GeoGebra Research in Indonesia: A Bibliometric Analysis

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ABSTRAK

Ada bukti bahwa memanfaatkan GeoGebra di kelas dapat bermanfaat, terutama di bidang matematika. *Dynamic Geometry Software* (DGS) seperti GeoGebra adalah kategori program komputer yang menggabungkan kemampuan aljabar dan geometris. Pada awalnya, GeoGebra tidak lebih dari sebuah aplikasi yang dapat digunakan pada komputer pribadi. Karena analisis bibliometrik digunakan dalam proyek penelitian GeoGebra. Selain itu, tujuan dari pekerjaan ini adalah untuk melakukan analisis bibliometrik untuk mengetahui perkembangan penelitian GeoGebra di Indonesia. Analisis bibliometrik dilakukan dengan tujuan untuk mengevaluasi pekerjaan sebelumnya yang telah dilakukan pada topik GeoGebra di Indonesia. Penelitian ini memakai metode penelitian kuantitatif deskriptif. Kami tertarik untuk mengkaji perkembangan hasil penelitian GeoGebra di Indonesia, serta pola sebaran publikasi di Scopus. Untuk tujuan penelitian ini, kami mengumpulkan daftar lengkap makalah yang relevan dengan mencari Judul, Abstrak, dan Kata Kunci Scopus. Hal ini membawa kami pada kesimpulan dari penyelidikan kami, yaitu sebagai berikut: *TITLE-ABS-KEY* ("GeoGebra") *AFFILCOUNTRY* (Indonesia). Total makalah yang dihasilkan adalah 131. Temuan dari database Scopus tidak dibatasi dengan cara apapun. Hasilnya ditampilkan dalam waktu singkat dan dalam kasus tertentu memberikan gambaran yang komprehensif tentang perkembangan dan kedudukan literatur GeoGebra oleh afiliasi dari Indonesia, termasuk informasi tentang penulis, institusi, negara, dan kata kunci penulis. Untuk tujuan kejelasan, kata kunci penulis sendiri adalah satu-satunya yang digunakan dalam analisis data dalam penelitian ini. Namun, saat ini tidak ada pustaka bahasa pemrograman R yang dapat menangani masalah ini.

Kata Kunci : bibliometrik; biblioshiny; geogebra; matematika; software geometri

ABSTRACT

There is evidence that utilizing GeoGebra in the classroom can be beneficial, especially in the field of mathematics. Dynamic Geometry Software (DGS) such as GeoGebra is a category of a computer program that combines algebraic and geometric capabilities. In the beginning, GeoGebra was nothing more than an application that could be used on personal computers. Because bibliometric analysis is employed in GeoGebra research projects. In addition, the objective of this work is to undertake bibliometric analysis to determine the development of GeoGebra research in Indonesia. A bibliometric analysis was carried out with the intention of evaluating the previous work that has been done on the topic of GeoGebra in Indonesia. This study is of a quantitative descriptive type. We are interested in examining the progression of GeoGebra research outcomes in Indonesia, as well as the distribution pattern of publications in Scopus. For the purpose of this research, we collected a complete list of relevant papers by searching Scopus' Titles, Abstracts, and Keywords. This brings us to the conclusion of our investigation, which was the following: TITLE-ABS-KEY ("GeoGebra") AFFILCOUNTRY (Indonesia). The total amount of papers that were produced was 131. The findings from the Scopus database are not constrained in any manner. The results are displayed in a short amount of time and in certain cases provide a comprehensive look at the developments and standing

of the GeoGebra literature by affiliation from Indonesia, including information on authors, institutions, nations, and author keywords. For the purpose of clarity, the author's own keywords are the only ones used in the data analysis in this study. However, no R programming language library currently exists that can handle this issue.

Keywords: Bibliometric; Biblioshiny; GeoGebra; Geometry Software; Mathematics.

INTRODUCTION

There is evidence that utilizing GeoGebra in the classroom can be beneficial, especially in the field of mathematics. This is particularly true in comparison to traditional teaching approaches (Jancheski & Jancheska, 2019). In the age of technology, it's crucial to connect teaching and learning with mediums that fit students' interests. GeoGebra's contributions to math teaching-learning are addressed as a tool to promote student interest and achievement and as an environment to thrive varied learning styles (Wassie & Zergaw, 2019).

Dynamic Geometry Software (DGS) such as GeoGebra is a category of a computer program that combines algebraic and geometric capabilities. In the beginning, GeoGebra was nothing more than an application that could be used on personal computers. On the other hand, it was ultimately redesigned to function as an application that could be run on mobile devices as well as the internet (e.g., smart phone or iPad) (Zdráhal et al., 2019).

According to (Wijaya et al., 2021) using GeoGebra can boost the confidence of future educators, as well as their ability to communicate, solve problems creatively, and think outside the box. Prospective mathematics educators were also found to benefit from encouragement and guidance throughout the duration of their projects, with the former having a direct causal effect on the development of greater self-assurance.

In order to spot developments in the field of GeoGebra research, we combed through a massive amount of literature. One such method for gaining early perspective on the huge body of published research is through bibliometric analysis. The term "bibliometrics" refers to the study of scientific literature through the use of quantitative and qualitative methods of analysis (Pritchard, 1969; Supriyadi, 2022). The study of GeoGebra has been documented through the use of bibliographic techniques. Previous study (Gökçe & Güner, 2022) is an example of bibliometric applied to the topic of GeoGebra. This research uses a bibliometric analysis approach using a web of science database by offering evidence to show trends and practices in studies related to GeoGebra, as well as to clarify their relationship with other concepts.

Therefore, the difference between this study and previous research (Gökçe & Güner, 2022) is that the databases used are sources obtained from the Scopus database and only focused on researchers affiliated with Indonesia. The purpose of this study is focused on analyzing to describe keywords, authors, journals, and characteristics of articles about Geogebra obtained from the Scopus database. Papers on this topic are interesting to discuss considering the importance of research in the use of Geogebra in responding to problems in learning.

RESEARCH METHOD

A bibliometric analysis was carried out with the intention of evaluating the previous work that has been done on the topic of GeoGebra in Indonesia. The first thing that has to be done in order to conclude a bibliometric study is to generate a comprehensive list of the publications that have the possibility of being a part of our sample. This is the first step that needs to be taken (Oermann et al., 2008). This study is of a quantitative descriptive type. We are interested in examining the progression of GeoGebra research outcomes in Indonesia, as well as the distribution pattern of publications in Scopus according to research affiliations, research themes, and scientific journals. For the goals of data analysis, reduction, visualization, and mapping, respectively, Bibliometrix R-tool and BiblioShiny were utilized throughout the course of this research. The analysis of the whole article mapping was carried out with R-Studio, which was the version of Bibliometrix that was used (Aria & Cuccurullo, 2017; Supriyadi, 2022).

The most influential countries, publications, and journals in any given field can be identified by an examination of cited works and the publications to which they refer. When doing literature searches, the most popular databases for obtaining bibliometric data are Web of Science (WoS), Scopus, and Google Scholar. Scopus data was used for this study's bibliometric analysis because of its extensive coverage, high-quality data, consistently reliable format, and ease of extraction. In addition, Scopus is used to index the results of this study.

For the purpose of this research, we collected a complete list of relevant papers by searching Scopus' Titles, Abstracts, and Keywords. This brings us to the conclusion of our investigation, which was the following: TITLE-ABS-KEY ("GeoGebra") AFFILCOUNTRY (Indonesia). The total amount of papers that were produced was 131. The findings from the Scopus database are not constrained in any manner. After they have been made available to the public, publications can be accessed for an unending amount of time. Afterwards, with the Scopus tool, we collect all of the metadata into a *.csv file. The analysis was carried out with the help of RStudio. We make use of a tool called "Biblioshiny," which was developed for those with no prior training in programming, in order to carry out complete scientometric and bibliometric analysis.

RESULT AND DISCUSSION

In this part, the findings of the bibliometric analysis will be presented. For the objectives of this analysis, a total of 131 journal articles written by 337 different authors and published in 34 different journals were investigated. There are 131 total papers, 11 of which are documents written by a single author. The authors index for each individual document is 3.16, and the overall number of author keywords is 141. In the following two subsections, the bibliometric approaches of citation analysis and content analysis, both of which are frequently utilized, will be explained so that publications can be analyzed.

The data reveal that the total number of articles kept rising from 2017 to 2020, then fluctuated (as depicted in Figure 1) until reaching its highest point in 2021. Table 1 also shows the top 10 journals in our data set, ranked by the journal H-index. Articles are ranked in this table according to their h-index value, total citations, net production, and publication year of first appearance (PY start). The journals with the most citations are the Journal of Physics: Conference Series, the International Journal of Instruction, the Proceedings of the American Institute of Physics, and the Journal of Educational and Information Technologies.
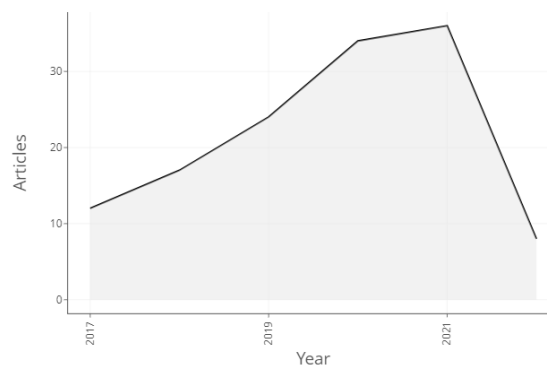

Figure 1. Annual Production Articles GeoGebra in Indonesia Research

Tabel 1. Top ten Impact Sources GeoGebra in Indonesia

Element	h_index	TC	NP	PY_start
Journal of Physics: Conference Series	6	110	41	2017
International Journal of Instruction	3	40	4	2018
AIP Conference Proceedings	2	9	4	2017
Education and Information Technologies	2	12	2	2020
International Journal of Interactive Mobile Technologies	2	10	3	2021
Journal on Mathematics Education	2	9	2	2018
TEM Journal	2	11	2	2019
2019 1st International Conference on Cybernetics and Intelligent System, ICORIS 2019	1	1	1	2019
2021 International Conference on Information Technology, ICIT 2021 – Proceedings	1	2	1	2021
ACM International Conference Proceeding Series	1	1	1	2017

By applying Bradford's Law and making use of the source impact, we were able to determine which journals included considerable amounts of information. Table 2 contains Bradford's law, which is responsible for the journal's recognizable section breakdown into three parts each. Our company places as a crucial resource in Zone 1 publications of journals that have a significant effect factor. Only one journal out of 131 journals was discovered to be in what was referred to as the "core zone 1." (responsible for nearly half of all papers published).

Table 2. Top Ten Sources GeoGebra in Indonesia Reseach based on Bradford's Law

Sources	Rank	Freq	cumFreq	Zone
Journal of Physics: Conference Series	1	78	78	Zone 1
AIP Conference Proceedings	2	8	86	Zone 2
International Journal of Instruction	3	4	90	Zone 2
International Journal of Interactive Mobile Technologies	4	3	93	Zone 3
Education and Information Technologies	5	2	95	Zone 3
IOP Conference Series: Earth and Environmental Science	6	2	97	Zone 3
IOP Conference Series: Materials Science and Engineering	7	2	99	Zone 3
Journal on Mathematics Education	8	2	101	Zone 3
Mathematics Teaching-Research Journal	9	2	103	Zone 3
Proceedings of The 7th Mathematics, Science, and Computer Science Education International Seminar, Msceis 2019	10	2	105	Zone 3
Pythagoras	11	2	107	Zone 3
TEM Journal	12	2	109	Zone 3
2019 1st International Conference on Cybernetics and Intelligent System, ICORIS 2019	13	1	110	Zone 3
2021 International Conference on Information Technology, ICIT 2021 – Proceedings	14	1	111	Zone 3
ACM International Conference Proceeding Series	15	1	112	Zone 3
Contemporary Educational Technology	16	1	113	Zone 3
Electronic Journal of E-Learning	17	1	114	Zone 3
Heliyon	18	1	115	Zone 3
Indian Journal of Forensic Medicine and Toxicology	19	1	116	Zone 3
International Journal of Applied Engineering Research	20	1	117	Zone 3
International Journal of Emerging Technologies in Learning	21	1	118	Zone 3
International Journal of Engineering and Technology(Uae)	22	1	119	Zone 3
International Journal of Information and Education Technology	23	1	120	Zone 3
International Journal of Innovation, Creativity and Change	24	1	121	Zone 3
International Journal of Learning, Teaching and Educational Research	25	1	122	Zone 3
International Journal of Scientific and Technology Research	26	1	123	Zone 3
Journal of Technology and Science Education	27	1	124	Zone 3
Matec Web of Conferences	28	1	125	Zone 3
Proceeding - 2016 International Conference on Sustainable Energy Engineering And Application: Sustainable Energy for A Better Life, ICSEEA 2016	29	1	126	Zone 3
Proceedings - 2021 7th International Conference on Education And Technology, ICET 2021	30	1	127	Zone 3
Proceedings - 2022 2nd International Conference on Technology Enhanced Learning in Higher Education, TELE 2022	31	1	128	Zone 3
Proceedings - International Conference on Computer And Information Sciences: Sustaining Tomorrow With Digital Innovation, Iccoins 2021	32	1	129	Zone 3
Solar Energy	33	1	130	Zone 3
Specialusis Ugdymas	34	1	131	Zone 3

In addition to this, we examine patterns in the number of publications that are produced each year according to the top ten sources. The increase in the number of articles by leading journals is illustrated in Figure 2. In order to demonstrate a smooth line with the

assistance of time plots or scatter plots, we make use of a loess smoothing approach that is a local weighted smoothing that is based on regression analysis. Loess smoothing is helpful in gaining an understanding of trends across time (Royston, 1992). Researchers from Indonesia are releasing an increasing amount of research on GeoGebra each year through the Journal of Physics: Conference Series as well as the AIP Conference Proceedings. Both the International Journal of Instruction, which is a journal with a rating of Q2 on Scopus, and the International Journal of Interactive Mobile Technologies, which has a rating of Q3 on Scopus, are journals that are frequently utilized by authors affiliated with the Indonesian country who publish research on GeoGebra.
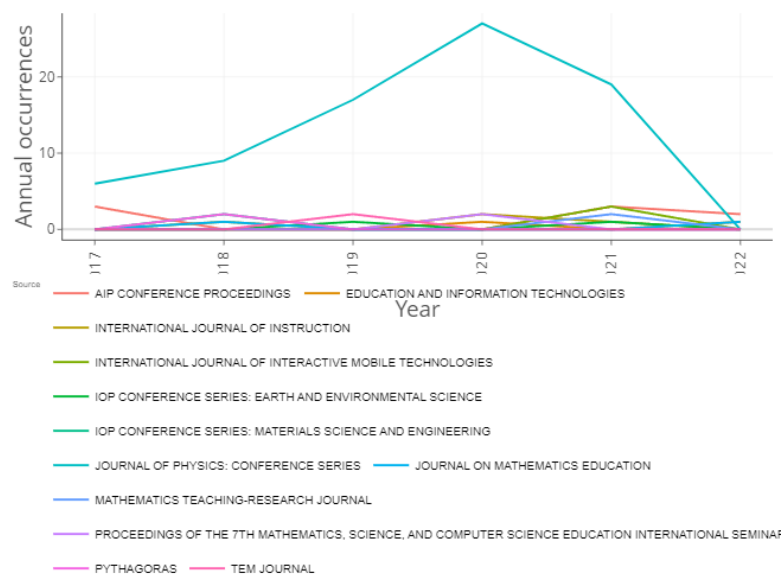

Figure 2. Source Growths GeoGebra Research in Indonesia

Next, the most influential authors are ranked according to their H-index, number of publications, or total number of citations. Figure 3 depicts a scatter plot of the number of publications made by the top 20 authors throughout the course of the time. It is clear that the majority of the well-known authors are considered to be classics within the sector, and very few of them, like Johar R, have produced any of it new in recent years. In addition, for the past three years, the majority of new research on Geogbera has been published by only a single author under the name of Putra ZH. Following this, Lotka's law (Figure 4) was developed as a means of describing the rate of publishing achieved by authors operating within this particular domain. According to Lotka's law, 83.4% of authors only produced one publication throughout the time period in question. When an author has a greater number of publications than other authors combined, this results in fewer total authors. In accordance with Lotka's law, only 12.2% of the authors produced two publications, and 3.6% of the authors made three publications.
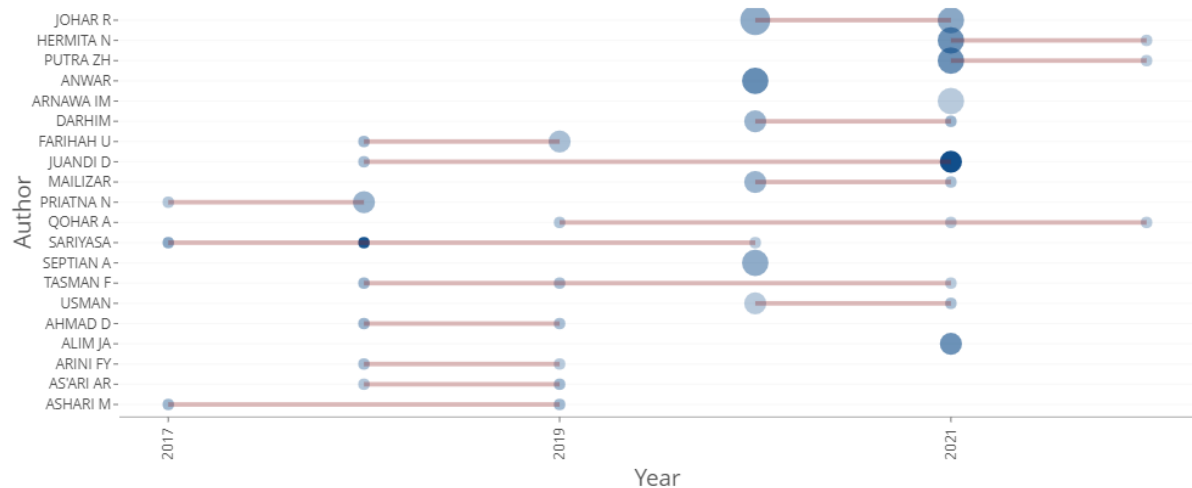
Figure 3. Top 20 Authors' of GeoGebra Research in Indonesia

Table 3. Top Authors' of GeoGebra in Indonesia authors' Research

Authors	DOI	TC	TCpY
(Rahman et al., 2021)	10.1088/1742-6596/1882/1/012070	1	0.5
(Lainufar et al., 2021)	10.1088/1742-6596/1882/1/012045	1	0.5
(Mailizar & Johar, 2021)	10.29333/iji.2021.14243a	1	0.5
(Lainufar et al., 2020)	10.1088/1742-6596/1460/1/012034	3	1
(Selvy et al., 2020)	10.1088/1742-6596/1460/1/012004	1	0.333
(Detiana et al., 2020)	10.1088/1742-6596/1460/1/012020	0	0
(Elvita et al., 2020)	10.1088/1742-6596/1460/1/012045	0	0
(Putra et al., 2022)	10.1109/TELE55498.2022.9800948	0	0
(Putra, Hermita, Alim, Dahnilsyah, et al., 2021)	10.3991/ijim.v15i19.23773	3	1.5
(Putra, Hermita, Alim, & Witri, 2021)	10.1109/ICIT52682.2021.9491790	2	1
(Putra, Panjaitan, et al., 2021)	10.1088/1742-6596/2049/1/012032	0	0
(Defi & Qohar, 2022)	10.1063/5.0099631	0	0
(Juandi et al., 2021)	10.1016/j.heliyon.2021.e06953	9	4.5
(Samura et al., 2021)	10.3991/IJIM.V15I22.24797	2	1
(Yerizon et al., 2021)	10.18178/ijiet.2021.11.10.1550	0	0
(Huda & Qohar, 2021)	10.1063/5.0043140	0	0
(Meisya & Arnawa, 2021)	10.1088/1742-6596/1742/1/012034	0	0
(Fikriah et al., 2021)	10.1088/1742-6596/1742/1/012029	0	0
(Priyatno et al., 2021)	10.1088/1742-6596/1742/1/012004	0	0
(Suryani et al., 2020)	10.1088/1742-6596/1470/1/012079	8	2.667
(Septian, Darhim, et al., 2020b)	10.1088/1742-6596/1657/1/012019	2	0.667
(Septian, Suwarman, et al., 2020)	10.1088/1742-6596/1657/1/012023	1	0.333
(Septian, Darhim, et al., 2020a)	10.1088/1742-6596/1613/1/012035	1	0.333
(Jatiariska et al., 2020)	10.1088/1742-6596/1503/1/012013	0	0
(Munandar et al., 2020)	10.1088/1742-6596/1462/1/012033	0	0
(Handayani et al., 2020)	10.1088/1742-6596/1460/1/012016	0	0
(Nurlisna et al., 2020)	10.1088/1742-6596/1460/1/012041	0	0
(Mursyidah et al., 2020)	10.1088/1742-6596/1460/1/012038	0	0

Authors	DOI	TC	TCpY
(Tasman et al., 2019)	10.1088/1742-6596/1317/1/012114	2	0.5
(Nasution et al., 2019)	10.1088/1742-6596/1227/1/012011	1	0.25
(Farihah, 2019b)	10.1088/1742-6596/1211/1/012057	1	0.25
(Farihah, 2019a)	10.1088/1755-1315/243/1/012104	1	0.25
(Jelatu et al., 2018)	10.12973/iji.2018.11421a	26	5.2
(Tasman & Ahmad, 2018)	10.1088/1757-899X/335/1/012112	5	1
(Farihah, 2018)	10.1088/1742-6596/1008/1/012079	4	0.8
(Juandi & Priatna, 2018)	10.1088/1742-6596/1013/1/012209	3	0.6
(Priatna et al., 2018)	10.1088/1742-6596/1013/1/012142	2	0.4
(Sariyasa, 2017)	10.1088/1742-6596/824/1/012057	9	1.5
(Priatna, 2017)	10.1063/1.4995157	1	0.167
(Wardhana et al., 2019)	10.1016/j.solener.2019.10.057	3	0.75
(Widjajanti et al., 2019)	10.18421/TEM81-42	3	0.75
(Dewi et al., 2019)	10.1088/1742-6596/1321/2/022094	0	0
(Dewi & Arini, 2018)	10.1088/1742-6596/983/1/012154	3	0.6
(Listiawan et al., 2018)	10.1088/1742-6596/1114/1/012121	1	0.2
(Wardhana et al., 2017)	10.1109/ICSEEA.2016.7873559	5	0.833

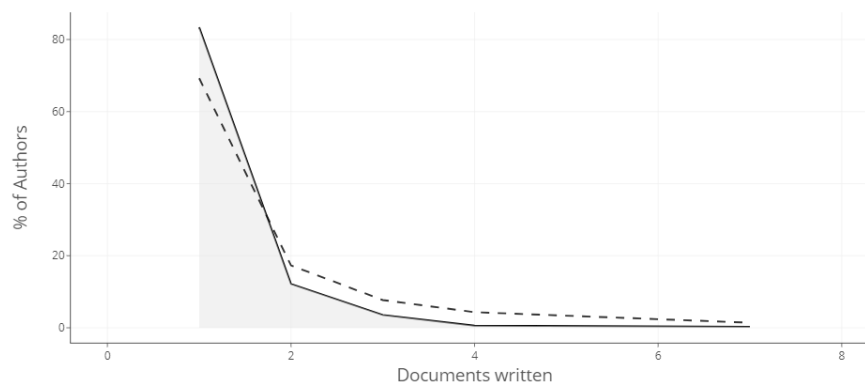*TC=Total Citations, TCpY=TC=Total Citations per Year.*

Figure 4. Publication GeoGebra Research in Indonesia Based on Lotka's Law

The universities like Universitas Pendidikan Indonesia, Universitas Negeri Padang, Universitas Negeri Semarang, University of Jember, and Universitas Negeri Malang are among the most well-known Indonesian affiliates that are of the utmost significance to the research that GeoGebra carries out. During that era and time period, each of these educational institutions was ranked as one of the top five universities in the world for having the highest total number of publications. This difference was accorded to the institutions based on the total number of publications produced by the institution. This distinction was presented upon the educational institutions on the basis of the total number of publications that were produced by the institution (Figure 5).

Figure 5. Most Relevant Institutions from GeoGebra Research in Indonesia

We did an analysis on the plus keywords that came up most frequently in the research on GeoGebra that was carried out by authors from Indonesia. This research was carried out by Indonesian authors. This was done for each and every one of the terms. A direct consequence of this is that *"students," "education," "computer,"* and *"mathematics learning"* are the top five author keywords. The subject of geometry is included from this list. By employing the word cloud that is depicted in Figure 6, we also provide a graphical representation of the top fifty or more terms that appear to be the most frequent overall.

Figure 6. Word Cloud from GeoGebra in Indonesia Research based on Keywords Plus

Figure 7 illustrates an interesting trend that can be drawn using the top ten author's keyword, and that trend is the trend of the increase of the keywords over the course of time. This trend can be drawn using the top ten author's keyword. Using the keywords written by the top ten authors, we can deduce this trend. The top 10 keywords used by the authors could be used to draw some conclusions about this pattern. If you look at the top 10 terms that were used by the authors, you can make some deductions about the trend that's been going on. This demonstrates that the majority of the keywords followed a pattern that was relatively consistent throughout the majority of the time period. On the other hand, an expanding tendency can be seen, most notably for the phrases *"GeoGebra," "Learning Media," "Spatial Ability," and "Critical Thinking Ability,"* amongst others. This expansion tendency can be seen for a number of other terms as well.
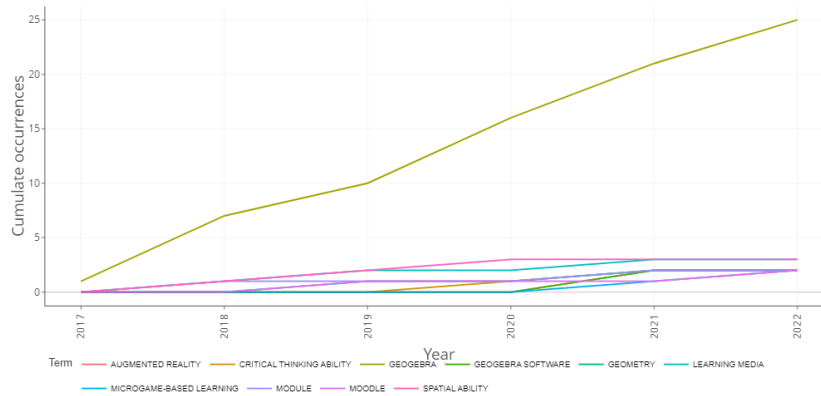
Figure 7. Author's keywords trend from GeoGebra Research in Indonesia

Using the information that is provided by the author's keywords, as well as the author's name and institution, we are able to generate a Three Field Plot, which is displayed in Figure 8. In the following graphic, the most important terms, authors, and institutions have been compiled into a single visual representation. The dimensions of the box provide context for determining the number of frequencies. By utilizing this picture, it is possible to track the contribution of each author on the terms that are used the most frequently at their respective renowned institutions. For instance, it has been observed that Putra ZH and Hermita N have been cited ten times. Hermita N is also mentioned ten times. The majority of them are connected in some way to the University of Riau and contribute to the "GeoGebra" project. Next up was a user who was only known by the alias Septian A. This individual had a total of eight different appearances and was affiliated with both Suryakancana University and the Indonesian Education University.
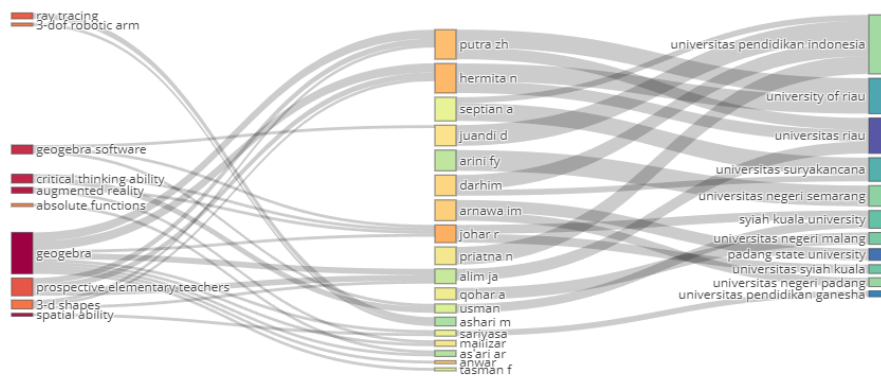
Figure 8. Three-Fields Plot from GeoGebra Research in Indonesia

After that, we can classify the themes that have been identified into strategic diagrams in order to examine the significance of research themes and their progression (Aria & Cuccurullo, 2017). A thematic map based on density (shown on the y-axis) and centrality may be found in Figure 9. (x-axis). Both the relevance of the selected theme and its progression toward completion are evaluated using the centrality and density metrics, respectively. The graph can be broken down into four distinct parts. Themes that are located on the bottom left of the list of ascending or descending themes ("GeoGebra software", "ray

tracing", and "moodle" as descending themes in our case). These are fresh ideas that appear to have the potential to be enhanced or eliminated from the research field altogether. Primary or transversal themes are those that can be found in the bottom right corner of the thematic map (categories with productivity or real options). These motifs have a small number of occurrences but a large centrality. On these topics, a significant amount of research has been carried out. The top left corner illustrates high density but less centrality; these themes are highly developed but stand alone ("microgame-based learning" and "user-generated microgames"). The top right corner depicts areas with a high population and centralization. The ideas that are elaborated on and discussed in this part are very important ("spatial ability", "geometry", and "critical thinking ability"). On the other hand, they frequently return to fundamental or overarching ideas. (Biblioshiny Bibliometrix for No Coders., 2020) The size of the thematic map is scaled up or down depending on the components that are included in the theme.
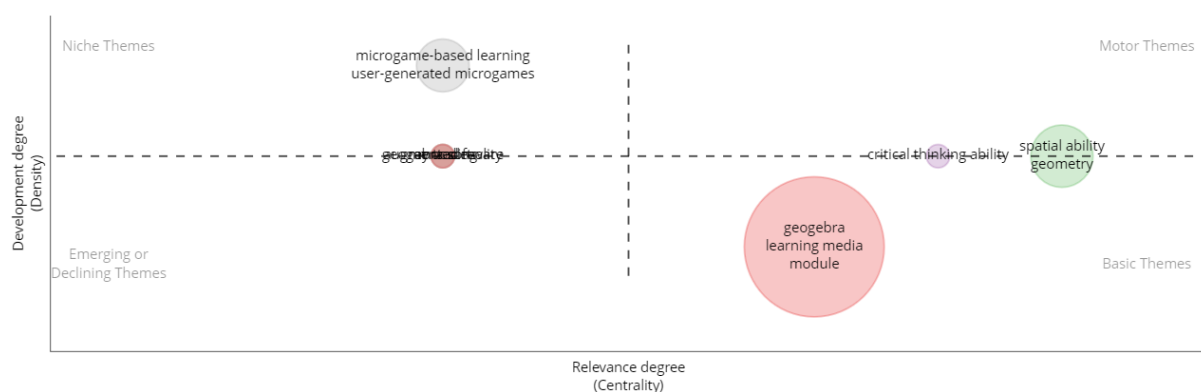

Figure 9. Thematic Map from GeoGebra Research in Indonesia

The final picture is a social structure that illustrates how different authors and institutions in the study domain are connected to one another. An influential group of regular writers, institutions, or countries, as well as the clandestine community that exists among them, can be discovered in this plot. The collaborative efforts of several institutions are depicted in figure 10. The image provides information about the Indonesian Education University is located in cluster 1, with connections to Suryakancana University and the Ternate State Islamic Institute. This information may be retrieved from the picture. These GeoGebra studies have produced several intriguing findings, such as the fact that, in addition to working together with Indonesian organizations on a home level, GeoGebra has also collaborated with institutions from other countries. This was discovered because to the partnership between Johannes Kepler University in Linz and Pamulang University in the Philippines. In addition, there is a partnership between three universities in Indonesia: Padang State University, Andalas University, and Malaysia University of Technology. This partnership is referred to as the Padang State University, Andalas University, and Malaysia University of Technology Collaboration.

Figure 10. Institutions Collaboration from GeoGebra Research in Indonesia

CONCLUSION

An in-depth bibliometric analysis of Indonesian-affiliated GeoGebra literature produced between 2017 and September 2022 is presented here. To analyze the impact and content of 131 journal articles indexed by Scopus, we utilized numerous R packages and the Biblioshiny library for R. The analysis demonstrates the feasibility of using R and the existing library for bibliometrics. In addition, the results are displayed in a short amount of time and in certain cases provide a comprehensive look at the developments and standing of the GeoGebra literature by affiliation from Indonesia, including information on authors, institutions, nations, and author keywords. It should be noted that there are a few caveats to this study that we hope to remedy in subsequent work. For the purpose of clarity, the author's own keywords are the only ones used in the data analysis in this study. Conversely, you can utilize search terms and abstract indexes like Scopus. Furthermore, the content analysis in this study does not take into account the use of synonyms. However, no R language program library currently exists that can handle this issue (by combining synonyms in one term). However, for the purposes of this analysis, we will be using each term independently. With future revisions, we want to address the aforementioned restrictions.

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