

IMPROVING SELF-REGULATED LEARNING AND CREATIVITY OF STUDENTS THROUGH GEOGEBRA IN SOLVING SPATIAL GEOMETRY PROBLEMS

Indra Kurniawan^{1*}, Andri Rahadyan²

^{1,2}Universitas Indraprasta PGRI

¹indra.kurniawan@unindra.ac.id, ²andri.rahadyan@unindra.ac.id

*Corresponding Author: Indra Kurniawan

ABSTRAK

Penelitian ini bertujuan untuk mengetahui implementasi GeoGebra dalam pemecahan masalah untuk meningkatkan kemandirian dan kreativitas siswa. Subjek penelitian ini adalah 6 orang siswa kelas 12 SMA IPA HSPG Bekasi Semester Ganjil Tahun Ajaran 2022/2023. Metode penelitian ini adalah kualitatif dengan pengumpulan data adalah wawancara berbasis tugas. Instrumen utama dalam penelitian ini yaitu peneliti dan instrumen bantu yaitu tes pemecahan masalah (PST). Teknik analisis data dalam penelitian ini dilakukan dengan cara: (1) mengelompokkan data ke dalam kategori kemandirian belajar dan kreativitas, (2) menyajikan data dalam bentuk teks naratif, dan (3) melakukan analisis untuk penarikan kesimpulan. Hasil penelitian pada siswa kategori tinggi terdapat peningkatan kemandirian belajar. Terbukti siswa semakin antusias mencoba GeoGebra pada pengerjaan soal dan kreativitas siswa pun meningkat terbukti siswa menemukan 1 cara baru. Pada siswa kategori sedang terdapat peningkatan kemandirian belajar, terbukti siswa semakin antusias mencoba GeoGebra pada pengerjaan soal walaupun siswa masih ragu, dan kreativitas siswa juga meningkat terbukti siswa menemukan 1 cara baru akan tetapi cara baru itu belum sempurna. Terdapat peningkatan kemandirian belajar siswa kategori rendah, terbukti dari awalnya sama sekali tidak menggunakan, siswa ini mulai mencoba GeoGebra walaupun siswa hanya bisa membuat bangun ruang saja, dan kreativitas siswa belum terdapat ada peningkatan.

Received 18 Des 2022 • Accepted 26 Des 2022 • Article DOI: 10.23969/symmetry.v7i2.6749

ABSTRACT

This study aims to determine the implementation of GeoGebra in solving problems to increase students' self-regulated learning and creativity. The research subjects were 6 grade 12 students at SMA IPA HSPG Bekasi Odd Semester 2022/2023 Academic Year. This research method is qualitative, with data collection in task-based interviews. The main instrument in this study is the researcher and the auxiliary device, namely the problem-solving test (PST). This study carried out data analysis techniques by (1) grouping data into self-regulated learning and creativity categories, (2) presenting data in the form of narrative text, and (3) conducting analysis to conclude. There was an increase in self-regulated learning in high-category students. Students were more enthusiastic about using GeoGebra in solving questions, and students' creativity has also increased by finding one new way. There was an increase in self-regulated learning in moderate-category students. Students were increasingly enthusiastic about using GeoGebra in solving questions, even though students still needed clarification. Student creativity also increased by finding one new way, but it could have been better. There was an increase in self-regulated learning in low-category students. Students started trying GeoGebra even though students could only make geometric shapes. There was no increase in student creativity.

Keywords: GeoGebra, geometry, spatial, self-regulated learning, creativity

Cara mengutip artikel ini:

Kurniawan, I., & Rahadyan, A. (2022). Improving Self-Regulated Learning and Creativity of Students through GeoGebra in Solving Spatial Geometry Problems. *Symmetry: Pasundan Journal of Research in Mathematics Learning and Education*. 7(2), hlm. 89-96



INTRODUCTION

Technologies that can be used in the learning process in the classroom have been developed, one of which is GeoGebra. GeoGebra is a mathematical software developed to assist the teaching and learning of mathematics. Teachers can use GeoGebra to design effective learning. The benefits obtained after the training on the GeoGebra application are to grow teachers' interest in using the GeoGebra application in the mathematics learning process in class. Furthermore, it adds insight for teachers to make ICT-based mathematics learning media more fun by producing illustrations of three-dimensional objects to increase comprehension. Students make it easier for teachers to convey abstract mathematical concepts to be more concrete and make it easier for teachers to ask questions about geometric shapes (Rosiyanti et al., 2020).

GeoGebra is handy as a mathematics learning media, such as demonstration and visualisation media, construction tools, and tools to assist the discovery process. The improvement of student learning outcomes at SMP Negeri 1 Mila, taught using GeoGebra, differs from learning outcomes other than using GeoGebra (Junaidi, 2018). GeoGebra has been extensively developed and designed in its appearance design so that teachers and students can use it easily. There is a GeoGebra designed for the Android version, where we all know that students cannot be separated from their smartphones. So the Android version of GeoGebra was created, all of which were designed with the hope that students could more easily use GeoGebra. It follows the opinion of Budiman & Ramdhani (2017) that GeoGebra is a mathematical software innovation that teachers or students can use in the learning process.

Learning mathematics in geometric shapes and three dimensions with the help of GeoGebra software significantly affects students' mathematical communication abilities compared to conventional learning media (Kustiawati, 2016). GeoGebra application support in video production helps students understand the concept of spatial shapes because students can visualise three-dimensional images effectively and efficiently (Sirad & Arbain, 2021). There is an increase in the ability to understand the geometric concepts of students who are given learning using the GeoGebra software media (Nulhakim et al., 2022). Students are motivated using the GeoGebra application. The average student response is solid. Using the GeoGebra application has proven helpful for students with material on flat side shapes (Rohmatunnisa et al., 2022). There is a difference in the increase in the HOTS of students who are taught using the GeoGebra application-assisted learning media with an average of 80.61 with a standard deviation of 4.29 and using media teaching aids, an average of 68.75 with a standard deviation of 12.03 (Lihu et al., 2019).

GeoGebra's implementation in learning mathematics can make students more independent in learning. Self-regulated learning needs to be owned by students to achieve success in school. In line with what was expressed by (Dörrenbächer & Perels, 2016), independent learning is very relevant for academic success. Meanwhile, other countries, such as Turkey, have considered self-regulated learning a critical aspect of academic achievement and success. The categories of self-regulated learning used in this study were high, medium, and low self-regulated learning. What is obtained from the indicator of self-regulated learning? Students who already have high freedom with the implementation of GeoGebra are expected to be able to develop creativity in problem-solving.

Creativity is a potential that affects the activities and development of students, so creativity is a fascinating field to study but complicated enough to cause differences. Creativity can be formulated as a process of the cognitive ability of students to produce something or new work from something already owned and then test the results of their hypothesis. The unique

thing in question can be familiar but can result from a combination of pre-existing elements. The ability to think creatively is critical in life and all the problems that exist in it by obtaining, managing, and utilising information (Prayudi & Rahman, 2021). Creativity is the ability that a person must create ideas. This study had three categories of creativity: high, medium, and low. Implementing GeoGebra in learning the building space material can increase student creativity. It is in line with the research that has been done (Aminy et al., 2021), which states that the help of GeoGebra is better than the ability to think mathematically and creatively.

From the observations made, data was obtained from the mathematics teachers at HSPG Bekasi. In teaching geometric material about calculating the distance of points to planes, students still drew on the blackboard so that the students visualising images would not be optimal. If imagining images only students do not understand well, then it will impact the understanding of building materials that will not be maximised. Therefore, it is necessary to implement GeoGebra in classroom learning so that students can also recognise and use the application in solving geometric material problems. After students can use GeoGebra properly, it is hoped that students can independently work on math problems and can train students creative abilities. In trying new ways gained from understanding GeoGebra. From the description above, the researchers are interested in conducting further research on implementing GeoGebra in solving geometric problems to increase students' independence and creativity.

METHODS

This research was conducted at Homeschooling Primagama Bekasi (HSPG Bekasi), with six research subjects in grade 12 SMA IPA Odd Semester Academic Year 2022/2023. The selection of research subjects was carried out by considering several criteria: (1) The student has studied the spatial structure material so that he can work on problems related to spatial construction in everyday life, (2) Students can operate a cell phone or computer properly. It needs to be considered because later, it will be used for the use of GeoGebra, and (3) the student can communicate his thoughts in the form of written and oral expressions. The selection of subjects in this study was by purposive sampling. The procedure for selecting subjects in this study, namely: (1) preparing the Initial Problem-Solving Test (PST) used for student selection; (2) use of the Initial Problem PST; (4) grouping of students in the categories of high, medium, and low self-regulated learning and creativity; (5) determine the criteria for selecting subjects; (6) selection of research subjects.

Data collection in this study was carried out through task-based interviews, namely: (1) selecting research subjects based on self-regulated learning and creativity categories based on predetermined criteria; (2) determining the time for data collection by discussing with the student concerned by considering his school schedule; (3) carry out student data collection in the following ways: (a) ask students to work on problem-solving assignments accompanied by implementing GeoGebra in the process and students are asked to communicate what is used when solving problems, (b) ask questions to students related to creativity and independent learning; (4) analyse the student data; (5) summarise the results of implementing GeoGebra in solving spatial problems to increase students' creativity and independence in learning.

The primary and auxiliary instruments were used to obtain data on increasing creativity and independence in student learning after the implementation of GeoGebra. The primary tool in this study was the researcher, who collected data directly from the data source. In contrast, the auxiliary instruments in this study were problem-solving abilities and interview guidelines. Data analysis techniques in this study were carried out by (1) grouping data into high, medium,

and low self-regulated learning categories, (2) grouping data into high, medium, and low creativity categories, (3) presenting data in the form of narrative text after it carried out an analysis of the similarities and differences and (4) concluding the implementation of GeoGebra in solving problems to increase student independence and creativity.

RESULTS AND DISCUSSIONS

Data collection was carried out after obtaining students who met the criteria for research subjects. Then carry out the first data collection with task-based interviews with six people, which are carried out alternately. From the data collection, the data is obtained, namely written expressions, student answers and oral expressions, in the form of interviews. Furthermore, an in-depth data analysis was carried out on the student's words based on high, medium, and low self-regulated learning and creativity categories. The first step of data analysis was conducted to determine self-regulated learning after applying GeoGebra in PST work. After the data was obtained, the second data analysis was performed to differentiate high, medium, and low creativity. Furthermore, implementing GeoGebra in solving geometric problems increases self-regulated learning and creativity.

Based on data analysis in the first and second retrieval of self-regulated learning in the high, medium, and low categories. Furthermore, valid data is obtained regarding the implementation of GeoGebra in solving geometric problems to increase self-regulated learning. The GeoGebra Implementation data on whether it can improve self-regulated learning in each student category is presented in Table 1 below:

Table 1. GeoGebra implementation of self-regulated learning

Categories Self-regulated learning	Student Activities	
	PST 1	PST 2
High	Students already used GeoGebra in working on PST but are still hesitant and still making cube drawings on paper.	Students are enthusiastic about using GeoGebra in doing PST in all questions, and they are more enthusiastic because they have immediately found the distance of the point to the field in question.
Moderate	Students already used GeoGebra in working on PST but still need clarification.	Students are getting used to using GeoGebra in doing PST. However, this student is still hesitant and afraid of being wrong in implementing the calculation of the distance of points to the field with GeoGebra.
Low	Students cannot operate GeoGebra in working on PST but this student	Students use GeoGebra in working on PST, but this student can only operate GeoGebra in making blocks and has not been able to find the distance of the point to the field

From the results of the data analysis, it was concluded that students with high, medium and low self-regulated learning in implementing GeoGebra in solving PST could increase student independence. It is evident in PST 1 and PST 2 that students in each category experienced an increase in their abilities according to the self-regulated learning category. From the results of the analysis above, it is highly recommended to introduce and teach GeoGebra to students so that they are accustomed to using GeoGebra in working on PST because GeoGebra can visualise mathematical problems in geometric material in a more conceptual and easy-to-understand manner. It follows the opinion of Purnomo (2021) that GeoGebra can be used to demonstrate or visualise mathematical concepts and construct mathematical concepts. Using

GeoGebra in learning mathematics can foster mathematical reasoning, foster creativity, support collaboration, and involve students more in the learning process. The more senses are involved, learning can be effective and efficient. How GeoGebra implemented and whether it can improve student creativity in each category of student creativity is presented in Table 2.

Table 2. GeoGebra Implementation on Creativity

Creativity category	Student Activities	
	PST 1	PST 2
High	Students already use GeoGebra in working on PST and can solve the PST problem in 2 different ways.	Students already use GeoGebra in working on PST and can solve the PST problem with two different ways of working and one new way obtained from the concept of understanding the use of GeoGebra.
Moderate	Students have used GeoGebra in working on PST and can solve PST questions in 1 way.	Students have used GeoGebra in working on PST and can solve the PST problem with one way of working and one new way, but the new method that is obtained has yet to reach the end, so it is still ongoing.
Low	Students have used GeoGebra in working on PST and can solve PST questions in 1 way.	Students have used GeoGebra in working on PST and can solve the PST problem in 1 way of working and not finding new ways of doing it.

Based on data analysis on the first and second takes on student creativity in the high, medium, and low categories. Furthermore, valid data were obtained on implementing GeoGebra in solving problems to build space to increase student learning creativity.

Table 3. GeoGebra Implementation in Solving Building Space Problems to Increase Self-regulated learning and Creativity

Category	Independent Learning	Creativity	Conclusion
High	In PST 1, they still needed to learn about using GeoGebra. Still, in PST 2, there was an increased enthusiasm for using GeoGebra because these students determined the distance from a point to a plane with GeoGebra.	On PST 1, they can do it in 2 ways. On PST 2, they can do it in 2 ways + 1 new way obtained from the GeoGebra concept.	There is an increase in self-regulated learning, as evidenced by students being more enthusiastic about applying GeoGebra to working on questions, and student creativity has also increased. It is evidenced by finding one new way of understanding the GeoGebra concept.
Moderate	On PST 1, they still needed clarification about using GeoGebra. On PST 2, there was an increase in using GeoGebra, but they still needed to figure out the answers generated on GeoGebra.	In PST 1, they can do it in 1 way. In PST 2, they can do it in 1 way and get one new way, but it has yet to be wholly resolved because they are still unsure about the concept they understand.	There is an increase in self-regulated learning as evidenced by students being more enthusiastic in applying GeoGebra in working on questions even though these students are still unsure, and student creativity has also increased. Perfect finish.
Low	In PST 1, they cannot operate GeoGebra. In PST 2, there is an improvement, they can only operate GeoGebra to make blocks, and they cannot find the distance from a point to a plane.	On PST 1, they can do it in 1 way. On PST 2, they can do it in 1 way, but they need help finding a new way.	There was an increase in self-regulated learning as evidenced from the beginning of not using it at all, these students started trying to implement GeoGebra even though they could only make geometric shapes, and for student creativity, there was no increase.

Based on the results of data analysis in Table 1 and Table 2, further in-depth analysis will be carried out to determine how GeoGebra is implemented in solving spatial problems to increase self-regulated learning and creativity. The results of the research on improving self-regulated learning and creativity can be seen in Table 3.

Based on the results of the data analysis above, the implementation of GeoGebra in solving geometric problems increases the independence of learning and student creativity. For students who have a high category, it is found that there is an increase in self-regulated learning. It is proven that students are more enthusiastic about implementing GeoGebra in working on questions, and the creativity of students has also increased. It is confirmed by finding one new way that is obtained from understanding the GeoGebra concept. Thus, GeoGebra can be implemented in learning and problem-solving in geometric materials because the results obtained can increase students' self-regulated learning and creativity in the High category. It follows the opinion of Puspitawati et al. (2018) /, which states that learning with GeoGebra media has a comparative advantage compared to conventional press in increasing student creativity and independence.

For students who have the medium category, it is found that there is an increase in self-regulated learning. It is proven that students are increasingly enthusiastic about trying to apply GeoGebra to working on questions, even though these students still need clarification, and student creativity has also increased. It is evidenced by finding one new way that is obtained from understanding the concept. GeoGebra, however, the new method still needs to be completed. For the medium category, self-regulated learning and creativity have increased. However, they still need to be developed and trained by implementing GeoGebra in learning and practice questions. Because the application of GeoGebra can provide a stimulus for students to think more creatively so that it can increase commensurate with the high category because this medium category requires consistent guidance to improve their abilities to the maximum. It follows the opinion of Purwasih et al. (2020), which states that worksheet learning based on GeoGebra software stimulates students to think creatively to solve problems.

For students with a Low category, it is found that there is an increase in self-regulated learning as evidenced from the beginning of not using it at all. Students are starting to try the application of GeoGebra even though these students can only make geometric shapes, and there has yet to be an increase in student creativity. For the low category, self-regulated learning and creativity have increased. However, they still need exceptional guidance and training to increase commensurate with the wide variety because their mathematical abilities still for the Low type need to be improved. Consistent guidance is needed to improve their abilities maximally. One of the ways that can be done is to guide these students in the form of video learning material and discussion of questions in the material about the distance from a point to the field of shapes. By giving this video, it is hoped that students can repeat the video. Later there will be independent learning in himself so that if it is developed, it will also be able to emerge creativity. It follows the opinion of Nuritha & Tsurayya (2021), which states that GeoGebra-assisted learning videos are effectively used as media or tools to help students learn mathematics, which can increase self-regulated learning and creativity.

CONCLUSIONS

Based on the results of the research, the following conclusions are obtained. (1) The high-category students have increased self-regulated learning, as evidenced by students being more enthusiastic about implementing GeoGebra in working on questions, and student creativity

has also increased. It is proven by finding one new way that is obtained from understanding the GeoGebra concept. (2) In the moderate-category students, there is an increase in self-regulated learning, as evidenced by students being more enthusiastic in applying GeoGebra in working on questions even though these students are still unsure, and student creativity has also increased. The new way needs to be completed. (3) In the low-category students, there is an increase in self-regulated learning, as evidenced by not using it at all at first. These students started trying to implement GeoGebra even though these students could only make spatial shapes, and there was no increase in student creativity.

ACKNOWLEDGEMENTS

The authors would like to thank the Research and Community Service Institution (LPPM) Universitas Indraprasta PGRI for permitting this service activity to be carried out well. Furthermore, the authors remembered to thank Homeschooling Primagama Bekasi (HSPG Bekasi) for giving time to where the team performed this service. Finally, the authors would like to thank the Symmetry journal editor, who was willing to publish this paper.

REFERENCES

- Aminy, M., Herizal, H., & Wulandari, W. (2021). Penerapan Model Problem Based Learning Berbantuan GeoGebra untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis Siswa SMA Negeri 1 Muara Batu. *Jurnal Pendidikan Matematika Malikussaleh*, 1(1). <https://doi.org/10.29103/jpmm.v1i1.4390>
- Budiman, H., & Ramdhani, S. (2017). Pengembangan Bahan Ajar Matematika SMA Berbasis GeoGebra Versi Android. *Science Tech: Jurnal Ilmu Pengetahuan Dan Teknologi*, 3(2), 75–80. <https://doi.org/10.30738/jst.v3i2.1607>
- Dörrenbächer, L., & Perels, F. (2016). Self-regulated learning profiles in college students: Their relationship to achievement, personality, and the effectiveness of an intervention to foster self-regulated learning. *Learning and Individual Differences*, 51. <https://doi.org/10.1016/j.lindif.2016.09.015>
- Junaidi, J. (2018). Meningkatkan Hasil Belajar Matematika pada Materi Bangun Ruang dengan Menggunakan Aplikasi GeoGebra di SMP Negeri 1 Mila. *Jurnal Numeracy*, 5(2), 184–193.
- Kustiawati, D. (2016). Pembelajaran Geometri Berbantuan Software Geogebra Terhadap Kemampuan Komunikasi Matematik Siswa. *Jurnal Ilmiah Pendidikan Matematika*, 1(2), 113–120.
- Lihu, I., Ma'rufi, M., & Ilyas, M. (2019). Pembelajaran Matematika dengan Menggunakan Median Pembelajaran Berbantuan Aplikasi GeoGebra untuk Meningkatkan Higher Order Thinking Skills Siswa Kelas VIII SMPN 6 Palopo. *Jurnal Penelitian Matematika Dan Pendidikan Matematika*, 2(2), 39–52.
- Nulhakim, A. L., Susanto, A., & Husain, A. (2022). Penggunaan Software Geogebra untuk Meningkatkan Kemampuan Pemahaman Konsep Bangun Ruang Matematis Siswa. *Prosiding Seminar Nasional Sains*, 186–190.

- Nuritha, C., & Tsurayya, A. (2021). *Pengembangan Video Pembelajaran Berbantuan Geogebra untuk Meningkatkan Kemandirian Belajar Siswa*. 05(01), 48–64.
- Prayudi, W. S., & Rahman, T. (2021). Peningkatan Kemampuan Berpikir Kreatif Matematis dan Self-Confidence Siswa SMA Melalui Strategi Pembelajaran Think Talk Write (TTW) dengan Mind Mapping. *Symmetry | Pasundan Journal of Research in Mathematics Learning and Education*, 6(1).
- Purnomo, J. (2021). Kebermanfaatan Penggunaan GeoGebra dalam Pembelajaran Matematika. *Indonesian Digital Journal of Mathematics and Education*, 8(1), 9–22. <http://p4tkmatematika.kemdikbud.go.id/journals/index.php/idealmathedu/>
- Purwasih, R., Sariningsih, R., & Sari, I. P. (2020). Self Efficacy terhadap Kemampuan High Order Thinking Mathematics Siswa melalui Pembelajaran Berbantuan Software GeoGebra. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 9(1), 166. <https://doi.org/10.24127/ajpm.v9i1.2663>
- Puspitawati, N. M., Santyasa, W., & Agustini, K. (2018). PENGARUH MEDIA GEOGEBRA TERHADAP MOTIVASI DAN KREATIVITAS BELAJAR MATEMATIKA SISWA SMK NEGERI 1 SINGARAJA. In *Jurnal Teknologi Pembelajaran Indonesia* (Vol. 8).
- Rohmatunnisa, Z. J., Anita, I. W., Rohaeti, E. E., & Sariningsih, R. (2022). Analisis Motivasi Belajar Siswa SMP Kelas VIII pada Materi Bangun Ruang Sisi Datar. *Jurnal Pembelajaran Matematika Inovatif*, 5(4), 1061–1070. <https://doi.org/10.22460/jpmi.v5i4.1061-1070>
- Rosiyanti, H., Astriyani, A., & Liani, F. (2020). Pemanfaatan Aplikasi GeoGebra bagi Guru Sekolah Dasar di Jakarta Selatan untuk Mata Pelajaran Matematika. *J-ADIMAS Jurnal Pengabdian Kepada Masyarakat*, 8(2), 70–75.
- Sirad, L. O., & Arbain, A. (2021). Pengembangan Video Pembelajaran Berbasis GeoGebra Materi Bangun Ruang Sisi Datar pada Pembelajaran Virtual. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, 10(4), 2436–2445. <https://doi.org/10.24127/ajpm.v10i4.4198>