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Comparison of the Effectiveness of Learning Model Problem Posing with Quantum Learning TANDUR toward Students' Understanding in Mathematics Concept

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Abstract

The purpose of this research is to know the effectiveness of the learning model Problem Posing type Post Solution Posing with Quantum Learning TANDUR type to understand the concept of mathematics on the integral material is not necessarily use three-teir multiple choice diagnostic test based E-Learning class XI MIPA students in SMA N 1 Bringin year Lesson 2019/2020. This research is a quantitative study of quasi-experimental experiments with the design of Posttest Only Control Group design. The samples in this study were students of grade XI MIPA 1 and XI MIPA 2 SMA N 1 Bringin. The instrument used in this study was about understanding the mathematical concept of Three-Teir Multiple Choice Diagnostic Test. The results of the study gained that the classifications of class-savvy category XI MIPA 1 have an average of 26.18% while the class XI MIPA 2 has an average of 21.47%. Thus, understanding the concept of class XI MIPA 1 is higher than the class XI MIPA 2. Then based on the results of the hypothesis test using an average similarity test with test-T scores obtained t-count =-0.00691 is between-2.02 ≤ t-table ≤ 2.02 which means that the effectiveness of implementation of learning model Problem Posing type Post Solution Posing same as the application of learning model of Quantum Learning TANDUR type towards understanding student mathematics concept.

***Keyword**: Problem Posing type Post Solution Posing; Quantum Learning type TANDUR; Understanding Mathematical concepts.*

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INTRODUCTION

Mathematics is one of the sciences that plays a very important role in the development of science and technology so that it is very important to learn. By saying so, mathematics is one of the compulsory subjects taught in schools at the elementary, junior high, high school and equivalent levels (Megawanti, 2015; Rahmad, 2021; Rokhisnain & Fatih'Adna, 2019; Rosnawati & Pendahuluan, 2013). Syahbana stated that mathematics as a scientific discipline that clearly relies on thinking processes is considered very good to be taught to students (Syahbana, 2012). In other words, learning mathematics aims to habituate the students to think systematically, logically, critically, and creatively (Bakker et al., 2021; Firdausi et al., 2018; Inglis & Attridge, 2016; Siagian, 2016).

The main problem that is often faced by students in learning mathematics is the low ability to understand students' concepts (Masitoh & Prabawanto, 2016; Mawaddah & Maryanti, 2016; Sáinz & Upadyaya, 2016; Sangwin, 2018). Factors that influence the low understanding toward students' concepts are the learning that is carried out tends to be teacher-centered, the teacher provides formulas and provides examples of questions and the solutions (Andri & Rismawati, 2018; Ardila & Hartanto, 2017; Yukentin et al., 2018). Student activities are only around working on problems based on existing formulas and based on examples given by the teacher without knowing where the formulas came from. In this sense, teacher-centered learning cannot develop the understanding of mathematical concepts.

Based on the observations and interviews result done by the researchers with mathematics teachers at SMA N 1 Bringin on October 14, 2019, it was found that student learning outcomes have not been able to reach the desired standard. This can be seen from the Mid-Semester Assessment (PTS) where many students still get scores below the Standard of Minimum Criteria (KKM) that has been set. The observation result shows that in class of XI MIPA, of 119 students only 14 or (12%) get scores above the KKM, while 105 or (88%) students' scores are still below the KKM. The KKM for mathematics subjects applied by schools is 75 out of 100. The phenomenon of the number of students getting scores below the KKM is due to the low ability to understand mathematical concepts so that learning outcomes do not meet the KKM. In addition, most of the students tend to be passive in participating in mathematics learning

activities. When learning mathematics takes place, students feel afraid and embarrassed to ask questions about the explanations or practices given by the teacher. There are various reasons students which cause the students' embarassment and fear. Among those reasons, students are considered stupid by other students because they ask easy things according to the views of other students. In addition, students lack of motivation to learn because they think that the material being taught is not useful for everyday life. To an extent, they want to quickly finish the learning process because they feel bored. It happens due to lack of interaction between teachers and students which results in students having difficulty understanding mathematical concept and material.

Facing those problems, various efforts can be made by the teacher. One of them is by using the right learning model. The learning model is a plan or a pattern that is used as a guide in planning classroom learning or tutorial learning and to determine learning devices including books, films, computers, curriculum and others (Fathurrohman, 2015; Rehalat, 2014; Rosmala, 2021; Tayeb, 2017).

In learning mathematics, it is necessary for the teacher to give freedom to students to think freely, be creative and learn independently according to their abilities in order to understand the subject matter presented by the teacher at school. In the Qur'an, it has been explained in the letter of Al Ankabut verse 14 which means: "We did send Nuh to his people, and he tarried among them a thousand years less fifty: but the Deluge overwhelmed them while they (persisted in) sin." (Kementerian Agama, 2014). In the Qur'an, Surah Al Ankabut verse 14 shows the subtraction operation, which is 1000 years - 50 years = 950 years. The meaning behind the way the year is addressed is that besides being easy to pronounce the number 1000 years - 50 years rather than mentioning the number 950 years, that is, as Muslims we must be able to think freely and creatively. Quantum learning makes a significant contribution to the development of one's creativity (Afacan & Gürel, 2019; Deporter & Hernacki, 1992; Syukria, 2019; Zeybek, 2017). One of the learning models that can be used to make students think freely and creatively according to their abilities is the Problem Posing learning model using Post solution Posing type and Quantum Learning TANDUR type.

The Problem Posing learning model is a learning model that requires students to pose their own questions through learning to make questions independently (Fernández & Molina, 2017; Lee et al., 2018; Nurina & Retnawati, 2015). Learning with Problem

Posing is a learning in which students are asked to formulate, form and ask questions from the provided situation, the situation can be in the form of pictures, stories, or other information related to the subject matter and then the students themselves must design how to solve them. (Brown & Walter, 2005; Shanti et al., 2017; Siswono, 2004). The role of the teacher in this activity is to motivate students to actively participate in learning activities and guide students in the process of problem solving (Oktavia, 2014). One of Problem Posing learning model types is the Post Solution Posing type. In the Post solution type Posing students make similar questions based on the teacher's explanation and students must be able to solve the problem (Mishra & Iyer, 2015; Whitin, 2006).

The TANDUR type of Quantum Learning model is a fun learning model and can create a meaningful impression for students (Amalia, 2013; Cahyaningrum et al., 2019). TANDUR stands for *Tumbuhkan* (Grow), *Alami* (Experience), *Namai* (Name), *Demonstrasikan* (Demonstrate), *Ulangi* (Repeat) and *Rayakan* (Celebrate) (Cahyaningrum et al., 2019). The TANDUR technique is a learning model designed by teachers to help students overcome the difficulties in understanding lessons or degrees of personal risk (Arviani et al., 2019; Sugiati et al., 2019; Werdiningtyas, 2021).

To measure the level of students' understanding of a mathematical concept, the researchers used the Three-Teir Multiple Choice Diagnostic Test. A diagnostic test is a test that aims to identify students' learning difficulties in terms of understanding key concepts on a particular topic (Caleon & Subramaniam, 2010; Cetin-Dindar & Geban, 2011; Kirbulut & Geban, 2014). The diagnostic test used in this study is a multiple-choice diagnostic test with three levels of questions called the "Three-tier Multiple Choice Diagnostic Test". The first level is a multiple choice question with three distractors and one answer key. The second level is the reason students answer the question, in the form of three reasons that have been provided with two distractors and one answer key and one open reason that can be filled in by the students themselves.. The purpose of the open reason is to identify the possibility of other reasons students have in choosing an answer that is not available in the three choices provided. The third level is the level of student confidence in choosing answers and reasons (Cetin-Dindar & Geban, 2011; Peşman & Eryılmaz, 2010).

In this study, researchers used electronic-based learning (e-learning). E-learning is defined as any teaching and learning that uses the internet to deliver learning content, interaction, or guidance (Suyanto, 2005; Yazdi, 2012). In this e-learning, researchers use the cisco webex meetings and WhatsApp applications for the learning process, Google forms for collecting assignments and working on the Three-Teir Multiple Choice Diagnostic Test.

Based on the explanation above, the researchers are interested in conducting research on the Comparison of the Effectiveness of the Post Solution Posing Problem Posing Learning Model with Quantum Learning TANDUR Type on Understanding Mathematical Concepts Using Three-Teir Multiple Choice Diagnostic Tests Based on E-Learning for Class XI MIPA Students at SMA N. 1 Bringin the 2019/2020 Academic Year. This study seeks to reveal the effectiveness of the use of post-solution posing problem posing learning model on understanding mathematical concepts using the Three-Teir Multiple Choice Diagnostic Test. In addition, it also reveals the effectiveness of using the TANDUR type of quantum learning model for understanding mathematical concepts using the Three-Teir Multiple Choice Diagnostic Test. At the end, this study will compare the effectiveness of applying the post solution posing type of problem posing learning model with the TANDUR type of quantum learning on understanding mathematical concepts using the Three-Teir Multiple Choice Diagnostic Test.

METHOD

The type of research is a quasi-experimental research with a posttest only control group design. The following research design can be seen in Table 1.

Table 1. Research Design

R_1	**X_1**	**O_1**
R_2	**X_2**	**O_2**

Description: R1: experimental class I was chosen randomly; R2: experimental class II was chosen randomly; X1: treatment with a post-solution problem posing learning model; X2: treatment with the TANDUR type of quantum learning model; O1: the posttest value of the experimental class I; O2: the posttest value of the experimental class II.

This research was conducted at SMA N 1 Bringin. The population in this study were all students of class XI MIPA SMA N 1 Bringin in the academic year of 2019/2020. Samples were taken using cluster random sampling technique, obtained class XI MIPA 1 as experimental class 1 and class XI MIPA 2 as experimental class 2.

The design in this study includes the stages of preparation, implementation, data analysis and conclusions. In the preparation stage, the procedures carried out by the researcher are: performing observations by looking at the facts on the ground; formulating the problem; preparing research proposals; developing research instruments; validating and testing research instruments; preparing a research place permit; and selecting and determining the research sample.

At the implementation stage, the researcher: conducting learning activities in the experimental class 1 with the post solution posing problem posing learning model and the experimental class 2 with the TANDUR type Quantum Learning learning model; conducting a test of students' understanding of mathematical concepts using a three-tier multiple choice diagnostic test instrument in the experimental class 1 and experimental class 2. Furthermore, in the data analysis stage, the researchers collecting data from the experimental class 1 and experimental class 2; and processing and analyzing the data obtained with the aim of answering the research questions. Finally, the researcher draws conclusions based on data analysis and the facts of the learning process found.

The instruments in this study were fragments of the syllabus that had been validated by experts, the Lesson Plan (RPP) which had been validated by experts, the comprehension test with the concept of the three-tier multiple choice diagnostic test which had previously been tested for validity, reliability, level of difficulty and discrimination index. The initial data analysis was carried out by testing the results of the midterm test in Odd Semester Assessment, namely normality test, homogeneity test, similarity test of two averages to determine the initial condition of the population and sample. Furthermore, the analysis prerequisite test was carried out by testing the results of the assessment of comprehension test using three-tier multiple choice diagnostic test, namely the normality test and homogeneity test to determine whether the two selected samples were normally distributed and had the same homogeneity or not. Then the final stage of data analysis was carried out by testing the results of the assessment of

comprehension test using the three-tier multiple choice diagnostic test, namely hypothesis testing and concept understanding analysis.

The criteria for the effectiveness of the learning model in this study are presented in Table 2.

Table 2. Effectiveness Criteria

Percentage	Criteria
1% - 24%	Ineffective
25% - 49%	Less effective
50% - 74%	Effective enough
75% - 100%	Effective

(Lubis, 2016)

The following interpretations of the answers to the question of comprehension test using the three-tier multiple choice diagnostic test are presented in Table 3. The following criteria for the percentage of students who understand the concept are presented in Table 4.

Table 3. Interpretation of Answers for Three-Tier Multiple Choice Diagnostic Test

Answer Combination			Classification of Student Answers	Category
Level 1	Level 2	Level 3		
Right	Right	High	Complete Understanding	Understand
Right	Wrong	High	Misconception	Misconception
Wrong	Right	High	Misconception	
Wrong	Wrong	High	Misconception	
Right	Right	Low	Lucky	Do not understand
Right	Wrong	Low	Not really understand	
Wrong	Right	Low	Not really understand	
Wrong	Wrong	Low	Not understand	

(Mubarak dkk, 2016)

Table 4. Percentage Criteria of Concept Understanding

Percentage	Criteria
0% ≤ P < 20%	Very low
20% ≤ P < 40%	Low
40% ≤ P < 60%	Average
60% ≤ P < 80%	High
80% ≤ P < 100%	Very high

(Alighiri dkk, 2018)

RESULT AND DISCUSSION

Data Analysis

The data used in this early stage of data analysis are the results of the Midterm test in Odd Semester. The tests used in this initial stage of data analysis include:

Normality test

Based on the results of the analysis of the normality test on the population data obtained X^2_{count} for each data less than X^2_{table} with df=3 and the significance level of 5% it can be concluded that the population data is normally distributed. Details about the results of the normality test can be seen in Table 5.

Table 5. Results of the Population Data Normality Test

No	Class	χ^2_{count}	χ^2_{table}	Distribution
1.	XI MIPA 1	4,43	7,81	normal
2.	XI MIPA 2	3	7,81	normal
3.	XI MIPA 3	3,36	7,81	normal
4.	XI MIPA 4	1,66	7,81	normal

Population data homogeneity test

Based on the results of the analysis of the homogeneity test on the population data obtained X^2_{count} less than X^2_{tabel} with the significance level of 5% and df=3 so that it can be concluded that the population has the same homogeneity. The details of the homogeneity test results are in Table 6.

Table 6. Results of the Population Data Homogeneity Test

Data	χ^2_{count}	χ^2_{table}	Criteria
Midterm Test	4,68	7,81	Homogen

The similarity of two averages test

Based on the results of the analysis of the two averages, the result of t_{count} is between $-2{,}00 \leq t_{table} \leq 2{,}00$ with the significance level of 5% and df= 58 so that it can be concluded that there is no difference in the average between the experimental class 1 and the experimental class 2. The details of the similarity test of the two averages are in Table 7.

Table 7. Results of the Similarity Test of Two Averages - Initial Stage Average

$\overline{x}_1$	$\overline{x}_2$	s_1^2	s_2^2	s^2	s	t_{count}
78,6	78,1	15,8	15,1	15,5	3,9	0,54

Based on the initial data analysis, it can be concluded that the sample comes from a population that is normally distributed and homogeneous. In addition, the two samples also have the same initial average score. It means that both samples depart from the same initial conditions.

Prerequisite test

The data used in this prerequisite test is the posttest result of the mathematic concept comprehension test (three-tier multiple choice diagnostic test). The tests used in this prerequisite test include:

Sample normality test

Based on the results of the analysis of the normality test of the sample data in Table 8, it is obtained χ^2_{count} for each data less than χ^2_{tabel} with df=3 and the significance level of 5%. It means that the sample data is normally distributed.

Table 8. Results of the Sample Data Normality Test

No	Class	χ^2_{count}	χ^2_{table}	Distribution
1.	Experimental class 1	2,93	7,81	normal
2.	Experimental class 2	1,07	7,81	normal

Sample homogeneity test

Based on the results of the analysis of the homogeneity of the sample data in Table 9, it is obtained χ^2_{count} less than χ^2_{table} with the significance level of 5% and df= 1 so that it can be concluded that the sample has the same homogeneity.

Table 9. Results of the Sample Data Homogeneity Test

Data	χ^2_{count}	χ^2_{table}	Criteria
concept comprehension test questions	0,048	3,84	Homogen

Final data analysis

Hypothesis test

Based on Table 10, the value of t_{count} = -0,00691 is between -2, 02≤ t_{tabel} ≤ 2,02 so that H_0 is accepted which means that there is no difference in the average between the experimental class 1 and the experimental class 2. Therefore, it can be concluded that the effectiveness of the application of the post solution posing type of problem posing learning model in the experimental class 1 is the same as the application of the TANDUR type of quantum learning learning model in the experimental class 2.

Table 10. Results of the Similarity of Two Posttest Averages Test

$\overline{x}_1$	$\overline{x}_2$	s_1^2	s_2^2	s^2	s	t_{count}
62,3	62,3	566,9	516,2	536	23,2	-0,00691

Mathematic concept comprehension analysis

After being analyzed, the instrument for the mathematic concept comprehension test of the three-tier multiple choice diagnostic test is feasible to use based on the validity test, reliability test, difficulty level test and differentiating power of the questions. Furthermore, the instrument was tested on each class that had been given treatment. The results of the students' answer in each question of mathematic concept comprehension questions were analyzed. The following is the interpretation of the results of the analysis of students' conceptual understanding.

Table 11. Analysis of Question Item

Category	Criteria	Number of questions	
		Experimental class 1	**Experimental class 2**
Understand	Very low	16	24
	Low	16	11
	Average	6	3
	High	2	2
	Very high		
Misconception	Very low	14	1
	Low	20	9
	Average	6	27
	High		3
	Very high		
Not understand	Very low		6
	Low	9	23
	Average	21	11
	High	10	
	Very high		

Based on Table 11 in experimental class 1, classically the understanding category has an average of 26.18%, misconceptions has an average of 24.61% and does not understand an average of 49.21%. Then, in the experimental class 2, the classical understanding category has an average of 21.47%, misconceptions has an average of 45.17% and does not understand an average of 33.36%. Therefore, it can be concluded that the students' understanding of mathematical concepts in experimental class 1 is higher than that of experimental class 2.

Discussions

Electronic-based learning (E-learning)

The government's decision to carry out online learning was due to the COVID-19 pandemic. In this study the researchers used: (a) the cisco webex meetings application is an application that supports video conferencing that can cover one class, making it easy to provide material and interact with students. (b) Google forms as a means of collecting assignments given by researchers. (c) WhatsApp application to communicate after learning takes place.

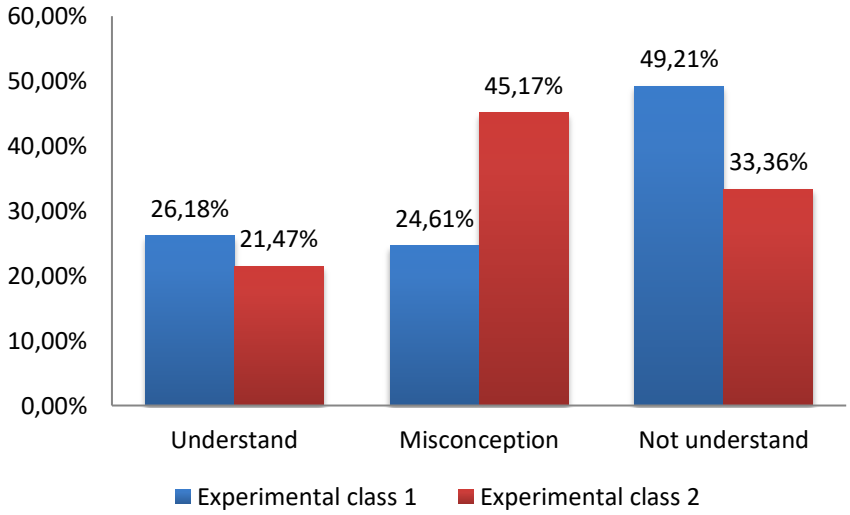

Figure 1. Comparison of Understanding Mathematical Concepts

The learning process based on e-learning in the experimental class 1 which uses a problem posing learning model of post solution posing type. The steps of the problem posing learning model of post solution posing type are as follows (Himmah & Istiqlal, 2019). (a) The teacher explains the subject matter to the students. The use of props to clarify concepts is highly recommended. (b) The teacher provides enough practice questions. (c) Students are asked to ask 1 or 2 challenging questions and the students concerned must be able to solve them. This task can be done in groups. (d) In the following meeting, the teacher asks students to present their findings in front of the class randomly. In this case, the teacher can determine students selectively based on the weight of the questions submitted by students. (e) The teacher gives homework individually. The characteristic of the post-solution posing problem type learning model is that students are required to make challenging, varied questions and solve them after the teacher explains and gives examples. In the learning process, students are required

to be active because students work on questions they make, of course, each student has their own difficulties in solving them. From these difficulties the teacher understands what the students have not understood so that the teacher can provide more explanations. In contrast to the conventional learning model, the learning activities tend to be dominated by the teacher (Elida, 2012; Mayasari & Afriansyah, 2016).

The electronic-based learning process (e-learning) in the experimental class 2 used the TANDUR type of quantum learning model. The steps of the TANDUR type quantum learning model are as follows (Putradi, 2018). (a) *Tumbuhkan* (Grow), it aims to develop students' interest in learning activities. (b) *Alami* (Experience), it brings the general experience of students by informing their knowledge. (c) *Namai* (Name), it provides opportunities for students to identify, sort, and define a concept with the knowledge they have. (d) *Demonstrasikan* (Demonstrate), students are given the opportunity to convey their knowledge in the learning process. (e) *Ulangi* (Repeat), students are given the opportunity to ask questions about learning that has not been understood, then make a conclusion. (f) *Rayakan* (Celebrate), it is to give an award or motivation to students for the learning outcomes they get. The characteristic of the TANDUR type of quantum learning model is the steps that make students active and fun. TANDUR stands for *Tumbuhkan* (Grow), *Alami* (Experience), *Namai* (Name), *Demonstrasikan* (Demonstrate), *Ulangi* (Repeat) and *Rayakan* (Celebrate)

The obstacles experienced by researchers when conducting e-learning are as follows: (a) Insufficient internet data packages causes students not to be able to do assignments and not to be able to participate in learning. (b) A weak signal network causes the material to not be perfectly received by students (c) The authenticity of the results of student answers is doubtful, researchers cannot monitor the learning process, therefore when the questions or assignments given to students might be done by anyone. (d) Lack of mastery in operating the application causes the interaction between students and researchers to be passive. (e) Ineffective learning activities, the longer the researcher explains, the more data packages are drained, both students and researchers. (f) Lack of students' motivation in implementing e-learning.

The advantages experienced by researchers when conducting e-learning are as follows: (a) It is free to determine learning time based on mutual agreement anytime and anywhere. (b) For students who are interested in participating in online learning,

students are actively asking, searching and learning the material taught by the researcher themselves.

Discussion of the students' concept understanding analysis

Students' understanding of mathematical concepts was measured using a three-tier multiple choice diagnostic test instrument. During the research, the researchers changed the printed version of the question into a digital version by using google forms so that it could be done using electronic media such as cellphones or laptops. Before the questions were given as posttest questions, the questions had been tested and analyzed for validity, reliability, discrimination index and the level of difficulty of the questions to determine the feasibility of the test questions for understanding the concept. Then, the questions were given as a posttest to the experimental class that has been given treatment. Based on Figure 1, the results of the problem of understanding the concept for the experimental class 1 is 26.18% and for the experimental class 2 is 21.47%. The percentage of understanding of the concepts of the two classes is relatively low due to constraints in the e-learning process.

The advantages of the research instrument on understanding the concept of the three-tier multiple choice diagnostic test are based on the findings of the researcher. Based on the interpretation of the answers to the question of the concept understanding, the teacher understands the students' abilities. To an extent, if there are misconceptions found during the learning activities, the teacher can clarify to the students. In addition, the teacher can repeat the material that the students really do not understand. Then, the teacher can provide enrichment or questions with a higher level of difficulty for students who already understand the material based on the data accuracy.

There are several shortcomings of the research instrument about understanding the concept of the three-tier multiple choice diagnostic test based on the findings of the researcher. The implementation takes a long time to make the instrument, what is more, it is integrated with the use of information technology such as the internet. Students become lazy to work on questions because the number of questions is three times more than the ordinary multiple choice questions. It took a long time in correcting the answers to be able to find out which material or questions had been understood, had misconceptions and did not understand at all. This can be overcome by the use of technology such as google forms but the teachers must be able to operate it at the first

place. The authenticity of the answers needs to be questioned because this is done at home so that the process of working on the questions can be done by anyone and can copy the answers of friends who have worked on the questions earlier.

CONCLUSION

The understanding of mathematical concepts of the students in experimental class 1 by applying the post solution posing type of problem posing learning model is higher than that of the experimental class 2 by applying the TANDUR type of quantum learning learning model. This can be seen classically for the understanding category, the experimental class 1 has an average of 26.18% while the experimental class 2 has an average of 21.47%. The implementation of the post-solution posing type of problem posing learning model is less effective for understanding mathematical concepts using a three-teir multiple choice diagnostic test based on e-learning. This can be seen classically, the posttest results for the experimental class 1 using the problem posing learning model of post solution posing type have an average of 26.18% included in the criteria for low level understanding and based on Table 2 an average of 26.18% included in the criteria less effective.

The implementation of the TANDUR type of quantum learning learning model is not effective for understanding mathematical concepts using a three-teir multiple choice diagnostic test based on e-learning. This can be seen classically, the posttest results for experimental class 2 using the TANDUR type of quantum learning learning model have an average of 21.47% included in the criteria for low-level understanding and with an average of 21.47% included in the ineffective criteria. The effectiveness of the application of the post solution posing type of problem posing learning model in the experimental class 1 is the same as the application of the TANDUR type of quantum learning learning model in the experimental class 2 towards understanding mathematical concepts using a three-teir multiple choice diagnostic test based on e-learning. This can be seen by comparing the results of the posttest average scores of students in experimental class 1 which is 62.26 out of 100 and experimental class 2 which is 62.31 out of 100. Based on the calculation of the hypothesis test with t-test statistics, it is stated that there is no difference in the average between the experimental class 1 and the experimental class 2. So it can be concluded that the average ability to understand mathematical concepts of students using the problem posing learning model of post

solution posing type is the same as the ability to understand mathematical concepts using the TANDUR type of quantum learning model.

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