Discovery Learning Research in Mathematics Learning: A Bibliometric Review

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Abstract

Discovery Learning is a learning model that changes learning from teacher-centred learning to student-centred learning so that students learn actively by discovering themselves, investigating themselves and cultivating a scientific attitude. The purpose of this research is to discover the research focus related to Discovery Learning in learning mathematics and its novelty. The method used is bibliometric analysis. The data taken comes from the Scopus database. The study results show increased publications related to Discovery Learning in mathematics learning from 2017 to 2023. The highest citation trend occurred in the 2017 publication, which has been cited 41 times. The country that has had a major impact on Discovery Learning research in mathematics learning is Indonesia. The research focus is divided into three parts, namely, 1) Discovery Learning, Mathematics Learning and student; 2) problem-solving and Indonesia; 3) junior high school and Geometry. New themes in this field are e-learning, teaching and learning, mathematical software, pre-service teachers, and technology.

Keywords: Bibliometric; discovery learning; mathematics learning.

Introduction

Education is very important and can improve the quality of human resources (Qin et al., 2021; Sohilait, 2021; Widiantari et al., 2022). According to (Sudarsana et al., 2019; Widiantari et al., 2021) Education is a conscious effort to create a learning process that can develop students’ self-potential and become human beings with noble character. in improving the quality of education in learning (Choirudin et al., 2021; Sohilait, 2021), educators can apply several learning methods, one of which is by applying Discovery Learning (Mulbar, 2021; Murni, 2017; Wang, 2020). According to (Honomichl & Chen, 2012) Discovery Learning is an important but controversial topic in the fields of psychology, education, and cognitive science. The discovery learning method was first developed by Bruner (Khadijah et al., 2023).

According to (Bruner, 1961), Discovery Learning is a process where students can understand meaning, concepts, and relationships through a process of intuition until finally, they can find a conclusion adapted to their cognitive development. (Bruner, 1961) considers that discovery learning is in accordance with the active search for knowledge by humans and gives the best results. (Bruner, 1961) suggested that students should learn through active participation with concepts and principles so that they are encouraged to gain experience and conduct experiments that allow them to discover the principles themselves. Discovery Learning is a learning model that changes learning from teacher-centred learning to student-centred learning so that students learn actively by discovering themselves, investigating themselves and cultivating a scientific attitude (Donato, 2022; Santiago et al., 2016). Meanwhile, according to (Affandi et al., 2022; and Recio, 2021), the learning model with Discovery Learning is a constructivist learning model that combines learning principles by discovery and radical constructivism with the principles of constructivism learning design theory. Discovery Learning is also interpreted as a series of activities in learning that involve students’ abilities to find systematically (Affandi, 2022; González, 2017; Swandi, 2020), critically and analyze so that they can formulate their own findings covering cognitive, affective and psychomotor aspects (Batubara, 2019; Syarif et al., (Batubara, 2019; Syarif et al., 2020). So, Discovery Learning is a student-centred learning model that involves students’ ability to discover a concept.
Through Discovery learning, students can also learn to think analytically and try to solve problems (Fahmi et al., 2019; Lingile & Payu, 2022; Marta et al., 2022). Meanwhile according to (Sunarsih et al., 2020), through learning Discovery Learning provides opportunities for students to discover a concept through examples found in everyday life (Laila et al., 2023; Sugianto et al., 2017; Vedianty et al., 2023). Discovery Learning is not only able to improve students’ metacognitive abilities but also to improve communication skills and student learning outcomes (Fauza et al., 2022; In’am et al., 2023; Sah et al., 2023). In addition, using discovery learning models also impacts the development students’ creative thinking abilities (Cholly et al., 2023; Hasanah et al., 2022; Sekaryanti et al., 2022). The discovery learning method has six sequences: stimulation, problem identification, data collection, data processing verification and generalization (Angraini et al., 2022; Rizqi et al., 2023; Widodo et al., 2023).

Mathematics is an important knowledge for students to acquire which is useful in solving problems in everyday life (Afriyanti et al., 2018; H Sinambela et al., 2018). Discovery learning is appropriate to be applied to mathematics learning because it has a better influence on learning outcomes (Afriyanti et al., 2018; Mengel-From, 2018). Learning model with Discovery learning for learning mathematics can improve students’ learning achievement in mathematics (Amiyani, 2018; Hudaefi, 2022). Meanwhile according to (Liao, 2016) learning models with Discovery learning can improve problem solving skills, so many researchers are researching related to discovery learning.

Discovery learning research has developed very rapidly in the last decade, Discovery learning research has also produced many findings in various fields of study (Kurniati et al., 2017; Sukma & Supriyono, 2019). Discovery learning research in education has indeed increased in recent years, but not only in education in general, discovery learning research in mathematics learning has also increased in recent years (Pratiwi & Miriam, 2022; Zhang et al., 2023). This means that an increase in research related to discovery learning in education is also followed by an increase in research on discovery learning in education, especially in the field of mathematics. For this reason, it is necessary to apply a statistical method to analyze the results of these studies in knowing the research focus and finding research novelty. One method that can be used in analyzing research in certain studies is using bibliometric analysis.

The purpose of this research is to find out the focus of research related to discovery learning in learning mathematics along with its novelty. Therefore, researchers conducting research on novelty and the focus of research on Discovery learning in learning mathematics with the Scopus database from 2017-2023. The research questions include; (1) how are the publication trends and citation trends related to discovery learning research in mathematics learning?; (2) how is the distribution of publications mappings and relations between countries in research related to discovery learning in mathematics learning?; (3) what are the novelties and research focus on discovery learning in learning mathematics?

Research Method

This study uses a bibliometric analysis method. Publications related to Discovery learning in mathematics learning taken from the Scopus database from 2017 to 2023 were analyzed using descriptive bibliometric analysis. The steps in collecting data are starting from identification, screening, eligibility and inclusion (Moher et al., 2009).

Bibliometric analysis can be used in analyzing publications (Agarwal, 2016; León-Castro, 2021; Liang, 2018). According to (Muhammad et al., 2022) bibliometric is a statistical method that contains a variety of information about research in a particular study. Many research has been using this bibliometric analysis, especially in the educational field (Hidayati et al., 2018; Oh, 2019; Wulandari et al., 2016). In obtaining this information from publications related to discovery learning in mathematics education, a database is needed (Darmayanti et al., 2023a; Gilari Satisunda et al., 2020; Khoir et al., 2018). The research used in this research is derived from the Scopus database.

Research related to this research is like research conducted by (Wicaksono et al., 2021) regarding bibliometric analysis related to research on Discovery learning in general in science education taken from Scopus database publication (Chertow, 2021; Segarra-Saaedra, 2020). The bibliometric analysis presented in this study provides relevant information about the main themes learned about discovery learning in mathematics learning, which can be seen in increasing creativity (Martin-Martin, 2018; Pereira, 2023), learning outcomes, and student achievement in teaching and learning activities at school (Karim & Zoker, 2023; Schabas, 2023; Winson et al., 2023). Therefore, this study suggests that further researchers discuss discovery learning in other fields of science such as mathematics.

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Identification is done by entering keywords according to the research theme you want to study. In this study, research on discovery learning in learning will be discussed. For this reason, the researcher entered the keywords "discovery learning" and "education" in the Scopus database. After entering the keywords, data is obtained for 98 publications according to the specified criteria as shown in figure 2. The data for 98 publications is then checked whether there are duplicate data or not. Because there were no duplicate data, the 98 publications could proceed to the next stage.

Screening is carried out to select publications from the first stage, publications must comply with the following criteria, namely articles published in the form of journals and conference papers and publications in English. After screening, 40 articles were discarded and did not proceed to the next stage. A total of 57 who met the criteria will then be carried out at the eligibility stage.

Eligibility is doing feasibility, titles and abstracts of 57 documents from the previous stage will be seen whether the documents meet the criteria, namely, titles and abstracts contain the words discovery learning and mathematics learning. After eligibility is carried out, 27 publications that meet the criteria are obtained which can be continued at the inclusion stage.

**Data analysis method**

Data obtained from the Scopus database is then stored in 2 different formats, first we save in CSV form and save in RIS form. CSV data will be entered and analyzed and the help of VOSviewer while RIS data will be entered into Harzing’s Publish or Perish Software. The publication trend and trend of research citations of discovery learning in mathematics learning are seen from the year of publication, and the distribution of countries and country relations is seen from the country of origin of the authors which will then be seen by novelty and research focus will be analyzed with the help of the VOSviewer application. Software Microsoft excel and Software Harzing’s Publish or Perish. VOSviewer is used in displaying the visualization of relations between countries, the focus of research. Harzing’s Publish or Perish software is used to calculate h-index and g-index values and other data about citations and Microsoft excel software is used to display country distribution on a world map.

**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 publications were analyzed that is from 2017 to year 2023.

Publications related to discovery learning in mathematics from 2017 to 2023 are separated by year of publication with a total of 27 publications. Number of publications 2020 and year 2021 is the most compared to other years. The trend of publications in this field has increased in several ways year. Publications in recent years have increased viz from 2017 to the year 2021. This thing in accordance with what is conveyed by (Pratiwi & Miriam, 2022; Wicaksono et al., 2021; Zhang et al., 2022) that research related to Discovery Learning is growing rapidly, especially in the field of mathematics. The biggest increase occurred from 2019 to 2020. In 2019 the total published articles were 5 and increased to 7 publications in the following year. Although from 2017 to 2021 total publication Keep going increased, however not in 2022 and in 2023, in the No There is published articles.

**Table 1. Citation Analysis of Publications**

<table>
<thead>
<tr>
<th>Year</th>
<th>TP</th>
<th>NCP</th>
<th>TC</th>
<th>C/P</th>
<th>C/CP</th>
<th>h</th>
<th>g</th>
</tr>
</thead>
<tbody>
<tr>
<td>2023</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2022</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2021</td>
<td>7</td>
<td>2</td>
<td>3</td>
<td>0.43</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2020</td>
<td>7</td>
<td>4</td>
<td>6</td>
<td>0.86</td>
<td>2.75</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>2019</td>
<td>5</td>
<td>4</td>
<td>7</td>
<td>1.40</td>
<td>31</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>2018</td>
<td>4</td>
<td>4</td>
<td>31</td>
<td>2.75</td>
<td>41</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>2017</td>
<td>4</td>
<td>4</td>
<td>41</td>
<td>10.25</td>
<td>41</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

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 publication, h=h-index, g=g-index

Discovery related publications Learning mathematics is analyzed based on the number of citations per year starting from 2017 to 2023. From table 1 above it can be seen that the highest NCP value is in 2017 to 2020 with 4 publications that have been cited at least 1 time out of the total publications in each that year. Meanwhile, the highest total citations were in the 2017 publication with a total of 41 citations. The highest h-index and g-index values were in 2017 with h-index = 4 and g-index = 4. This means that publications in 2017 have had a huge impact on Discovery research Learning in current mathematics learning. In 2017 there were 4...
publications that have been cited which can be seen in table 2 below.

<table>
<thead>
<tr>
<th>No</th>
<th>Author (Year)</th>
<th>Title</th>
<th>Sources</th>
<th>Citation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Ramdhani et al., 2017b)</td>
<td>Discovery Learning with Scientific Approach on Geometry</td>
<td>International Conference on Mathematics and Science Education, ICMScE 2017</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>(Yurniati &amp; Hanum, 2017)</td>
<td>Improving mathematics achievement of Indonesian 5th grade students through guided discovery learning</td>
<td>Journal on Mathematics Education</td>
<td>14</td>
</tr>
<tr>
<td>3</td>
<td>(Kartikaningtyas et al., 2017)</td>
<td>Contextual Approach with Guided Discovery Learning and Brain Based Learning in Geometry Learning</td>
<td>International Conference on Mathematics and Science Education, ICMScE 2017</td>
<td>6</td>
</tr>
</tbody>
</table>

Research conducted by (Ramdhani et al., 2017; Rionanda et al., 2022) entitled “Discovery Learning with Scientific approach on Geometry” gets the highest number of citations, namely 16 times, the article discusses. Publication source from table above can also be used as a reference for researchers who want to publish their articles related to Discovery Learning in learning mathematics like journal “Journal on Mathematics Education”.

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

The geographical distribution of countries and patterns of relations between countries are seen based on the origin of the authors of documents that have been published regarding Discovery Learning in mathematics learning from 2017 to 2023.

Spread geographical from the country of origin writer can seen in Figure 4 above. Countries with the highest total publications are on the continent of Asia, namely Indonesia with 22 publications, second to fifth from the continents of Asia, Africa and Europe, namely Saudi Arabia, Egypt, Switzerland, and Germany having published 1 document each, geographic distribution Discovery-related publications Learning in mathematics learning is spread over almost all continents, starting from the continents of Asia, Africa, and Europe. This means that America and Australia have not there is an article published related field this. Viewed from amount the citation publication from Indonesian state writers became the most with 62 times cited. America and Australia have not published an article yet, this does not mean that these two continents do not apply the discovery learning model in mathematics learning. it’s just that these two continents are not included in the continents that publish articles on the Scopus database about discovery learning, especially in mathematics from 2017 to 2023. Indonesia is a country that has a big impact on research related to this field, this is in accordance with what was conveyed by (Darmayanti et al., 2023b; Pratiwi & Miriam, 2022) that Indonesia is one of them countries that publish the most related articles Discovery Learning in learning mathematics.

On the picture on seen that only There is three countries, meaning two other countries No including into the signifying image both countries no own cooperation relations with other countries. Relations between countries can be seen from the number of links, from Figure 5 on seen that the three countries mutually related. This means that Indonesia, Germany and Switzerland are countries with a level of cooperation equivalent. Then n on the image can also be seen only there is One color that is red, meaning only there is one cluster because the number of countries of course No many.

What is the focus of research and novelty related to Discovery research Learning in learning mathematics?
Keywords used shared by the author can be seen in Figure 6 above. The total keywords displayed are 35 items. Discovery's research focus Learning in mathematics learning from 2017 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 keywords with a red circle consisting of 18 items, the largest circle shows the research focus. In the first research focus, the keyword that has the largest circle is the Discovery keyword Learning, Mathematics Learning and student, meaning that these keywords are the focus of the first research. Discovery Learning and Mathematics Learning indeed become theme on research this. Research conducted by (Roza et al., 2018) which discusses the practicality of Discovery based mathematics learning devices Learning for the topic of sequence and subsequent series, the research also explains that learning uses Discovery learning not only enhances student learning, but also decreases their chances of leaving the learning process at an early stage. It means study furthermore can choose other material with device learning certain.

The second research focus is the keywords with a green circle consisting of 10 items, the largest circle shows the focus of the research. In the second research focus, the keywords that have the largest circle are problem solving and Indonesia. This means that these keywords are the focus of the second research. This in accordance with spread geographic in figure 4, that the country of Indonesia is a country with publication the most related field this, by No direct Most research conducted is at in Indonesia. Research conducted by (Herdiana et al., 2017) which discusses about influence method learning invention to mathematics ability analogy junior high school students. Study mentioned suggest that research furthermore before use method discovery, the teacher should identify ability student. this aim for create condition Where high and medium students will help low students.

Third focus study This can be used as a reference for future researchers who want to take a theme in accordance with this field. Furthermore will seen novelty and theme new related study Discovery Learning in learning mathematics from 2017 to year 2023.

![Network Visualization](image1)

**Figure 6. Network Visualization**

![Overlays Visualization](image2)

**Figure 7. Overlays Visualization**

Novelty research related to Discovery Learning in mathematics learning from 2017 to 2023 can be seen from the links between keywords and the color of the keyword circles displayed from the overlay visualization in figure 7 above. In looking at novelty, researchers focus on 2 categories, namely keywords that are the focus of research and keywords that become new themes. The new themes are indicated by a yellow circle, such as e-learning, teaching.
and learning, mathematical software, pre-service teacher, and technology. This means that these keywords have only been used together in the last few years. Theme This new research can be used as a reference for future researchers who want to take a theme in accordance with this field. Key words of discovery learning together with mathematics learning is not directly connected with the theme keywords new such as, mathematical software, pre service teacher, and technology. The relationship between these keywords can be used as a research novelty related to Discovery Learning in mathematics learning that is useful for further research.

Conclusion

Based on the results and discussion above it can be concluded that the increase in publications regarding Discovery Learning in learning mathematics is from 2017 years up to 2023. The most citation trend occurred in the 2017 publication which has been cited 41 times. Countries that have had a major impact on Discovery research Learning in learning mathematics is the country of Indonesia. The research focus is divided into three parts, namely, 1) Discovery Learning, Mathematics Learning and students; 2) problem solving and Indonesia; 3) junior high school and Geometry. New themes in this field are e-learning, teaching and learning, mathematical software, pre-service teacher, and technology. Key words of discovery learning together with mathematics learning is not directly connected with the theme keywords new such as, mathematical software, pre service teacher, and technology.

The research focus that has been discussed in this paper can be used as a reference for future researchers who wish to take a theme in accordance with this field. The relationship between these keywords can be used as a research novelty related to Discovery Learning in mathematics learning that is useful for further research. Researchers can also search for data with sources from other databases such as WoS, Google scholars and others.

Reference


