

Bibliometric analysis: Learning outcomes research in mathematics learning (1992-2023)

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Abstract

Learning Outcomes are values, attitudes, and skills as a result of the learning process. The purpose of this study is to look at the research landscape related to learning outcomes in mathematics learning from 1992 to 2023. The method used is descriptive bibliometric analysis. The data taken comes from the enhanced Scopus database. The results showed that the trend of the most publications related to learning outcomes in learning mathematics was in 2020 and 2022 with a total of 14 publications. The most citation trend occurred in the 2009 publication which has been cited 262 times. The country that has had a major impact on research on learning outcomes in mathematics learning is the United States of America. The research focus is divided into three parts, namely 1) motivation and reasoning, 2) technology and higher school, and 3) universities and assessments. New themes in this field are mathematical problems, higher education, blended learning, and GeoGebra. The learning outcomes keyword is not directly connected with the 7 other keywords, namely, ICT, critical thinking, mathematics achievement, pre-service teacher, gender difference, and secondary school. Keywords with new themes such as mathematical problems are not together with learning outcomes but are not directly connected with keywords with other new themes such as higher education, blended learning, and GeoGebra.

Keywords: Learning Outcomes, Bibliometric, Mathematics Learning, Scopus

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INTRODUCTION

Learning outcomes are patterns of action, values, understanding, attitudes, appreciation and skills (Dakir et al., 2021). Learning Outcomes are a change in attitude that persists in an individual as a result of the individual's interaction with the environment (Sudargini & Purwanto, 2020; Titl et al., 2016). Meanwhile according to Triyanti et al. (2021), Learning Outcomes are variables that are tied to teaching materials, teachers and students. So, Learning Outcomes is a value, attitude and skills as a result of the learning process.

The desired learning outcomes are learning outcomes from education that are planned based on the competencies that students want to develop, not from the content owned by the teacher (Erikson & Erikson, 2019). The purpose of learning outcomes is the existence of a change that occurs in a person after learning at school (Isroani, 2022). Determining student learning outcomes is an important step in improving the quality of learning in schools (Albariki & Sunarto, 2020; Ayadat et al., 2020; Dinh & Nguyen, 2022).

The problem of decreasing learning outcomes is a question mark for teachers, parents and the school (Harli, 2022). Likewise learning outcomes in learning mathematics. Mathematics is one of the sciences that is important for students to have which is useful in everyday life (Mayani et al., 2022). Learning mathematics can be an important factor in learning outcomes (Purnawan, 2021). According to Lin et al. (2020) students' mathematics learning outcomes are positively related to the teacher's leadership style and student's style of freedom. But in reality Learning Outcomes in learning mathematics is still categorized as low, this is in accordance with what was conveyed by Lumbantoruan et al. (2022) that student learning outcomes in learning mathematics is still relatively low.

Research related to learning outcomes continues to increase every year, this is in accordance with what was conveyed by Al-Shabibi & Al-Ayasra (2019) that recent study that addressed learning outcomes, where they found that this study started in 2012 and that the number of these studies had increased over the years, culminating in the 2016 study. That is, the interest of researchers regarding student learning outcomes at school was quite high. For that we need a method that can be used in analyzing the results of these studies.

Bibliometric analysis can be used to analyze publications related to learning outcomes in mathematics within a certain time span. This is in accordance with what was conveyed by Muhammad & Mukhibin (2023)

that one of the methods used in the analysis of research results is bibliometric analysis there have been many studies that have used bibliometric analysis including research by Muhammad et al. (2022), Muhammad, Himmawan et al. (2023), Muhammad, Marchy et al. (2023). Bibliometrics is a research field with a long history, many bibliometric studies have been conducted and several bibliometric studies have investigated a topic or field based on documents indexed in Scopus or the Web of Science (Amiri et al., 2023). Researchers use the Scopus database to find the necessary data. According to Alviz-Meza et al. (2022), Scopus is the most widely used database for publishing articles.

Learning outcomes as a starting point in academic libraries, assessment of student learning outcomes is important for accountability with stakeholders (Goss, 2022). Most studies focus on learning outcomes, which have implications for academic performance (Goksu et al., 2020). Previous research related to learning outcomes in mathematics learning has looked at several variables such as looking at the influence of learning media (Dwijayani, 2019; Jayadi, 2022; Rahmawati et al., 2022; Saputra et al., 2019), learning model (Salam et al., 2019; Sukardjo & Salam, 2020) on student learning outcomes in mathematics learning. A meta-analysis study of learning outcomes was also carried out by Candra and Retnawati (2020) who have seen the effect of constructivism learning on student learning outcomes. Research conducted by Harun et al. (2021) regarding the meta-analysis of the success of learning mathematics, from this study it was explained that there were two factors that led to students' success in learning mathematics, namely internal and external factors. Therefore it is necessary to do research related to student learning outcomes in learning mathematics.

The purpose of this study is to look at the research landscape related to learning outcomes in mathematics learning from 1992 to 2023. The research questions are as follows.

- 1) What are the publication trends and citation trends related to learning outcomes research in mathematics learning from 1992 to 2023?
- 2) How is the geographical distribution of publications and patterns of relations between countries related to research on learning outcomes in mathematics learning?
- 3) What is the focus of research and novelty related to research on learning outcomes in learning mathematics?

METHOD

The method used in this research is descriptive bibliometric analysis. The data obtained came from the Scopus database related to research on learning outcomes in mathematics learning from 1992 to 2023. The data collection process was carried out in several stages such as identification, screening, eligibility and inclusion Moher et al., (2009), for more details can be seen in Figure 1.

Identification was carried out by entering keywords in the database used, in this study the researchers entered the keywords "learning outcomes" OR "learning outcomes") AND ("education") in the Scopus database. From this search, 1637 publications were obtained that met the criteria in this stage. Screening is the second step that must be carried out, in the screening process the researcher determines several criteria including, namely, publications must be in English, publications are in the form of articles, publications are included in the mathematics category. After the screening process was carried out, 188 publications were obtained that were in accordance with criteria at this stage The third process is to manually look at the titles and abstracts of the 188 publications The criterion is whether the learning outcomes are discussed in the field of learning mathematics or only Education in general Publication of learning outcomes in learning mathematics will be further analyzed at the interim stage he continued. from the results of this feasibility as many as 64 publications did not match the criteria set. The number of publications that are included in the inclusion stage is 124 documents.

The refined data will be analyzed with the help of several applications. Publication trends related to research on learning outcomes in mathematics learning from 1992 to 2023 are displayed with the help of Microsoft Excel software which are grouped by year of publication. In calculating annual citations researchers use the Publish or Perish software, besides being able to calculate the total citations from annual publications, the software can also calculate the h-index and g-index values.

The Vosviewer application is used to see patterns of relations between countries related to research on learning outcomes in mathematics learning from 1992 to 2023, namely by network visualization. The software is also used to see the focus of research in this field and see the novelty of the research

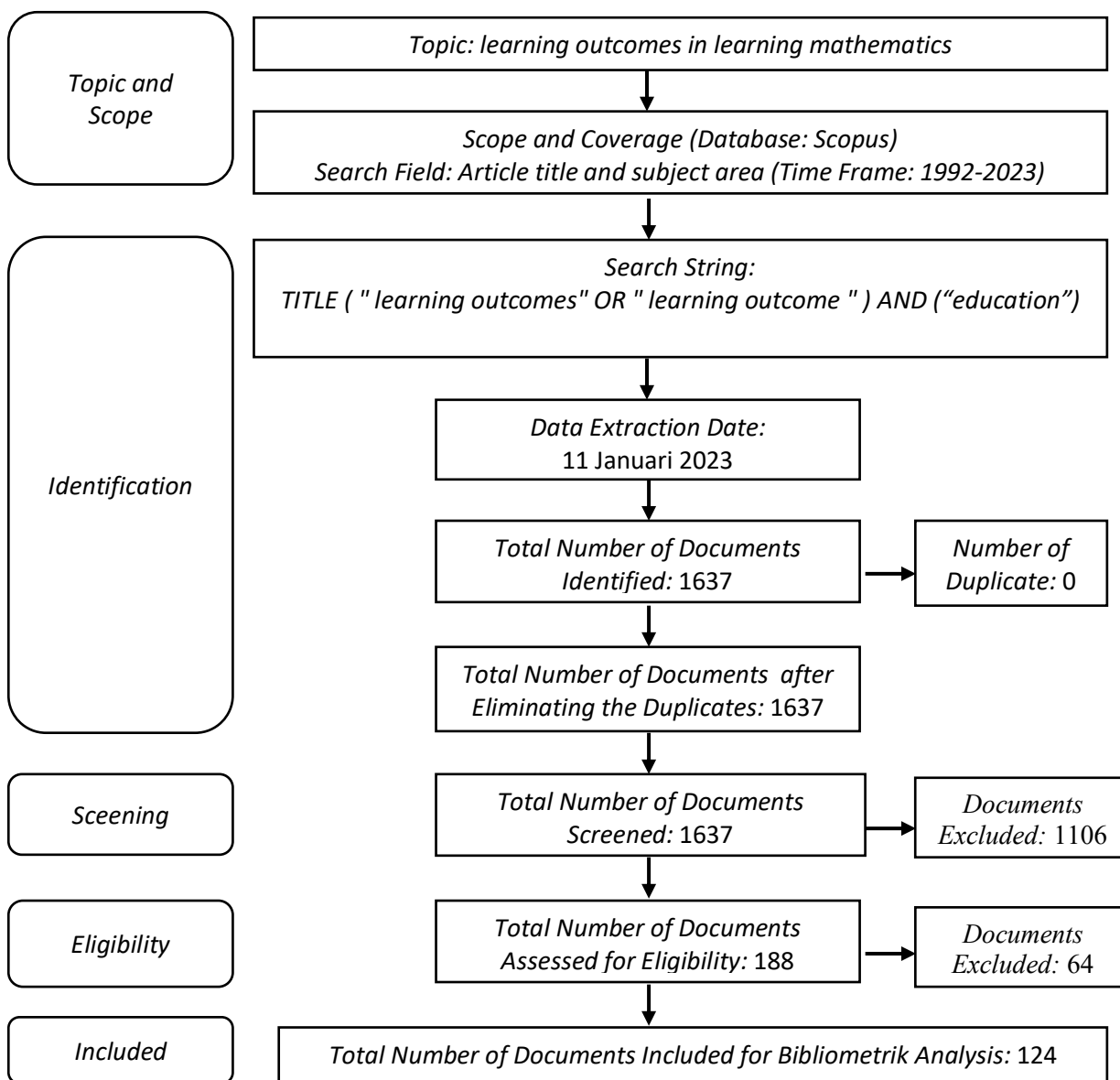


Figure 1. Data collection process

RESULTS AND DISCUSSION

In presenting the research results, the researcher ranks the research questions starting from publication trends, citation trends, geographic distribution, patterns of relations between countries, and research focus. The first publication was found in 1992 which will continue until 2023.

What are the publication trends and citation trends related to learning outcomes research in mathematics learning from 1992 to 2023?

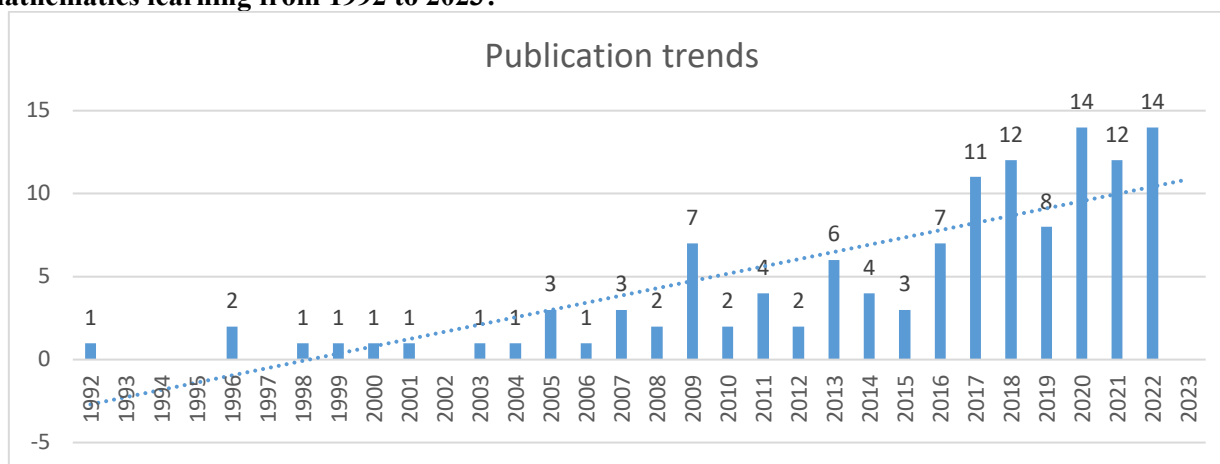


Figure 2. Publication trends (1992-2023)

Publications related to learning outcomes in mathematics from 1992 to 2023 are separated by year of publication. A total of 124 publications spread over several decades. The number of publications in 2020 and 2022 is the highest compared to other years. Publication trends in this field have increased from year to year, this can be seen from the trend line in Figure 2 above. Publications in recent years have seen a large increase in numbers. This is in accordance with what was conveyed by (Al-Shabibi & Al-Ayasra, 2019) that research related to learning outcomes continues to increase every year. The biggest increase occurred from 2019 to 2020. In 2019 the total published articles were 8 and increased by 75% to 14 publications the following year. As for publications in 2020, one of them is done by (Lopez-Caudana et al., 2020) on the use of Robotics to Enhance Active Learning in Mathematics: A Multi-Scenario Study, the results of the study demonstrated a very good impact on students' attention and motivation, and made it possible to define the conditions that need to be met for an effective relationship between teachers and technological tools, so that learning outcomes Math is better. most likely to be obtained.

Table 1. Citation Analysis of Publications

Year	TP	NCP	TC	C/P	C/CP	h	g
2023	-	-	-	-	-	-	-
2022	14	5	8	0,57	1,6	2	2
2021	12	10	47	3,92	4,7	4	6
2020	14	11	62	4,43	5,63	5	7
2019	8	6	28	3,5	4,66	4	5
2018	12	10	145	12,08	14,5	7	12
2017	11	8	130	11,82	16,25	6	11
2016	7	7	105	15	15	4	7
2015	3	2	77	25,67	38,5	2	3
2014	4	4	108	27	27	3	4
2013	6	5	62	10,33	12,4	5	6
2012	2	2	26	13	13	1	2
2011	4	4	60	15	15	3	4
2010	2	2	25	13	12,5	2	2
2009	7	7	262	37	37	6	7
2008	2	2	7	3,5	3,5	2	2
2007	3	3	125	42	42	2	3
2006	1	1	2	2	2	1	1
2005	3	3	7	1	2,33	3	3
2004	1	1	97	97	97	1	1
2003	1	-	-	-	-	-	-
2002	-	-	-	-	-	-	-
2001	1	1	13	13	13	1	1
2000	1	1	7	7	7	1	1
1999	1	1	19	19	19	1	1
1998	1	1	17	17	17	1	1
1997							
1996	2	2	28	14	14	2	2
1995	-	-	-	-	-	-	-
1994	-	-	-	-	-	-	-
1993	-	-	-	-	-	-	-
1992	1	-	-	-	-	-	-

Notes. TP=total of publication, NCP=number of cited publication, TC=total citations, C/P=average citations per publication, C/CP=average citations per cited pblication, h=h-index, g=g-indeks

Publications related to mathematics learning outcomes were analyzed based on the number of citations per year starting from 1992 to 2023. From table 1 above it can be seen that the highest NCP score was in 2021 with 11 publications that had been cited at least 1 time out of the total publications for that year (TP= 14). Meanwhile, the highest total citations were published in 2009 with a total of 262 citations. The highest h-index and g-index values were in 2018 with h-index = 7 and g-index = 12. This means that publications in 2018 have

had a huge influence on research on learning outcomes in current mathematics learning. In 2018 there were 8 publications that had been cited at least 2 times as can be seen in Table 2.

Table 2. Articles published in 2028 (citation > 1)

No	Author (year)	Title	Sources	Citation
1	(Chien & Chu, 2018)	The Different Learning Outcomes of High School and College Students on a 3D-Printing STEAM Engineering Design Curriculum	International Journal of Science and Mathematics Education	33
2	(Y. Chen & Chang, 2018)	The impact of an integrated robotics STEM course with a sailboat topic on high school students' perceptions of integrative STEM, interest, and career orientation	Eurasia Journal of Mathematics, Science and Technology Education	29
3	(Smith & Mancy, 2018)	Exploring the relationship between metacognitive and collaborative talk during group mathematical problem-solving—what do we mean by collaborative metacognition?	Research in Mathematics Education	26
4	(Muijs et al., 2018)	Assessing individual lessons using a generic teacher observation instrument: how useful is the International System for Teacher Observation and Feedback (ISTOF)?	ZDM - Mathematics Education	19
5	(Buchholtz et al., 2018)	Combining and integrating formative and summative assessment in mathematics teacher education	ZDM - Mathematics Education	11
6	(J.-C. Chen et al., 2018)	A novice mathematics teacher educator–researcher’s evolution of tools designed for in-service mathematics teachers’ professional development	Journal of Mathematics Teacher Education	9
7	(Ardiyani & Gunarhadi, 2018)	Realistic mathematics education in cooperative learning viewed from learning activity	Journal on Mathematics Education	9
8	(Tabach & Schwarz, 2018)	Professional development of mathematics teachers toward the facilitation of small-group collaboration	Educational Studies in Mathematics	7

Research conducted by (Chien & Chu, 2018) with the title "The Different Learning Outcomes of High School and College Students on a 3D-Printing STEAM Engineering Design Curriculum" gets the most number of citations, namely 33 times, the article discusses significant differences in creativity, prediction accuracy, competition results, and results study. The research has been widely cited because the research findings serve as a reference for the design, development, and implementation of future STEAM curricula. Publication sources from the table above can also be used as a reference for researchers who want to publish their articles related to learning outcomes in learning mathematics.

How is the geographical distribution of publications and patterns of relations between countries related to research on learning outcomes in mathematics learning?

The geographical distribution of countries and patterns of relations between countries are seen based on the origin of the authors of published documents related to learning outcomes in mathematics learning from 1992 to 2023.

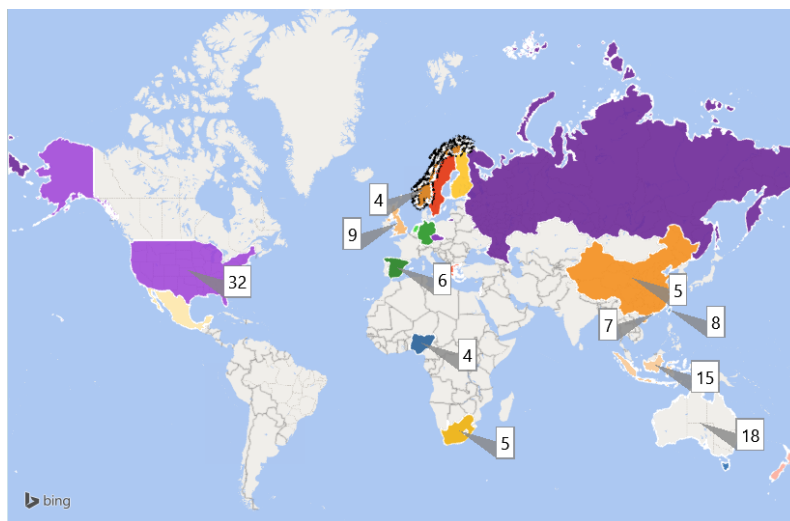


Figure 3. Geographic distribution (TP > 2)

The country with the highest total publications is on the American continent, namely the United States of America with 32 publications, second on the continent of Australia, namely Australia having published 18 documents, followed by countries from the Asian continent, namely Indonesia, with a total of 15 publications. geographic distribution of publications related to learning outcomes in mathematics learning spread over almost all continents, starting from the Americas, Asia, Africa, Australia, and Europe. This means that the United States is a country that has a major impact on research related to this field, this is in accordance with what was conveyed by (Ali, 2018) that the United States is the country that publishes the most articles in the field of mathematics learning.

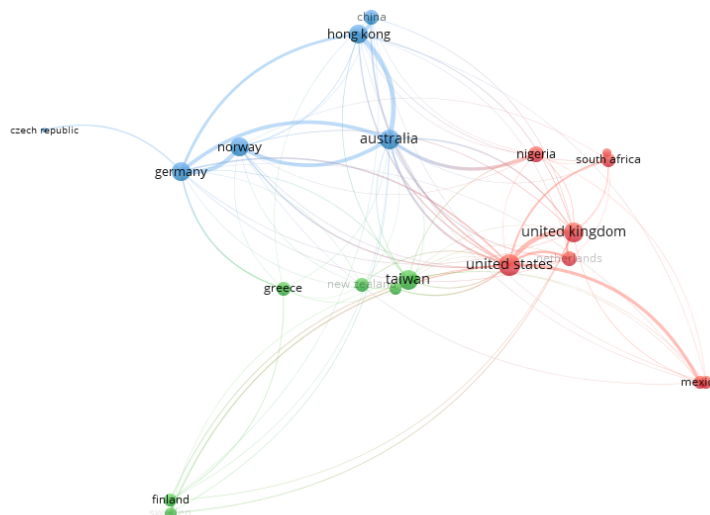


Figure 4. The pattern of relations between countries

Relations between countries can be seen from the number of links, from Figure 4 above the country with the most links is the United States with a total of 16 links. This means that the United States is a country with a high level of cooperation with other countries. Then in the picture it can also be seen based on clusters which are distinguished by the color of the circle. The red circle is the first cluster consisting of 8 countries, meaning that the eight countries form a separate cluster which has been researched jointly with the countries in the cluster. Furthermore, the second cluster is marked with a green circle and the last cluster with a blue circle.

What is the focus of research and novelty related to research on learning outcomes in learning mathematics?

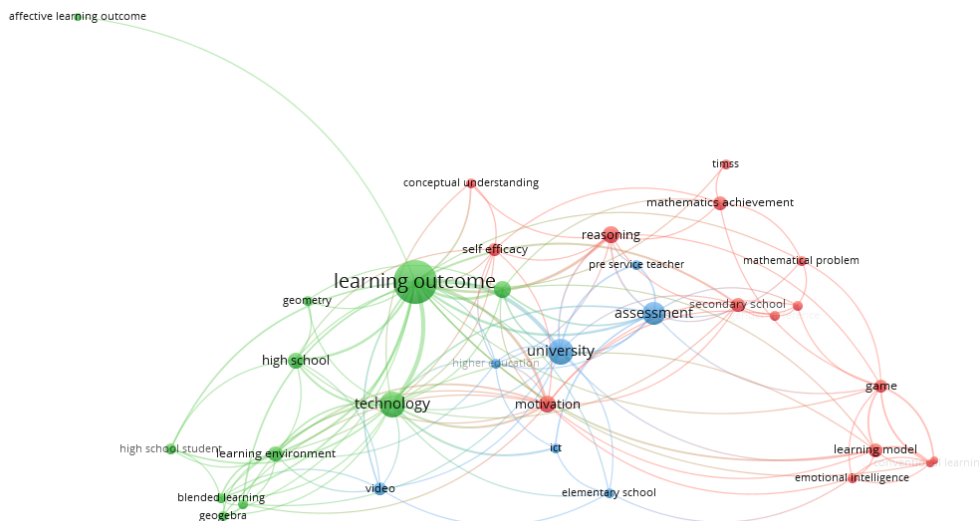


Figure 5. Network Visualization

The total keywords displayed are 33 items. The focus of research on learning outcomes in mathematics learning from 1992 to 2023 is divided into three parts. These three parts can be seen from the color of the circle. The red circle is the largest cluster and is the focus of the first study, followed by green and blue. The largest circle indicates these keywords have been used together frequently. The bigger the occurrence value, the bigger the circle.

The first research focus is the keyword with a red circle consisting of 15 items, the largest circle shows the research focus. In the first research focus, the keywords that have the largest circle are the keywords motivation and reasoning, meaning that these keywords are the focus of the first research. Research conducted by Chien & Chu (2018) which discusses the relationship between motivation and learning outcomes, then the study also explains that students experience problems related to low learning motivation, which causes their mathematics learning outcomes to be low. This research provides an overview of learning motivation with student learning outcomes, especially on learning motivation which can affect learning outcomes in students' mathematics subjects. The advice given by this study for further research is to involve other variables that can affect learning outcomes in mathematics. In addition, further research also needs to involve other high schools of the same level on a wider scale, in order to obtain broader and more complete results.

The second research focus is the keyword with a green circle consisting of 11 items, the largest circle shows the research focus. In the second research focus, the keywords that have the largest circle are learning outcomes, mathematics education, technology and higher school. Because learning outcomes and mathematics education are the themes of this research, the focus of the second research specifically consists of technology and higher school. The use of technology as a medium used in evaluation can affect learning outcomes in mathematics (Nurhikmah et al., 2021). For this reason, further research is needed regarding learning outcomes and technology in learning mathematics.

The third research focus is the keyword with a blue circle consisting of 7 items, the largest circle shows the research focus. In the third research focus, the keywords that have the biggest circles are university and assessment. This means that these keywords are the focus of recent research. Research conducted by Atisnaini and Mustadi (2019) with the population in the study being 3rd semester students of PGMI UIN Sunan Kalijaga Yogyakarta in Indonesia. This research has compared the learning model of Student Teams Achievement Division (STAD) with Numbered Head Together (NHT) on students' mathematics learning outcomes. Research conducted by Antara et al. (2020) has developed an assessment instrument for mathematics learning outcomes based on Higher Order Thinking Skills (HOTS), but by continuing to explore more diverse sources as material for consideration in terms of development for further research.

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