Research Article

A Systematic Literature Review: Implementation of Geogebra Mathematical Software on Students Mathematical Abilities in Learning Mathematics

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Abstract.

Difficulties in learning and mastering mathematics are well-founded, partly because mathematics is a lesson that requires students to think logically, systematically, and reflectively, and requires diligent, thorough, and earnest effort. One way that students can use to hone and improve their mathematical abilities is by applying mathematical software in learning mathematics. One of the widely used mathematical software is Geogebra. This systematic literature review aims to provide a description by analyzing the implementation of Geogebra on students' mathematical abilities in learning mathematics through literature review. Data collection were carried out by documenting and reviewing 25 articles related to the use of Geogebra on mathematical abilities published in the 2019-2022 period published in national and international journals that can be accessed and downloaded from Google Scholar, ProQuest and Eric databases. Mathematical abilities that can be improved through the application of geogebra include: mathematical communication, understanding of mathematical concepts, mathematical reasoning, solving mathematical problems, and mathematical connections. The results of the study provide information that Geogebra has a positive, effective, and better influence in improving students' mathematical abilities in the process of learning mathematics. The Geogebra application is also integrated with various models, approaches.

Keywords: Geogebra, mathematical ability, learning mathematics, systematic literature review

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1. INTRODUCTION

Mathematics is undeniably one of the sciences that plays a very important role in civilization, so mastering mathematical skills is very important to be able to compete and achieve progress in modern times. However, most students experience difficulties in learning mathematics, although sometimes these difficulties are deliberately made to train and familiarize students with thinking activities and problem solving activities. Difficulties in learning and mastering mathematics are well-founded because mathematics

is a lesson that requires students to think logically, systematically and reflectively, and requires diligent, thorough and earnest effort so to master math.

Mathematics is a subject that requires students to be able to think critically, analytically, logically and systematically in solving problems. So that students need to hone and improve their mathematical abilities in learning mathematics. This is in line with the general objectives of learning mathematics set by the 2006 National Education Standards Agency which are contained in Permendiknas No. 22.

To achieve this goal, one of the steps that can be focused is to improve students' mathematical abilities. Mathematical ability is the ability or skills possessed by students in dealing with and solving mathematical problems which consist of reasoning, communication, problem solving, connections, conceptual understanding, and critical and creative thinking, and so on. This is in accordance with the opinion of As'ari et al. in Munaji & Setiawahyu (1) who argue that mathematical abilities are needed in daily activities/activities because they are part of life skills, such as the development of reasoning, communication, and problem solving.

Good mathematical communication skills will help students solve problems, provide explanations, and connect problem solutions with the ideas they have. In addition, it is known that the learning process using Geogebra has proven effective, effective, and better in increasing students' ability to understand concepts.

Communication is important in learning mathematics, because communication helps students solve mathematical problems given. So communication skills are important to have. Mathematical communication ability is the ability possessed by students in conveying or expressing mathematical ideas/ideas both orally and in writing in the learning process. According to Ramdani that mathematical communication ability is the ability to communicate in which there are activities of writing, listening, studying, interpreting, and evaluating ideas, terms, symbols, and mathematical information obtained through the process of observing, listening, presenting, and discussing.

One of the goals of learning mathematics is that students can think logically, analytically, and critically. These goals relate to mathematical reasoning abilities. Mathematical reasoning ability is the ability or skill of students in solving mathematical problems by understanding, thinking, proving, evaluating, and drawing logical, valid, and legitimate conclusions based on facts, concepts, principles, characteristics and relationships and can develop these patterns or relationships to analyze the situation of the given mathematical problem (2,3).

In the learning process, students are never separated from a problem. So that students are required to be able to find solutions or solutions to the problems given. According to Polya (4) that problem solving is an effort made in finding solutions or ways out of the problems encountered to achieve the expected goals. Thus, mathematical problem solving abilities are skills or abilities in an effort to find solutions or solutions to mathematical problems that require students to be able to think creatively, logically and systematically in solving problems by using the knowledge and skills they have learned in developing their creativity, skills, and learning outcomes to achieve a goal.

Mathematical connection ability is the ability or skill of students in solving mathematical problems by associating one concept/rule with another by recognizing, understanding, and using mathematical ideas so that they can be connected or connected into a single unit so that it becomes a solution to the given mathematical problem (5).

One that supports the improvement of students' mathematical abilities is the use of Geogebra. Geogebra is a geometry learning application that is used to create dynamic mathematical objects with the aim of connecting mathematical concepts through visuals/images so that students are able to understand material that is considered difficult so that it can be explained. The application of Geogebra is very influential and effective in improving students' mathematical abilities, such as communication skills, understanding concepts, reasoning, problem solving, and mathematical connection skills in learning mathematics (6–8).

Based on the background that has been described, the purpose of this study is to provide a description of the implementation of Geogebra on students' mathematical abilities in learning mathematics. So that researchers and prospective researchers can use it as a reference or guide in further research related to the implementation of Geogebra in learning mathematics to improve students' mathematical abilities.

2. METHOD

The research method used in this research is using the Systematic Literature Review (SLR) method. According to Shuttleworth a literature review does not only mean reading literature, but rather an in-depth and critical evaluation of previous research on a topic. A research method that summarizes the results of primary research to provide more comprehensive and balanced facts. Systematic Literature Review (SLR) is a selective methodological review in obtaining research results. The goal of the SLR is not simply to

gather all the available evidence on the question, but rather to support the development of evidence-based guidelines for practitioners. Another purpose of the Systematic Literature Review (SLR) put forward by.

In SLR research, there are steps that must be taken, according to Zawacki-Richter et al. in his book, Systematic Reviews in Educational Research, including: Formulating research questions (developing research questions), applying inclusion criteria to select articles. analyzing data (appraising the quality of studies). Meanwhile, according to Thovawira et al. the steps in SLR research include: determining the object of research.

In this SLR research method the researcher carried out the research steps used, namely taking the initial steps by determining the research object. In this study the research object was the Implementation of the Metacognitive Approach in Learning Mathematics. Furthermore, data was collected from articles contained in the Google Schoolar database. The selected articles are articles that meet the suitability level with the research problem formulation. The keywords used by researchers in searching for this article are “Geogebra” and “Mathematical Communication”. The articles taken are articles published within the period 2018 to 2023 both nationally and internationally.

Next is the selection and evaluation process related to the articles that have been selected. At this stage, review and selection of articles that fall into the inclusion category. If it fits into that category, an analysis can be carried out. Furthermore, for articles that were not selected because they did not meet the criteria, they were not included in the next process so that the research results would not be biased. After that, it is followed by making a report on the findings as the last step of this Systematic Literature review research. Recommended Report Elements for a Systematic Review and Meta-Analysis (PRISMA) Approach to Analyzing Journal Article Collections. PRISMA is based on four steps: Identification, screening, eligibility, inclusion.

Based on search results from the data base Searches were conducted on Scopus, ProQuest, Google Scholar and Eric. The four main search terms we picked up based on our basic research topics. Geogebra, Geogebra Mathematics Software, Mathematical Skills, and Learning Mathematics, (“Geogebra”) AND (“Mathematical Skills” OR “Mathematics Skills”).

3. RESULTS AND DISCUSSIONS

The results of the research included in the Systematic Literature Review are the analysis and summary of the articles that have been obtained related to the implementation of geogebra and mathematical abilities. Based on the literature search, twenty five (25) related articles were obtained.

The results show that the learning process using Geogebra is better and significantly improves students' mathematical communication skills. This finding is in line with research conducted by Rusmini & Daulay and Fauziyah et al., who found that Geogebra affects students' mathematical communication skills.

In addition, it is known that the learning process using Geogebra has proven to be effective and better in increasing students' ability to understand concepts. This is supported by research findings conducted by Desniarti & Ramadhani (9) and Nurdin et al. (10). In addition, Nurdin et al. (10) and Suryawan & Permana (11) found that the use of Geogebra was very effective in increasing students' understanding of mathematical concepts. Yanti et al. (12) also found that Geogebra can improve students' understanding of mathematical concepts. Meanwhile, in a study conducted by Mubaid et al. (13), it was found that geogebra helps increase students' understanding and involvement in mathematical concepts. In other words, learning methods that use Geogebra have been proven to be effective and better in increasing students' conceptual understanding abilities. With a good understanding of concepts, it is easier for students to connect and associate concepts and principles to solve problems so that they will produce good solutions and solutions. This has an impact on the achievement and achievement of students.

The results obtained also show that the learning process using Geogebra is better and helps students solve problems significantly. In their study, Nurhayati et al. (14), Intan et al. (15), Sari et al. (4), and Nazaruddin et al. (16) found that the use of Geogebra had a significantly positive effect on improving students' problem solving abilities. In addition, Irianto & Nur (17) found that using Geogebra can improve students' problem solving skills. In other words, the learning process using Geogebra is proven to be better and has a bigger impact.

In addition, it was found that the learning process using Geogebra proved to be better at improving students' mathematical connection abilities and that students were more actively involved in learning mathematics in class. GeoGebra can also help improve students' mathematical connection abilities. This is in line with the findings found in

Septian & Komala (18), Aulia (19), Bernard & Senjayawati (20), Septianingrum et al. (5), and Mentari et al. (21). In other words, the learning process using GeoGebra is more effective than conventional learning models. They show that the learning process using Geogebra improves students' mathematical connection skills and increases the activity level of students. With the various findings obtained, it is very important to improve students' mathematical abilities to help them deal with and solve various mathematical problems that can be applied in everyday life. As in the ability to understand mathematical concepts which is a fundamental thing that needs to be owned so that students are able to understand what things need to be prepared and can be used as a solving solution.

The results of the study show that the learning process using Geogebra is more effective in improving mathematical connection skills. Researchers also found that students were more actively involved in mathematics lessons in class. Students' mathematical connection ability can be improved with geogebra. This is in line with the findings found in Septian & Komala (18), Aulia (19), Bernard & Senjayawati (20), Septianingrum et al. (5), and Mentari et al. (21). In other words, the learning process using GeoGebra is more effective than conventional learning media. Students showed that the learning process using Geogebra improved students' mathematical connection skills and increased their activity level.

Students' problem-solving abilities will have an impact on their mathematical reasoning abilities and their mathematical communication skills when solving mathematical problems encountered in everyday life. Mathematical connection skills help students connect concepts and ideas with concepts and principles and relate them to mathematical procedures used to solve problems. According to As'ari et al. in Munaji & Setiawahyu (1), mathematical ability is very important for daily activities because it is part of life skills, which includes communication, problem solving, and reasoning.

Research using geogebra also uses various learning models. As implemented by Mubaid et al. (13), Septian & Komala (18), and Sugandi et al. (3) who use the Problem Based Learning (PBL) learning model. The same thing was done by Rusmini & Daulay who combined geogebra with Problem Solving learning. Irianto & Nur (17) combines the Team Games Tournament (TGT) learning model. Fauziyah et al. (22) combines the Numbered Head Together (NHT) model. Likewise with Septianingrum et al. (5) who use the Two Stay Two Stray (TSTS) learning model. Learning that involves the real world of students also does not forget to be included in the integration with GeoGebra. As used by Yanti et al. (12) which uses scientific learning. Other models include the Inquiry Model

by Amalia (23), the Eliciting Activities Model (MEAs) by Aulia (19), and Master Learning by Nazaruddin et al. (16). The Metaphorical Thinking approach cannot be separated from the combination with geogebra used by Bernard & Senjayawati (20). Apart from models and approaches to learning, Van Hiele's theory can also be used, as was done by Budiman & Rosmiati (2).

Based on the description that has been described, the implementation of Geogebra has a positive, effective, and better effect on improving students' mathematical abilities in the learning process. Mathematical abilities that can be improved through the implementation of GeoGebra include: (1) mathematical communication skills, (2) mathematical concept understanding abilities, (3) mathematical reasoning abilities, (4) mathematical problem solving abilities, and (5) mathematical connection abilities.

4. CONCLUSION

Based on the results of the research and discussion that have been described, it can be concluded that the implementation of Geogebra has a positive, effective, and better effect on improving students' mathematical abilities in the learning process. Mathematical abilities that can be improved through the implementation of GeoGebra include: (1) mathematical communication skills, (2) mathematical concept understanding abilities, (3) mathematical reasoning abilities, (4) mathematical problem solving abilities, and (5) mathematical connection abilities. In addition, Geogebra can be combined with various models, approaches, and learning theories that can be used in the process of learning mathematics so that students' mathematical abilities can increase.

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References

[1] Munaji M, Setiawahyu MI. Profil Kemampuan Matematika Siswa Smp Di Kota Cirebon Berdasarkan Standar Timss. Teorema: Teori dan Riset Matematika. 2020;5(2):249. https://doi.org/10.25157/teorema.v5i2.3732.

[2] Budiman H, Rosmiati M. Penerapan Teori Belajar Van Hiele Berbantuan Geogebra untuk Meningkatkan Kemampuan Penalaran Matematis Siswa. Prisma. 2020;9(1):47–56.

[3] Sugandi AI, Bernard M. Linda. Efektivitas pembelajaran daring berbasis masalah berbantuan geogebra terhadap kemampuan penalaran matematis di era covid-19. AKSIOMA: Jurnal Program Studi Pendidikan Matematika. 2020;9(4):993–1004.

[4] Sari CP, Eriani ND, Audina T, Setiawan W. Pengaruh Pembelajaran Berbantuan Geogebra Terhadap Peningkatan Kemampuan Pemecahan Masalah Matematik Siswa SMP. J Educ. 2019;1(3):411–6.

[5] Septianingrum RA, Wahyuningsih ED, Utami WB. Model Pembelajaran Two-Stay Two-Stray Berbantuangeogebra Terhadap Kemampuan Koneksi Matematis. Jurnal Edukasi dan Sains Matematika (JES-MAT). 2019;5(2):113–24. https://doi.org/10.25134/jes-mat.v5i2.1860.

[6] Lestari L, Mulyono M, Syafari S. The effect of reciprocal peer tutoring strategy assisted by GeoGebra on students' mathematical communication ability reviewed from gender. Educ Q Rev. 2019;2(2):292–8.

[7] Rhamawati WF. Metaphorical thinking approach assisted geogebra to improve connection mathematical ability of junior high school students. J Phys Conf Ser. 2019;1315(1):1–7.

[8] Putri NR, Sabandar J, Sugandi AI. The development teaching materials on the Geogebra-assisted discovery learning method to improve mathematics understanding ability. JIML. Journal of Innovative Mathematics Learning. 2021;4(3):132–41.

[9] Desniarti D, Ramadhani R. Pengaruh Geogebra Terhadap Kemampuan Pemahaman Konsep Pada Matakuliah Geometri Analitik Bidang. Jurnal Penelitian Pendidikan Mipa. 2019;4(1):237–46.

[10] Nurdin E, Ma'aruf A, Amir Z, Risnawati R, Noviarni N, Azmi MP. Pemanfaatan video pembelajaran berbasis Geogebra untuk meningkatkan kemampuan pemahaman konsep matematis siswa SMK. Jurnal Riset Pendidikan Matematika. 2019;6(1):87–98.

[11] Suryawan IP, Permana D. Media Pembelajaran Online Berbasis Geogebra sebagai Upaya Meningkatkan Pemahaman Konsep Matematika. PRISMA. 2020;9(1):108–17.

[12] Yanti R, Laswadi, Ningsih F, Putra A, Ulandari N. Penerapan Pendekatan Saintifik Berbantuan Geogebra dalam Upaya Meningkatkan Pemahaman Konsep Matematis Siswa A . Pendahuluan Pendidikan merupakan usaha dan upaya pendidik yang bekerja secara interaktif dengan peserta didik untuk meningkatkan, mengembangk. AKSIOMA: Jurnal Matematika dan Pendidikan Matematika Vol. 2019;10(2):180–94.

[13] Mubaid A, Sutrisno, Endahwuri D. Efektifitas Model Pembelajaran Problem Based Learning Dan Model Pembelajaran Learning Cycle 5E Berbantuan Geogebra Terhadap Kemampuan Pemahaman Konsep Matematis Siswa Kelas XI SMK Antonius Semarang. Imajiner: Jurnal Matematika dan Pendidikan Matematika. 2019;1(6):323–31.

[14] Nurhayati, Meirista E, Suryani DR. Pengaruh Penggunaan Geogebra Terhadap Kemampuan Pemecahan Masalah Matematika. Magistra : Jurnal Keguruan dan Ilmu Pendidikan. 2019;6(2):74–82.

[15] Intan R. Gunadi F. Pengaruh Penggunaan Geogebra terhadap Kemampuan Pemecahan Masalah Matematis Siswa Berdasarkan Minat Siswa terhadap Gaya Mengajar Guru Pada Metode Inkuiri. In: Prosiding Seminar Nasional Matematika dan Pendidikan Biologi. 2019. p. 223–8.

[16] Nazaruddin KY. Novianti. Pengaruh penggunaan media pembelajaran geogebra terhadap minat dan kemampuan pemecahan masalah matematis. JRPM: Jurnal Riset Pendidikan. 2020;1(1):7–11.

[17] Irianto MSQ, Nur AS. Penerapan model pembelajaran kooperatif tipe tgt berbantuan aplikasi geogebra untuk meningkatkan kemampuan pemecahan masalah matematika. Magistra: Jurnal Keguruan dan Ilmu Pendidikan. 2019;6(1):1–9.

[18] Septian A, Komala E. Kemampuan Koneksi Matematik Dan Motivasi Belajar Siswa Dengan Mengunakan Model Problem-Based Learning (Pbl) Berbantuan Geogebra Di Smp. Prisma. 2019;8(1):1–13.

[19] Aulia M. Penerapan model eliciting activities (meas) berbantuan Geogebra untuk Meningkatkan Kemampuan Koneksi dan Disposisi Matematis Siswa. Bandung; 2019.

[20] Bernard M, Senjayawati E. Meningkatkan Kemampuan Koneksi Matematik Siswa Smp Dengan Menggunakan Pendekatan Realistic Mathematis Education. Jurnal Mercumatika: Jurnal Penelitian Matematika dan Pendidikan Matematika. 2019;3(2):79–87.

[21] Mentari A, Rahman B, Wijaya S. Perbedaan Peningkatan Kemampuan Koneksi Matematis Siswa SMP melalui Pembelajaran Berbantuan Puzzle dan Geogebra Ditinjau Berdasarkan Gender. ARITHMETIC: Academic Journal of Math. 2020;2(1):69–88.

[22] Fauziyah S. Ponoharjo., Oktaviani DN. Pengaruh Model pembelajaran numbered head together berbantuan geogebra terhadap kemampuan komunikasi matematis peserta didik. Jurnal Ilmu Pendidikan Ahlussunnah. 2019;2(2):36–48.

[23] Amalia N. Pengaruh model pembelajaran inkuiri dengan media software geogebra terhadap kemampuan penalaran kreatif matematis siswa. Skripsi. UIN Sunan Gunung Djati Bandung; 2019.