. (2018). The need analysis development of mathematics learning model based realistic mathematical education and literacy in junior high school. *Proceedings of the International Conferences on Educational, Social Sciences and Technology - ICESST 2018*, 86–94. https://doi.org/10.29210/2018113

Sari, N. H., Sutiarso, S., & Dahlan, S. (2019). Analysis of students problem solving ability by using polya steps in linear program material. *International Conference on Mathematics and Science Education*, *4*, 39–44.

Selvianiresa, D., & Prabawanto, S. (2017). Contextual Teaching and Learning Approach of Mathematics in Primary Schools. *Journal of Physics: Conference Series*, *895*(1), 012171. https://doi.org/10.1088/1742-6596/895/1/012171

Sibaen, N. W., Buasen, J. A., & Alimondo, M. S. (2023). Principal components of students' difficulties in mathematics in the purview of flexible learning. *Journal on Mathematics Education*, *14*(2), 353–374. https://doi.org/10.22342/jme.v14i2.pp353-374

Silseth, K., & Erstad, O. (2018). Connecting to the outside: Cultural resources teachers use when contextualizing instruction. *Learning, Culture and Social Interaction*, *17*(22), 56–68. https://doi.org/10.1016/j.lcsi.2017.12.002

Simonsmeier, B. A., Flaig, M., Deiglmayr, A., Schalk, L., & Schneider, M. (2022). Domain-specific prior knowledge and learning: A meta-analysis. *Educational Psychologist*, *57*(1), 31–54. https://doi.org/10.1080/00461520.2021.1939700

Sinay, E., & Nahornick, A. (2016). *Teaching and learning mathematics research Series I : Effective instructional strategies*. Toronto District School Board.

Siniguian, M. T. (2017). Students' difficulties in solving mathematical problems. *International Journal of Advanced Research in Engineering and Applied Sciences*, *6*(2), 1–12. https://doi.org/10.1063/5.0120257

Siregar, R. N., Suryadi, D., Prabawanto, S., & Mujib, A. (2023). Students' mathematics self-efficacy in learning social arithmetic topic. *International Journal of Evaluation and Research in Education*, *12*(4), 2176–2185. https://doi.org/10.11591/ijere.v12i4.25480

Sousa, M. J., Martins, J. M., & Sousa, M. (2019). Decision-Making Processes for Effective Problem Solving to Potentiate Organisations Sustainability. *European Journal of Workplace Innovation*, *5*(1), 119–132. https://doi.org/10.46364/ejwi.v5i1.593

Soyadı, B. B. Y. (2015). Creative and Critical Thinking Skills in Problem-based Learning Environments. *Journal of Gifted Education and Creativity*, *2*(2), 71–71. https://doi.org/10.18200/jgedc.2015214253

Suciati, Kartowagiran, B., Munadi, S., & Sugiman. (2019). The single-case research of coastal contextual learning media on the understanding of numbers counting operation concept. *International Journal of Instruction*, *12*(3), 681–698. https://doi.org/10.29333/iji.2019.12341a

Sudarman, S., Djuniadi, D., & Sutopo, Y. (2017). The Formation of Conservation – Based Behaviour of Mechanical Engineering Students through Contextual Learning

Approach. *International Journal of Environmental and Science Education*, *12*(4), 617–627.

Surya, E., Putri, F. A., & Mukhtar, M. (2017). Improving mathematical problem-solving ability and self-confidence of high school students through contextual learning model. *Journal on Mathematics Education*, *8*(1), 85–94. https://doi.org/10.22342/jme.8.1.3324.85-94

Swars, S. L., Smith, S. Z., Smith, M. E., Carothers, J., & Myers, K. (2018). The preparation experiences of elementary mathematics specialists: examining influences on beliefs, content knowledge, and teaching practices. *Journal of Mathematics Teacher Education*, *21*(2), 123–145. https://doi.org/10.1007/s10857-016-9354-y

Takunyaci, M. (2021). Investigation of Mathematics Teachers' Self-Efficacy in Teaching Mathematics in the COVID-19 Pandemic Process. *Education Quarterly Reviews*, *4*(2), 396–407. https://doi.org/10.31014/aior.1993.04.02.289

Univeren, D., & Karakus, G. (2020). An Alternative Approach in Constructivist Mentoring for Textual Analysis in Turkish Courses. *International Education Studies*, *13*(2), 71. https://doi.org/10.5539/ies.v13n2p71

Yeh, C. Y. C., Cheng, H. N. H., Chen, Z.-H., Liao, C. C. Y., & Chan, T.-W. (2019). Enhancing achievement and interest in mathematics learning through Math-Island. *Research and Practice in Technology Enhanced Learning*, *14*(1), 1–19. https://doi.org/10.1186/s41039-019-0100-9

Zhong, L., & Xu, X. (2019). Developing real life problem-solving skills through situational design: a pilot study. *Educational Technology Research and Development*, *0123456789*. https://doi.org/10.1007/s11423-019-09691-2

Zhou, M., & Brown, D. (2017). Educational Learning Theories. In *Education Open Textbooks*. GALILEO, University System of Georgia. https://oer.galileo.usg.edu/education-textbooks/1