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The experiment of TAPPS, TSTS, and DL learning models viewed through adversity quotient in mathematics learning achievement

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Abstract. This research is an experiment about learning model of Thinking Aloud Pairs Problem Solving (TAPPS), Two Stay Two Stray (TSTS), and Discovery Learning (DL) viewed through Adversity Quotient (AQ) in mathematics learning achievement with quasi experimental using 3x3 of factorial design. The subjects of the research were 280 students from three Vocational High Schools in Gunungkidul Regency, Indonesia. The research instruments used were test and questionnaire. The data analysis technique used was two-way anova with unbalanced cells and post hoc test using Scheffe method. The research results showed that: 1) TSTS improves mathematics learning achievement better than TAPPS and DL learning models. The use of TAPPS leads to better mathematics learning achievement than the use of DL. 2) Students with AQ climbers showed better mathematics learning achievement than those with AQ campers and quitters types. Students with campers type showed better mathematics achievement than students of quitters type. 3) Students with AQ climbers type have better mathematics learning achievement than students with AQ quitters type when subjected to the TAPPS, students with AQ climbers type have better mathematics learning achievement than students with AQ quitters type when subjected to the DL, and students with AQ campers type have better mathematics learning achievement than students with AQ quitters type when exposed to the DL. 4) For students with AQ climbers and quitters types, learning by using TSTS give better mathematics learning achievement than using DL.

1. Introduction

Mathematics is a universal science that underpins the development of modern technology that plays an important role in various disciplines and develop the human mind power. Abstract mathematical concepts correlate with each other to form new, more complex concepts [1]. With regard to shaping the concept of new mathematical knowledge, students are introduced to things that are abstract. Many assume that mathematics is difficult, because it is identical to a series of numbers, symbols, and formulas that can be solved through mathematical arithmetic operations. Of course this will affect the student's mathematics learning achievement.

One of the goals of learning mathematics for students is that they have a good learning achievement. The intellectual ability of students can determine the success of students in achievement. The learning achievement is the result obtained by students during the learning process that happens in the form of figures or values [2]. In line with this, the academic achievement refers to particular learning that happens in a particular setting and defined by examination marks, the teachers' given grades and percentiles in academic subjects [3]. However, one of the greatest crises of educational systems in



many countries, especially developing countries, is the problem of low academic achievement [4]. In the learning process in school, each student is expected to obtain satisfactory learning achievement. Achievement was obtained by way of learning, both at school and at home. However, sometimes students are faced with obstacles both within themselves and the surrounding environment.

The low of mathematics learning achievement is influenced by students' seriousness in learning mathematics, level of boredom, self-confidence about mathematics, and teachers who teach mathematics [5].

Efforts to improve the quality of education have been done by improving the implementation of learning, especially in Indonesia. However, the effort has not been enough to gain satisfactory results. This can be seen from the mathematics learning achievement shown by the students that is still low. The fact was supported by the students' mathematics achievement which is still low. The low achievement of students' mathematics learning can be seen in the report of the National Examination of Vocational High School of 2017 as follows.

Table 1. National examination result of vocational high school in Indonesia in the year of 2017.

National Exam Score	Indonesian	English	Mathematics	Competence	Total Average
Average	64.23	40.35	36.81	73.59	214.98
Category	C	D	D	B	D

Based on Table 1, it can be seen that the average of the national exam score of all mathematics subjects of the vocational high school in Indonesia in the academic year of 2017 was 36.81 with the D category. The same problem is also found in Daerah Istimewa Yogyakarta. The mathematics national exam results of Vocational High School lesson in Yogyakarta in year of 2017 are presented in the table 2 below.

Table 2. Mathematics national exam result of vocational high school in D.I. Yogyakarta.

Average Result of UN Mathematics Vocational High School in D.I. Yogyakarta	2015	2016	2017
Average	55.30	48.53	49.23
Category	C	D	D

Based on the national exam results of Vocational High School in Table 2 during the last three years, it can be seen that the results of Mathematics National Exam subjects are still low. In the year 2015 the average of mathematics was 55.30 with C category. Even in the year 2016 the average of mathematics experience decrease to 48.53 with D category. In 2017, the results of mathematics were not much different from the previous year, 49.23 with D category. The same results can also be seen from the achievement of Mathematics National Exam in Gunungkidul Regency as the following.

Table 3. National exam results of vocational high school 2017 in Gunungkidul Regency.

National Exam Score	Indonesian	English	Mathematics	Competence	Total Ave-rage
Average	72.98	45.81	50.43	76.94	246.16
Cate-gory	B	D	D	B	D

Based on Table 3 above, it can be seen that the acquisition value is still in the low category of 50.43 with D category. The low learning achievement may be due to the use of learning models.

Based on the background shown above, the researchers are interested in applying cooperative learning model Thinking Aloud Pair Problem Solving (TAPPS), Two Stay Two Stray (TSTS), and Discovery Learning (DL) to see which learning model lead to better student mathematics achievement.

2. Literature Review

Pate and Miler research results [6] shows that the use of TAPPS learning model gives better result compared to the class that was not exposed to TAPPS learning model. TAPPS process can help the students in solving complex problems.

TAPPS cooperative learning gives the students a chance to discuss with their peers that are in the process of problem solving. Each group consisted of two children, one of them is as a problem solver and the other is a listener [7]. Within the pair, one student plays the role of problem solver while the other student plays the role of listener. The problem solver talks, verbalizes each step of his or her thought process and starts with a statement of the problem to be solved. As the problem solver works on the problem, he explains what they are doing and why. The listener role is the more difficult role. The listener must keep the problem solver taking. Short silence requires the listener to prompt the problem solver for what they are thinking. The listener needs to understand in detail every step by the problem solver, including the diversions and errors. And the listener is not supposed to help solving the problem. TAPPS has a role division of problem solver and listener alternately done so that each student will be able to solve problem.

Discovery learning (DL) is a learning model that involves the active participation of students in exploring and discovering their own knowledge and using it in problem solving. DL is a student centered learning model, it declines the concept that says that instructors are useless in the learning model but they play the role of the monitor. Students apply their experience and knowledge to solve the problems, meanwhile, instructors should guide and encourage them to learn deeply and effectively. This ensures that the mode of teaching method in mathematics seems to be important for students' development of mathematical proficiency [8].

The TSTS cooperative learning model is the way students share their knowledge and experience with other groups, this is done by working together or between groups [9]. The TSTS learning syntax is combined with group work, then two students work with another group and two other students remain in group to receive two from another group [9]. The students in groups are given tasks in the form of problems that should be discussed and answered depending on the learning materials. The purpose of the visit is to obtain a variation in the settlement of the given problem, after returning to the original group, the settlement given from the other group is discussed again at the origin group which will be presented in front of the class.

To be able to optimize the inner the potential within a learning model, a student should have a high motivation and not easily give up if he/she faces with difficulties. This is what is often referred to as Adversity Quotient (AQ). Therefore, the purpose of this study is also to find out which one provides better mathematics learning achievement between students with AQ quitters, campers, or climbers type.

Adversity can be defined in many ways such as difficulties, failures, problems, or even misfortune. Furthermore, adversity quotient is one's resilience and the ability to survive in facing constant change, stress and difficulty or difficulty is only a measure of how students respond to adversity [10]. Adversity in mathematics is defined as learning difficulties in understanding mathematics that shows how much students struggle to learn, having a passion for self-struggle, in the way of how many students want to improve themselves [11].

There are three types of AQ, namely quitters type, campers type, and climbers type. Students with quitters type have assumptions that mathematics is complicated, confusing, and dizzy. Their motivation is very poor, so when they find a little difficulty in solving mathematics problems they give up and quit without spending any efforts. Students with campers type are those who do not want to take great risks and feel satisfied with the achieved conditions or circumstances. Students of this type tend to give up early, spend less efforts in studying. In mathematics learning, students with campers type do not try to the maximum extent possible, they try to be always only in the safe zone, and to be always simple. Students with climbers type are students who have goals or targets. To achieve those goals, they are able to work persistently. In addition, they also have the courage and high discipline.

Like people determined to climb a mountain, this type of students always want to reach the top. Thus, there are three types of adversity quotient as quoted by [10].

The three types are grouped into four dimensions of adversity quotient that are control, origin and ownership, reach, endurance [11]. In mathematics, students with great control of themselves can avoid unnecessary stress and thoughts. In the end, students can learn easily, have an open mind over mathematics. The second dimension is origin and ownership. Origin and ownership are defined as something that is done to help a person learn and adapt behaviors that can improve the quality of self. The highest origin and ownership possessed, shows how much responsibility that is owned and the more likely it is that a person perceives that success is always being influenced by external factors and student's self. The third dimension is reach. Reach measures how far adversity enters the student's field of life. In Mathematics, the reach can be seen in how many students can overcome difficulties and turn into something positive for themselves. This can be seen when students learn math like coping with panic, despair, sadness, and easily give up or not. The fourth dimension is endurance. Endurance here means how a person sees a problem they have. For example, if students look at mathematics is difficult due to lack of skills then they will improve their skills to make it easier for them to learn mathematics, but if students see mathematics like something that is too difficult to learn then they will stop to learn which can be interpreted that there is no interest in learning. Thus The three types are grouped into four dimensions of adversity quotient by [11].

Based on several definitions and classifications of AQ type as mentioned above, in this study AQ is defined by an individual ability of students to be able to survive all kinds of difficulties to find a way out, solve various problems, reduce obstacles and obstacles by changing the way of thinking and attitude to the difficulty. The categorization of adversity quotient in this study is based on four components that are control, origin and ownership, reach, and endurance. The categorization of adversity quotient according to [10] is based on the result of filling instrument which consists of 40 item statements, are as follows: (a) AQ Climber is at the interval 135-200 of the score of the questionnaire because the students can survive and keep trying to solve the problem despite facing severe problems, (b) AQ Camper is at the interval 60-134 because students have been able to take advantage of the potential possessed although it is not maximal. they prefer a safe road, tend to be satisfied quickly, and (c) AQ Quitter is at the interval 0-59 because in that score it is still less students who take advantage of their potential and may have experienced unnecessary problems that can cause great losses and make students less determined to overcome difficulties which they face.

3. Method

This research is quasi experimental using 3x3 factorial design. The population of this research is all students of Vocational High School in Gunungkidul Regency Yogyakarta, meanwhile the its subjects are the students of the tenth class from three schools in Gunungkidul Regency Yogyakarta. The schools were categorized into three categories based on the national exam score of the students in 2017 using stratified cluster random sampling technique. Each school represents one of the three categories, namely high, medium, and low. Based on the results of categorization, SMK Negeri 1 Wonosari was selected to represent the high category, SMK Negeri 1 Ponjong for the medium category, and SMK Muhammadiyah 1 Playen for the low category.

The subjects of this study are 280 students divided into high category schools are taken 94 students, medium category are taken 93 students and school with low category are taken 93 students. The research was conducted in second semester of academic year 2017/2018.

The instruments are used in this research are a questionnaire of adversity quotient and mathematics learning achievement test. Questionnaire of adversity quotient consists of 40 statement items and instrument of mathematics learning achievement test consist 30 items. Before the instruments are given on the subject of the study, each questionnaire is validated and tested first. In this study, the validity test used is the validity test of the content by the validator. Each instrumennt has been validated by two experts. After obtaining validation from two experts, the instrument was tested to 76 students outside the research sample. The data that has been collected and then it is analyzed by using

internal consistency test and reliability test with Cronbach Alpha technique for questionnaire of adversity quotient and internal consistency, difficulty level reliability test for instrument of mathematics learning achievement. In the test questionnaire adversity quotient, questionnaire amounted to 60 items of statement and instrument of mathematics learning achievement amounted to 40 items. Based on the results of the instrument analysis it is obtained 40 items statement for questionnaire of adversity quotient and 30 items for instrument of mathematics learning achievement that is ready to be used as research instrument.

This research instruments used were test to investigate mathematics students' achievement and questionnaire to investigate students AQ. The data analysis technique used is two-way anova with unbalanced cells and post hoc test using Scheffe method.

4. Result and Discussion

Normality test

The normality test is performed to determine whether the selected sample is from a normally distributed population. This study used the Lilliefors method for normality test. The following is a result of normality test data analysis.

Table 4. The Result of normality test.

Model	$L_{\text{observation}}$	$L_{0.05}$	Decision	Conclusion
TSTS	0.09178	0.09187	H_0 is not rejected	Normal
TAPPS	0.07517	0.09138	H_0 is not rejected	Normal
DL	0.06710	0.09187	H_0 is not rejected	Normal

Based on Table 4, it appears that for each population, H_0 is not rejected. This suggests that samples for experimental class of TSTS, TAPPS, and DL come from normally distributed populations.

Homogeneity test

The homogeneity test is conducted to determine whether the variance of a number of populations is equal or not. To test it used Barlett test. The following is a result of the homogeneity test data analysis.

Table 5. The Result of homogeneity test.

Model	$\chi^2_{\text{observation}}$	$\chi^2_{0.05}$	Decision	Conclusion
TSTS, TAPPS, DL	5,9090	5,991	H_0 is not rejected	Homogeneous

From Table 5, H_0 is not rejected. It can be concluded that the population for TSTS, TAPPS, and DL model have the same variance or homogeneous.

Two ways analysis of variance with unbalanced cells

Two ways analysis of variance with unbalanced cells was performed to test whether or not there were significant differences in effect on some treatments on the mathematics learning achievement. The following is two ways analysis of variance with unbalanced cells data.

Table 6. The result of two ways analysis of variance with unbalanced cells.

Source	Sum of square	df	Mean of square	$F_{\text{observati-on}}$	$F_{0.05}$	Decision
(A)	4075.19	2	2037.60	32.0960	3.0291	H_{0A} is rejected

(B)	2967.74	2	1483.87	23.3738	3.0291	H_{0B} is rejected
(AB)	697.54	4	174.39	2.7469	2.4050	H_{0AB} is rejected
Error	17204.27	271	63.48	-	-	-
Total	24944.75	279	-	-	-	-

Based on Table 6, it can be said that. (a) H_{0A} is rejected, meaning that there is a difference in mathematics learning achievement after using the learning model. (b) H_{0B} is rejected, then there is a difference in mathematics learning achievement after using AQ, and (c) H_{0AB} is rejected, meaning that there is an interaction between the learning model and AQ in relation to the mathematics learning achievement. Because H_{0A} , H_{0B} , and H_{0AB} are rejected, it is necessary to carry on a post hoc test using Scheffe method to know which have significantly different mean.

Multiple Comparison

Multiple comparison test is a follow up of the analysis of variance. When the analysis of variance results shows that H_0 is rejected. This test used Scheffe method to see which learning model gives significantly different mean. Before doing that multiple comparison test, table 7 below shows the marginal average data results.

Table 7. Marginal average data.

Learning Model (A)	Adversity Quotient (B)			Marginal Average
	Climbers	Campers	Quitters	
TSTS	85.1333	82.2931	81.0680	83.1548
TAPPS	83.4483	78.7972	72.6448	78.3340
DL	76.1462	76.5706	67.4727	73.2237
Marginal Average	82.1277	79.0566	73.1035	-

Table 7 is used to help interpret the multiple comparison test based marginal average from TSTS, TAPPS, DL learning models, and Climbers, Campers, Quitters AQ types. The result of inter-lines comparison test can be seen in the following table.

Table 8. Inter-lines comparison test results.

H_0	$F_{\text{observation}}$	F	Critical Region	Decision
$\mu_1 = \mu_2$	17.1135	6.0582	{ F F > 6.0582 }	H_0 is rejected
$\mu_1 = \mu_3$	72.2417	6.0582	{ F F > 6.0582 }	H_0 is rejected
$\mu_2 = \mu_3$	19.2313	6.0582	{ F F > 6.0582 }	H_0 is rejected

Based on Table 8, it is clear that all of the null hypothesis is rejected. This means that there is a significant difference between learning models on mathematics learning achievement. In the current research based marginal average on Table 7, teaching and learning with TSTS model gives better mathematics learning achievement than TAPPS and DL. Teaching and learning with TAPPS model lead to better mathematics learning achievement than using DL learning model. The results of the post hoc test calculations inter-columns comparison can be seen in the following table.

Table 9. Inter-columns comparison test results.

H_0	$F_{\text{observation}}$	F	Critical Region	Decision
$\mu_1 = \mu_2$	7.1635	6.0582	$\{ F F > 6.0582 \}$	H_0 is rejected
$\mu_1 = \mu_3$	57.9589	6.0582	$\{ F F > 6.0582 \}$	H_0 is rejected
$\mu_2 = \mu_3$	25.8502	6.0582	$\{ F F > 6.0582 \}$	H_0 is rejected

Based on Table 9, it is clear that all of the null hypothesis is rejected. This means that there is a significant difference between AQ types on mathematics learning achievement. In the current research based on marginal average on Tabel 7, students with AQ climbers type have better mathematics learning achievement than students with AQ campers and quitters types. Students with AQ campers type have better mathematics learning achievement than students with AQ quitters type. The results of inter-cells comparison on the same line can be seen in the following table.

Table 10. Inter-cells comparison test result on the same line.

H_0	$F_{\text{observation}}$	$F\alpha$	Critical Region	Decision
$\mu_{11} = \mu_{12}$	2.1135	15.7812	$\{ F F > 15.7812 \}$	H_0 is not rejected
$\mu_{11} = \mu_{13}$	3.9660	15.7812	$\{ F F > 15.7812 \}$	H_0 is not rejected
$\mu_{12} = \mu_{13}$	0.3174	15.7812	$\{ F F > 15.7812 \}$	H_0 is not rejected
$\mu_{21} = \mu_{22}$	5.4730	15.7812	$\{ F F > 15.7812 \}$	H_0 is not rejected
$\mu_{21} = \mu_{23}$	26.6579	15.7812	$\{ F F > 15.7812 \}$	H_0 is rejected
$\mu_{22} = \mu_{23}$	9.5765	15.7812	$\{ F F > 15.7812 \}$	H_0 is not rejected
$\mu_{31} = \mu_{32}$	0.0418	15.7812	$\{ F F > 15.7812 \}$	H_0 is not rejected
$\mu_{31} = \mu_{33}$	17.2326	15.7812	$\{ F F > 15.7812 \}$	H_0 is rejected
$\mu_{32} = \mu_{33}$	21.8338	15.7812	$\{ F F > 15.7812 \}$	H_0 is rejected

After analyzing Table 10, the result showed that null hypothesis is not rejected except null hypothesis for $\mu_{21} = \mu_{23}$, $\mu_{31} = \mu_{33}$, and $\mu_{32} = \mu_{33}$. In the hypothesis $\mu_{21} = \mu_{23}$, H_0 is rejected. It means that students with AQ climbers and Quitters types have significant differences when exposed to the TAPPS learning model. Based on the marginal averages shown in Table 7, it can be concluded that students with AQ climbers type have better mathematics learning achievement than students with AQ quitters type when exposed to the TAPPS learning model.

In hypothesis $\mu_{31} = \mu_{33}$, H_0 is rejected. It means that students with AQ climbers and Quitters types have significant differences when exposed to the DL learning model. Based on marginal average in Table 7, it can be concluded that students with AQ climbers type have better mathematics learning achievement than students with AQ quitters type when exposed to the DL learning model.

Finally, the result of Scheffe method also showed that hypothesis $\mu_{32} = \mu_{33}$, meaning that H_0 is rejected. Therefore students with AQ campers and quitters types have significant differences when subjected to the DL learning model. Based on the marginal averages shown in Table 7, it can be concluded that students with AQ campers type have better mathematics learning achievement than students with AQ quitters type when exposed to the DL learning model.

Table 11. Inter-cells comparison test result on the same column.

H_0	F _{observation}	F	Critical Region	Decision
$\mu_{11} = \mu_{21}$	0.7439	15.7812	{ F F > 15.7812 }	H_0 is not rejected
$\mu_{11} = \mu_{31}$	19.8474	15.7812	{ F F > 15.7812 }	H_0 is rejected
$\mu_{21} = \mu_{31}$	11.5144	15.7812	{ F F > 15.7812 }	H_0 is not rejected
$\mu_{21} = \mu_{22}$	3.0920	15.7812	{ F F > 15.7812 }	H_0 is not rejected
$\mu_{12} = \mu_{32}$	8.0732	15.7812	{ F F > 15.7812 }	H_0 is not rejected
$\mu_{22} = \mu_{32}$	1.3656	15.7812	{ F F > 15.7812 }	H_0 is not rejected
$\mu_{13} = \mu_{23}$	15.0047	15.7812	{ F F > 15.7812 }	H_0 is not rejected
$\mu_{13} = \mu_{33}$	41.4128	15.7812	{ F F > 15.7812 }	H_0 is rejected
$\mu_{23} = \mu_{33}$	6.5041	15.7812	{ F F > 15.7812 }	H_0 is not rejected

After analyzing Table 11, the results show that null hypothesis is not rejected, except hypothesis for $\mu_{11} = \mu_{31}$ and $\mu_{13} = \mu_{33}$. In the hypothesis $\mu_{11} = \mu_{31}$, H_0 is rejected. Meaning that when viewed from students with AQ climbers type, there is a significant influence on the learning model of TSTS and DL on the mathematics learning achievement. Based on the marginal averages in Table 7, it can be concluded that for students with AQ climbers type, teaching and learning mathematics using learning model TSTS lead to better mathematics learning achievement than DL learning model.

Finally, Scheffe method also reported for hypothesis $\mu_{13} = \mu_{33}$, that is H_0 is rejected. Based on marginal average in Table 7, it can be concluded that for students with AQ quitters type, teaching and learning mathematics using learning model TSTS give better mathematics learning achievement than using DL learning model.

Based on the statistical analysis of the test it can be concluded that students with adversity quotient of climbers type have better mathematics achievement than students with adversity quotient of campers and quitters types. Students with adversity quotient of campers type have better mathematics achievement than students of quitters type. It is relevant that adversity quotient influences to the achievement in solving problem. That students with adversity quotient of climbers type having high learning motivation, creative thinking and being able to understand mathematics problems well [12]. Other studies have shown that students face many situations or obstacles in their daily life, and to overcome or solve this problem, adversity quotient is needed [13]. These results support three other studies performed by [14,15], who found a significant influence between the adversity quotient and students' academic achievement. Mathematics Achievement of students strongly predicts their Adversity Quotient. The high ability in solving problems in mathematics greatly helps the ability of a person to cope up in adverse situations, overcome failures and continue to move forward and upward in life [16].

On the learning model, for students who received treatment of TAPPS models and who did not receive TAPPS model treatment, achievement of students who could be treated better than those who did not [6]. Research [17] concludes that the TSTS learning model is better than the NHT learning model and conventional learning model and can improve student achievement. In this study, the TSTS learning model is also more effective than TAPPS and DL.

Based on the experiment learning model conducted, this research produced several findings as an effort to improve mathematics learning achievement. Mathematics teachers are expected to use a varied learning model such as the TSTS, DL or other learning model because students are required to

conduct learning activities directly and can train students' level of thinking. For students, it is recommended to know each type of AQ as a self-evaluation and motivation to continue learning and practicing. Using this models, students can emphasize process skills (of doing mathematics), discuss and collaborate, argue and communicate with classmates so that they can find themselves (student inventing) as opposed to teacher telling and ultimately students use that mathematics to solve problems both individually and in groups [18].

5. Conclusion

Based on the results of the research and the discussion that has been done, it can be concluded: 1) Teaching and learning with TSTS lead to mathematics learning achievement more than that with TAPPS, and DL learning models. Teaching and learning with TAPPS lead to better mathematics learning achievement than DL learning model. 2) Students with AQ climbers type have better mathematics learning achievement than students with AQ campers and quitters types. Students with adversity quotient of campers type have better mathematics achievement than students of quitters type. 3) Students with AQ climbers type possess better mathematics learning achievement than students with AQ quitters type when subjected to the TAPPS learning model. Meanwhile, students with AQ climbers type possess mathematics learning achievement than students with AQ quitters type when subjected to the DL learning model. Students with AQ campers type possess better mathematics learning achievement than students with AQ quitters type when subjected to the DL learning model. 4) For students with AQ climbers type and AQ quitters type, teaching and learning mathematics using learning model of TSTS improves better mathematics learning achievement than when using DL learning model.

For further studies, a similar research can be tested on the students with different level of education, different learning material, and also different learning model without losing the main characteristic of this research, mathematics learning achievement viewed by adversity quotient

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