THE EFFECTIVENESS OF THE GROUP INVESTIGATION MODEL BY GEOGEBRA-ASSISTED ON STUDENT LEARNING OUTCOMES AND SELF-EFFICACY IN ELEMENTARY ALGEBRA COURSES

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Abstract: The Elementary Algebra course is a compulsory course offered in the FKIP UNIB Mathematics Education Undergraduate Study Program with a weight of 2 credits. This course aims to enable students to solve problems related to quadratic equations and quadratic functions and construct graphs. This research aimed to determine the effect of the Group Investigation model with Geogebra tools on student learning outcomes and self-efficacy in Elementary Algebra courses in the Mathematics Education study program at Bengkulu University. The type of research carried out was quasi-experimental research with a pretest and post-test control group design. The research sample was students from the Bachelor of Mathematics Education study program at Bengkulu University, semester 1A with 29 students and semester 1B with 29 students. Semester 1A students applied the Group Investigation model assisted by Geogebra, and semester 1B students applied the conventional method. Data were analyzed statistically, descriptively, and inferentially through the MANOVA test. This research shows differences between the experimental class, which applies the GeoGebra-assisted group investigation model, and the control class, which uses the conventional model regarding learning outcomes and self-efficacy.

INTRODUCTION

The introduction, typed in capital letters, contains the background of solving a problem, clear theory, urgency and rationalization, a literature review from primary sources, a problem-solving plan, updated knowledge, activity objectives, and hypothesis development, references to national and international journals, Clear State of the Art, The novelty of the methods used and their impact on the development of science, laws or regulations are not just written down, the article is enough to be determined, and explain the relationship to the article.

The Elementary Algebra course is a compulsory course offered in the FKIP UNIB Mathematics Education Undergraduate Study Program with a weight of 2 credits. This course aims to enable students to solve problems related to quadratic equations and quadratic functions and construct graphs. Patricia (2019) revealed that students still make many facts

and principal errors in Elementary Algebra courses. Apart from that, in previous Elementary Algebra lessons, students experienced many difficulties in determining the roots of solutions to equations and quadratic functions and difficulties in drawing graphs of quadratic functions. Then, the learning outcomes of students from the class of 2022 in Algebra learning were low. Previously, they were still low, only getting an average score of 56.3. This is a problem that must be resolved as early as possible.

As facilitators in lectures, lecturers must be able to help students obtain the expected abilities. This ability will be maximized through activities centered on the students. In the Minister of Education and Culture Regulation No. 3 of 2020, the characteristics of the learning process are regulated, which consist of interactive, holistic, integrative, scientific, contextual, thematic, practical, collaborative, and student-centered. Lecturers should be able to design learning that meets these characteristics. One of the learning models that can be used is Group Investigation.

Shoimin (2014) revealed that Group Investigation is a form of cooperative learning model that is based on the participation and activities of students to search for information on the material to be studied through the available materials. The Group Investigation type cooperative learning model can create an active learning process because students will learn more by creating, working in groups, sharing knowledge, and taking responsibility for the tasks given by the teacher. Slavin (2005) describes several steps in Group Investigation cooperative learning, namely: 1) Identifying the Topic and Organizing Students into Groups; 2) Planning the Tasks to be Learned; 3) Carrying out Investigation; 4) Preparing the Final Report; 5) Present the Final Report; and 6) Evaluation.

Group Investigation is very suitable for Elementary algebra courses. To support lectures with this model, lecturers can use the Geogebra application. Geogebra can be used as a mathematics learning medium to demonstrate or visualize mathematical concepts and as a tool to construct mathematical concepts (Utari et al.; E., 2022). Geogebra is accessible, dynamic, multiform math software for all educational levels that combines geometry, algebra, tables, graphs, statistics, and calculus in one easy-to-use package. Some of Geogebra's advantages include: 1) graphs, algebra, and tables are connected and very dynamic; 2) Easy to use but has lots of advanced features; 3) authoring tool (modification tool) to create interactive learning materials as web pages; 4) available in many languages to our millions of users worldwide; and 5) Open-source software that is freely available for non-commercial users (Utari et al.; E., 2022).

To improve student learning outcomes, it cannot be separated from a sense of self-confidence in the student's abilities. According to Jatisunda (2017), the learning process in school will run smoothly if it is supported by psychological aspects related to students' attitudes towards learning, namely self-efficacy. This is also supported by the regulation of the Minister of Education and Culture of the Republic of Indonesia No. 64 (2013), which states that the level of competency students must have is curiosity, self-confidence, and interest in mathematics. Often, students need help demonstrating academic achievement according to their abilities optimally. One reason is that students often need clarification on whether they can complete the assignments given to them. This problem shows that high self-efficacy is crucial for student learning.

According to Bandura (1994), self-efficacy is a belief in the ability to organize and carry out a series of actions to achieve a specified result. With self-efficacy in students, students can assess their success in completing mathematical connection skills. With self-efficacy, students are trained to be confident in their abilities, dare to face challenges, not give up easily in solving problems, and know their weaknesses and deficiencies. , then indirectly it can change students' habits so that they are not embarrassed to ask questions, dare to express opinions in class, and collaborate with other people, then indirectly it can also hone students' mathematical connection skills (Minarti & Nurfauziah, 2016; Kurnia et al., 2108). Based on this, the problem formulation in this research is how effective the Geogebra-style Group Investigation learning model is on student learning outcomes and self-efficacy in the Elementary algebra course.

RESEARCH METHODS

This type of research is quasi-experimental research (quasi-experimental research design). This type of research was chosen because not all variables that appear in experimental conditions can be measured or controlled (Sugiyono, 2014). The design of this research is a nonequivalent control group design, with the design as follows:

Experiment Class	O_1	X	O_2	
Control Class		O_3		O_4

Notes:

O_1 = *Pretest* Experiment Class

O_2 = *Posttest* Experiment Class

O_3 = *Pretest* Control Class

O_4 = *Posttest* Control Class

X = Learning using Group Investigation assisted by Geogebra

The population in this study were all undergraduate students in Mathematics Education at Bengkulu University. The sample for this research is students from the class of 2022. This sample was selected using a purposive sampling technique because students from the class of 2022 were taking Elementary algebra courses at the time this research was carried out. The sample to be used as an Experiment Class is class A, using the Group Investigation model assisted by Geogebra with 29 students, and the Control Class sample is class B, using conventional learning with 29 students.

Two data collection techniques are used in this research, namely, non-test and test. The non-test technique is in the form of distributing response questionnaire sheets. The data collection technique is a description test that aims to measure the effectiveness of the Group Investigation Model in the Elementary algebra course. The instruments used to collect information are a pretest Sheet, Post-test, and Likert scale response questionnaire.

The data analysis technique used is the Manova test. In multivariate analysis of variance, a MANOVA assumption test is required, namely that the data obtained comes from a normally distributed population and a homogeneous covariance matrix using SPSS. The data to be analyzed is data before and after treatment.

The normality test was carried out using the correlation coefficient. If the correlation is more than r_table, namely 0.98914, or the significance value in the correlation column is less than 0.05, then the data comes from multivariate average distribution data.

The homogeneity test of the covariance matrix of the two populations was carried out using the Box's M test via the SPSS program. Suppose the significance value in the Box's equality test of covariance matrices table is more than 0.05. In that case, the variance-covariance matrices of the two experimental groups are said to be homogeneous.

RESULTS AND DISCUSSION

The format of research results and discussion is not separated, given the limited number of pages available to authors. Manuscripts are written with a line density of 1.5 spacing, Times New Roman 12 font. Research results can be presented with the support of tables, graphics, or images as needed to clarify the presentation results verbally. Table titles, graphs, and image captions are arranged in concise phrases (not sentences). The image/graphic caption is placed below the image/graph, while the table title is above it. The title begins with a capital letter. Refrain from repeating writing the numbers listed in the table in the discussion text. If you want to emphasize the results obtained, it is better to present them in another form, for example, a percentage or difference. Just refer to the table containing the numbers to show the numbers in question. International journals do not want statistical language (such as significantly different treatments) to be written in the discussion. Avoid copying and pasting statistical analysis results tables directly from statistical data processing software.

A. Hypothesis Test Results/Answers to Research Questions

The data used in this group investigation research assisted by Geogebra to test hypotheses is data from the pretest and post-test in the Experiment and Control Class. In this geogebra-assisted group investigation research, the data used to test the research hypothesis and the effectiveness of the geogebra-assisted Group Investigation (GI) model is data after treatment. A complete explanation of the results of the hypothesis test will be presented as follows:

1. Test Assumptions

The assumption test was carried out before testing the research hypothesis related to pretest and post-test data on mathematics learning outcomes (cognitive) and self-efficacy. The assumption tests carried out were multivariate and univariate normality and homogeneity tests. A complete explanation is outlined as follows.

a. Multivariate Assumption Test

In multivariate analysis, the assumptions that must be met first are normality and homogeneity tests. The multivariate normality test used is the Mahalanobis distance (d_j^2) as seen from the scatter plot graph between the Mahalanobis distance (d_j^2) and qi with the help of SPSS. The homogeneity test used is the Box's M test with the help of SPSS.

b. Multivariate Normality Test on Pretest

The normality test is used to see whether the sample data comes from a normally distributed population. To check the normality of multivariate data, you can use the bivariate correlation coefficient with the help of SPSS. The results of the multivariate normality test with bivariate correlation coefficients can be seen in Table 1.

Table 1. Multivariate Normality Test Results with Correlation in Pretest

	Bivariat Correlation Point	**Signifcance**	**Notes**	**Conclusion**
Pretest	0,932	0.000	Sig < 0,05	Normal

Table 1. shows that the bivariate correlation value in the pretest is greater than $_{table}$ = 0.2586, so it can be concluded that the pretest data comes from a normally distributed population. Apart from that, it can be seen through the significance value that the significance value in the pretest is less than 0.05, so it can be concluded that the pretest data comes from a normally distributed population.

c. Covariance Matrix Homogeneity Test in the Pretest

The homogeneity test of the covariance matrix uses the Box's M test with the help of the SPSS program. The results of the covariance matrix homogeneity test can be seen in Table 2.

Table 2. Covariance Matrix Homogeneity Test Results on Pretest

	Pretest
Box's M	2,509
F	0,804
Sig	0,491

Based on the data in Table 2, the significance of the Box's M value is more than 0.05. The covariance matrix's homogeneity assumption is fulfilled for the data before treatment (pretest). It can be stated that the two classes are homogeneous, or both classes have the same abilities. Based on the normality and homogeneity test results on the pretest data, both classes can be used for research (given treatment).

d. Multivariate Normality Test on Post-test

The normality test is used to see whether the sample data comes from a normally distributed population. To check the normality of multivariate data, you can use the bivariate correlation coefficient with the help of SPSS. The results of the multivariate normality test with bivariate correlation coefficients can be seen in Table 3.

Table 3. Multivariate Normality Test Results with Correlation on Post-test

	Bivariat Correlance Point	**Significance**	**Notes**	**Conclusion**
Posttest	1,000	0,000	Sig < 0,05	Normal

Table 3 shows that the bivariate correlation value in the post-test is greater than r_{table}=0.2586, so it can be concluded that the post-test data comes from a normally distributed population. Apart from that, it can be seen through the significance value that the significance value in the post-test is less than 0.05, so it can be concluded that the post-test data comes from a normally distributed population.

e. Covariance Matrix Homogeneity Test on Post-test

The homogeneity test of the covariance matrix uses the Box's M test with the help of the SPSS program. The results of the covariance matrix homogeneity test can be seen in Table 4.

Table 4. Covariance Matrix Homogeneity Test Results on Post-test

	Post-test
Box's M	1,054
F	0,338
Sig	0,798

Based on the data in Table 4, the significance of the Box's M value is more than 0.05. The covariance matrix's homogeneity assumption is fulfilled for the data after treatment (post-test). So, both classes have the same abilities. Based on the results of the normality and homogeneity tests on the post-test data, the Manova test can be continued to check the difference in the effectiveness of the Geogebra-assisted Group Investigation model compared to the conventional model.

f. Differences in Learning Effectiveness

The following hypothesis test was carried out to determine whether there was a difference between the Geogebra-assisted GI learning model and the conventional/lecture learning model. The test carried out is the MANOVA test; the data will be used after treatment (post-test). The results of the calculation with the help of the SPSS program are shown in Table 5.

Table 5. MANOVA Test Results Data After Treatment (Post-test Data)

Data	*F*	*Sig*
Data *post-test*	7,837	0,001

Based on Table 5, there is information that the significance value of F is less than 0.05, namely 0.001, meaning that the data after treatment, there are differences in learning outcomes and self-efficacy between the Experiment Class which applies the geogebra-assisted GI learning model and the Control Class which uses the conventional model.

After receiving information, there was a difference between the Experiment Class, which applied the geogebra-assisted group investigation model, and the Control Class, which used the conventional model in terms of learning outcomes and self-efficacy. Based on the results of the MANOVA test, researchers need to conduct further tests to determine which learning model is more effective in terms of learning outcomes and self-efficacy using the independent sample t-test with the help of the SPSS program. The results are as follows:

Table 6. T-test Results on Learning Outcomes

t-test for Equality of Means		
t	**df**	**Sig.**
3,752	56	0,000

Based on the t-test results in Table 6, the t-count price=3.752 is obtained, and we know the t-table price=2.668. By the hypothesis testing criteria, because t-count>t-table, then H0 is rejected, and H1 is accepted. This means that learning using the Group Investigation method with the help of the Geogebra application is more effective than the conventional model regarding the Elementary algebra learning outcomes of Bengkulu University students. In other words, learning using the Group Investigation method with the

help of the Geogebra application can influence the Elementary algebra learning outcomes of Bengkulu University students.

Table 7. Hasil Uji *t* pada *Self Efficacy*

t-test for Equality of Means		
t	**df**	**Sig.**
3,189	56	0,001

Likewise, in the t-test of the mathematical self-efficacy abilities of Bengkulu University students. Based on the t-test results in Table 7, the t_count price=3.189 is obtained, and we know the t_table price=2.668. By the hypothesis testing criteria, because t_count>t_table, then H0 is rejected, and H1 is accepted. This means that learning using the Group Investigation method with the help of the Geogebra application is more effective than the conventional model regarding the mathematical self-efficacy of Bengkulu University students in the Elementary algebra course. In other words, learning using the Group Investigation method with the help of the Geogebra application can influence the mathematical self-efficacy of Bengkulu University students in the Elementary algebra course.

The Group Investigation learning model, with the help of GeoGebra, is an active learning model that can be used in the classroom. This statement is the opinion of Qamaruzzaman and Fajriah (2022), who stated that using the Group Investigation learning method with the help of GeoGebra can improve students' learning outcomes because they become more active during the learning process, especially during investigations.

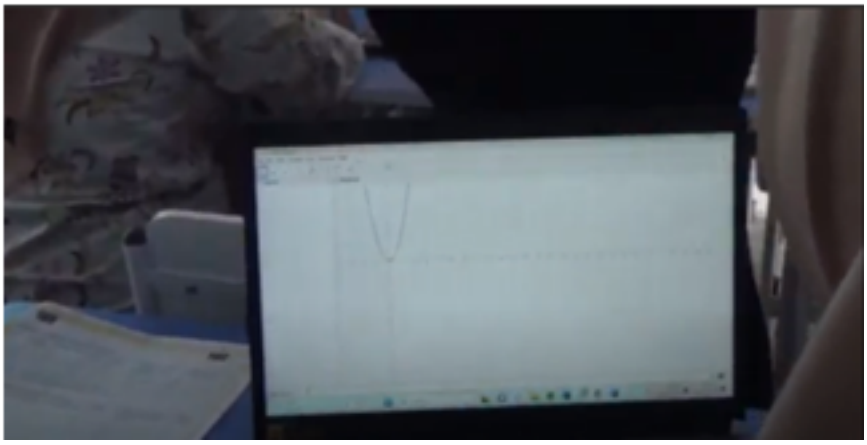

Figure 1. Learning Process with Group Investigation Assisted by Geogebra

The group learning model based on discovery or investigation is known as Group Investigation (Widyanto, 2017). This model consists of six stages: group formation, subject identification, investigation planning, investigation implementation, final report preparation, final report presentation, and evaluation (Pratami et al., 2019). Researchers used the Slavin method (in Taniredja, 2014). Group Investigation can improve learning outcomes because of group work. These results are to the research results of Widyanto (2017), which states that when the group formation learning process is carried out heterogeneously, the learning outcomes of low and medium-ability students can be influenced by the learning process of high-ability students with the help of GeoGebra.

Figure 2. Group Investigation Process

In previous research, Salsabila et al. (2023) found that the Group Investigation model can improve leadership attitudes, self-confidence in one's abilities (self-efficacy), social abilities, and better learning outcomes in terms of knowledge than conventional methods. In the research of Faujiyah et al. (2017), Trisnawati (2019) also found that using a group investigation model can improve student learning outcomes and self-efficacy. According to research by Pratami et al. (2019), applying the Group Investigation model can improve social studies learning outcomes on the theme of my dreams in class IV of SD Negeri 6 Panjer in the 2018/2019 academic year. Apart from that, in research conducted by Rahmawati et al. (2020), the Group Investigation model is a learning model that suits physics characteristics and encourages students to study concepts actively.

Apart from that, using Geogebra can also make students more interested and active in class. This aligns with research conducted by Fitriasari (2017), which states that learning using GeoGebra can make students more active in the learning process.

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of research tests, the following conclusions were obtained:

(1) There is a difference between the Experiment Class, which applies the geogebra-assisted group investigation model, and the Control Class, which uses the conventional model regarding learning outcomes and self-efficacy.

(2) Learning using the Group Investigation method with the help of the Geogebra application is more effective than the conventional model in terms of the Elementary algebra learning outcomes of Bengkulu University students. In other words, learning using the Group Investigation method with the help of the Geogebra application can influence the Elementary algebra learning outcomes of Bengkulu University students.

(3) Learning using the Group Investigation method with the help of the Geogebra application is more effective than the conventional model in terms of the mathematical self-efficacy of Bengkulu University students in the Elementary algebra course. In other words, learning using the Group Investigation method with the help of the Geogebra application can influence the mathematical self-efficacy of Bengkulu University students in the Elementary algebra course.

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