Jurnal Ilmiah Profesi Pendidikan
Volume 9, Nomor 2, Mei 2024
ISSN (Print): 2502-7069; ISSN (*Online*): 2620-8326

Geogebra As A 21st Century Learning Tool: A Systematic Literature Review

Maulina Fakhrunnisa Salsanabila*, Dian Endang Lestari, Dela Yulanda Sari
Program Studi Pendidikan Matematika, FMIPA, Universitas Negeri Yogyakarta, Indonesia
*Corresponding Author: maulinafakhrunnisa.2022@student.uny.ac.id [1)]
dianendang.2022@student.uny.ac.id [2)]
delayulanda.2022@stundet.uny.ac.id [3)]

Article History
Received : February 07th, 2024
Revised : March 18th, 2024
Accepted : April 26th, 2024

Abstract: Learning in the 21st century requires the use of media in learning which results in new desires and interests, increases motivation and stimulation in learning, and even has a psychological effect on students. Technology-based learning media can make learning more interesting, because the use of appropriate media can help convey material abstractly, so that students can more easily understand the material. The existence of technology in learning mathematics helps students in understanding mathematical concepts. One form of math learning media is GeoGebra. This study aims to analyze the distribution of education levels, materials, and 21st century skills that are most often used in the application of the GeoGebra application as a 21st Century Mathematics learning media. The research method used was systematic literature review. The research subjects were 33 journal articles obtained from the Scopus, Google Scholars, ScienceDirect, Springer, ResearchGate, OJS (Open Journal System), and Eric databases in the last 7 years. The results showed that the study of 21st century geogebra increased in 2020 and the peak occurred in 2022 with the research method used dominated by quasi-experiments. In addition, the junior high school education level, geometry transformation material and analytic geometry of the field, as well as creative thinking skills become the most dominating and widely conducted research.

Keywords: GeoGebra, Learning Media, , Skills, 21st Century Learning

INTRODUCTION

The rapid development of the times in the 21st century requires the formation of competent, creative and innovative human resources in solving a problem. One example of innovation in education, especially mathematics, is being able to improve and enhance the process of teaching and learning activities. This requires teachers to make a learning innovation that keeps up with the times, where teachers present learning by utilizing technology. According to Rafiqoh (2020), the factors that influence changes in mathematics learning in the 21st century are rapid changes in the fields of work, economy, business and technology. These changes require to have basic 21st century skills, namely 4C (creative, critical thinking, cooperation, and communication).

As time goes by, Information and Communication (ICT) or commonly referred to as Information and Communication Technology (ICT) in Indonesia is growing rapidly. The development of ICT in Indonesia has penetrated the field of education. The results of a study conducted by Cambridge International through the Global Education Census suggest that students in Indonesia are the highest users of IT in the classroom at 40%. The results of this study show that Indonesia is ranked highest in terms of using technology in the classroom, compared to students in other developed countries. This survey was conducted to determine the quality of education around the world for students aged 12-19 years. Based on this data, the use of ICT in Indonesia is very high, especially for students. This high use of ICT is utilized by students in various disciplines. One of them is the discipline of mathematics.

Technology in the 21st century is a must to master, both as a learning medium and a learning resource. The existence of technology in learning mathematics helps students in understanding mathematical concepts. One form of math learning media is GeoGebra. GeoGebra is a software application in mathematics that can visualize two dimensions and three dimensions accurately and can be used for geometry, algebra,

and calculus subject matter. According to Hidayat (2021) GeoGebra has an important role in helping teachers to display 2D and 3D visualizations that make learning more fun. The exploration contained in GeoGebra makes students learn to self-construct the concepts learned. The rapid development of the times in the 21st century requires the formation of competent human resources. This requires teachers to make a learning innovation that follows the times, where teachers present learning by utilizing technology. Therefore, this literature review will present related results:

1. What are the most frequently used research methods in 21st century geogebra research?
2. What is the distribution of 21st century geogebra research in each year?
3. What is the distribution of education levels in geogebra research in the 21st century?
4. What is the most explored material in 21st century geogebra research?
5. What 21st century skills are most often used in 21st century geogebra research?

METHODS

This research uses the Systematic Literature Review (SLR) method, which is a systematic, clear, thorough literature study by identifying, evaluating, and collecting existing research data. The Systematic Literature Review technique is carried out with five steps, namely: (1) formulate the research question, (2) map and search for articles that are in accordance with the research question posed, (3) classify and evaluate the articles that have been collected, (4) summarize the articles, (5) interpret the findings in the article. The search process is used to obtain relevant sources to answer research problems or research questions as well as other related references from research databases (Scopus, Google Scholars, ScienceDirect, Springer, ResearchGate, OJS, Eric) taken as many as 33 articles that are the focus of this study in the last 7 years, using the keywords GeoGebra and 21st century skills.

Then in the next stage, an activity is carried out to decide whether the data found is suitable for use in SLR research or not. A feasible study is selected if the following criteria are present:

a. The data found was published within the 2017-2024 timeframe.
b. Data obtained from Scopus, Google Scholars, ScienceDirect, Springer, ResearchGate, OJS, Eric.
c. The data used only relates to GeoGebra and 21st century skills.

The results of the search process will be selected based on inclusion and exclusion criteria. This process leaves 33 journals after scanning the data. Table 1 shows the distribution of articles based on the inclusion and exclusion criteria selection results.

Table 1. Distribution of articles based on inclusion and exclusion criteria selection results

No	Journal Name	Journal Index	Number of Articles
1	Malaysian Journal of Learning and Instruction	Scopus Q2	1
2	Journal on Mathematics Education	Scopus Q2	1
3	International Journal of Instruction	Scopus Q2	1
4	International Journal of Evaluation and Research in Education (IJERE)	Scopus Q2	1
5	Cogent Education (2023)	Scopus Q2	1
6	International journal of emerging technology in learning	Scopus Q2	1
7	International Journal of Interactive Mobile Technologies (iJIM)	Scopus Q3	1
8	Jurnal Of Educational and social research	Scopus Q3	1
9	Journal of Education and Practice	Scopus Q3	1
10	TOJET: The Turkish Online Journal of Educational Technology	Scopus Q4	1
11	Journal of Physics	Scopus Q4	6
12	Jurnal Elemen	Sinta 2	4
13	Jurnal Riset Pendidikan Matematika	Sinta 2	2
14	Jurnal Didaktik Matematika	Sinta 2	2
15	Al-Ishlah: Jurnal Pendidikan	Sinta 2	1
16	Aksioma: Jurnal Program Studi Pendidikan Matematika	Sinta 2	7
17	Al-Jabar: Jurnal Pendidikan Matematika	Sinta 2	1
	Total		33

RESULTS AND DISCUSSION

A recent analysis of the systematic literature contained in table 2 regarding the distribution of articles by research type or research method shows that experimental methods are the dominant trend in 21st century Geogebra research, accounting for about 63.64% of the studies conducted. Among these methods, research and development (R&D) accounts for about 30.3%, while case studies and mixed method approaches are only about 3.03% each. This is in line with the research of Uwurukundo et al (2021) that quasi-experimental research is the most preferred choice in research on geogebra. Pin & Rosli (2023) say that mix method research is relatively little, so the research method in this study found only one article that discusses 21st century geogebra. Not only that, according to Li et al (2020) qualitative research is also relatively little, so in this study only one article was found that discusses 21st century geogebra. In contrast to R&D research which is in second place after quasi-experiments because there are many things that can be developed in the world of education, especially in geogebra, and R&D is a research method that focuses on making products without ruling out their quality. R&D produces a product that can be used in the learning process from the aspects of valid, practical, and effective (Muchlis et al., 2021). Thus, R&D opens up great opportunities for researchers who want to develop geogebra both in terms of media, learning tools in the form of teaching modules and student worksheets, and so on that allow for further development.

Discussion

Table 2. Distribution of articles based on research type

Approach	Type of Research	Article Code	Quantity	Percentage %
Quantitative	Experiment	P02, P03, P04, P05, P08, P09, P10, P12, P13, P14, P15, P16, P17, P22, P23, P24, P25, P26, P28, P30, P32	21	63,64
Qualitative	Case Study	P01	1	3,03
Others	R&D	P06, P11, P18, P19, P20, P21, P27, P29, P31, P33	10	30,30
	Mix method	P07	1	3,03

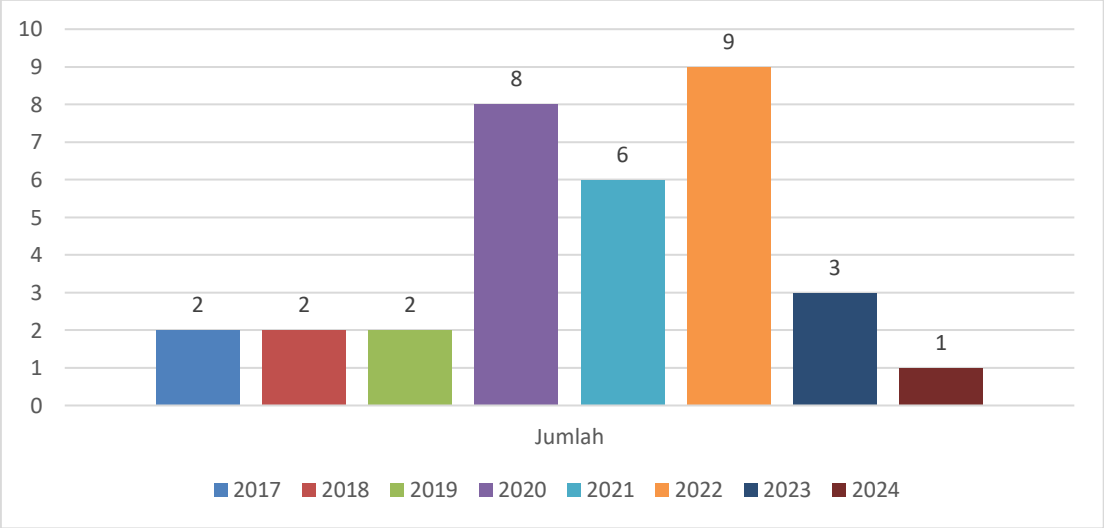

Figure 1. Distribution of articles based on year of publication 2017-2024

Based on Figure 1, it is known that the number of publications of articles on geogebra in the 21st century from 2017 to 2019 does not experience an increase and also does not experience a decrease, meaning that publications experience stability in the same amount. The new increase will occur in 2020 considering that this year there is a Covid-19 outbreak that requires

students to learn online. Online learning makes teachers have to take extra initiative to keep learning going well so that geogebra becomes one of the solutions that can be applied to online learning without lack of space and time (Daniel, 2020). This is supported by Pin and Rosli's research (2023) which shows that 2022 is the year with the highest level of publications related to geogebra in the 21st century. However, this increase is not the highest peak of the publication record related to geogebra in the 21st century, records show that the highest peak occurred in 2022. This is certainly in line with the research of Susanto et al (2023) which shows that 2022 became the most studies related to geogebra in the 21st century. Thus, geogebra research in the 21st century is still very much needed every year considering students who need to understand geometry concepts through more dynamic visualizations, can be used as feedback to check the correctness of the painted images, provide convenience in the process of investigating the properties of geometric objects, and more importantly geogebra can be applied to offline and online learning.

Table 3. Distribution of articles by education level

No	Education Level	Article Code	Quantity	Percentage %
1	Primary School	P29, P31	2	5,9
2	Junior High School	P01, P02, P04, P05, P06, P11, P19, P20, P21, P23, P28	11	32,3
3	Senior High School	P04, P08, P10, P12, P13, P14, P17, P22, P30, P32	10	29,4
4	Vocational High School	P16, P25, P26, P33	4	11,8
5	University	P03, P07, P09, P15, P18, P24, P27	7	20,6

Based on table 3, it is known that the highest geogebra research in the 21st century was conducted at the junior high school education level, which included around 32.3%, then high school around 29.4%, followed by universities around 20.6%, vocational schools around 11.8%, and finally primary schools which accounted for around 5.9%. The results of this study are similar to Rachmawati et al (2023) which shows that the most applied education level in 21st century geogebra research is at the junior high school level. The results of this study are also complemented by Susanto et al (2023) which shows that the elementary level of education is relatively little done in 21st century geogebra research. However, this does not rule out the possibility that geogebra can also be applied to elementary school students, considering that elementary school is the initial foundation of an educational unit so that geogebra can be sought to be applied at this level of education as a basic stage for the learning process at the next level of education to be more technologically literate.

The process of selecting materials in mathematics learning that will be used as research is adjusted to the level of education. Table 4 shows that geometric transformations and plane analytic geometry are the dominant and most common materials in 21st century geogebra research, which each account for about 11.1% of the studies conducted. Then the material of flat-sided space, cartesian coordinates, derivatives, and integral calculus contributed about 7.4% each. This is similar to the results of research by Susanto et al (2023) which shows that geometry and derivatives are the most selected materials in 21st century geogebra research. This is also supported by the statement of Poutirer et al (2023) which says that geogebra is suitable for teaching mathematics in the fields of geometry, algebra, calculus, probability and statistics. Thus, geometry can help students visualize abstract concepts contained in mathematics. On the other hand, there are many factors that cause the high number of studies that take geometry material in 21st century geogebra research, one of which is caused by the difficulty of learning that causes them to be unable to visualize abstract concepts in mathematics, even students do not like tasks related to geometry material.

Table 4. Distribution of articles by material in math learning

No	Name of Material	Article Code	Quantity	Percentage %
1	Lines and angles	P01	1	3,7
2	Flat and Spatial Buildings	P02	1	3,7
3	Straight Line Equation	P04	1	3,7

No	Name of Material	Article Code	Quantity	Percentage %
4	Flat Sided Spaces	P20, P31	2	7,4
5	Phytagoras Theorem	P21	1	3,7
6	Quadratic Equation	P23	1	3,7
7	Quadrilateral	P06	1	3,7
8	Triangle	P19	1	3,7
9	Cartesian Coordinates	P11, P29	2	7,4
10	Circle	P05	1	3,7
11	Dimension Three	P08	1	3,7
12	Derivatives	P13, P14	2	7,4
13	Two Variable Linear Inequality System	P22	1	3,7
14	Linear Program	P30	1	3,7
15	Geometric Transformation	P16, P26, P32	3	11,1
16	Trigonometry	P33	1	3,7
17	Integral Calculus	P03, P09	2	7,4
18	Polar Coordinates	P15	1	3,7
19	Analytic Geometry of the Plane	P07, P18, P27	3	11,1

Based on table 5 related to the distribution of articles based on 21st century skills, it shows that creative thinking skills are the dominant trend in 21st century Geogebra research, covering about 19.2% of the studies conducted. This is in line with the research of Susanto et al (2023) which shows that creative thinking skills are the dominating ability in 21st century Geogebra research. The use of GeoGebra to improve creative thinking skills in mathematics can be adapted to a variety of learning models including problem-based learning and discovery (Selvy et al., 2020; Yullah et al., 2022). On the other hand, critical thinking skills in mathematics can be adjusted by using blended learning models, problem-based learning, and react strategies (Samura & Darhim., 2023; Rahman et al., 2021; Sugandi et al., 2022). In addition, problem solving skills in mathematics can be adjusted using the discovery model, brain based teaching approach, cooperative group investigation type, realistic mathematics education (Murni et al., 2017; Nuswantari, 2020; Susanti et al., 2022; Yatim et al., 2022). Mathematical representation skills in mathematics can be adjusted by using contextual teaching learning and realistic mathematics education models (Amalia et al., 2020; Nuraeni et al., 2021). Mathematical communication and collaboration skills in mathematics can be adjusted by using cooperative group investigation type (Susanti et al., 2022). Mathematical reasoning ability in mathematics can be adjusted by using social cognitive learning and problem-based learning (Negara et al., 2022; Sugandi et al., 2020). Mathematical connection ability in mathematics can be adjusted by using project based learning and knisley mathematics learning (Ichtiari et al., 2024; Septian, 2022). Spatial ability in mathematics can be adjusted by using problem based learning (Sari et al., 2022).

Table 5. Distribution of articles based on 21st century skills

No	Skill Name	Article Name	Quantity	Percentage %
1	Collaboration	P01, P22	2	7,7
2	Critical Thinking	P02, P04, P27, P30	4	15,4
3	Creative Thinking	P02, P23, P28, P32, P26	5	19,2
4	Mathematical Representation	P03, P11, P12	3	11,5
5	Problem Solving	P05, P13, P22, P33	4	15,4
6	Spatial	P31	1	3,9
7	Mathematical Communication	P07, P08, P22	3	11,5
8	Mathematical Reasoning	P17, P25	2	7,7
9	Mathematical Connection	P09, P10	2	7,7

CONCLUSION

Based on the results of the research that has been done, it can be concluded that GeoGebra-assisted learning is better, efficient, and effective than students who are taught with conventional learning. GeoGebra in its use also has the advantage of making math learning more effective and efficient because it shortens the time needed to draw graphs obtained with more precision and detail, while the disadvantage is that students who are less or less proficient in computers. collaborative work environment will have difficulty in performing GeoGebra applications. So that further research is expected to examine related to the use of GeoGebra in the field of mathematics and other similar fields at a higher level.

REFERENCES

Amalia, S. R., Purwaningsih, D., Widodo, A. N. A., & Fasha, E. (2020). Model Problem Based LearningBerbantuanGeoGebradan ModelRealistic Mathematics Educationterhadap Representasi MatematisSiswaditinjau dari Gaya Kognitif. *Jurnal Elemen*, *6*(2), 157–166. https://doi.org/10.29408/jel.v6i2.1692

Celen, Y. (2020). Student Opinions on the Use of Geogebra Software in Mathematics Teaching. *The Turkish Online Journal of Educational Technology*, *19*(4), 84–88. https://orcid.org/0000-0002-7991-4790

Daniel, S. J. (2020). Education and the COVID-19 pandemic. *Prospects*, *49*(1–2), 91–96. https://doi.org/10.1007/s11125-020-09464-3

Eviliasani, K., Sabandar, J., & Fitriani, N. (2022). Problem-Based Learning Assisted by GeoG ebra to Improve Students ' Mathematical Understanding. *Al-Islah: Jurnal Pendidikan*, *14*, 85–98. https://doi.org/10.35445/alishlah.v14i1.1092

Hadi, W., & Faradillah, A. (2022). Implementation of Geogebra Online Based on Guided Inquiry To Increase Problem Solving Ability and Student Learning Independence. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(2), 882. https://doi.org/10.24127/ajpm.v11i2.5000

Hidayat, T. (2021). Penggunaan Aplikasi GeoGebra Sebagai Media Pembelajaran Matematika SMK. Inovasi Pendidikan, 8(1), 118–127. https://doi.org/10.31869/ip.v8i1.2573

Ichtiari, A. R., Fisher, D., Rahman, T., & Yatim, S. A. M. (2024). Enhancement of students' mathematical connection through Knisley mathematics learning model assisted by GeoGebra. *Jurnal Elemen*, *10*(1), 28–42. https://doi.org/10.29408/jel.v10i1.19786

Kim, K. M., & Md-Ali, R. (2017). Geogebra: Towards realizing 21st century learning in mathematics education. *Malaysian Journal of Learning and Instruction*, *Specialissue*, 93–115. https://doi.org/10.32890/mjli.2017.7799

Kusumah, Y. S., Kustiawati, D., & Herman, T. (2020). The effect of geogebra in three-dimensional geometry learning on students' mathematical communication ability. *International Journal of Instruction*, *13*(2), 895–908. https://doi.org/10.29333/iji.2020.13260a

Latifi, M., Hattaf, K., & Achtaich, N. (2021). The effect of dynamic mathematics software geogebra on student' achievement: The case of differential equations. *Journal of Educational and Social Research*, *11*(6), 211–221. https://doi.org/10.36941/jesr-2021-0141

Li, Y., Wang, K., Xiao, Y., & Froyd, J. E. (2020). Research and trends in STEM education: a systematic review of journal publications. *International Journal of STEM Education*, *7*(1). https://doi.org/10.1186/s40594-020-00207-6

Muchlis, E. E., Priatna, N., & Dahlan, J. A. (2021). Development of a web-based worksheet with a project-based learning model assisted by GeoGebra. *Jurnal Riset Pendidikan Matematika*, *8*(1), 46–60. https://doi.org/10.21831/jrpm.v8i1.40985

Murni, V., Sariyasa, S., & Ardana, I. M. (2017). GeoGebra Assist Discovery Learning Model for Problem Solving Ability and Attitude toward Mathematics. *Journal of Physics: Conference Series*, *895*(1). https://doi.org/10.1088/1742-6596/895/1/012049

Negara, H. R. P., Wahyudin, Nurlaelah, E., & Herman, T. (2022). Improving Students' Mathematical Reasoning Abilities Through Social Cognitive Learning Using GeoGebra. *International Journal of*

Emerging Technologies in Learning, *17*(18), 118–135. https://doi.org/10.3991/ijet.v17i18.32151

Nisiyatussani, Ayuningtyas, V., Fathurrohman, M., & Anriani, N. (2018). Geogebra Applets Design and Development for Junior High School Students To Learn Quadrilateral Mathematics Concepts. *Journal on Mathematics Education*, *9*(1), 27–40.

Nuraeni, Z., Indaryanti, I., & Sukmaningthias, N. (2021). Pengembangan Perangkat Pembelajaran Bercirikan CTL Berbantuan GeoGebra Menggunakan Model Flipped Learning. *Jurnal Elemen*, *7*(1), 58–69. https://doi.org/10.29408/jel.v7i1.2723

Nurdin, E., Ma'aruf, A., Amir, Z., Risnawati, R., Noviarni, N., & Azmi, M. P. (2019). Pemanfaatan video pembelajaran berbasis Geogebra untuk meningkatkan kemampuan pemahaman konsep matematis siswa SMK. *Jurnal Riset Pendidikan Matematika*, *6*(1), 87–98. https://doi.org/10.21831/jrpm.v6i1.18421

Nurhayati, E., Nengsih, W., Rohaeti, E. E., & Herdiman, I. (2018). Pengembangan Bahan Ajar Materi Garis Istimewa pada Segitiga dengan Pendekatan Problem Posing berbantuan Geogebra. *Jurnal Didaktik Matematika*, *5*(1), 54–65. https://doi.org/10.24815/jdm.v5i1.10073

Nuswantari, D. (2020). Development of Learning Materials Through RME Assisted by Geogebra Software to Improve Students Problem Solving ability. *Journal of Education and Practice*, *11*(8), 61–68. https://doi.org/10.7176/jep/11-8-08

Owusu, R., Bonyah, E., & Arthur, Y. D. (2023). The Effect of GeoGebra on University Students ' Understanding of Polar Coordinates The Effect of GeoGebra on University Students ' Understanding of Polar Coordinates. *Cogent Education*, *10*(1). https://doi.org/10.1080/2331186X.2023.2177050

Pin, N. A., & Rosli, R. (2023). Systematic Literature Review: The Use of GeoGebra Software in Geometry Learning: Sorotan Literatur Bersistematik: Penggunaan Perisian GeoGebra dalam …. *Jurnal Pendidikan Sains Dan Matematik Malaysia*, *13*(1), 64–78. https://ojs.upsi.edu.my/index.php/JPSMM/article/view/7624

Poutirer, Z., Ondigi, S. R., & Miheso-O'Connor, M. K. (2023). Pre-Service Teachers' Perception of the Use of Geogebra in Teaching and Learning Geometry in the Colleges of Education, Ghana. *JOHME: Journal of Holistic Mathematics Education*, *7*(1), 1. https://doi.org/10.19166/johme.v7i1.6124

Rachmawati, A. D., Juandi, D., & Darhim, D. (2023). Examining the effectiveness of a GeoGebra-assisted open-ended approach on students' mathematical creative thinking ability. *Jurnal Elemen*, *9*(2), 604–615. https://doi.org/10.29408/jel.v9i2.16483

Rafiqoh, S. (2020). Arah Kecenderungan dan Isu dalam Pembelajaran Matematika Sesuai Pembelajaran Abad 21 Untuk Menghadapi Revolusi Industri 4.0. *Jurnal MathEducation Nusantara, 3*(1), 58–73. https://jurnal.pascaumnaw.ac.id/index.php/JMN/article/view/101/91.

Rahman, O., Usman, & Johar, R. (2021). Improving high school students' critical thinking ability in linear programming through problem based learning assisted by GeoGebra. *Journal of Physics: Conference Series*, *1882*(1). https://doi.org/10.1088/1742-6596/1882/1/012070

Rhilmanidar, R., Ramli, M., & Ansari, B. I. (2020). Efektivitas Modul Pembelajaran Berbantuan Software GeoGebra pada Materi Bangun Ruang Sisi Datar. *Jurnal Didaktik Matematika*, *7*(2), 142–155. https://doi.org/10.24815/jdm.v7i2.17915

Romaito, P., Safitri, I., Sarida, H., Nisah, H., Uswatun, Hasanah, Apriani, D., Afsari, S., Dwichanda, O., & Lucky, Y. (2021). The Mathematics Learning using Geogebra Software to Improve Students' CreativeThinking Ability. *Journal of Physics: Conference Series*, *1819*(1). https://doi.org/10.1088/1742-6596/1819/1/012008

Samura, A. O., & Darhim. (2023). Improving Mathematics Critical Thinking Skills of Junior High School Students Using Blended Learning Model (BLM) in GeoGebra Assisted Mathematics Learning. *International Journal of Interactive Mobile Technologies*, *17*(2), 101–117.

https://doi.org/10.3991/ijim.v17i02.36097

Sari, H. A., Susanto, S., & Yudianto, E. (2022). Pengembangan Perangkat Pembelajaran Geometri Bangun Ruang Berbantuan Geogebra Untuk Meningkatkan Kemampuan Spasial Siswa Sekolah Dasar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(3), 2441. https://doi.org/10.24127/ajpm.v11i3.5568

Selvy, Y., Ikhsan, M., Johar, R., & Saminan. (2020). Improving students' mathematical creative thinking and motivation through GeoGebra assisted problem based learning. *Journal of Physics: Conference Series*, *1460*(1). https://doi.org/10.1088/1742-6596/1460/1/012004

Septian, A. (2022). Student's mathematical connection ability through GeoGebra assisted project-based learning model. *Jurnal Elemen*, *8*(1), 89–98. https://doi.org/10.29408/jel.v8i1.4323

Septian, A., Darhim, & Prabawanto, S. (2020). Geogebra in integral areas to improve mathematical representation ability. *Journal of Physics: Conference Series*, *1613*(1). https://doi.org/10.1088/1742-6596/1613/1/012035

Septian, A., Sugiarni, R., & Monariska, E. (2020). The Application of Android-based GeoGebra on Quadratic Equations Material toward Mathematical Creative Thinking ability. *Al-Jabar : Jurnal Pendidikan Matematika*, *11*(2), 261–272. https://doi.org/10.24042/ajpm.v11i2.6686

Sugandi, A. I., Bernard, M., & Linda, L. (2020). Efektivitas Pembelajaran Daring Berbasis Masalah Berbantuan Geogebra Terhadap Kemampuan Penalaran Matematis Di Era Covid-19. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(4), 993. https://doi.org/10.24127/ajpm.v9i4.3133

Sugandi, A. I., Sofyan, D., Linda, L., & Sari, D. R. (2022). Pengembangan Modul Geometri Analitik Berbasis Strategi React Berbantuan Geogebra Untuk Melatihkan Kemampuan Berpikir Kritis. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(2), 850. https://doi.org/10.24127/ajpm.v11i2.4963

Susanti, D., Jailani, J., & Irfan, L. (2022). Pembelajaran Kooperatif Tipe Group Investigation Berbantuaan Geogebra Untuk Mendukung Keterampilan Collaboration, Problem Solving, Dan Communication. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(2), 1000. https://doi.org/10.24127/ajpm.v11i2.4726

Susanto, N. C. P., Kusmiyati, K., & Utami, S. (2023). Systematic Literature Review: Penerapan Software Geogebra Terhadap Kemampuan Berpikir Matematis. *Jurnal Ilmiah Soulmath : Jurnal Edukasi Pendidikan Matematika*, *11*(2), 127–140. https://doi.org/10.25139/smj.v11i2.6677

Ulfiyani, Putra, Z. H., & Noviana, E. (2023). Pengembangan Media Pembelajaran Materi Sistem Koordinat Berbasis Geogebra di Sekolah Dasar. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *12*(3), 3431–3444.

Uwurukundo, M. S., Maniraho, J. F., & Tusiime, M. (2022). Effects of GeoGebra on Students' Attitudes towards Learning Geometry: A Review of Literature. *African Journal of Educational Studies in Mathematics and Sciences*, *17*(2), 127–138. https://doi.org/10.4314/ajesms.v17i2.10

Yatim, S. S. K. M., Saleh, S., Zulnaidi, H., & Yatim, S. A. M. (2022). Effects of integrating a brain-based teaching approach with GeoGebra on problem-solving abilities. *International Journal of Evaluation and Research in Education*, *11*(4), 2078–2086. https://doi.org/10.11591/ijere.v11i4.22873

Yullah, A. S., Susanto, S., & Suwito, A. (2022). Efektivitas Model Pembelajaran Discovery Berbantuan Geogebra Ditinjau Dari Kemampuan Berpikir Kreatif Siswa. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *11*(2), 1222. https://doi.org/10.24127/ajpm.v11i2.5010

Zetriuslita, Nofriyandi, & Istikomah, E. (2019). The effectiveness of Geogebra-assisted direct instruction learning in improving students' mathematical communication skill viewed from academic level. *Journal of Physics: Conference Series*, *1315*(1). https://doi.org/10.1088/1742-6596/1315/1/012049