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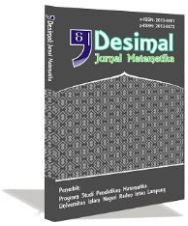

Student team achievement divisions (STAD) and jigsaw learning in terms of numerical abilities: The effect on students' mathematics learning outcomes

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ABSTRACT

The learning process is inseparable from the strategies and learning models used. The application of the learning model is an effort to improve student's abilities and learning outcomes. This research aims to determine the effect of the STAD and Jigsaw cooperative learning models in terms of numerical abilities on learning outcomes. Data collection was carried out using a test instrument to see students' mathematics learning outcomes. Data analysis is carried out by using a two-way ANOVA statistical test and further testing using the Tukey test. Based on the results of the research, it can be concluded that there is a significant effect between the STAD type cooperative learning model in terms of numerical abilities on mathematics learning outcomes, but for the Jigsaw model there is no effect of the learning model in terms of numerical abilities on mathematics learning outcomes and there is no difference between classes that using the STAD model with a class that uses the JIGSAW model in terms of numerical abilities on students' mathematics learning outcomes.

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INTRODUCTION

Education is a form of effort that is carried out consciously and intentionally to change behavior and mature humans, both individually and in groups through learning and training (Dewi & Septa, 2019; Fatimah & Puspaningtyas, 2020) Education in the current era of globalization allows humans to easily access a variety of information (Kristin, 2016). The need for education is something that is inevitable in every phase of the history of human civilization. Through thoughts and changes in civilization, humans agree that education is important even though with different backgrounds and perspectives in seeing its virtues (Triwiyanto, 2014)

Education is seen as a process that is very beneficial for humans in living life (Achdiyat & Utomo, 2017; Aoun, 2017; Eisner, 2017). As stated in the formulation of the objectives of National Education number 20 article 3 concerning the

National Education system explains that National Education functions to develop capabilities and shape dignified character and civilization in the context of educating the nation's life, aiming to develop the potential of students to become human beings who believe and fear God Almighty, having noble character, being healthy, knowledgeable, capable, creative, independent and being a democratic and responsible citizen (Suprayitni & Wahyudi, 2020). So, to achieve the benefits of education, it is realized in a learning atmosphere and learning process so that students can actively develop the potential that exists in themselves.

The learning process can literally be interpreted as a learning concept that actively involves students both physically, psychologically, and emotionally in the learning process. Because learning is a two-way communication process, teaching is carried out by the teacher as an educator, while learning is carried out by students (Sagala, 2005). In the learning process, it is necessary for teachers to create and innovate to make learning more meaningful and fun (Irawan, 2016). Teachers, in implementation in schools, have the responsibility to realize the goals of national education. To achieve this goal, the learning process requires professional teachers so that learning runs properly. Students need to be educated and nurtured by professional teachers so that the resulting quality will be maximized.

A professional teacher is a teacher who has extensive knowledge and is not just a textbook that becomes their teaching material. By having the ability to the field of knowledge, a professional teacher can certainly choose the right model, strategy, and teaching method for their students (Illahi, 2020). Professional teachers always master the material or subject matter that will be taught in teaching and learning interactions, and always develop skills on an ongoing basis, both in terms of their knowledge and experience. The teacher is tasked with measuring whether students have mastered the knowledge learned under the guidance of the teacher in accordance with the formulated objectives (Arikunto, 2008; Kusumaningrum et al., 2019; Mansir & Karim, 2020). Teachers should be able to provide a sense of calm and comfort to students, especially mathematics learning activities because it can provide students with prolonged memory. Mathematics learning conveyed by the teachers will be well received by students if the learning provided is not rote but learning through a process of understanding.

Mathematics teachers must make learning interesting and fun in order to achieve competence and teacher's professionalism in teaching and learning activities. Because in general students think that mathematics is one of the most difficult subjects, because students have to memorize formulas, follow examples of problem-solving given, and deliver subject matter that is considered less interesting (Udjaja et al., 2018). A mathematics teacher should try to reduce the abstract character of the mathematical object so that it is easier for students to understand mathematics lessons at school (Soedjadi, 2000). Coinciding with the Regulation of the Minister of National Education Number 22 of 2006, mathematics teachers must be able to realize effective mathematics learning. Thus, students are able to understand mathematical concepts, are able to use their reasoning, are able to solve problems, communicate ideas, and have an attitude of appreciating the usefulness of mathematics in life (Muthmainnah & Marsigit, 2018). In addition, professional mathematics teachers must also understand the abilities of students, especially the students' own mathematical abilities such as counting, addition, and most importantly the students' numerical abilities.

Numerical ability is the ability to handle numbers, and perform simple problem solving, and numerical skills, in this case, include numerical justification, numerical logic, numerical computing, numerical estimation, and data representation (E. R. Abed et al., 2016; Andrade & Bessa, 2017; Hawes et al., 2019). Factors that are very influential on students' numerical (counting) abilities are remembering factors, precision, and also individual accuracy in doing something whether it's thinking or counting (Eva, 2018). So it is clear that numerical ability is the ability of a student to perform calculations using numbers.

Problems that arise when students cannot follow the learning process carried out by the teacher because of the limitations possessed by students such as not mastering basic mathematical arithmetic operations (addition, multiplication, subtraction, division, power, root operations) which can hinder the learning process carried out in class. In the observations that the researchers made in 9th grade (class IX) of SMP Negeri 7 Kerinci that the learning process was running modestly, the teacher explained with his own method and students learned in their own way so that students could not use their abilities to the fullest. Based on the criteria of professional teachers, this shows that mathematics teachers at SMP Negeri 7 Kerinci are still not professional in carrying out the learning.

The researcher also found a problem in class IX that there were still students who could not operate numbers, considering the students who were about to take the final school exam and the national exam. Students in class IX are still lacking in the ability to count, operating numbers, translate real form questions into mathematical concepts, and lack motivation or confidence in solving these math problems. This is based on the results of student tests showing that the scores obtained by students do not reach the Minimum Completeness Criteria (KKM) that have been set at the school. The researcher had a discussion with students at the school that students had difficulty in operating numbers, operating roots, and powers, and this was evident from the student test results sheets that could not answer questions properly and clearly. Students answer questions that are not in accordance with the answers and make simple answers such as the form of question 2 to the power of 3, the answer should be the same as 2 * 2 * 2 but students answer 2 * 3 so that they get different answers and as well as when working on the root form question. Students still cannot simplify root forms or rationalize root forms. In addition, students also said they did not dare to ask questions about what they did not understand from the explanation given by the teacher. They also do not have high confidence in solving problems given by the teacher either directly in the learning process or during exams or tests.

The learning carried out is still passive and uninteresting. The lecture-based learning model is still dominant in the learning process. The use of the lecture method in learning makes various kinds of students who have numerical abilities see mathematics as a difficult subject, unimaginative, difficult to understand, and require a lot of memorization and quantitative abilities (Ademola K, 2016). This will lead to low student learning outcomes in mathematics at the school. Whether or not the learning outcomes are complete is due to several factors, apart from the students themselves, the factors that greatly influence student learning outcomes are the teacher and the learning model used.

Based on this, the researchers want to see student learning outcomes based on numerical abilities and can find out knowledge based on the ability of each student in mathematics. In order for learning to run properly, researchers will

use a learning model that makes the mathematics learning process also dominated by student activities by bringing mathematics closer to other friends to ask questions or discuss. Considering that the previous learning process was still running sober and monotonous learning. The researcher wanted to give something new to the learning process, namely group work and discussion-based. A good alternative and solution in this learning process is using the STAD and JIGSAW models.

STAD is a cooperative learning method in which students help themselves and their groupmates learn in small heterogeneous groups (Aliyyah et al., 2019) and STAD is a teaching method where the teacher presents basic material and assigns tasks to the group (Gumelar, 2017; Jambari, 2019; Stewart & Sliter, 2005). In that learning, STAD was also adapted to increase students' learning motivation and reading comprehension through teamwork (Wang et al., 2017). The team study in question is students doing the assignments given by the teacher. Students are placed in study teams consisting of four people who are mixed according to their level of performance, gender, and ethnicity. Students are asked to build familiarity in the discussion process to solve problems. The team with the highest score will get a prize, this can motivate students who have better abilities in a team to encourage and help other less able members to achieve team goals (Putpuek & Kiattikomol, 2017). It can improve the abilities and better learning outcomes. The relevant research has been studied by Putri & Sutriyono (2018) entitled The Effect of STAD Learning Methods on Mathematics Learning Outcomes in Class VIII Students. This research aims to increase the effect of the STAD learning method on mathematics learning on the learning outcomes of class VIII students on the material of two-variable linear equations. The conclusion of the research is that there is an effect of the STAD method on mathematics learning on the learning outcomes of class VIII students of SMP Negeri 3 Karanganyar.

In addition to STAD, Jigsaw can also improve students' mathematics learning outcomes because Jigsaw is a type of cooperative learning strategy where each individual in a team needs information to complete the tasks given in the group (A. Z. Abed et al., 2019; Azmin, 2016; Theobald, 2017). In Jigsaw the teacher must understand students' abilities and experiences and help students activate these schemes so that the subject matter becomes more meaningful (Wati & Anggraini, 2019). Students in the jigsaw learning method have many opportunities to express opinions and process the information obtained and can improve students' abilities as well as student learning outcomes. A. Z. Abed et al. (2019) have studied the effect of applying the Jigsaw strategy that the use of this method instills a sense of cooperation in learning among students. In addition, it has a positive impact on student's academic achievement in mathematics classes. In addition, students also develop a positive attitude towards mathematics. Such an attitude may be beneficial for students to develop an interest in learning mathematics. Based on these discoveries, mathematics curriculum designers, and instructors are advised to incorporate Jigsaw teaching methods in mathematics classrooms. This research also highlights that a teacher-centered approach is an obsolete and less effective teaching method in teaching mathematics.

So based on the background of the problem, the purpose of this research is to see the effect of the STAD and Jigsaw learning models in terms of numerical abilities on students' mathematics learning outcomes and to see the comparison of the STAD and the Jigsaw model on students' mathematics learning

outcomes. Researchers focus on one domain, namely the cognitive domain. Because STAD and Jigsaw models had a positive impact on secondary school students in mathematics and their approach was found to be applicable across various domains of knowledge in mathematics. So that the purpose of the research becomes a hypothesis in this research.

STAD in this research is modified based on the condition of students, school environment, and school infrastructure. The modification corresponds to each phase of the STAD syntax. Modifications to the syntax add an InFocus Projector media in order to display videos and images related to the teaching material in the class. In addition to the projector, the researchers also added a game in the form of a math quiz.

This game will be designed in such a way by the teacher with tiered questions from easy to difficult. These questions are about teaching materials and are given during class discussions so that all students are ready to accept these questions. The question is given directly by the teacher who teaches and will be answered by the student at random, if the student is successful then he will get appreciation from the teacher with additional daily scores and it is even possible to be given a souvenir. This is done in order to support the learning process and motivate student learning. It can improve abilities and better learning outcomes.

METHOD

This research was conducted in the even semester of class IX Senior High School (SMP) Negri 7 Kerinci. Before the research was conducted, the researchers first tested for normality, homogeneity, and average similarity on the odd semester test scores for class IX as many as 83 students from four classes. The normality test was carried out because it fulfilled the assumption of population normality in the analysis of parametric statistical data. The school where the research was conducted had four classes, while the researchers needed two experimental classes and one control class. Because the research was conducted at the beginning of the even semester or second semester, the researcher took the initiative to use the odd semester test scores or the first semester of mathematics which were used as a reference as test data for normality, homogeneity, and the average similarity of class IX. Normality test also aims to see if the population distribution is normally distributed or not.

The sample selection in this research used a random sampling technique from four population classes so that three samples were obtained, namely experiment 1 class IX-B using the STAD learning model, experiment 2 class IX-C using the Jigsaw learning model, and control class IX-D using conventional learning. Conventional in question is adapted to the learning methods commonly applied by mathematics teachers at SMP Negeri 7 Kerinci such as lectures, question and answer, and assignments. The implementation of the research begins with giving a pre-test to the experimental group and the control group to see the initial ability level of the students. The results of the pre-test scores were divided into two levels based on the students' numerical abilities which consisted of high numerical abilities and low numerical abilities categories. Determination based on the level by subtracting the maximum score by the minimum score on the pre-test score and then dividing by two. The results of these calculations are used as intervals to divide the ability into two levels. Then the criteria were obtained based on the level of students' numerical abilities as a moderator variable. So that in this experimental quantitative research, a 3×2

factorial design was obtained which consisted of 2 experimental classes, 1 control class, and 2 levels of numerical ability. The relationship between research variables is presented in Table 1 below:

Table 1. Factorial Design

Model Numerical Abilities	STAD (S)	JIGSAW (J)	CONTROL (K)
High (T)	ST	JT	KT
Low (R)	SR	JR	KR

This quasi-experimental research was carried out with a procedure that went through the stages of the research workflow starting from identifying problems, formulating problems, and study of literature which in the end obtained research tools in the form of lesson plans and research instruments in the form of essays covering cognitive. Before being tested, these research tools were validated by experts (competent education experts), and then made necessary improvements according to the results of the validation.

Before the instrument was used as a data collection tool, first the instrument was tested on 42 students who were not samples with the aim of getting good questions, then statistical tests were carried out in the form of validity test, reliability test, discriminating power, and difficulty indexes. After statistical tests were carried out, the next data collection was conducting a posttest to see the results of students' mathematics learning. The researchers will calculate the difference between the pretest and posttest scores, after getting the scores, then it will be analyzed whether there is an effect of the STAD type cooperative learning model in terms of numerical abilities on students' mathematics learning outcomes.

The scores analyzed in this research are the difference between the pretest and posttest scores. Before analyzing the hypothesis test data, the data obtained were first tested for normality and homogeneity test as a prerequisite test, and then a hypothesis test would be carried out using a two-way ANOVA test which aims to prove whether the established hypothesis was true or not and continued with the Tukey test.

RESULTS AND DISCUSSION

During the research, experimental group 1 was treated in the form of a learning approach, namely the STAD cooperative learning model and the experimental class 2 using the JIGSAW type learning model. While the control group, still uses the conventional approach. The next thing to do is to do a posttest to see the results of students' mathematics learning and the researchers will calculate the difference between the pretest and posttest scores, after getting the scores, then it is analyzed whether there is an effect of the STAD and Jigsaw cooperative learning models based on numerical abilities on students' mathematics learning outcomes. The scores analyzed in this research are the difference between the pretest and posttest scores.

Based on the results of the research, it can be seen that there is an effect of the STAD type cooperative learning model in terms of numerical abilities on the mathematics learning outcomes of class IX students of SMP Negeri 7 Kerinci. Seen from the significance value obtained, it is smaller than the 0.05 significance level on the class variable that is 0.017 (0.017 <0.05) so it can be concluded that H0 is rejected and H1 is accepted. The results of this research are in accordance with the research framework which states that if in the learning process the teacher uses the right learning model, namely the STAD type learning model because it is an effective method to use in the classroom. (Lantajo et al., 2018; Silalahi & Hutauruk, 2020). The same thing has also been studied by Amin et al. (2020), the results

of the research also indicate that the use of the STAD type model has a significant influence on the students' mathematics learning outcomes. This achievement can be seen in student activities during learning. Based on the results of the observation questionnaire, shows that student activities strongly support the continuity of learning so that the learning process becomes active. It can also be seen from the results of research by Sudana & Wesnawa (2017) that there is an improvement in the process and achievement of student learning outcomes, namely (1) an improvement in student learning activities in group learning activities, and completing assignments; (2) improving student learning outcomes in cognitive, affective, and psychomotor aspects; (3) students have a positive response to the learning process.

Students take advantage of the extensive time to understand and learn their assignments together with groups and active communication so that learning goes according to plan. During the learning process, students seemed enthusiastic about collecting information sources. Students use their numerical abilities to solve problems given by the teacher and exchange information. One of the basic abilities that students must have in learning mathematics is numerical ability. Numerical ability is the ability to handle numbers, and perform simple problem solving, and numerical skills, in this case, include numerical justification, numerical logic, numerical computing, numerical estimation, and data representation (E. R. Abed et al., 2016; Andrade & Bessa, 2017; Hawes et al., 2019). In addition, the presence of a developmental score can motivate students to encourage each other and help each other in completing the material studied to get group awards (Suprapti, 2016).

The results of this research show that there is no effect of the JIGSAW type cooperative learning model in terms of numerical abilities on the mathematics learning outcomes of class IX students of SMP Negeri 7 Kerinci. It can be seen from the significance value obtained that is smaller than the 0.05 significance level on the class variable, namely 0.117 (0.117 > 0.05). So, it can be concluded that H0 is accepted and H1 is rejected. There are several factors from teachers or students that must be considered if one wants to use the Jigsaw type of learning model. Factors that come from the teacher are that they must be able to manage the class in a conducive manner, ensure that students are ready to learn, divide students with different abilities into one group, the allocation of learning time must be used properly by the teacher and lesson planning must be maximized. The factor from students is that they have to get used to looking for information both from books and from friends in a group. Students with high abilities must be willing to help students with low abilities in one group, students must also often relate problems to everyday life and not feel ashamed to express opinions.

The same problem was also found by Windasari & Cholily (2021) that the application of the Jigsaw cooperative model itself still made students a little confused about starting a lesson so it took a little more time to organize the learning process. Even though the application of the Jigsaw model is very effective in the learning process. Kahar et al. (2020) explained that the implementation of learning using the jigsaw type cooperative learning model can increase student activity in participating in learning which has implications for student learning outcomes in class. If these factors are not met and teachers who use the Jigsaw learning model do not minimize their shortcomings, then the Jigsaw learning

model may not affect students' mathematics learning outcomes.

Table 2. Independent Samples Test STAD and JIGSAW

Independent Samples Test				
		t-test for Equality of Means		
		t	df	Sig. (2-tailed)
Learning Outcomes	Equal Variances Assumed	1.53	39	.134
	Equal Variances Not Assumed	**1.53**	**38.3**	**.135**

Furthermore, based on the results of the research using the t-test, it was found that the sig. (2-tailed) value was 0.135. This value is compared with an alpha of 0.05 so it can be concluded that the value of sig. (2-tailed) > *alpha* that is 0.135 > 0.05. So, there is no difference between the STAD class and the JIGSAW class in terms of numerical ability on the learning outcomes of class IX students of SMP Negeri 7 Kerinci. The same thing has been studied by Malfriana (2020) that the results of the analysis show that there is no difference in student learning outcomes taught by the Jigsaw and STAD cooperative learning models. This means that the application of the Jigsaw and STAD cooperative learning models seen from the indicators of student learning outcomes, namely the post-test and gain results are the same. However, the research by Asnawi et al. (2020) showed that there were significant differences in student achievement between students who were taught the Jigsaw type of cooperative learning model and students who were taught the STAD type of cooperative learning model. Incidents like this are commonplace due to several factors during the learning process. In this design, the experimental group was given learning treatment using the STAD and Jigsaw learning models, while the control group was taught using conventional learning, then each group was given a pretest to see the students' initial ability level and a posttest to see the ability through the results of students' mathematics learning with learning models. There is no special treatment was given to the control group during the learning process.

Table 3. Tukey Test

Dependent Variable: Learning Outcomes Tukey HSD				
(I) STAD and JIGSAW	(J) STAD and JIGSAW	Mean Difference (I-J)	Std. Error	Sig.
STAD	**JIGSAW**	3.69	2.447	**.295**
	CONTROL	7.50*	2.447	**.009**
JIGSAW	**STAD**	-3.69	2.447	**.295**
	CONTROL	3.81	2.417	**.264**
CONTROL	**STAD**	-7.50*	2.447	**.009**
	JIGSAW	-3.81	2.417	**.264**

Based on Table 3, it can be seen that the *p-value* in the STAD class against the Jigsaw and control classes are 0.295 and 0.009, respectively. When compared with an *alpha value* of 0.05, the *p-value* of the STAD class against the JIGSAW class is

greater than the *alpha value* (0.295 > 0.05), thus it can be concluded that there is no difference in average between the two classes, while the class with the model STAD to the control class is smaller than the *alpha value* (0.009 < 0.05), thus it can be concluded that there is an average difference between the classes. The class with the Jigsaw model against the control class obtained a *p-value* of 0.264, when compared with an *alpha value* of 0.05, the *p-value* for the class with Jigsaw against the Control class was greater than the *alpha value* (0.264 > 0.05). Based on these results, it can be concluded that there is no difference in the average between the two classes.

The average value of the pretest and posttest results for the sample class will be presented in Table 4 below:

Table 4. The Average Value of Students' Pretest and Posttest Results

Group	*Pre-test*	*Treatment*	*Post-test*
Experiment 1	48.5	STAD	69
Experiment 2	44.5	JIGSAW	67.38
Control	45	Control	60

Based on Table 4, it can be seen that the average value of the students' pretest results before the implementation of the learning model obtained an average value in the experimental class 1 of 48.5, in the experimental class 2 of 44.5, and in the control class an average of 45 was obtained. It can be concluded that the average score of the students' pretest results only ranged from 44 to 48.5. After that, a posttest was carried out after giving treatment in each class so that the average value of experiment 1 is 69, experiment 2 is 67.38 and the control class is 60. So, it can be concluded that there are significant differences before giving treatment and after giving treatment in each class.

To compare the results of the pretest with the posttest in this research using the N-Gain test. N-Gain is used to determine the improvement in students' abilities between before and after giving treatment. The N-Gain test has an interpretation level that refers to the N-Gain score. For high interpretations with an N-Gain score of 0.70 (effective), for moderate interpretations with a score between 0.30 N-Gain < 0.70 (quite effective), and for low interpretations with an N-Gain score < 0.30 (ineffective). So, it is obtained as follows:

Table 5. N-Gain Test Calculation Results

No.	Class	*N-Gain Score*	Interpretations
1	Experiment 1	0.49	Enough
2	Experiment 2	0.56	Enough
3	Control	0.50	Enough

Based on Table 5 above, it can be concluded that the results of the N-Gain test show that the experimental class 1 gets 0.49 and the experimental class 2 gets 0.56. So, it can be concluded that there is an improvement with a moderate interpretation. The results of N-Gain for the control class obtained 0.50. So, it can be concluded that the control class also experienced moderate interpretation. So overall, the experimental class and the control class are quite effective in improving students' mathematics learning outcomes.

CONCLUSIONS AND SUGGESTIONS

Based on the results of the research using the two-way ANOVA statistical test and further testing, it can be concluded that there is a significant effect between the STAD type cooperative learning model in terms of numerical abilities on students' mathematics learning outcomes, but for the Jigsaw model, there is no effect of the learning model in terms of numerical abilities on students' mathematics learning outcomes and there is no difference in average between the STAD class and the JIGSAW class in terms of numerical abilities to the learning outcomes of class IX students at SMP Negeri 7 Kerinci.

It is recommended to teachers and further researchers if using the STAD and Jigsaw models in the learning process to pay more attention to the appropriate material to be taught in class. Because based on the experience of researchers that the STAD and Jigsaw learning models require good planning and require class management and the right time. Teachers in choosing a good learning model need to consider students' basic abilities in mathematics, especially numerical abilities or numeracy skills so that the learning model used can really improve students' mathematics learning outcomes. To improve the external expertise of this research, similar research can be carried out using the STAD and JIGSAW learning models based on numerical abilities that contain mathematics lessons and take subjects at the high school or college level.

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