Mathematical Representation Abilities and Self-Confidence through Application of Discovery Learning Model with Geogebra-assisted

Dwy Lestari[1], Usman Usman[1]*, and Said Munzir[2]

[1]Department of Mathematics Education, Universitas Syiah Kuala, Banda Aceh, Indonesia
[2]Department of Mathematics, Universitas Syiah Kuala, Banda Aceh, Indonesia
usmanagani@usk.ac.id

Abstract. The research aims to determine the increase in mathematics representation abilities and self-confidence of senior high school students, with an emphasis on implementation of the discovery learning model with Geogebra-assisted. This research is quantitative research with a true experimental design method with a pretest-posttest design. The population of this research was class XI students from one senior high school in Aceh, Indonesia. A simple random sampling used to choose 100 students. The instrument to obtain data on mathematical representation abilities was tested while to obtain data about self-confidence was a questionnaire. Research data was analyzed by N-gain and t-test. The results revealed that increasing the mathematics representation abilities and self-confidence of students through the discovery learning model with Geogebra-assisted is better than students taught through conventional learning.

Keywords: Mathematics Representation Ability, Self-Confidence, Discovery Learning, Geogebra.

1 Introduction

Mathematics learning will be successful if it is able to provide improvements in several aspects required by the curriculum, such as cognitive aspects. The cognitive aspect is a person's ability to connect, assess and consider an event [1]. One of the cognitive aspects is the ability to represent mathematically [2].

Representation is the activity of presenting an idea or concept again in a different form. Representation is aspect of conception and plays an important role in presenting mathematics concepts in various ways [3]. Mathematics representation is also interpreted as a sign or combination of characters, diagrams, objects, images, or graphics, which can be implemented in mathematics learning [4].

Mathematics representation ability is a student's ability who used to communicate mathematical ideas or thoughts learned in various ways. Mathematics representation ability is the ability to describe complex problems in a more theoretical, systematic and comprehensive form that can help problem solve mathematics [5].

Mathematics representation ability is an important thing in learning mathematics because students can develop understanding of concepts and know the relationships between concepts. Representational abilities can also be a means of communicating ideas for solving mathematical problems, and can be used to facilitate and support

R. Johar et al. (eds.), *Proceedings of the 2nd Annual International Conference on Mathematics, Science and Technology Education (2nd AICMSTE)*, Advances in Social Science, Education and Humanities Research 828,
https://doi.org/10.2991/978-2-38476-216-3_11

conclusions [6]. Mathematics representation abilities are used by students to find the concept learning and create ways to communicating abstract mathematics ideas to concrete ones so that students can more easily solve mathematical problems [7]. The role of mathematical representation must be used as an important element in supporting students' understanding of mathematical concepts and relationships. Representations are also used in communicating mathematical relationships, arguments and understanding of oneself and others as well as in applying them to realistic problem situations through mathematical modeling.

There are three aspects of mathematical representation skills that students need to discover and communicate mathematical ideas and thoughts, namely the visual aspect, the symbolic aspect and the verbal aspect. Aspects of mathematical representation ability are formulated into three, namely: 1) Representations are used to model and interpret mathematics, social and physical phenomena, 2) design and implement representations to record and communicate mathematics ideas, 3) Select, use and translate for problem solving [8].

Apart from mathematics representation being an important to supporting learning, there is an affective aspect who can supports the role of representational abilities, namely self-confidence. Self-confidence in the learning process is an important predictor cause students' success in learning mathematics is in line with their level of self-confidence. A student's success in learning mathematics is based on a higher sense of self-confidence compared to other students [9]. Self-confidence is one aspect that influences students' success in completing assignments and finding good, appropriate and effective solutions [10]. Thus, students need a good level of self-confidence to be able to represent every idea they have.

Self-confidence is a belief in the potential that each individual has to be calm in an effort to resolve and resolve the problems they face. Self-confidence is also defined as confidence in one's abilities in mathematics [11].

Based on the correlation and role of representational abilities and self-confidence, teachers should be able to evaluate learning in order to improve both. Teachers must also be more careful in applying appropriate models and media to achieve mathematical abilities and learning goals.

Using appropriate learning models and media can help teachers to improve students' mathematics representation abilities and self-confidence. The learning models and media applied must be able to actively involve students in the learning and stimulate students to want to express their mathematical ideas. The choice of learning model must be in accordance with the material presented because different material requires different learning models so that learning objectives and learning outcomes can be achieved optimally [12]. Apart from learning models, technology-based learning media will simplify the learning process so that it can improve the quality of learning and mathematics representation abilities [13].

There is previous research related to the Discovery Learning model and GeoGebra, namely research by Oktaria, Alam and Sulistiawati [14] which looked at the effect of using GeoGebra software media to improve mathematics representation abilities of class VIII junior high school students. Furthermore, research by Haeruman, Rahayu and Ambarwati [15] examined influence the discovery learning model on increasing critical mathematical thinking skills and self-confidence in terms of high school students' initial mathematics abilities in Bogor. Subsequent research conducted by Putra

[16] examined inquiry and discovery learning models in students' mathematical representation abilities.

This research will examine the used of discovery learning model to improve mathematics representation abilities and self-confidence together. Discovery learning is a learning activity who can encouragement for students to be able to ask questions, explain, and then understand the main idea of what they are learning [17]. The discovery learning model stimulates students to formulate hypotheses better and more deeply when asked to find and construct various important information [18].

Apart from the learning model, the media used in learning also influences the achievement of a learning objective. Geogebra is one of the technological media that can be used in mathematics learning. Geogebra software can be a powerful instructional tool that facilitates connection and representation [19]. Geogebra software provides students with direct experience in learning so that it supports discovery activities and can motivate students to learn [20]. This strengthens that Discovery Learning model can be collaborated with learning media Geogebra software to improve students' representation abilities and self-confidence.

The use of discovery learning models with Geogebra software assist can help the problem of students' low representational abilities and self-confidence. This is because, in the discovery learning syntax, students use representations in it. At the data collection stage, students need a visual representation in the form of a table to contain the various data collected. At the data collection stage, students also need the confidence to carry out exploration to find the data they need. Every syntax in discovery learning uses a representation in it. At the conclusion drawing stage, students need confidence to present their findings in front of the class. Through the use of Geogebra software media, students are given the opportunity to explore to help students discover learning concepts independently. The research aim was analyzing the increase in mathematical representation abilities and self-confidence of students who were taught using the Geogebra-assisted discovery learning model.

2 Method

This research is experimental with quantitative approach. This research used two sample groups, namely experimental group used discovery learning models Geogebra-assisted and control group used conventional learning. The sampling technique uses simple random sampling. Population of this research is 6 classes of class XI, while the sample is 100 students, from one senior high school in Aceh, Indonesia. in experimental class there 50 students and in control class there 50 students. Experimental research is research that looks at the cause and effect of a treatment on the dependent variable [21]. In this research there two variables, namely independent e and dependent variable. Independent variable is mathematics learning with the Geogebra-assisted discovery learning model, while dependent variable is mathematical representation ability and self confidence. The hypothesis in this research is:

1. Increasing the mathematical representation abilities of students taught through the Geogebra-assisted discovery learning model is better than students taught through conventional learning.

2. Increasing the self-confidence of students taught through the discovery learning model assisted by Geogebra is better than students taught through conventional learning.

The collected data were analyzed quantitatively using descriptive statistics. The design used was pretest-posttest control group design with design [22]. O_1 is pre-test O_2 is post-test and X is Learning mathematics through Geogebra-assisted discovery learning model.

Table 1. Research design

Class	Pre-test	Treatment	Post-test
Experiment	O_1	X	O_1
	O_2		O_2

The data in this research were obtained from the instruments namely mathematical representation ability tests and self-confidence questionnaires. The mathematical representation ability test instrument is designed to adjust the syllabus to the school where the research takes place. questionnaire instruments adapted from the book Hard Skills and Soft Student Mathematics Skills by Hendriana, Rohaeti and Sumarmo [23]. Instruments are assessed based on content validity, criterion validity and construct validity about with material of linear equations in two variables.

The stages applied in this research were creating research instruments, testing the initial skills of all class students, determining samples, conducting pre-tests and administering questionnaires before learning was carried out to determine students' initial abilities, applying learning with the discovery learning models with geogebra-assisted for experimental groups and conventional learning is learning that uses the expository method where teacher explains, conducts questions and answers and gives exercise, assignments for the control group, conducting final tests and final questionnaires after treatment, analyzing quantitative data, and drawing conclusions from research results. The data was then analyzed for N-gain, normality, homogeneity and t-test.

N-gain is a calculation of the amount of increase before and after learning whole. The following is the Normalized Gain formula:

$$N - gain = \frac{posttest\ score - \ pretest\ score}{ideal\ score - \ pretest\ score}$$

The normalized gain score criteria are as follows

Tabel 3. Normalized Gain Score

Gain Score	Interpretation
$g > 0{,}7$	High
$0{,}3 > g \leq 0{,}7$	Medium

$g < 0,3$	Low

The normality test used to know that data is normally distributed or not which is a requirement for determining the type of statistics used in subsequent analysis. The statistical analyses used for the normality test is the Kolmogorov Smirnov. After the data meets the normal requirements, then a homogeneity test is carried out to see whether the data is homogeneous or not. The statistical analyses used for the homogeneity test is Levene. The paired-observation t-test was conducted to find out whether the average increase in the mathematics representation communication ability of experimental class was better than control class.

3 Result and Discussion

Experimental class activities is doing in five meetings, for the first meeting was conducted pre-test and questionnaire, followed by learning for three meetings, at the last meeting conducted post-test and questionnaire. The learning process was carried out using the discovery learning model with Geogebra-assisted in the following stages:

1) The teacher provides a stimulus in the form of an initial stimulus. Students are faced with something that causes confusion, this will increase students' curiosity. The teacher does not give generalizations so that there is a desire to investigate on their own.
2) The teacher gives students opportunity to identify other relevant problems and then formulate them into a hypothesis.
3) At the data collection stage, students are given the opportunity to explore using GeoGebra, reading other sources to find data that can prove the hypothesis.
4) The data that has been collected is then processed by conducting experiments to find the concepts that have been formulated by the teacher as goals that must be achieved.
5) The teacher assigns students to represent their findings in front of class and then asks other students to provide comments based on their findings.
6) The teacher guides students to draw conclusions together.

After the learning phase was carried out, it was followed by data collection on the mathematics representation abilities and self-confidence of two groups. The data were analyzed to find out whether the results obtained were in accordance with the formulated hypothesis.

Based on the results of the normality and homogeneity of distribution of pre-test and post-test data, it was obtained that pre-test and post-test data of mathematical representation ability came from normally distributed data and homogeneous variance. It is important to know the data of the two classes with normal and homogeneous distribution in order to illustrate that there was no difference between the control and experimental class, so that the control class only acts as a controller. Furthermore, data analysis was carried out, namely the average difference test with the significance level $\alpha = 0,05$.

In summary, results of the average difference test for mathematical representation ability can be presented in Table 3.

Table 3. Representational normalized mean gain difference test

Ability Aspect	Group	N-gain	Std.Deviation	t	Sig.	df
Mathematics Representation	Experiment	0,4375	.21804	5,634	0,000	99
	Control	0,2470	.24812			

Based on Table 2 obtained sig. = 0,000 ($p < 0.05$). It means H_0 rejected and H_1 accepted. Therefore, it can be concluded, increasing the mathematics representation ability of students taught by the Geogebra-assisted Discovery Learning model is better than students taught with conventional learning.

An increase in mathematical representation ability shows that students have been understand and represent ideas in solving mathematical problems. Students have been able to use visual, verbal and symbolic representations in solving different mathematical problems. This is in according with the results of research that has been conducted on elementary school students with the conclusion that the application of discovery learning models is very suitable to be applied in learning because it can improve student achievement [24].

After seeing the results of increasing the mathematics representation abilities of students who were taught discovery learning model with Geogebra-assisted, another analysis was carried out to see the increase in the self-confidence of students who were taught with the Geogebra-assisted discovery learning model.

Based on the results of the analysis of N-gain, normality and homogeneity of the distribution of the questionnaire data, it was obtained that the students' self-confidence questionnaire data came from data that was normally distributed and had homogeneous variance. This shows that the experimental class and the control class have no differences, so the control class actually acts as a controller. Furthermore, data analysis was carried out, namely the average difference test with the significance level $\alpha = 0,05$.

In summary, the results of the test for differences in the average self-confidence questionnaire can be presented in Table 4.

Table 4. Self confidance normalized mean gain difference test

Ability Aspect	Group	N-gain	Std.Deviation	t	Sig.	df
Self Confidence	Experiment	0,3092	.23819	6,849	0,000	99
	Control	0,0070	.25904			

Based Table 3 obtained sig. = 0,000 ($p < 0.05$). It means H_0 rejected and H_1 accepted. Therefore, it can be concluded that increasing the self-confidence of students taught by the Geogebra-assisted Discovery Learning model is better than students taught with conventional learning.

Increased self-confidence shows that students have confidence in their own abilities, are able to act independently in making decisions, can be responsible for their actions and dare to express their opinions in front of the class. This is in accordance with the results of research that has been done and obtained results that the learning model of discovery learning on self-confidence with material of linear equations in two variables has increased [25].

4 Conclusion

Based on these results, it was concluded that the increase in mathematical representation abilities and self-confidence of students taught using the Geogebra-assisted discovery learning model was better than students taught using the conventional learning model. The increase in mathematical representation abilities and self-confidence is due to the ongoing learning process having a positive influence on mathematical representation abilities. Students who usually tend to memorize concepts and solve problems given during learning are able to understand learning concepts. This increase was also caused by the Discovery Learning model syntax which was applied to support student activities in representing their ideas.

References

1. Susanto, “Perkembangan anak usia dini. Jakarta: Kencana Prenada Media Group”, 2012.
2. R. M. Novira, Mulyono, and Isnarto, “Kemampuan representasi matematis dalam model pembelajaran somatic, auditory, visualization, intellectually (SAVI)”, PRISMA, Prosiding Seminar Nasional Matematika 2, pp. 287-292, 2019.
3. Usman, D. Juniati, and T. Y. E Siswono, ‘Differences conception prospective students teacher about limit of function based gender”, AIP Conference Proceedings, 1867(August), 2017.
4. B. Mainali, “Representation in teaching and learning mathematics”, International Journal of EdENCEucation in Mathematics, Science and Technology, 9(1), pp. 0–21, 2021.
5. D. Rahmawati, E. Hidayanto, and R. B. Anwar, “Process of mathematical representation translation from verbal into graphic”, International Electronic Journal of Mathematics Education, 12(3), pp. 367-381, 2017.
6. S. J. Pape, and M. A. Tchoshanov, “The role of representation(s) in developing mathematical understanding”, Theory into Practice, 40(2), pp. 118- 125, 2001.
7. I. Lette, and J. T. Manoy, “Representasi siswa SMP dalam memecahkan masalah matematika ditinjau dari kemampuan matematika”, MATHEdunesa, 8(3), pp. 569–575, 2019.
8. NCTM. “Standards for Secondary Mathematics Teacher”. United States of America : The National Council of Teachers of Mathematics, Inc. 2003.

9. A. Hosein, and J. Harle, “The relationship between students’ prior mathematical attainment, knowledge and confidence on their self-assessment accuracy”, Studies in Educational Evaluation, 56, pp. 32-41, 2018.
10. N. C. A. Ulfa, and R. Sundayana, “Kemampuan representasi matematis siswa pada materi bilangan berdasarkan self-confidence”, Jurnal Inovasi Pembelajaran Matematika: PowerMathEdu (PME), Vol 01, 2022.
11. Çiftçi, K., and Yildiz, P. (2019). The effect of self-confidence on mathematics achievement: the meta-analysis of trends in international mathematics and science study (TIMSS). International Journal of Instruction, 12(2), 683–694.
12. S. Marfu’ah, Zaenuri, Masrukan, and Walid “Model pembelajaran matematika untuk meningkatkan kemampuan penalaran matematis siswa”, PRISMA: Prosiding Seminar Nasional Matematika, 5, pp. 50–54, 2022.
13. R. Nursanti, and A. Hartoyo, “Pengembangan media pembelajaran berbasis ICT untuk meningkatkan kemampuan representasi matematis siswa dalam materi SPLDV”, Jurnal Pendidikan dan Pembelajaran, 4(5), 2015.
14. M. Oktaria, A. K. Alam, and Sulistiawati. “Penggunaan Media Software GeoGebra untuk Meningkatkan Kemampuan Representasi Matematis Siswa SMP Kelas VIII”. Jurnal matematika kreatif-inovatif, 7(1), 2016.
15. L.D. Haeruman, W. Rahayu, and L. Ambarwati, L. “Pengaruh model discovery learning terhadap peningkatan kemampuan berpikir kritis matematis dan self- confidence ditinjau dari kemampuan awal matematis siswa SMA di Bogor”. Jurnal Penelitian Dan Pembelajaran Matematika, 10(2), 157–168, 2017.
16. I. S. Putra. “Model Pembelajaran Inkuiri Dan Discovery Dalam Kemampuan Representasi Matematis Siswa”. Jurnal Pembelajaran Matematika Inovatif, 5(5), 2022.
17. P. Thorsett, “Discovery learning theory: a primer for discussion”, 2002.
18. F. Y. Euphony, C. Y. Calvin, C. Emily, CHANG, and C. Tak-Wai, “The effectiveness of inductive discovery learning in 1: 1 mathematics classroom”, Proceedings of the 18th International Conference on Computers in Education, Asia-Pacific Society for Computers in Education, pp. 743-747, 2010.
19. I. Bayazit, and Y. Askoy, “Connecting Representations and Mathematical Ideas with GeoGebra”, Tersedia https://ggijro.files.wordpress.com/2011/07/article-8.pdf. 2011.
20. S. Sylviani, and F. C. Permana, “Pembelajaran matematika tingkat sekolah dasar menggunakan aplikasi geogebra sebagai alat bantu siswa dalam memahami materi geometri”, Jurnal Pendidikan Multimedia Vol. 1,. 2019.
21. J. W. Creswell, Penelitian kualitatif dan desain riset, Yogyakarta: PT Pustaka Pelajar. 2014.
22. D. Ary, L. C. Jacobs, and A. Razavieh, “Introduction to research in education (8th Ed)”, Belmont: Wadsworth, Cengagr Learning, 2010.
23. Sumarmo, U.E. E. Rohaeti, and H. Hendriana. “Hard skills dan soft skills matematika siswa”. PT Refika Aditama: Bandung. 2017.
24. Z. Fajri, “Model pembelajaran discovery learning dalam meningkatkan prestasi belajar siswa SD”, JURNAL IKA Vol 7, 2019.
25. L. Marjani, A. Rinaldi, H. Hendriana, and I. W. Anita, ”Penerapan pendekatan pembelajaran discovery learning terhadap self confidence siswa SMP di kabupaten Purwakarta”, Jurnal Pembelajaran Matematika Inovatif, Vol 1, 2018.