Comparison of Mathematics Learning Outcomes with Student Team Achievement Divisions and Team Assisted Individualization Model

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Abstract— **The purpose of this study was to determine the difference between student learning outcomes in mathematics using the Student Team Achievement Divisions (STAD) learning model and the Team Assisted Individualization (TAI) learning model. The research method is descriptive quantitative with a quasi-experimental approach, and a two-group posttest only control design. Samples were taken by means of convenience sampling. The data collection technique is a test instrument by looking at the learning outcomes. The results and findings, based on the results of hypothesis testing using the t-test, obtained that t count is greater than t table of 3.179> 1.995 with a significance level of 0.05. These findings are supported by the calculation of learning outcomes for experimental class I using the Student Team Achievement Divisions method with the average value is 70.01, this shows a higher value than the experimental class II which uses the Team Assisted Individualization method which averages 66.90. The conclusion is that there are differences in the learning outcomes of students who are taught using the Student Team Achievement Divisions model with students who are taught using the Team Assisted Individualization learning model. The Student Team Achievement Divisions learning model produces higher learning outcomes and is recommended to be used in teaching all mathematics materials at all levels**

Keywords— **Mathematics Learning; Model Mathematics with STAD and TAI; Comparison STAD and TAI**

I. INTRODUCTION

In building a nation, the state must start from the development of education [1]. This is because the most important part of the country's infrastructure is education [2]. Countries that are not ready in terms of education will have difficulty keeping up with the development and development of increasingly perfect technology [3]. Countries that pay attention to education make humans and their performance better and able to compete in supporting themselves [1].

Education that has the ability to support infrastructure is education that is capable of developing students. The state realizes education by building schools as formal places [4]. In the world of education, a person gets the development of abilities, changes in attitude and makes students better at doing something [5]. This is related to the law that applies in Indonesia No. 20 of 2003 which explains the understanding of education, namely an effort to realize an atmosphere of learning activities so that students take the initiative to hone their abilities to have

confidence, self-control, personality, intelligence, noble character, and skills that everyone needs [6]. In general, education builds a thought that demands an achievement that can be accounted for in the problems at hand [7]. Learners as human beings who have reason and are able to think, have a special part in personal development to become human beings who continue to learn through thinking and verbalization [7]. Holistic thinking in every aspect of life, is expected to be able to produce individuals who are in harmony with their goals [7]. Education is also the most important aspect as a means for students to hone their minds and character through learning in the classroom and online [8]. Education is designed with the aim of achieving learning, so as to make changes in student behavior after learning [9]. In general, mathematics is a subject that has the most role in the development of other sciences [10]. Mathematics has been formally given from an early age, starting at the elementary school level to higher education [11]–[13]. However, those who experience the most difficulties are at the elementary-high school level [14]. In the process of implementing mathematics learning material, students experience many difficulties in certain materials [15]. This argument is supported by reality data from mathematics learning outcomes as seen from the Minimum Completeness Criteria (KKM) standards that are not achieved. Improving the quality of the learning process for mathematics is an important topic for discussion. Various attempts have been made to make learning mathematics easier [16]. One of them is by designing and implementing appropriate learning models [8], [17], [18], methods, and strategies [19]–[21]. The process of learning mathematics is attempted with the aim of students obtaining learning outcomes [22]. Real and actual learning outcomes from students are a reflection of the implementation of the process which is influenced by the models and strategies used [23].

Researchers observed the learning process for class XI IPA 4 and XI IPA 1 at SMA Negeri 17 Tangerang Regency. The learning process in the classroom is more likely to be taught by the teacher and practice questions. According to students, there were several reasons that resulted in not liking mathematics, including classroom management that was not programmed properly, students did not concentrate and lack of practice

so that by itself it affected learning outcomes. Low scores are related to active learning, for example, being shy about asking the teacher and being active in doing practice questions [24]–[26]. The results of this kind of learning can be seen in the daily test scores for rows and series. The data obtained, both classes have a non-pass percentage of less than 50%. These data explain that the learning outcomes of students in learning mathematics are relatively low. The Minimum Completeness Criteria (KKM) of 65 is the standard for measuring mathematics learning outcomes for class XI IPA at SMA Negeri 17 Tangerang Regency. If you are active in the learning process, you will not only get aspects of learning outcomes but also get other aspects, namely affective aspects and social aspects [27]. Considering the main role of student participation, the teacher should make a learning situation that involves students, the teacher tries to improve the quality of learning activities, namely in designing various kinds of learning processes in the classroom [28]. Learning is a relationship between teachers and students. With the establishment of this relationship, students maintain knowledge actively in the learning process that takes place in an inspiring, mutually active and facilitated manner so as to obtain the expected abilities [3].

Planning varied learning activities is very useful for teachers to do during a meaningful learning process so that they can explore the competencies of students. The learning process that has meaning becomes a benchmark for students to get good learning outcomes, so the ability of educators is needed in planning meaningful learning process activities. Teachers who use learning models affect the quality of students, because the teaching methods used by educators are interrelated with the achievement of learning objectives. Teachers who choose the wrong learning model will make learning outcomes decrease so teachers need to need competence in learning models. Researchers apply a cooperative learning model for students to participate in the learning process personally so that it has an important meaning and gets good learning outcomes. Cooperative learning model that involves students into groups to solve difficulties and design conclusions so that this learning experience can improve learning outcomes. There are several types of cooperative learning models, including Student Team

Achievement Divisions and Team Assisted Individualization. The Student Team Achievement Divisions learning model utilizes groups, each group has four to five heterogeneous students. The meaning of a heterogeneous group is a group consisting of students who have different basic academic abilities, ethnicities, and genders. The Team Assisted Individualization learning model utilizes group competition to get the best score, where each group has a coach for the group and tries to adjust individual differences and help each other in heterogeneous groups. STAD and TAI learning models are learning that prioritizes learning in groups. This is intended to overcome the differences in knowledge possessed by each student. By doing initial thoughts, it is hoped that students will be able to explore knowledge and experience learning firsthand. The STAD and TAI learning models have a basic similarity, namely in their implementation, students provide responses through group discussions and direct a personal understanding seen from individual learning outcomes tests. Students who are not able to hone their knowledge competence and discuss with more qualified students, while for students who are helpful, cooperative learning provides an understanding that IA is in a building community. Researchers want to compare the learning outcomes of students who are taught using the STAD and TAI learning models. This study can explain the differences in learning outcomes of students who are taught using the STAD and TAI learning models so that they can be used by teachers as reference materials of choice in setting learning models

II. METHOD

The research method used is a quantitative research method. The type of research method used is quasi-experimental research [29]. In this study, the two classes were compared given different treatments without changing the composition of the two classes. In the first experimental class, teaching using the STAD learning model was applied, then held a test to see the results of the treatment [30]. In the second experimental class, teaching using the TAI learning model was applied, then held a test to see the results of the treatment. The experimental design used learning outcomes (two-group posttest only design). The population in this study were all students of class XI IPA SMA Negeri 17 Tangerang Regency in the second semester of the 2021/2022 academic year which consisted of five classes with a total of 175 students. The selected samples were two classes, namely, class XI IPA 4 as experiment I and class XI IPA 1 as experiment II. The sampling technique used in this study is a convenience sampling technique, which is taking samples that are in accordance with the provisions of samples from certain populations that are not difficult to obtain. The sample selection was based on convenience, the availability of classes that received permission from the school, and the suitability of the material in conducting sample selection. To find out the similarity of the characteristics of the sample, the two classes' average learning outcomes were tested based on the values of the Barisan and Series Daily Tests obtained from the school [31].

The instrument used in this study was a test. The test instrument used is an essay question. The research data were obtained from the learning outcomes of the students of class XI IPA 4 in experiment I who were taught using the STAD learning model and class XI IPA 1 in the experimental class II who was taught using the TAI learning model obtained through a written test on the material limit of algebraic functions where the test used carried out by the two classes are the same. The validity of the instrument carried out by the researcher is the validity of the content and the validity of the conception. Content validation involves three experts, namely: 1) validator I, namely Advisory Lecturer I Mathematics Education at the Christian University of Indonesia, 2) validator II, namely Advisory Lecturer II for Mathematics Education at Indonesian Christian University, and 3) validator III, namely Mathematics Teacher at SMA Negeri 17 Tangerang Regency. Validation was carried out once on the learning outcomes instrument. Validation of the concept using test questions, namely: 1) instrument validity, 2) instrument reliability, 3) discriminating power of questions, and 4) the level of difficulty of the questions. The descriptive statistics in this study are calculating the mean, median (Me), mode (Mo), standard deviation, and variance [32].

The data analysis consisted of the equivalence test of the Barisan and Series Daily Deuteronomy scores and data analysis of student learning outcomes. The equivalence test of the Daily Test scores in both classes aims to determine whether the initial abilities of the two classes are the same or not [32]. After the data was collected and before conducting the data analysis test, the data was analyzed to determine whether the data was normal and homogeneous [33]. For processing the data, the researcher used the help of Ms. Excel. To answer the hypothesis in this study, an average test was performed using a t-test. For processing the data, the researcher used the help of Ms Excel (Zhao et al., 2019).

III. RESULT AND DISCUSSION

The population of this study were all students of class XI IPA as many as 175 students. The sample of this research is students of class XI IPA 4 as experiment I and XI IPA 1 as experiment II. The research was conducted in three stages, namely the first stage of testing the average similarity of learning outcomes for the two classes using the Barisan and

Sequence Daily

Test scores, then the second stage of learning which was carried out for three meetings and the third stage of learning outcomes tests. In the experimental class I applied the Student Team Achievement Divisions (STAD) learning model and in the experimental class II the Team Assisted Individualization (TAI) learning model was applied. Researchers teach the material limit algebraic functions. Furthermore, to answer the formulation of the problem in this study, data processing of learning outcomes was carried out. Researchers used test instruments to measure student learning outcomes, first tested in different classes, namely class XI IPA 2 SMA Negeri 17 Tangerang Regency, then after being declared eligible then the instrument was able to measure the learning outcomes of students who became the research sample, then the data was analyzed further Carry on.

The results of the analysis of the test questions consist of validity, reliability, discriminatory power and level of difficulty. A total of 10 questions were tested with an allocation of 90 minutes. In this study, the initial ability analysis was obtained from the data of the Barisan and Sequence Daily Tests for both classes. This test was conducted to see if the two classes had the same initial ability. The data were analyzed descriptively with the aim of providing an overview of the results of the processing that has been carried out.

TABLE 1
Second Class Test Results for Ability Differences

Class	n	x_{max}	x_{min}	$\bar{x}$	s
XI IPA 4	35	5	95	51,143	31,949
XI IPA 1	35	5	95	49,429	32,782

The data obtained based on the descriptive data processing above cannot be concluded as to the average similarity of the learning outcomes of the two classes. Therefore, data processing was carried out using inferential statistics to ensure the significance of the similarity in the average learning outcomes of the two classes. The normality test aims to determine the normality of the data on the daily test scores for rows and series from the two classes.

TABLE 2
Test the Normality of The Data on the Daily Test Values of Rows and Series From Both Classes.

Class	N	L_{hitung}	L_{tabel}	Test Decision
XI IPA 4	35	0.117	0.150	Ho Normal
XI IPA 1	35	0.143	0.150	Distribution

Based on the normality test that has been carried out, information is obtained that the data for the Daily Deuteronomy of Barisan and Series both groups have the same results, namely that both data are normally distributed. Therefore, the homogeneity test was then carried out. The homogeneity test aims to determine whether the variance of the two groups is homogeneous or not.

TABLE 3
Test the Homogeneity of Variance of the Two Groups

Class	N	(s^2)	F_{hitung}	F_{tabel}	Test Decision
XI IPA 4	35	1020.71	1.05	1.76	Ho Homogeneous Data
XI IPA 1	35	1074.66			

Based on the homogeneity test that has been carried out, information is obtained that the variance of the Daily Deuteronomy of Barisan and Series data for the two groups is homogeneous. Therefore, a t-test was then carried out (test for

the difference between the two means). The difference test of the two averages aims to process the data to find out if there are similarities between the two averages of learning outcomes from the values of the Barisan and Series Daily Tests of the two classes.

TABLE 4
Results of T-Test (Difference Test of Two Means) for Both Groups

S_{gabung}	t_{hitung}	t_{tabel}	Test Decision	Conclusion
32,368	1,261	1,995	Ho	No Difference

Based on the summary of the results of the t-test, namely. Thus, Ho is accepted. This shows that both classes have the same ability so that learning is carried out using the Student Team Achievement Divisions (STAD) learning model and the Team Assisted Individualization (TAI) learning model $t_{Hitung} < t_{tabel}$ 1,26 < 1,995.

This data analysis was carried out with the aim of answering the hypothesis that there were two differences in the average learning outcomes of students in the experimental class I and experiment II. Before testing the hypothesis, the normality test, homogeneity test, and t-test were first carried out. From the learning outcomes of the experimental class I and the experimental class II, data obtained from the learning outcomes were processed descriptively. Descriptive data processing was carried out to determine the average, maximum score, minimum score and standard deviation of the two classes. Descriptive analysis was carried out before processing the inferential statistical data.

TABLE 5
Results of Descriptive Data Processing

Class	N	x_{max}	x_{min}	$\bar{x}$	s
Experiment I (STAD)	35	97.279	34,014	70.010	19,271
Class	N	x_{max}	x_{min}	$\bar{x}$	s
Experiment II (TAI)	35	96,599	21,088	66,900	14,759

The data obtained based on the descriptive data processing above cannot be concluded as to the difference between the two average learning outcomes of the two classes. Therefore, data processing was carried out using inferential statistics to prove the significance of the difference in the average learning outcomes of the

two classes. The normality test aims to determine the normality of the learning outcomes data from the two classes.

TABLE 6
Test Normality Learning Outcomes from Both Classes

Class	n	L_{hitung}	L_{tabel}	Test Decision
Experiment I (STAD)	35	0.130	0.150	Ho Normal
Experiment II (TAI)	35	0.079	0.150	

In the table above, it is known that the "experimental class I value (0.130 < 0.150) so that the accepted hypothesis is that the experimental class I comes from a population that is normally distributed. Likewise in the experimental class II where the value is (0.079 < 0.150), so the accepted hypothesis is that the experimental class II comes from a normally distributed population. Therefore, the two learning outcomes data were normally distributed, then the homogeneity test was carried out. $L_{hitung} < L_{tabel}$. The homogeneity test aims to determine whether the variance of the two groups is homogeneous or not. In this study, the homogeneity test of the learning outcomes data used Fisher's exact test with a significant level.

TABLE 7
The Results of the Homogeneity Test of the Two Groups With $\alpha = 0, 05$

S_{gabung}	t_{hitung}	t_{table}	F_{hitung}	F_{tabel}	Test Decision
17,164	3,179	1,995			
S_{gabung}	t_{hitung}	t_{table}	1.70	1.74	Ho: Homogeneous Data

From the calculation results obtained the value of the variance of the experimental class learning outcomes I was 371.37 and the learning outcomes of the experimental class II was 217.83. So that a value with a significant level is obtained for the numerator dk = 34 and the denominator dk = 35, then it is obtained. Because the learning outcomes of the experimental class I and the learning outcomes of the experimental class II are smaller than that, it is accepted. So, both population distributions have the same or homogeneous variance. Therefore, the next step is to test the hypothesis $F_{hitung} = 1, 79$, $\alpha = 0, 05$, $F_{table.} = 1, 74$, $F_{hitung} < F_{table}$ 1, 70 < 1, 74, the prerequisite test is

done and it is known that the two classes are normally distributed and homogeneous, then the next test is hypothesis testing with t-test.

TABLE 8
The Test Results of the Average Value of the Two Groups

S_{gabung}	t_{hitung}	t_{table}	Test Decision	Conclusion
17,164	3,179	1,995	Reject Ho	There are two differences in the average learning outcomes

Based on the test of the value of students' mathematics learning outcomes using the t-test, obtained a price with a significant level and degrees of freedom (db = 68) obtained a value of. So that is 3,179 > 1,995 or in other words rejected with the learning outcomes of students who are taught using the Student Team Achievement Divisions (STAD) learning model are higher than those taught using the Team Assisted Individualization (TAI) learning model. This shows that there are differences in student learning outcomes after learning through the Student Team Achievement Divisions (STAD) learning model and the Team Assisted Individualization (TAI) learning model t_{hitung} = 3,179, α = 0,05 t_{table} = 1,995, t_{hitung} > t_{ttable}. H_0 the findings of researchers in the experimental class I, the learning process using the Student Team Achievement Divisions (STAD) learning model is more interesting on the subject of limit algebraic functions.

Learners get a learning experience together with group friends and teachers. In this learning model, students sit in groups to discuss problems given by the teacher through LKK. Students write their understanding in the worksheet provided, each student's answer at this stage is very different. It can be seen that students struggle to communicate the solutions they understand to existing problems. Each group member discusses their understanding and together solve the existing problems. At this stage, students experience social interaction and communicate with each other from a variety of knowledge. After the students finished discussing, there was a presentation consisting of five people in each group. Then the teacher chooses a group

number that directs students to ask the group who is presenting in front of the class. The scores obtained will be collected to determine the progress score. This activity makes students enthusiastic and encourages students to do their best for the group. In this STAD learning, students look active and enthusiastic during the learning process. Active students ask questions and are able to express opinions to the teacher and to other students. The knowledge gained by students is built together so that the learning process is more interesting and easy to understand. In addition, the STAD learning model also increases the enthusiasm of students during the learning process.

The findings of the researchers in the experimental class II using the TAI learning model, namely the learning process in the experimental class II the teacher explained the material and gave examples of questions. The sample questions given during the explanation were the same as some of the questions in the LKK experimental class I. After learning was carried out in both classes, at the last meeting a test was conducted using a test instrument, namely 6 questions describing the results of learning mathematics. The data obtained was then processed to see if there were differences in the learning outcomes of students who were taught using the Student Team Achievement Divisions (STAD) and Team Assisted Individualization (TAI) learning models. Based on the previous hypothesis testing, it was found that it was rejected. Thus, the alternative hypothesis which states that the average learning outcomes of students using the Student Team Achievement Divisions (STAD) learning model are higher than those using the Team Assisted Individualization (TAI) learning model at a significant level of 0.05. This means that before the STAD and TAI learning models were applied, the learning process was still focused by the teacher in explaining and at the final conclusion. Students are less active in participating in the learning process. However, after applying the STAD and TAI learning models, the learning process is more active and creative**.**

IV. CONCLUSIONS

Based on data analysis is carried out , then researcher conclude that application of different STAD learning models by significant with TAI on results study participant educate class XI IPA limit function algebra . This thing appointed by results calculation mark $t_{hitung} = 3,179 > t_{able} = 995$ ith a significant level $\alpha = 0, 05$. Results from research explains that difference results study participant educate with apply the STAD learning model more tall compared to with TAI. Based on experience in the learning that takes place During research , then writer can provide suggestions, namely : 1) Participants educate should more understand discipline with apply the STAD learning model, when To do Duty group no depend on friends who understand the material better and orderly in work on LKK, 2) The teacher must more can condition class so that intertwined interaction two directions , especially for teachers at SMA Negeri 17 Kabupaten Tangerang, 3) Existence cooperation in Thing STAD learning model licensing , source books for support the learning process, there are facility for documentation, and provided LCD facility for make it easy presentation results work group , and 4) Expected other research can study all realm cognitive ($C_1 - C_6$) and expected other research can To do study kind of with To do assessment on *pre-test*.

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