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Implementation TANDUR Learning Using GeoGebra Towards Student Learning Result Viewed from Independence Learning

Ni Wayan Suardiati Putri¹, I Wayan Gede Wardika²

^{1,2}Teknik Informatika, STMIK STIKOM Indonesia

¹suardiatiputri@stiki-indonesia.ac.id, ²iwayangedewardika@stiki-indonesia.ac.id

ABSTRACT

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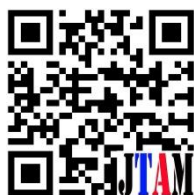
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The purpose of this study was to determine the effect of the TANDUR learning model assisted by GeoGebra on mathematics learning outcomes in terms of student learning independence which is a quasi-experimental research. The number of respondents in this study were 71 students. Collecting data on learning independence is collected through a questionnaire, and data on mathematics learning outcomes are collected through tests of mathematics learning outcomes in the cognitive domain. Data analysis was performed using two-way analysis of variance (ANOVA) with the help of SPSS, at a significance level of 5%. The results show that the learning outcomes of students who use the TANDUR learning model assisted by GeoGebra are better than the learning outcomes of students who use conventional learning models, student learning outcomes using the TANDUR learning model assisted by GeoGebra are better than using conventional learning models in students who have learning independence high, and the learning outcomes of students who use conventional learning models are better than students who use the GeoGebra-assisted TANDUR learning model for students who have low learning independence.



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A. INTRODUCTION

The use of computer technology is currently growing. The Industrial Revolution Era 4.0 demands interaction between machines and computer equipment both hardware and software in helping to solve problems in the industrial world optimally. Currently electronic devices can already be integrated with computer applications is called Internet of Things (Hartawan & Sudiarsa, 2019)(Ekayana, Hartawan, Desnanjaya, & Joni, 2020). In addition to controlling remotely, current technological developments also make it possible to control the system automatically (Desnanjaya, Iswara, Ekayana, Santika, & Hartawan, 2020). This requires system designers/developers to be able to think logically and mathematically in building/developing systems to solve problems in the industrial world. STMIK STIKOM Indonesia is a high school in the field of computers that produces graduates with knowledge and skills in the field of computers. As an Educational Institution, STMIK STIKOM Indonesia is obliged to educate students to be able to achieve the expected results.

The field of computers is very closely related to mathematics, because mathematics is the basis for the development of computer science. However, students still think that learning computer must be directly taught to make computer programs. Even before students are

taught to make computer programs, students are first taught to be able to think logically and mathematically. Computer technology is designed to be able to solve problems in the community or industry with a variety of limited resources, such as energy, time, and cost. That requires the ability of a system designer who is able to solve problems optimally. One problem solving technique with these limitations can be trained through a linear program which is the subject of mathematics courses. Based on teaching experience, students are not interested in learning linear program material. Students tend to be passive and less enthusiastic during the learning process. This can be influenced by the learning model and teaching aids used by the lecturer during the learning process. One learning model that can be used is the TANDUR learning model which is a manifestation of quantum learning (Quantum Teaching)(Putri, Suandhi, & Putra, 2017). Quantum teaching can create a pleasant learning environment, students become more active, like to play and conduct experiments (Rachmawati, 2012). Quantum teaching is also used to improve writing skills in English lessons (Wigati, 2016). The Quantum Learning Model is more effective for improving students' critical thinking skills when compared to the Expository Learning Model in elementary school students (Ramadhani & Ayriza, 2019). Research conducted by Kalsum and Fadhila with a pre-experimental research model of physics class IX science students implementing quantum teaching methods with the TANDUR technique. TANDUR is the application of Quantum Teaching which is a learning model designed by teachers to help overcome students who have difficulty in learning. TANDUR is short for *Tumbuh* (Enroll), *Alami* (Experience), *Namai* (Label), *Demonstrasikan* (Demonstrate), *Ulangi* (Review), and *Rayakan* (Celebrate). The results of the research conducted showed that the application of the TANDUR quantum teaching method has met the pre-determined classical completeness standards for the achievement of students' cognitive learning outcomes (Kalsum & Fadhila, 2018). In the "Experience" and "Demonstrate" sections of the TANDUR learning model, we need a tool that can apply the learning model, so that students can express what they learn, especially in linear program material. A suitable tool is the GeoGebra application.

GeoGebra is a computer program (software) designed for learning mathematics, especially geometry, algebra, and calculus (Wayan, Putri, & Ardana, 2014). This program makes it possible to visualize complicated linear program concepts and help improve students' understanding of the material concepts (Hanč, Lukáč, Sekerák, & Šveda, 2011)(Kushwaha, Chaurasia, & Singhal, 2014)(Bakar, Ayub, & Mahmud, 2015). GeoGebra can also be used to play games that make learning more interesting (Cukierman et al., 2014). GeoGebra can describe mathematical concepts and procedures well through visuals and graphics, so it is very helpful for students in understanding the material. GeoGebra also allows for active interaction between teachers and students. GeoGebra can be used as a tool to improve student achievement(Zulnaldi, Oktavika, & Hidayat, 2020). GeoGebra is able to improve students' conceptual and procedural knowledge and at the same time significantly be able to improve student achievement in mathematics (Zulnaldi & Zamri, 2017). Utilization of GeoGebra helps students in solving problems in their daily lives and with the state of the environment in which they live. If students can understand what is conveyed by the lecturer, then students tend to be more active in the learning process which will lead to an increase in student learning outcomes. Learning outcomes can be influenced by the independence of student learning. Students must be able to learn independently to support their ability to understand the concept of linear programming. The purpose of this study was to analyze the effect of the application of GeoGebra media-assisted TANDUR learning on student learning outcomes in terms of learning independence.

B. METHODS

1. Types of Research

This type of research is quasi-experimental research where experiments are carried out in classes that are already available. The use of classes that are already available is done because researchers only examine the effect of independent variables on the dependent variable. With the GeoGebra Media Assisted TANDUR Learning model as an independent variable, student mathematics learning outcomes are the dependent variable, and the moderator variable is Learning Independence.

The research design used is factorial design with treatment by level design, where one of the independent variables will function as a moderator variable.

Table 1. Research Design *Treatment By Level 2 x 2*

Learning Model (A) Independence Learning (B)	TANDUR Learning Model using GeoGebra (A₁)	Conventional Learning Model (A₂)
High Independence Learning (B ₁)	A ₁ B ₁	A ₂ B ₁
Low Independence Learning (B ₂)	A ₁ B ₂	A ₂ B ₂

Information: A₁ = student learning outcomes in mathematics taught with the GeoGebra Media Assisted TANDURAR Learning model, A₂ = student learning outcomes in mathematics taught using conventional learning models, A₁B₁ = mathematics learning outcomes of students who have high Learning Independence who are taught with the GeoGebra Media Assisted TANDUR learning model, A₁B₂ = mathematics learning outcomes of students who have low Learning Independence who are taught with the GeoGebra Media Assisted Learning Model, A₂B₁ = mathematics learning outcomes of students who have high Learning Independence who are taught with conventional learning models, A₂B₂ = mathematics learning outcomes of students who have low Learning Independence who are taught with conventional learning models.

2. Population of Research

Population is a generalization area that consists of subjects that have certain qualities and characteristics determined by researchers to be studied and then drawn conclusions (Arfilindo & Wahyuni, 2014)(Sugiyono, 2016). The population in this study was conducted at STMIK STIKOM Indonesia. Consideration of choosing this campus as a place of research because understanding the concept of linear program subjects is still lacking and similar research has never been held.

Sampling is done in two stages. In the first stage, two classes were randomly selected as samples. Furthermore, the two classes were tested for their similarity using the F test. This was done to determine whether the two groups of samples obtained had homogeneous abilities or not. The data used as the basis for testing the equation is the math scores of the even semester students. The midterm scores were analysed using the one-way analysis of variance, namely the F test. After the F test, it could be concluded that the students' abilities in the two sample classes tested were equivalent. In the second stage, the drawing was repeated to determine one class to be an experimental group and one class to be a control group. The results of the draw gave the result that class A became the experimental group while class W became the control group.

3. Data collection technique

Furthermore, from each of the experimental groups and the control groups that have been formed, group segregation is done based on the level of student learning independence. In the experimental class is divided into two groups, namely groups of students who have high and

low learning independence. Similarly, in the control class where the class also consists of groups of students who have high and low learning independence.

To determine learning independence in the form of high learning independence and low learning independence is a student self-study questionnaire. The results of this student learning independence test are ranked first, then many students who have high and low learning independence are determined by finding 33% of the many students from each group. As many as 33% of the upper group is stated as a group that has high learning independence and 33% of the lower group is stated as a group that has low learning independence. Taking each of the 33% upper and lower groups is based on recommendations (Putra & Wardika, 2019) which states that if the total score is normally distributed, then the 33% highest score and the 33% lowest score will respectively be the upper and lower groups. . Individuals who have learning independence around the average between high learning independence and low learning independence are not taken as a sample because it is less able to reflect the tendency whether the individual is high or low

The analysis showed that class A class as an experimental group gave the results that the upper and lower groups each consisted of 12 students. Furthermore, the results of sorting analysis in class Was a control group were obtained by 11 students each into the upper and lower groups.

4. Data Analysis

The data collected in this study are data about learning independence and mathematics learning outcomes. Questionnaire for independence learning using a questionnaire while student mathematics learning outcomes use the test description. After that, the learning independence test and the mathematics learning achievement test were tested to get an empirical picture of the appropriateness of the instrument used as a research instrument. Instrument refers to something that can function as a helper so that efforts to achieve goals are easier (Wardika & Putra, 2019). To test the data collected, the data is processed using prerequisite test analysis and variance analysis test (ANAVA). Before testing the hypothesis, first the analysis prerequisite tests are carried out so that the conclusions drawn meet the prerequisites. The first prerequisite test is to test data normality. The normality test of data distribution is carried out to fulfil whether the data obtained can be further tested or not. If the data distribution is normally distributed, further tests can be carried out. Testing the normality of data distribution is used by the Kolmogorov Smirnov test. If the data is normally distributed, then the variant homogeneous test is then performed. Homogeneous variance test is intended to ensure that differences that occur in hypothesis testing actually occur due to differences between groups, not as a result of differences in groups. The variance homogeneity test in this study was carried out with the Levene Test. Furthermore, the statistical analysis used to test the research hypothesis is a two-way ANAVA with Treatment by Level design. Based on this, the hypothesis to be tested is as follows:

$$H_0 : \mu_{A1} = \mu_{A2}$$

$$H_0 : \mu_{A1} \neq \mu_{A2}$$

Information: μ_{A1} = Average of student learning outcomes taught by the GeoGebra Media Assisted Learning Model, μ_{A2} = Average student learning outcomes learned with conventional learning models.

C. RESULT AND DISCUSSION

The design in this study is the design of treatment by Level using ANAVA Two Path as a tool for analysing data. Calculation of central size (mean, median, mode) and size of data distribution (standard deviation) can be presented in Table 2 below.

Table 2. Recapitulation of Mathematics Learning Outcomes Score Calculation Results

Statistic \ Sample	A ₁	A ₂	A ₁ B ₁	A ₁ B ₂	A ₂ B ₁	A ₂ B ₂
Mean	76,88	68,68	87,33	66,42	69,73	67,64
Median	76,50	68,50	85,00	67,50	68,00	69,00
Modus	85,00	68,00	100,00	68,00	66,00	77,00
Maximum	100,00	82,00	100,00	85,00	82,00	80,00
Minimum	45,00	40,00	75,00	45,00	56,00	40,00
Varian	236,20	102,13	101,33	153,90	72,02	140,05
Deviation Standards	15,37	10,11	10,07	12,41	8,49	11,83

Student mathematics learning outcomes taught by the GeoGebra Media Assisted TANDUR Learning model (A₁) show an average value of 76.88, a maximum value of 100.00 and a minimum of 45.00. Student mathematics learning outcomes taught by conventional learning models (A₂) show an average value of 68.68, a maximum value of 82.00 and a minimum of 40.00. Mathematics learning outcomes of students who have high learning independence taught with the GeoGebra Media Assisted Learning Model (A₁B₁) show an average value of 87.33, a maximum score of 100.00 and a minimum of 75.00. Mathematics learning outcomes of students who have low learning independence taught with the GeoGebra Media Assisted Learning Model (A₁B₂) show an average value of 66.42, a maximum value of 85.00 and a minimum of 45.00. Student mathematics learning outcomes that have high learning independence taught by conventional learning models (A₂B₁) show an average value of 69.73, a maximum value of 82.00 and a minimum of 56.00. While the learning outcomes of mathematics students who have low learning independence who are taught with conventional learning models (A₂B₂) show an average value of 67.64, a maximum value of 80.00 and a minimum of 40.00.

Then the hypothesis test is conducted. Hypothesis testing in this study was carried out through a statistical method using Two-Way ANAVA, while a summary of the ANAVA Two-Line analysis results can be presented in Table 3 below.

Table 3. Tests of Between-Subjects Effects

Dependent Variable: LEARNING_RESULTS

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	3419.602 ^a	3	1139.867	9.714	.000
Intercept	243187.472	1	243187.472	2072.490	.000
CLASS	770.515	1	770.515	6.566	.014
INDEPENDENCE LEARNING	1519.000	1	1519.000	12.945	.001
CLASS * INDEPENDENCE_ LEARNING	1017.000	1	1017.000	8.667	.005
Error	4928.311	42	117.341		
Total	253190.000	46			
Corrected Total	8347.913	45			

a. R Squared = .410 (Adjusted R Squared = .367)

The Two Path ANAVA calculation results in the table above for the hypothesis can be seen in the third row (CLASS), F value of 6.566 and a value (Sig.) Of 0.014. Because (Sig.) <A, so H₀ is rejected and H₁ is accepted. This means that mathematics learning outcomes between students using the TANDUR learning model assisted by GeoGebra Media are different from students using conventional learning models. The results of the recapitulation table calculation of the Mathematics Learning Outcomes Score Calculation results show that the group of students who took part in learning using the TANDUR learning model assisted by GeoGebra media (Group A1) had an average score of learning outcomes in mathematics of 76.88, while the group of students who took part in learning with the model Conventional learning (Group A2) has an average value of mathematics learning outcomes of 68.68. This shows that the learning outcomes of students using the TANDUR learning model assisted by GeoGebra Media are better than student learning outcomes using the conventional learning model.

Based on the results of data analysis it has been proven that student learning outcomes using the TANDUR learning model assisted by GeoGebra Media are better than students using conventional learning models. Hypothesis test results obtained state that student learning outcomes using the TANDUR learning model assisted by GeoGebra Media are better than student learning outcomes using learning with conventional learning models. This is in line with the results of research conducted by (Prof. Dr. I Made Yudana, 2013) (Wayan et al., 2014) that the TANDUR learning model produces learning outcomes are better than conventional learning. The use of GeoGebra media can also facilitate the learning process so as to improve learning outcomes, this is evidenced by (Nur, 2016) (Rohaeti & Bernard, 2018).

D. CONCLUSIONS AND SUGGESTIONS

Based on the results of hypothesis testing and discussion in this study, a general proportion can be made, that the learning model and learning independence are essential in achieving learning outcomes. These proportions can be broken down into conclusions of research results that are answers to the problems raised in this study. The conclusions of this study are as follows: Student learning outcomes using the TANDUR learning model assisted by GeoGebra Media are better than student learning outcomes using conventional learning models.

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