Bibliometric Analysis of Articles Related Misconception in Biology by Country and Journal[¶]

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Abstract*: The aim of this study is to reveal the content analysis and trends of studies on misconceptions in biology education. Within the scope of the research, articles containing misconceptions about biology were accessed from the Scopus database. "Biology and misconception" was searched in the title, abstract and keywords in the Scopus database on September 13, 2022. A total of 410 publications about misconceptions in biology education were found in the search. The years of accessed publications were determined between 1970 and 2022. A total of 410 publications were analyzed in the research, regardless of language. According to the data obtained, 53 countries and 143 journals published articles on misconceptions in biology. However, in order to obtain clearer data, 3 articles were determined as the minimum number of articles for a country, and 31 countries and 27 journals were considered in this research. According to this research, in terms of the number of documents, the USA is the most published country with 199 articles, and Turkey is the second most published country with 39 studies. It was also revealed that the most cited countries were the United States, Australia and the United Kingdom, respectively. "CBE Life Sciences Education" and "American Biology Teacher" journals were determined as the journals with the most publications on the subject. In addition, Journal of Research in Science Teaching, CBE Life Sciences Education, International Journal of Science Education, Journal of Biological Education, Evolution: Education and Outreach were identified as the most cited journals in the studies. The results of this study are thought to be important for the future development of studies on misconceptions in biology education. Regarding the results obtained from the research; Different indexes can be used in future studies, and other types of publications such as theses, conference proceedings or books can be used in analyses.*

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Introduction

ONE OF THE main purposes of biology education is to ensure that students understand and apply concepts in biology subjects correctly. For this reason, before teaching biology subjects, it is necessary to reveal the concepts that students have about the subject. Because students learn some science concepts from previous teaching processes or have prior knowledge from observations in their lives. Students bring this prior knowledge with them when they attend science classes for the first time, and research on students' prior knowledge revealed that they have misconceptions about many biology concepts (Yağbasan & Gülçiçek, 2003). Students' misconceptions about science are one of the important issues brought up by academic studies (Riche, 2000).

Misconceptions are a problematic issue for students and teachers in science education. This may be due to the abstract nature of science subjects (Ayas et al., 2003; Keleş & Kefeli, 2010). In order for biology teaching to be effective with the developed strategies, students' misconceptions regarding science concepts must first be identified and eliminated. As a result, many researchers have focused on detecting and eliminating students' misconceptions (Riche, 2000). Considering that misconceptions are an educational problem, it is thought that the results of a study in which articles published in peer-reviewed journals on misconceptions in biology education are examined in terms of many criteria will provide important information to researchers and academicians, as in other branches of science. Studies conducted in the field of biology education, such as, aim to reveal the current trends in the field, to determine which subjects are satisfied or what kind of new research is needed, and thus to increase the quality of education (Karamustafaoğlu, 2009; Şimşek et al. 2008). In addition, research and published scientific articles guide new researchers about what previous research is (Henson, 2001; Tsai & Wen, 2005). Because people doing research should first seek answers to the questions "what are the previous studies in the literature?", "what topics and problems will need to be studied" and "what are the ways to meet these needs and how can they be done?" (Karamustafaoğlu, 2009; Şimşek. et al., 2008). It is important to examine research in the field of biology education at regular intervals to determine the trends of these studies and ultimately to shed light on researchers who want to work in science education (Çiltaş et al., 2012). This situation makes it necessary to examine these studies with content analysis (Gül & Özay Köse, 2018). Within the framework of the stated reason, this study aims to identify research articles published in peer-reviewed journals published in different countries regarding misconceptions in the field of biology education and to examine these studies in terms of certain criteria. In addition, this study is important in terms of guiding studies on misconceptions in biology education and design-

ing more comprehensive new studies. In this context, the articles scanned in the Scopus database were subjected to bibliometric network analysis. Bibliometric analysis is a method that provides the most accurate data about the historical development and trends of a subject in the literature and helps researchers who want to study in the relevant literature where to start (Özay, 2022). With bibliometric analysis, various features of academic publications are evaluated using quantitative analysis. In this way, it is possible to create a general framework for a particular discipline by examining the statistical data of the studies such as author, subject, cited studies and authors (Akcan et al., 2023; Çetinkaya Bozkurt & Çetin, 2016).

When the literature is examined, bibliometric analysis has been applied by many researchers from different disciplines to detect trends in research (Azer, 2017; Çelik et al., 2021; Çetinkaya Bozkurt & Çetin, 2016; Karagöz & Ardıç, 2019; Kulak 2018; Kulak & Çetinkaya 2018; Kumar et al. , 2021; Moral-Muñoz et al., 2020; Polat et al., 2013; Zhang et al., 2022).

The aim of this study is to reveal the content analysis and trends of studies on misconceptions in biology education. The bibliometric analysis used in the research was conducted to find answers to the questions given below.

- What is the distribution of countries where studies on misconceptions in the field of biology education are carried out?
- What is the distribution of journals in which studies on misconceptions are conducted in the field of biology education?

Method

This research is a compilation study and a descriptive research design was followed. Descriptive research is conducted to identify and explain current and experienced situations (Karasar, 2009). The bibliometric method was chosen to discover the countries and journals that publish the most in hundreds of misconception studies conducted in biology education. Bibliometric analysis is a method that provides the most accurate data about the historical development and trends of a subject in the literature and helps researchers who want to study in the relevant literature where to start (Özay, 2022). This method was preferred because hundreds or even thousands of studies are analyzed in depth with the bibliometric method and the visual mapping technique for the research field is given with graphic descriptions (Zupic & Cater, 2015).

Data Collection Process

Within the scope of the research, articles containing misconceptions about biology were accessed from the Scopus database. Scopus is an Elsevier or-

ganization that hosts many journals from many publishers, providing summaries, citations, full documents to the user, and also includes author attributes (Özgirgin, 2010). In addition, Scopus is a heterogeneous database that makes publications from many sources available to researchers (Ramalho et al., 2020). The reason for using the Scopus database instead of Web of Science or Google Scholar for bibliometric analysis is that the Scopus database is the largest database in the literature, produces information with better decisions and results, and bibliometric studies are comprehensive in fields such as technology, science, art, medicine and social sciences, and is more preferred because it provides a broad perspective (Ekinci & Özsaatçi 2023; Işın, 2022; Mart ń et al., 2018).

First of all, the "Article Title, Abstract, Keywords" section was selected in order to get the most results from the "Search" button in the Scopus database. Then, a search was made by typing "biology and misconception" in the "search document" section of Scopus. The reason why it is searched this way is; Misconception is expressed in different ways by different scientists in the literature (G ülev, 2008; Helm, 1980; Sutton, 1980). For example; According to Novak (1977), prejudices, pre-concepts, erroneous ideas, alternative frameworks are in the form of pure concepts, intuitive or internal concepts, and alternative interpretations. Although these terms generally express the same concept, the term misconception is used more in the literature. For this reason, the term "biology and misconception" was preferred when searching. Therefore, the limitation of this study is that the research was conducted only in the form of "biology and misconception". As a result of the search, 751 publications were found. However, since not all of these publications were related to misconceptions in biology education, the "Social Sciences" section was selected from the "Subject Area" section of Scopus and a filter was made, and a total of 410 publications regarding misconceptions in biology education were reached. The searches were made on September 13, 2022. Since the years of the accessed publications started in 1970, studies between 1970 and 2022 were included in the research. No language discrimination was made in the research. The publications were then exported to CSV form and then subjected to bibliometric analysis using VOSviewer (Visualization of Similarities) Software.

Data Analysis

Bibliometrics is a measurement method used to describe and analyze the progress of a particular discipline or a particular field of research, using computer technology to display the results of visual literature analysis in a simple and clear graph (He et al., 2022; Merig ó et al., 2015). Bibliometric network analysis used in the bibliometric method is an approach technique used in the context of analyzing the relationships between research subjects,

authors and institutions within a discipline and showing and interpreting how these relationships are (Buonocore et al., 2018; Taddeo et al., 2019). The reason why bibliometric network analysis was preferred as the method in the study is that the holistic and temporal plane, which is difficult to understand due to the continuous cumulative development of the literature on misconceptions in biology, will be summarized in an understandable way. Another reason for using bibliometric network analysis in the study is that scientific research is determined by visualizing the relationships between certain topics, journals, authors, institutions or countries (Van Eck & Waltman, 2010).

VOSviewer is the software that can be used in mapping for bibliometric data analysis (Al Husaeni & Nandiyanto, 2022; Al Husaeni et al., 2023; Hamidah et al., 2020; Mulyawati & Ramazan, 2021). This software allows collecting the literature efficiently and establishing mutual relationships between selected publications within the options (Kuzior & Sira, 2022). VOSviewer software visualizes bibliometric networks for easier analysis. With the VOSviewer program, analysis of certain subject areas, analyzes to determine word density in studies, content analysis of websites, analysis of theses and co-authorship, and detection of relevant words in the field can be provided. At the same time, detecting meaningful relationships in big data can be made more possible (Artsın, 2020). In this research, VOSviewer v.1.61 (Centre for Science and Technology Studies) program was used for bibliometric analysis of 410 publications.

Findings and Discussion

Country Analysis: Countries where Articles are Published Most

Country analysis was conducted to reveal the spatial distribution of publications. According to the data obtained, 53 countries have published articles on misconceptions in biology education. However, in order to obtain clearer data, the minimum number of articles for a country was determined as 3 articles and 31 countries were considered. For each of the 31 countries, the total strength of co-authorship affiliations with other countries was calculated (**Table 1**).

According to **Table 1**, the USA is the country that publishes the most with 199 articles, and Turkey is the second most productive country with 39 studies. This can be considered as an indicator that the USA attaches importance to studies in the field of biology education. Abdullah (2022) stated in his research that the USA has been the country with the most publications in biology education for 63 years. As a result of examining the articles published in the field of science education in their study, Yurdakul and

Table 1. Countries Publishing the Most Articles.

Country	Documents	Citations	Citations Per Document	Total Link Power
United States of America	199	4,632	23.3	20
Turkey	39	295	7.6	0
United Kingdom	28	433	15.5	3
Canada	17	432	25.4	7
Germany	15	162	10.8	3
Australia	14	994	71.0	4
Indonesia	12	67	5.6	2
Brazil	6	27	4.5	0
Greece	6	28	4.7	1
Malaysia	6	26	4.3	3
Israel	6	107	17.8	3
Singapore	5	148	29.6	2
South Africa	5	39	7.8	0
Argentina	4	62	15.5	1
Chile	4	50	12.5	2
Hong Kong	4	111	27.8	0
Portugal	4	60	15.0	0
Slovenia	4	7	1.8	0
Thailand	4	10	2.5	1
Chinese	3	8	2.7	1
Czech Republic	3	6	2.0	1
Denmark	3	146	48.7	4
France	3	2	0.7	0
Holland	3	4	1.3	1
Nigeria	3	85	28.3	1
Slovakia	3	8	2.7	1
Spain	3	12	4.0	0
Sweden	3	19	6.3	2
Switzerland	3	26	8.7	1
Taiwan	3	88	29.3	0
India	3	47	15.7	0

Bozdoğan (2022) stated that the USA is the most active country in this field and that the USA hosts 40% of the articles published in this field. As emphasized in the Demir and Çelik (2020) study, it is stated that the USA plays a key role in the development of scientific relations and communication in the international arena and acts as a bridge. It is seen that Turkey is the second most productive country with 39 studies. Similarly, Yurdakul and Bozdoğan (2022) stated in their study that Turkey is the second most active country within the scope of articles published in the field of science education. However, total citations of documents by country are also given. In this study, it

is seen that the United States ranks first with 4,632 citations and Australia ranks second with 994 citations. These countries are followed by the United Kingdom with 433 citations and Canada with 432 citations. Developed countries place significant emphasis on science education and continually strive to enhance and update their science teaching programs, recognizing that every success achieved in education is vital for the future development and competitiveness of their societies (Yavuz Topaloğlu & Balkan Kıyıcı, 2015). In the study of Orhan and Aydın (2022), according to the results obtained by a similar analysis, it was determined that the country with the most publications was the United States of America and it was stated that this country was followed by Turkey.

The study also determined which countries researchers took part in joint studies. It has been determined that the USA is the country with which we cooperate the most and that Turkey does not have co-authored studies with different countries on this subject (**Figure 1**). Contributing countries appear in the analysis in a single row around the circle. A high betweenness value of a node in the network indicates that it has the most impact on the relationships within the cluster (Demirgil, 2018). It can be seen that the USA is at the center and its most important partners are the United Kingdom, Canada and Argentina. It is seen that the USA is included in the network structure where different countries are connected to each other and plays an intermediary role between countries. In addition, according to the time trend of the country analysis, studies conducted in recent years have found that the USA is in cooperation with Indonesia (**Figure 2**).

Journal Analysis: Most Popular Journals on Misconceptions in Biology

In order to determine the journals with the most publications based on the articles obtained, journals with at least 3 publications on the subject were selected. 27 out of a total of 143 journals meet the relevant threshold (**Table 2**).

According to **Table.2**, "*Cbe Life Sciences Education*" and "*American Biology Teacher*" were determined as the journals with the most publications (41 articles) on the subject. Additionally, citation analysis of the journals with the most publications was conducted. Accordingly, *Journal of Research in Science Teaching* (23 articles, 1,314 citations), *Cbe Life Sciences Education* (41 articles, 1,206 citations), *International Journal of Science Education* (15 articles, 742 citations), *Journal of Biological Education* (35 articles, 1,206 citations). 721 citations), *Evolution: Education and Outreach* (31 articles, 673 citations) were the most cited journals in the studies. When the citations received by the publications in the mentioned journals are examined, it is seen that a few journals stand out. For example, *Journal of Research in*
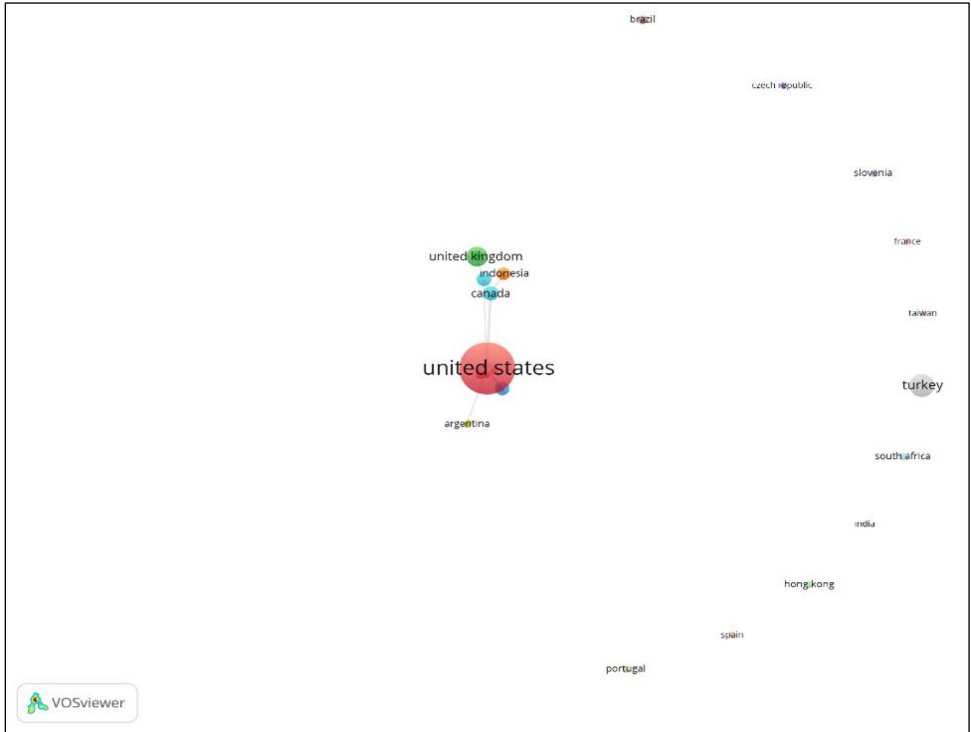
Figure 1. Cooperation between Countries.

Figure 2. Temporal Trend of Clusters.

Table 2. Most Popular Journals on Misconceptions in Biology.

Journal	Documents	Citations	Total Link Power
American Biology Teacher	41	311	46
Cbe Life Sciences Education	41	1206	115
Journal of Biological Education	35	721	83
Evolution: Education and Outreach	31	673	86
Journal of Research in Science Teaching	23	1314	99
International Journal of Science Education	15	742	50
Research in Science Education	10	134	15
Journal of Baltic Science Education	7	35	16
Science Education	6	594	44
Asia-Pacific Forum on Science Learning and Teaching	5	3	1
Education Sciences	5	41	8
Energy Education Science and Technology Part B: Social and Educational Studies	5	21	5
Science and Education	5	35	16
Bioscene	4	11	3
Cell Biology Education	4	176	14
Journal of Science Teacher Education	4	193	27
Jurnal Pendidikan Ipa Indonesia	4	50	3
Procedia - Social and Behavioral Sciences	4	68	2
Computers and Education	3	81	6
Journal of Geoscience Education	3	30	0
Journal of Microbiology and Biology Education	3	4	1
Journal of Science Education	3	8	10
Journal of Science Education and Technology	3	60	6
Research in Science and Technological Education	3	80	4
Zygon	3	8	0
International Journal of Science and Mathematics Education	3	92	11
International Journal of Innovation in Science and Mathematics Education	3	5	7

Science Teaching (1,314) is in the middle of the list in terms of the number of publications, but it ranks first in terms of the number of citations. When we look at the journal "*American Biology Teacher*", we see that the journal, which publishes a large number of articles (41) and has high link strength, receives very few citations per article. As a matter of fact, a similar situation is seen in some other journals. This may provide guiding information regarding journal selection for future biology education researchers. In addition, according to this research, "*Cbe Life Sciences Education*" journal stands out as the journal with the highest link strength (115) among all journals.

Looking at the figure created with VOSviewer, it can be seen that the most cited journals are grouped around 8 clusters (**Figure 3**) and in **Figure 4**, according to time, it can be seen that the "*Science and Education*" has been
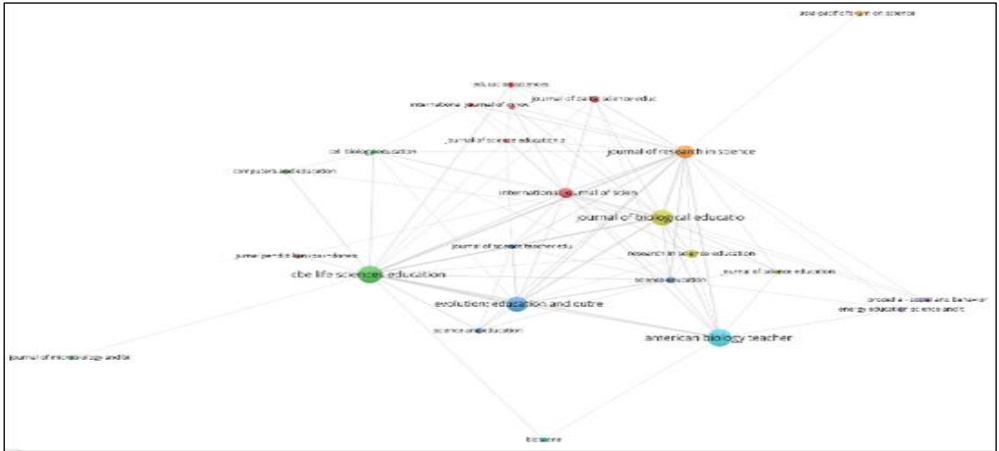
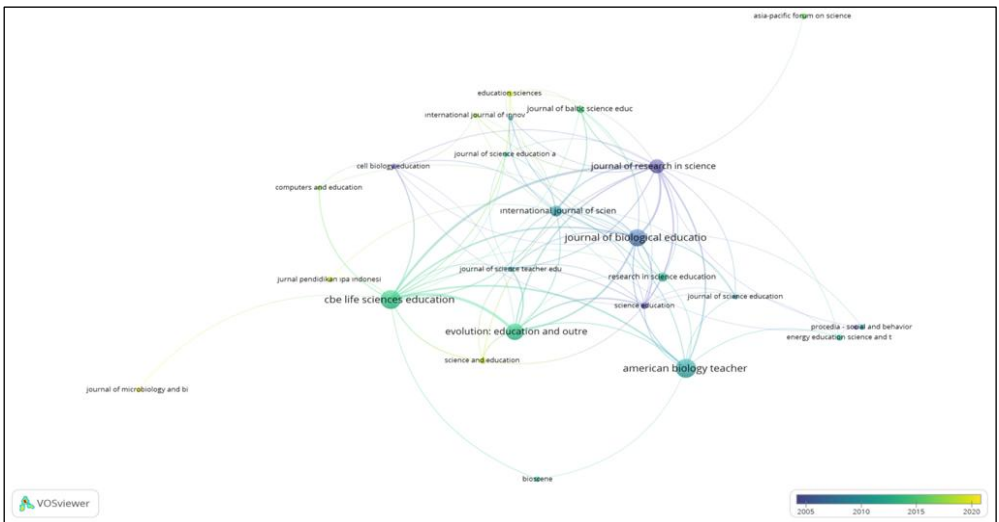**Figure 3. Most Cited Journal Clusters (Co-Citation Analysis).**

Figure 4. Temporal Trend of Clusters.

preferred by researchers in recent years. There also appear to be many connections between the clusters. Here, the fact that a node has many connections with other nodes can ensure that it has a central position in the cluster. When the social network is examined, it is seen that the relationships are mostly tied up through magazines such as "*Journal of Biological Education*", "*American Biology Teacher*" and "*Journal of Research in Science Teaching*". This shows that these journals have a very important position in the network. Similar to our study, Orhan and Aydın (2022) stated in their study that, as a

result of examining articles on science (science, physics, chemistry, biology) and mathematics education, the most cited journal was "*Journal of Resource in Science Teaching*". It can be said that academics have recently shown increasing interest in the research in these journals, the journals have influential publications in their field and therefore have an influential position in the sector. The choice of these journals shows that journals with content directly related to the field of study attract attention. Therefore, it can be said that these journals are alternative journals for future research in this field.

Conclusion and Recommendations

In this study, studies on misconceptions in biology education are included. Bibliometric analyzes of published studies were conducted using country and journal parameters. The data set used in this study was created based on 410 works indexed in the Scopus database between 1970 and 2022. In this respect, the study is considered to be the study with the most comprehensive data set, aiming to reveal the general situation regarding misconceptions in the literature.

According to the results obtained, it was revealed that the most cited countries were the United States, Australia and the United Kingdom, respectively. *Journal of Research in Science Teaching*, *CBE Life Sciences Education*, *International Journal of Science Education*, *Journal of Biological Education*, *Evolution: Education and Outreach* were identified as the most cited journals in the studies. The results of this study are thought to be important for the future development of misconceptions in biology education. Although the research is specifically a study on misconceptions, it is generally related to biology education as a research field. Therefore, it gives an idea about how the subject can be addressed in relevant disciplines. The article focuses on the spatial and publication distributions of the existing literature on misconceptions in biology education. In future studies, more comprehensive studies can be conducted by including cultural and regional factors. The study is limited to published articles using misconceptions in biology education. Researchers can perform more detailed biometric analyzes using various keywords to familiarize themselves with basic research in the chosen research field and also benefit from these publications. Additionally, this study is limited to studies available in the Scopus database. Different indexes can be used in studies. The type of publication included in the sample of the study is limited to articles. Other types of publications, such as theses, conference proceedings, or books, may be used in the analysis. Further studies can be conducted using different restrictions when searching for articles.

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