Research Trends of Discovery Learning from 2015 to 2019: A Bibliometric Analysis

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Abstract. Discovery learning is an alternative learning model that can improve the science learning process. Discovery learning research has developed rapidly in recent years. Discovery learning research has produced many theoretical and empirical findings. Many trends and problems have emerged, highlighting the complexities and dynamics of research in discovery learning. Therefore, this study aims to determine current trends regarding discovery learning. This study used a bibliometric analysis approach based on the Scopus database. Based on the title, abstract, and keywords, this research succeeded in obtaining 634 documents from 2015 to 2019 for further study. This study uses bibliometric standards as a measure to report research results such as year of publication, country/territory of publication, type of document, type of source, subject area, author, affiliation, keyword analysis, and author collaboration analysis. The results showed that the publication of discovery learning has increased significantly since 2015, although it had decreased in 2017. The increase in the number of discovery learning research shows the importance of applying discovery learning in the learning process. The implications of this research for the development of discovery learning in a variety of frameworks, although much discovery learning research has been conducted.

1. Introduction

One learning approach that has the potential to be applied in science learning is the scientific approach. The scientific approach is a connecting bridge in the development and development of attitudes, skills, and knowledge. This scientific approach is appropriate to use in science learning because it is a student-centered learning approach and at the same time, the learning process meets scientific criteria \cite{1}, \cite{2}. The application of the scientific approach can use several learning models, one of which is the discovery learning model. The learning theory which is the basis of the discovery learning model is constructivist. Constructivist theory in discovery learning shows that the main focus of this theory is more on students in the learning process than on educators. The theory believes that students who interact with various objects and events will acquire and understand patterns of handling these objects and events \cite{3}, \cite{4}.

Discovery learning model is a model that allows students to find new ideas without the need to memorize what the educator teaches \cite{5}, \cite{6}. Discovery learning provides the concept that in the learning process students are trained to find concepts or theories related to the material being taught \cite{7}, \cite{8}. Students build their knowledge by conducting experiments to find principles from these experiments in discovery learning \cite{9}, \cite{10}. Discovery learning leads learners to build knowledge based on new information and data collected by them in an exploratory learning environment \cite{11}, \cite{12}. Discovery learning in science learning is important as meaningful and lifelong learning. Discovery learning occurs...
when individuals are involved, especially in the use of mental processes to discover some concepts and principles. Discovery learning encourages students to build and create relationships between their knowledge and their application in everyday life [13]. Discovery is done through observation, classification, measurement, prediction, determination, and inferior. This process is called the cognitive process, while discovery itself is the mental process of assimilative concepts and principles in the mind [14].

Discovery learning has several advantages, namely 1) the knowledge gained is long-lasting or long to remember or easier to remember; 2) the results of discovery learning have a better transfer effect, in other words, the concepts and principles that are owned by students are easier to apply to new situations; 3) thoroughly discovery learning improves students' reasoning and ability to think freely; 4) specifically, discovery learning trains students' cognitive skills to find and solve problems without the help of others; 5) discovery learning arouses students' curiosity, motivates to work continuously until they find answers; and 6) discovery learning trains students to analyze and manipulate information, not just accepting it [15]. Discovery learning accommodates students in assimilating a concept consisting of observing, hypothesizing, explaining, measuring, and concluding [16].

In recent years there has been a lot of literature on discovery learning with a variety of research methods, but there is no literature based on bibliometric analysis as a whole published in Scopus indexed journals. With the large number of articles related to discovery learning published in the world, it is necessary to adopt a method that contains a statistical basis from all available scientific literature so that it can evaluate the current status of research and the contribution of researchers at each university in various fields of science that allows new research roadmaps to emerge. Bibliometric analysis can be used to see the distribution of the number of publications and citations of various scientific documents [17]. In this regard, the study includes indicators such as scientific activity parameters, the identification of research groups and authors, citations of published publications, consumption of information, impact factors, h-index, among others [18].

The arrangement of this article includes several parts, namely the second part explaining the data collection process and the techniques used in this article. The results of the bibliometric analysis as a whole are summarized in the third section. The last section of the article discusses the findings of the study. The main objectives of this study are to better understand the quantity and visual aspects of the current literature and to obtain reliable results for future learning research findings and research trends. The use of bibliometric analysis to visualize and map discovery learning research is still very rare, so this research is important. This study aims to analyze comprehensive research that focuses on bibliometric analysis and information mapping with the help of the Scopus database and VOSviewer.

2. Methods

Bibliometric techniques were first used by information scientists to study the growth and dissemination of reported scientific articles [19], [20]. Bibliometrics is a method of measuring documents using statistical methods, including the application of quantitative analysis [21], [22]. Bibliometric mapping will help turn publication metadata into maps or visualizations, which will benefit the scientific community and the public so that it is easier to manage and process into more useful insights, for example, keyword visualization to identify research topics or clusters in multiple disciplines, map authors from specific journals to identify the geographic coverage of authors and journals as well as a map of institutional cooperation, international cooperation as part of the framework for identifying new technologies [23]. Bibliometric analysis is also called scientometrics which is part of the research evaluation methodology, research methods are extracted from various documents so that a separate method can be used for bibliometric analysis [24]. The bibliometric approach will allow you to identify possible technological patterns or research directions using author keywords, title keywords, and keywords plus [25].

The research results are evaluated based on the experience of the journal growth. The following keywords have been used to scan articles related to discovery learning. We focus on the title of the article because it is a specific topic and very important for the field of research and the purpose of the
report. The search was conducted in July 2020. We got several results from Scopus, such as author, title, abstract, country/territory, citation, author affiliation, and references. Based on our search we have obtained 634 documents that match our keywords. Documents compiled from Scopus, classified in Conference Papers (130) and Articles (504).

This article describes various outcome indicators for bibliometric analysis. Bibliometric analysis, or scientometric is a field of research that aims to explore the latest literary developments that provide direction and motivation for further research. A complete record of the number of publications from the source. A complete citation of the number of citations obtained by this publication. Citation documents are used to evaluate the number of citations obtained divided by the number of publications. The bibliometric approach used in this study uses modern technology in the fields of information engineering, database management, and statistics. A bibliometric approach was used to empirically and visually analyze discovery learning research from 2015 to 2019, combined with the VOSviewer software.

3. Results and Discussion

Bibliometric results for different performance indicators have been shown in this section, including documents by year, documents by country/territory, documents by author, documents by affiliation, documents by subject area, keyword co-occurrences analysis, and author collaboration analysis.

3.1. Research Growth and Geographical Distribution

Discovery learning was published in Scopus in 2015 with 105 documents, rising to 116 documents in 2016 and decreasing to 109 documents in 2017. In 2018, an exponential increase in the publication of discovery learning began (see Figure 1). In 2019, the highest number of publications was 168. From year to year, the number of these publications increased significantly, although it decreased in 2017. A total of 53 countries contributed to the publishing of discovery learning, where Figure 2 was sponsored by the top 10 countries. Countries are determined based on the author's affiliation. The 10 most active countries are represented in Figure 2. In Figure 2, with 307 documents, the United States is the largest contributor. For both the second and third positions, Indonesia and the United Kingdom each contributed 114 documents and 34 documents. Australia and Germany each contributed 25 documents and 21 documents to the fourth and fifth documents, respectively.

![Figure 1. Research Growth from Discovery Learning](image-url)
3.2. Subject Area and Affiliation

This section is analyzed by classifying published documents by subject area as shown in figure 3. The delivery of discovery learning research mostly came from Social Sciences (41.5%), Chemistry (31.9%), Physics and Astronomy (6.6%), Computer Science (4.4%), Engineering (3.4%), Psychology (2.0%), Business, Management and Accounting (1.7%), Arts and Humanities (1.5%), Medicine (1.2%), Mathematics (0.9%), and Other (4.8%) can be seen in Figure 3.

We also evaluate documents based on the top 10 affiliates. Most of the discovery learning studies came from Universitas Negeri Padang (18 documents), Universitas Sebelas Maret (15 documents),
Miami University (12 documents), Universitas Negeri Yogyakarta and Universitas Pendidikan Indonesia (9 documents), University of Wisconsin-Madison, and Universitas Jember (7 documents), Purdue University, The University of Sydney, and the University of California, Los Angeles (6 documents). Clearly, documents by affiliation are shown in Figure 4.

3.3. Author of The Most Documents

The authors with the most documents from the Scopus database were extracted and sorted by many discovery learning publications. The author with the most documents is Bretz, S.L., and Yezierski, E.J. with 6 documents. Next is followed by Sajidan with 5 documents. Meanwhile, the other authors only had 3 documents. More clearly, it can be seen in Figure 5.

3.4. Keyword Co-occurrences Analysis

Author's keyword analysis for co-occurrences using VOSviewer software. Coexistence keywords can effectively reflect research hotspots in the scientific field and provide additional support for scientific research [26]. This analysis aims to analyze the content, patterns, and trends of a collection of documents by measuring the strength of terms and to calculate the number of keywords from a research document that appears simultaneously in the articles studied [23], [27]. VOSviewer has the advantage of displaying a bibliometric map that is comprehensive and easy to interpret [28], [29]. The size of the circle is positively correlated with the appearance of the keyword in the title and abstract. Therefore, the
size of the product label and circle depends on the weight of the item. The heavier the item, the larger the item's label and circle [30]. The distance between the two points reflects the strength of the two points. Generally, the shorter the distance, the stronger the relationship. A line between two keywords means they appear together [31]. The result from the connection strength between two nodes refers to how often they occur together. The relationship between the two nodes can be displayed as a quantitative indicator [32]. Figure 6 shows the visualization of the most influential keywords used by Scopus authors. In all publications related to discovery learning, we have 47 keywords at a time. Related keywords (such as keywords displayed in the same color) are usually supplied together. Figure 6 shows that discovery learning, critical thinking, development model, learning model, and student are closely related and often occur together.

Figure 6. Keywords Co-occurrences Network Visualization

VOSviewer can display density visualizations (see Figure 6). Each node on the keyword density visualization board has a color, depending on the density of the items in that node. In other words, the color of the nodes depends on the number of objects in the node environment. Keywords appear more frequently in the red area; conversely, keywords appear less frequently in green areas [31]. Figure 6 visually shows the focus of the study. Discovery learning, critical thinking, development model, learning model, and student are the keywords.

Figure 7. Keywords Co-occurrences Density Visualization
3.5. Author Collaboration Analysis

In the context of research, considering that research is not always carried out individually, collaborative writing is required [33]. Therefore, in terms of ideas, funds, facilities, and equipment, as well as opportunities to share certain knowledge, expertise, and technology, cooperation between researchers and institutions is required. This study shows that 7 authors have a strong association. Each author has a different link. The author with the most links is Bretz, S. L., and Yezierski, E. J. Clearly, see Figure 8.

![Figure 8. Author Collaboration Network Visualization](image)

4. Conclusion

This research analyzes various academic articles on discovery learning published from 2015 to 2019. This study uses selected bibliometric indicators to prove previous research models with the help of the Scopus database. In total, 634 documents of bibliometric information were extracted from the Scopus database. The results show that the trend of discovery learning research began in 2015, decreased in 2017, then increased exponentially in 2018. The United States is the largest contributor to discovery learning research publications, followed by Indonesia and the United Kingdom. Discovery learning phenomena are primarily related to Social Sciences, Chemistry, Physics and Astronomy, Computer Science, dan Engineering. However, other subjects have also published articles, such as Psychology, Business, Management and Accounting, Arts and Humanities, Medicine, and Mathematics. Universitas Negeri Padang published the largest number of contributors, followed by Universitas Sebelas Maret and Miami University. Keywords Co-occurrences Network Visualization shows that discovery learning, critical thinking, development model, learning model, and student are closely related and often occur together. Author Collaboration Network Visualization shows that the author with the most links is Bretz, S. L., and Yezierski, E. J.

Regardless of the benefits provided in this article, researchers have to consider many drawbacks. The drawback of this research is that it uses special keywords to find the initial list of academic articles indexed by Scopus. However, this method is very common in previous bibliometric studies. Although Scopus is one of the largest online databases listing all scientific articles, Scopus is unable to cover all available sources. Additionally, there is no 100% perfect search query for aggregating all academic articles in a related field. Despite these limitations, this work illustrates the knowledge of phenomena about current trends in the scientific literature on discovery learning.

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