Research Trends of Students' Mathematical Ability on Algebra Materials Based on Gender: Bibliometric Analysis

Sri Rah Hayu[1*], Lilis Marina Angraini[2]

[1,2]Mathematics Education, Islamic University of Riau, Indonesia

*Corresponding author: srirahhayu@student.uir.ac.id

Article Info	Abstract
	Mathematical skills are not only used in the world of education but also in various professional fields, such as science, technology, and economics. This study uses blibliometric analysis whose data source is obtained from Google Scholar and uses the keyword of students' mathematical ability in algebra material based on gender with a maximum of 1000 data. Researchers analyzed 948 out of 990 articles from 2019-2024. This study uses Publis or Perish software for data search through Google Scholar and VOSviewer to obtain analysis results that are by the objectives of this research was carried out to find out the research trends of mathematical abilities based on gender and to find out future research opportunities. This study shows that the most publications are in 2023 with 200 publications. The results of the research provide recommendations for variables that can be researched in the future, namely algebraic thinking and high mathematical ability.

To cite this article

1. Introduction

According to Davita and Pujiastuti (2020), mathematics is one of the disciplines that has an important role in education and is taught at all levels of education. Meanwhile, according to Kuswanti et al., (2017) mathematics is the basic knowledge needed by students to improve learning outcomes and to pursue higher education. The Teaching and Learning Process Course

Team (MKPBM) states that mathematics is one of the lessons taught in schools to help students prepare themselves to face a life that is always dynamic, through the practice of acting based on logical, rational and critical thinking (Mz, 2013). In addition, mathematics also serves as a tool to understand the relationship between variables, formulate hypotheses, and make predictions (Nasution, 2013). Patterns and structures in mathematics develop analytical and critical thinking skills that are essential in decision-making in various fields.

Algebra is an abstract mathematical material. Algebra is considered the foundation in learning mathematics, if students do not master the basics of algebra well, it will be difficult for students to learn the next material because mathematics is hierarchical (Prambudi & Yunianta, 2020). Another opinion reveals that Algebra is an important subject in mathematics because it is used in various other subject matter, therefore students must be able to master and understand algebra material as the basis for further learning and algebra has a complex level of difficulty in each problem (Vandini, 2015). Kartika (2018) said that there are still many students who cannot reach the Minimum Completeness Criteria (KKM) when studying algebra and other materials related to algebra. Many things are the cause of low mathematics learning outcomes of students, one of which is the learning media used by teachers. What happens is that without realizing it, everyone must use the concept of algebra in everyday problems (Hasibuan, I., 2015).

Effendi (2012) revealed five standards of ability to learn mathematics according to NCTM including communication, problem-solving, connection, representation and reasoning. And several studies mention factors that affect mathematical ability, namely the gender of students (Gender). For example, according to the mathematical reasoning ability on algebra material, female students are better than male students, each male student gets 6.22 and female students 8.22. Another opinion stated that female students tended to be better than male students on indicators of identifying problems, solving problems with several alternative solutions, and evaluating algebraic form materials (Ghifari, M et al., (2021). According to Junia & Kartika, (2024), students' numeracy literacy skills in solving problems, both male and female students, were stated to have a medium category with an average score of 65.37 with a total of 24 out of 36 students or 66.67%. According to Nurjanah et al., (2019) the mathematical reasoning ability of students in class VIII-ASMP Angkasa Lanud Sulaiman is that male students have lower mathematical reasoning skills compared to female students.

As the number of related studies increases, it is important to understand how research trends in this field evolve. One of the research trends is using bibliometric analysis. Bibliometrics comes from the words bibliography and metrics, biblio has the meaning of book while metrics has the meaning of measuring (Firmansyah et al., 2021). In other words, bibliometrics is a statistical analysis of various publications, both in the form of articles and books (Nur et al., 2024). Another meaning of bibliometrics is the science that studies authorship using mathematical and statistical analysis (Rohanda & Winoto, 2019). By using bibliometric techniques, we can identify the development of relevant topics, such as the influence of stereotype threats on mathematics performance, the role of self-efficacy in student achievement, and efforts to overcome the gender gap in mathematics education. These data are not only useful for academics to determine the direction of future research but also for education policymakers who want to design more inclusive and effective learning programs.

This article aims to find out the analysis of research trends on students' mathematical ability in algebra material based on gender and to understand how the chances of students' mathematical ability based on gender can be used in future research. It is hoped that the results of this study can provide a comprehensive illustration of the direction and focus of research in this field, as well as offer useful insights for academics and education practitioners to reduce the gender gap and improve the quality of mathematics learning for all students regardless of their gender background.

2. Methods

This study uses bibliometric methods to analyze trends and research developments on students' mathematical abilities based on gender. Bibliometrics is a statistical analysis of various publications, such as books and scientific articles. According to Febriyanti (2020), the purpose of bibliometric analysis is to explain the writing process, the nature and direction of the descriptive calculation, and the analysis of various phases of communication. The research data was taken using the Publish or Perish software, using the Google Scholar database and analyzed using the VOSviewers application.

The stages in bibliometric analysis using Publish or Perish software are as follows: Enter the keyword "students' mathematical ability by gender" with the Google Scholar database, vulnerable to searches from 2019-2024 and the maximum number of results 1000.
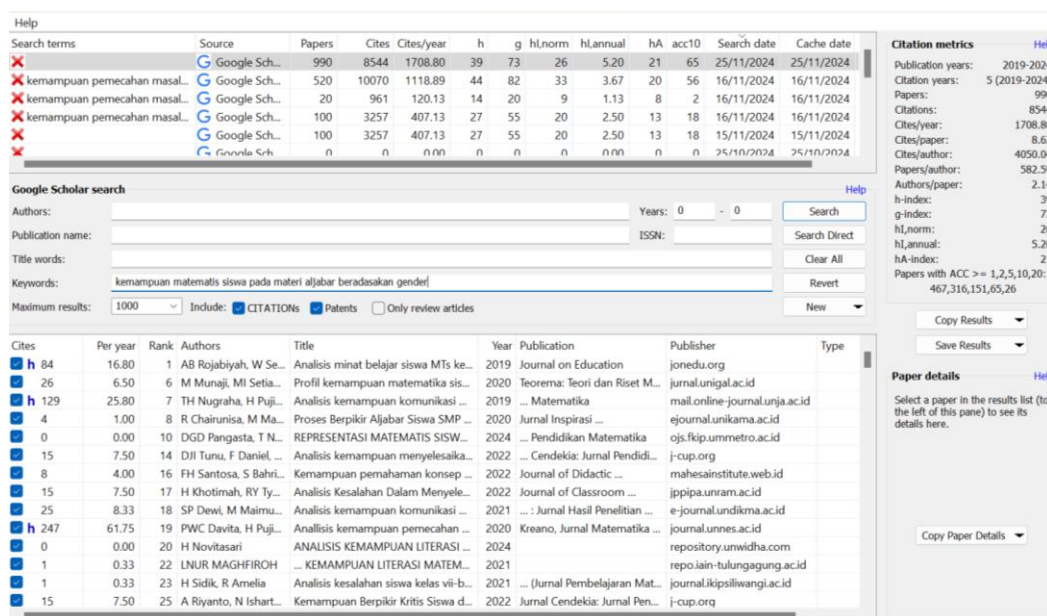

Figure 1 Database search using Google Scholar

Based on Figure 1, the maximum search allowed by Google Scholar is 1000 data. With a maximum search of 1000 data, we take to research 990 data, and based on the year taken 948. Figure 1 shows information about citation marks, which are quantitatively described in full shown in Table 1.

The explanation from Table 1 can be seen in the results and discussion section. The next step is that the data is stored in RIS and CSV formats. Format RIS is used to analyze data in the form of networks and maps using VOSviewer software, while CSV is used to analyze (process) data in Excel form which can then be made in the form of tables and graphs.

Table 1 - Citation marks

Result	Explanation
Keyword	Students' mathematical abilities in algebraic material by gender
Publication years	2019-2025
Citation years	5 (2019-2024)
Papers	990
Citation	8554
Cites/year	1708.80
Cites/paper	8.63
Cites/author	4050.04
Papers/author	582.59
Authors/paper	2.14
h-index	39
g-index	73
hI, norm	26
hI, annual	5.20
hA-Index	21

Vosviewer software implements a map of the development of scientific publications with the title "Students' Mathematical Abilities by gender". The results of the processing using VOSviewer software are Network Visualization, Overlay Visualization, and Density Visualization. Here are the steps for using Vosviewer Software with a database from Publish or Perish (Aprinita Sari et al., 2022):

1. Open the Vosviewer software and click Create.
2. Select Create a map based on text data, then click Next.
3. Select Read data from reference manager files, then click next.
4. Select RIS to enter the data that has been saved from Harzing's publish or perish software, then click next.
5. Select the title and abstract field, then click next.
6. Next, select full counting, and click next.
7. After that click finish.
8. After pressing finish, filter for terms related to and not related to mathematical reasoning ability, click ok and save the VOSviewers image result.

3. Results and Discussion

3.1. Results of Publish or Perish Data Development

Based on data collection using Publish or Perish software and the Google Scholar database covering the years 2019-2024, table 1 lists 990 articles about students' mathematical abilities in algebra material by gender, 8544 citations, 1708.80 cites/years, 8.63 cites/paper, 4050.04 cites/author, 582.59 papers/author, 2.14 Author/paper, 39 h-index, 73 g-index, 26 hI, norm, 5.20 hI, annual, and 21 hA-index.

3.2. Development of Scientific Publications

Judging from the results of scientific publications on students' mathematical abilities by gender from 2019-2024, 990 articles were obtained and 42 of them did not have a year of publication so the author only used 948 articles published in google scholar in the following table.

Table 3 - Development of scientific publications

Year	Number of Publications	Percentage
2019	117	12%
2020	133	14%
2021	170	18%
2022	198	21%
2023	200	21%
2024	130	14%
Jumlah	968	100%

Based on table 3 above, there are 117 publications with a percentage of 12% in 2019, 133 publications with a percentage of 14% in 2020, 170 publications with a percentage of 18% in 2021, 198 publications with a percentage of 21% in 2022, 200 publications with a percentage of 21% in 2023, and 130 publications with a percentage of 14% in 2024. In 2019-2023, research on students' mathematical abilities based on gender has experienced a significant increase. And in 2023-2024 it will decrease. From the data above, it can be informed that scientific publications regarding students' mathematical abilities in algebra material based on gender must be developed a lot.
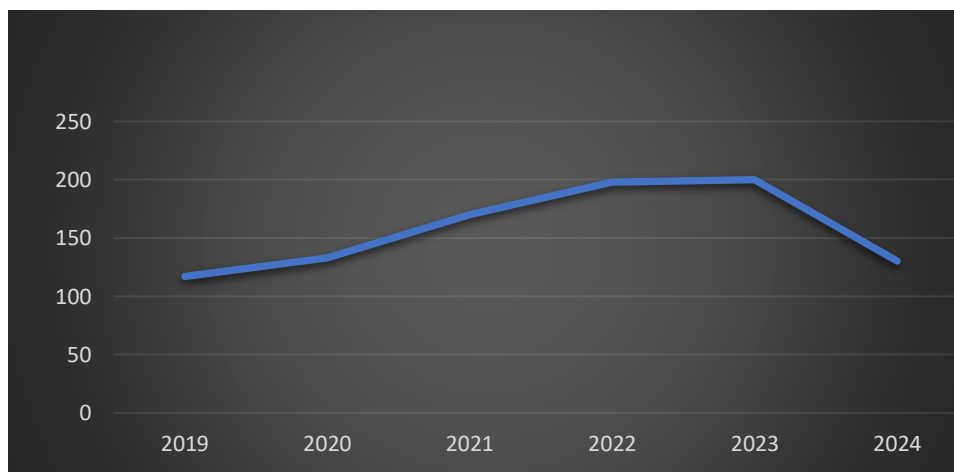

Figure 2 The graph curve of the development of scientific publications from 2019-2024

Figure 2 shows the graph curve of the development of scientific publications from 2019-2024 which began to decline in 2022-2024. From the graph, we can see that the lowest publication occurred in 2019 with 117 publications, and the most publications were in 2023, which was 220 publications.

3.3. Map of the Development of Scientific Publications

The publication mapping uses a binary calculation method with a minimum number of words as many as 5 out of 4644 words and those that meet the threshold are only 119 while the selected ones are only 40 words. In visualization, there are nodes (circles) indicating that the

author is at the edge (network) of knowing the relationship between the authors. Aribowo (2019) revealed that the distance of the associated sphere shows that the larger the sphere, the more variables are studied simultaneously.
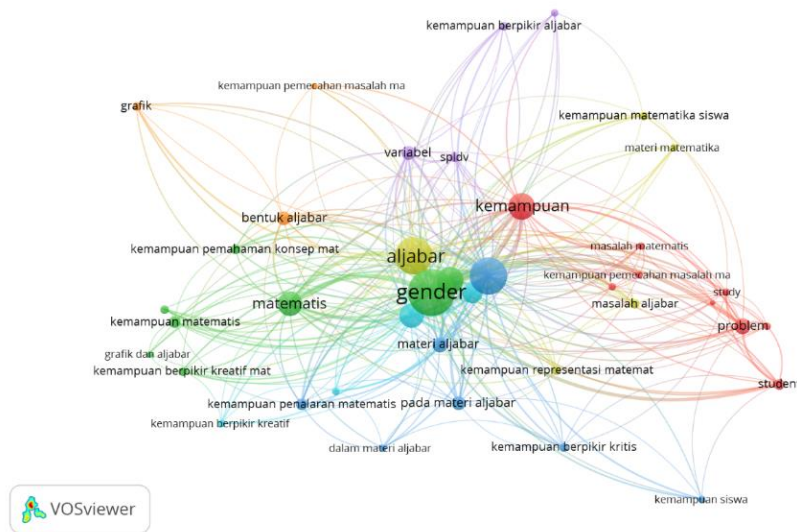

Figure 3 Network visualization VOSviewer

Based on Figure 3, 40 variables are studied. Of the 40 variables, there are 289 relationships formed between items and the strength of the relationships between items is 1210. The centre of students' mathematical ability research on gender-based algebra material is "Gender" located in cluster 2. In this study, 7 groups are distinguished by red for Cluster 1, green for Hunter cluster 2, blue for Cluster 3, olive green for Cluster 4, purple for Cluster 5, Tosca cluster 6, and orange for Cluster 7. The results of Network Visualization showed the relationship between variables consisting of 19 variables in Cluster 1, 8 variables in Cluster 2, 7 variables in Cluster 3, 5 variables in Cluster 4, 4 variables in Cluster 5, and 4 variables in Cluster 6, and 3 variables in cluster 7. For example, cluster 1, variables based on the ability to relate to algebraic problem variables, algebraic thinking, problem-solving ability and so on. This means that research on many abilities is tied to these variables, but there are still variables that are rarely researched, for example, students' abilities, and critical thinking skills.
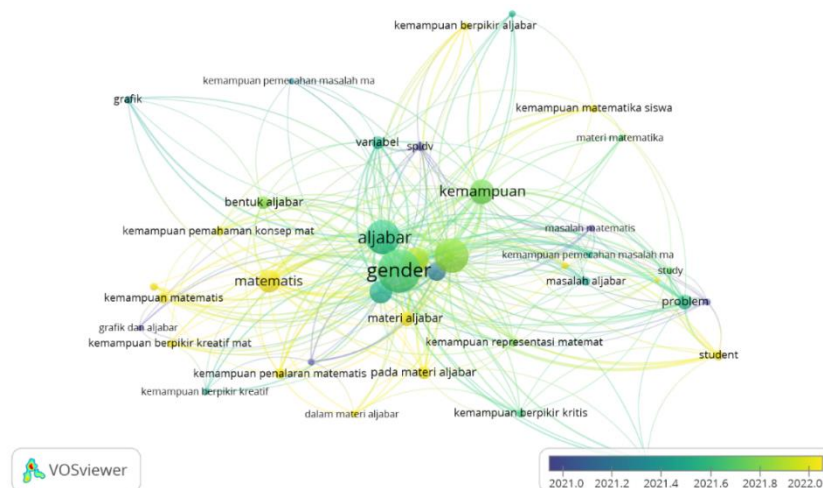

Figure 3 Overlay visualization Vosviewer

Based on Figure 4, the results of the Overlay Visualization Vosviewer, the student's mathematical ability in algebra material based on gender is centred on Gender located in cluster 2. According to Dwi Pratiwi Siregar et al (2023), the yellow colour indicates that new variables have been used together in recent years. The newly used variables are mathematical ability, mathematical reasoning, algebra material, student, understanding of mathematical concepts, algebra material, and mathematics.
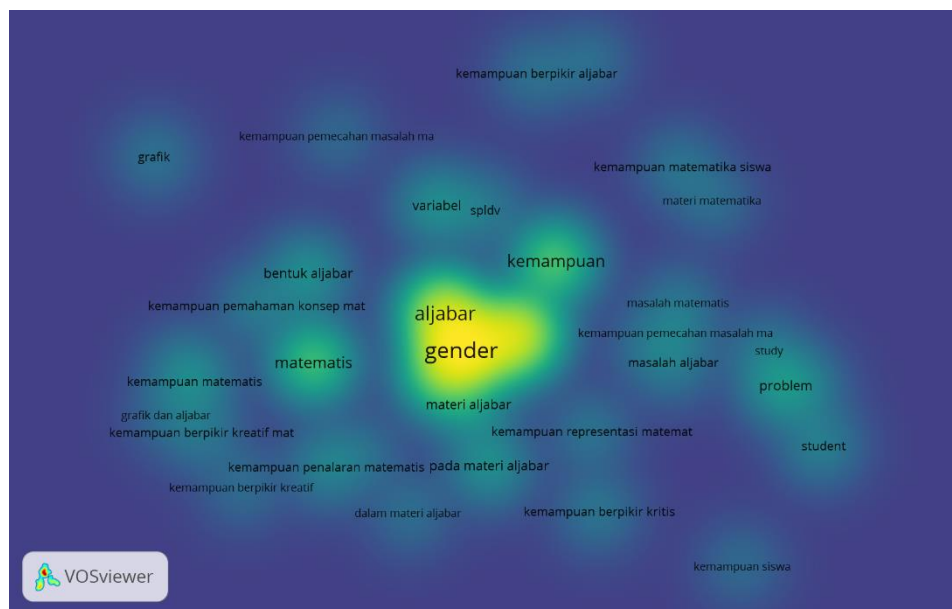

Figure 4 Density visualization Vosviewer

Based on Figure 5, the research trend of students' mathematical ability in algebra material based on gender in full Counting Density Visualization there are 40 variables related to students' mathematical ability based on gender. In Density Visualization, the more yellow the colour indicates that the variable has been widely used for research. Meanwhile, the dimmer colour indicates that the variable has not been widely used in research. To see research opportunities related to students' mathematical abilities that will be carried out in the future, you can use VOSviewer to see existing research statistics. The appearance of the yellow colour shows how the research trend of students' mathematical abilities. From Figure 5 we can see two terms that we can use for further research, namely: algebraic thinking and high mathematical ability.

4. Conclusions

Based on the results and discussions, the number of publications in the Google Scholar database from 2019-2024 through Publish or Perish software with the keyword "students' mathematical abilities in gender-based algebra materials" has the most publications in 2023, which is 200 publications. By using the VOSviewer application, we can see how research is progressing and we can find out what variables have not been widely researched, for example, such as algebraic thinking and high mathematical skills that can be used for the next research.

Acknowledgements

References

Aprinita Sari, R., Zulfah, & Astuti. (2022). Analisis Bibliometrik Terhadap Kemampuan Penalaran Matematis. *Jurnal Ilmiah Matematika Realistik (JI-MR*, *3*(2), 119–124.

Aribowo, E. K. (2019). Analisis Bibliometrik Berkala Ilmiah Names: Journal of Onomastics dan Peluang Riset Onomastik Di Indonesia. In *Online)* (Vol. 31, Issue 1).

Davita, P. W. C., & Pujiastuti, H. (2020). Anallisis Kemampuan Pemecahan Masalah Matematika Ditinjau Dari Gender. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *11*(1), 110–117. https://doi.org/10.15294/kreano.v11i1.23601

Dwi Pratiwi Siregar, K., Ramadhaniyati, R., Muhammad, I., & Agus Triansyah, F. (2023). *Analisis Bibliometrik: Fokus Penelitian Critical Thinking pada Sekolah Menengah (1992-2023)*. *4*, 349–360. http://jurnaledukasia.org

Effendi, L. A. (2012). *Pembelajaran Matematika dengan Metode Penemuan Terbimbing untuk Meningkatkan Kemampuan Representasi dan Pemecahan Masalah Matematis Siswa SMP*.

Febriyanti, N. (2020). Bibliometrik: Analisis Pengujian Hukum Lotka pada Pola Prosduktifitas Pengarang Dan Analisis Pengujian Hukum ZIPT Pada Abstrak Artikel Di Bidang Pendidikan Biologi. *Jurnal Iqra'*, *12*(2).

Firmansyah, M. I., Myrna, R., & Widianingsih, I. (2021). Analisis Bibliometric Dari Program Hibah (Bibliometric of Grants Program). *Shaut Al-Maktabah: Jurnal Perpustakaan, Arsip Dan Dokumentasi*, *13*(2), 131–144. https://doi.org/10.37108/shaut.v13i2.565

Ghifari, M., Salsabila, E., & Aziz, T. A. (2021). Analisis kemampuan berpikir reflektif matematis pada bentuk aljabar ditinjau perbedaan gender. *JKPM (Jurnal Kajian Pendidikan Matematika).*

Hasibuan, I. (2015). Hasil belajar siswa pada materi bentuk Aljabar di Kelas VII SMP Negeri 1 Banda Aceh tahun pelajaran 2013/2014. *Jurnal peluang*, *4*(1).

Junia, A., & Kartika, H. (2024). Analisis Kemampuan Literasi Numerasi Siswa SMP Kelas VIII dalam Memecahkan Masalah Soal Cerita Aljabar Ditinjau dari Jenis Kelamin. *Prosiding Sesiomadika*.

Kania, N., Suryadi, D., Kusumah, Y. S., Dahlan, J. A., Nurlaelah, E., & Elsayed, E. E. (2024). Comparative Praxeology: Assessing High-Level Cognitive Skills in TIMSS and Indonesian

National Examinations. International Journal of Applied Learning and Research in Algebra, 1(1), 25–47. https://doi.org/10.56855/algebra.v1i1.1160

Kartika, Y. (2018). Analisis Kemampuan Pemahaman Konsep Matematis Peserta Didik Kelas VII SMP Pada Materi Bentuk Aljabar. Jurnal Pendidikan Tambusai, 2(4), 777–785. Retrieved from https://www.jptam.org/index.php/jptam/article/view/25

Kuswanti, Y., Setiawani, S., & Lestari, N. D. S. (2017). Analisis Soal Dalam Buku Siswa Matematika Kurikulum 2013 Untuk Sekolah Menengah Pertama Kelas VII Berdasarkan Dimensi Kognitif Trends International Mathematics and Science Study (TIMSS). *Jurnal Edukasi*.

Mulya, D., Darwati, J., & Sarah Inayah. (2024). Exploring Middle School Students' Mathematical Connection Skills in Solving Systems of Linear Equations. International Journal of Applied Learning and Research in Algebra, 1(1), 61–69. https://doi.org/10.56855/algebra.v1i1.1176

Mz, Z. A. (2013). Perspektif Gender Dalam Pembelajaran Matematika. *Marwah: Jurnal Perempuan, Agama Dan Jender*, 15–31.

Nasution, M. (2013). Memahami Pendekatan keterampilan Proses dalam Pembelajaran Matematika. *Logaritma*, *11*.

Nur, P., 1∗, P., Rustika, P., Hidayat, R., Matematika, P., Keguruan, F., Pendidikan, I., & Cirebon, U. M. (2024). *Analisis Bibliometrik: Tren Penelitian Kemampuan Pemahaman Konsep Matematis Siswa dalam Pembelajaran Matematika (2019-2024)*. *7*(1). http://jurnal.umk.ac.id/index.php/anargya

Nurjanah, S., Kadarisma, G., & Setiawan, W. (2019). Analisis kemampuan penalaran matematik dalam materi sistem persamaan linear dua variabel pada siswa SMP kelas VIII ditinjau dari perbedaan gender. Journal on Education, 1(2), 372-381. *Journal On Education*.

Prambudi, E. Y., & Yunianta, T. N. (2020). Pengembangan Media Bus Race Algebra Pada Materi Bentuk Aljabar Untuk Siswa Kelas VII SMP. Jurnal Cendekia: Jurnal Pendidikan Matematika, 04(01), 8–22. DOI: https://doi.org/10.31004/cendekia.v4i1.150

Rahayu, S., Cahyani, R. E., Herlina, Y., & Kumar, K. (2024). Analysis of Difficulty Learning Mathematics on Algebra Material Based on Gender. International Journal of Applied Learning and Research in Algebra, 1(1), 10–24. https://doi.org/10.56855/algebra.v1i1.1167

Rohanda, & Winoto, Y. (2019). Analisis Bibliometrika Tingkat Kolaborasi, Produktivitas Penulis, Serta Profil Artikel Jurnal Kajian Informasi & Perpustakaan Tahun 2014-2018. *PUSTABIBLIA: Journal of Library and Information Science*. https://doi.org/10.18326/pustabiblia.v3i1.1-15

Vandini, I. (2015). Peran Kepercayaan Diri Terhadap Prestasi Belajar Matematika Siswa. Jurnal Formatif, 5(3), 210–219.