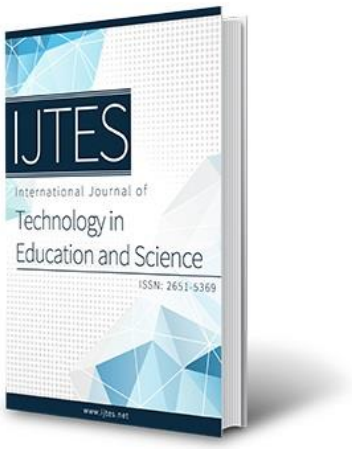

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A Bibliographic Perspective of Flipped Classroom Studies in Science Education

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A Bibliographic Perspective of Flipped Classroom Studies in Science Education

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Abstract

The aim of study is to specify bibliographically analyses 72 articles published between 2010 and 2020 in the field of science regarding the flipped classroom model. In the study, bibliographic analysis variables such as the year of the studies, research areas, keywords, the most publishing journals, organizations, countries, cited studies, the cooperation network of the authors and the indexes scanned were determined and analyzed descriptively. According to the results of the study, the most publications regarding the flipped classroom model in science education were in the field of chemistry education between 2018 and 2020, and flipped classroom, chemistry, science education and STEM were used as keywords. In addition, it has been determined that the countries with the highest number of publications in this field are USA and Turkey, the most publishing organizations are Near East University and the most published journal is Journal of Chemical Education. Furthermore, it is seen that the most cited work in the reviewed studies was written by Jamie L. Jensen, the authors with the most author collaboration network were Marie Barnard and the indexes including the most publications were Scopus and Web of Science.

Introduction

Today, in parallel with the current developments in education, students; the constructivist learning approach, which allows taking an active role, gaining a sense of responsibility and organizing learning processes according to themselves, is at the forefront. The role of the teacher has also changed and the teacher has shifted from the "wise on the stage" position to the "guide on the edge" with this approach, (Velegol & Zappe, 2015). It is recommended that teachers benefit from technological opportunities to organize learning environments for active participation of students and to make them more efficient in the constructivist learning approach. In parallel with the development of technology, new searches have been made in teaching processes where both the student is active and the technology is used. As a result of these searches, blended learning environments that have been frequently encountered in recent years have emerged.

Learning environments in which education and technology are used together are called blended learning in the literature (Osguthorpe & Graham, 2003). “Blending” actually emerges as a concept that asserts the use of technological opportunities in education in addition to face-to-face education (Bersin, 2004). Blended learning,

on the other hand, is expressed as a teaching practice prepared by integrating different learning approaches with technology, activity and activity types (Strayer, 2012).

Although it is recommended to combine different learning approaches and technology in learning environments in blended learning, in face-to-face education it is not easy for teachers to maintain a balance between the lesson and practice strategies due to the limitations arising from the duration of the lesson and the classroom environment. It is emphasized that in teacher-centered learning environments, most of the time allocated to the lesson is spent with the presentation of the theoretical sections, so the students cannot find an environment for practice and discussion and cannot make inferences (Çakıroğlu & Öztürk, 2016). In this direction, we come across the flipped classroom model, which is one of the blended learning types in which teaching is applied mostly at home and the practice and discussion environment is in the classroom.

The flipped classroom model generally means that students prepare for the face-to-face lesson by watching the online lesson videos at home in advance; it is expressed as a blended learning approach in which they use active learning strategies when they are in the classroom (Bergmann & Sams, 2012). Similarly, in the peer education method developed by Mazur in 1997. In order to the students to better grasp the topics they find complex, they are asked to read the simple information at home before the lesson, and they are expected to apply their homework in the classroom.

Although this method applied by Mazur was made for peer teaching purposes, it can be considered as one of the first examples of the application, the flipped classroom model (Talbert, 2017). Later, in the study conducted by Lage, Platt and Treglia (2000), they asked students to watch the recorded course contents instead of reading the course, and they called this method "transformed classroom". In a study conducted by Baker and Mentch (2000) in the same year, the positive aspects of the traditional class reversal were presented together with its justifications. In the following years, flipped classroom practices started to be included in secondary education as well.

The first example of the flipped classroom learning model in secondary education was implemented in 2007 by Jonathan Bergmann and Aaron Sams, two chemistry teachers working at Woodland Park High School. Bergmann and Sams (2012) thought of a solution for students missed the lesson, they have been published their lecture notes by purchasing software that they can record their lectures and publish online. However, soon after this method attracted the attention of students and teachers, they have the idea that time in the classroom should be reviewed and radical changes should be made.

In this direction, they put forward the idea that instead of wasting time by explaining the course topics in the classroom, it would be more productive to use the classroom as a place for more practice, problem solving and interaction and the course could be watched outside. This situation is accepted as the first application of the flipped classroom model (Frydenberg, 2012; Tucker, 2012). After this year, studies on the model have increased in parallel with the development of technology, and studies in different areas have begun to investigate the benefits and limitations of the flipped classroom model and its types of application.

In the studies carried out with the application of the flipped classroom model, the benefits and limitations of this model have been revealed. useful features of the flip model; providing life-long learning opportunities (Bergmann, Overmyer & Wilie, 2011), creating a learning environment according to the student's own pace and opportunity (Bergmann and Sams, 2012), giving the student unlimited repetition opportunities (Fulton, 2012), no time constraints for learning (Bergmann & Sams, 2012) and giving the student the opportunity to be more active during the lesson by preparing them for the lesson in advance (Talbert, 2012). In addition, the reverse model; student having the opportunity to learn the parts that they cannot understand in the classroom again (Bergmann & Sams, 2012), giving the opportunity to listen to the students who cannot attend the lesson (Miller, 2012), contributing to the students in increasing their high-level thinking skills (Duerden, 2013), it is also emphasized that it has positive features such as eliminating learning deficiencies by reinforcing it during the lesson (Hinojosa, Ramirez and Rodriguez, 2014). In addition to many useful features of the flipped classroom model, this model also has limitations. Students have difficulties in learning in an individual environment (Duerden, 2013), not being sure whether the videos are watched by each student (Bergmann and Sams, 2012), difficulties in accessing the internet and other materials (Nielsen, 2012), not getting immediate feedback while watching the course videos (Enfield, 2013), the cost of the method (Duerden, 2013) can be shown as the limitations of the flipped classroom model.

Although the flipped classroom model has many benefits, it is inevitable that the use of this model in the education system will increase. The application of the flipped classroom model in the education system and the revealing of its many benefits through studies have increased the use of the flipped classroom model in different areas. When the studies are examined, the effects of the flipped classroom model on academic achievement (Aburezeq, 2020; Al & Ahlam, 2020; Shukla & McInnis, 2021), its effect on affective properties (Chan, Lam, Yat, & Ng, 2020; Colomo-Magaña, Soto-Varela, Ruiz-Palmero, Gómez-García, 2020; Li & Yang, 2021) and opinions on the model (Aslan, 2020; Sigurðardóttir & Heijstra, 2020; Yeboah, Rita, Ernest, Doreen, Abraham, 2020). However, it is seen that there are studies that can reveal the studies in this field by examining in depth and indicate what the trend is in this direction. Köse and Yüzüak (2020); Lencastre, Bento, Morgado, and Freires, (2020); Rahman, Yunus and Hashim, (2019); while examined the studies on the flipped classroom model with content analysis; Aydın, Ökmen, Şahin and Kılıç, (2021); Jang and Kim, (2020) analyzed it by meta-analysis. Considering the studies, apart from content analysis and meta-analysis, there are also studies that examine the researches on the flipped classroom model with the bibliographic analysis method.

Bibliographic analysis is an analysis method that quantitatively expresses the bibliographic features of the ever-growing literature (Lopes, Fidalgo-Neto & Mota, 2017). Bibliometric methods are based on the principle of obtaining a general view of the researched subject area with bibliographic data obtained from databases (Zupic, 2015) and are mostly performed for two purposes: performance analysis and scientific mapping. In bibliographic analysis, scientific publication performance of institutions or countries is determined, while scientific mapping reveals the dynamics in the scientific field and the structure of these dynamics. (Cobo, López-Herrera, & Herrera-Viedma, 2011).

There have been rapid changes and developments in the scientific field recently, it is important to reveal the structure of scientific dynamics. In this regard, scientific mapping or bibliometric mapping; it stands out in terms

of showing a spatial example that reflects the relationship of disciplines, fields, specialties, publications and authors with each other. With this mapping method, it is possible to reveal a general picture of academic studies in a particular field and to discover useful information from the data of the studies conducted (Cobo et al., 2011). Scientific mapping analysis is commonly done through keywords (authors, countries, publications, etc.) and finds a great application area (Small, 1999).

It is seen that the studies on the flipped classroom model are examined with the bibliographic analysis method are limited in the literature. Çakır, Sayın, and Bektaş (2021) bibliographically analyzed to 2955 studies conducted in all areas related to the flipped classroom model between the years 2015-2019 according to some variables such as; publication year, publication language, publication type, the institution, country that published the most, the network structure of cited authors and the most frequently used keywords in publications. Similarly; Julia, Afrianti, Ahmed, Supriyadi, Dolifah, Isrokatun, and Ningrum, (2020) bibliographically reviewed 200 studies between 2010 and 2019 years and Urbano, Teran, Gomez, Solarte, Sepulveda, and Meza, (2020) 61 studies.

When the studies on the flipped classroom model are examined, it is seen that the studies focus on studies in all areas related to this model. It is thought that an in-depth examination of the studies on the flipped classroom model only in the field of science education is necessary for future studies in the field of science. In terms of content, science subjects include abstract subjects too much and the classroom environment is insufficient to practice in the teaching of this course. Since the flipped classroom model allows students to learn abstract concepts by practicing more in the classroom environment (Baker & Mentch, 2000), it is thought that it is of great importance to examine the studies on the flipped classroom model in science education from all aspects. Sakar and Sağır (2017) examined the studies on the flipped classroom model in their studies and stated that the studies in the field of science education are more than in other fields. Therefore, it is thought that determining the tendencies of the studies in the field of science education by examining the bibliographical point of view will be effective in determining the direction of the studies to be done in the field of science related to the flipped classroom model in the future.

In this study, it is aimed to specify the trends of the studies made by examining the publications related to the flipped classroom model in the field of science from a bibliographic point of view, and to determine the network structure of the authors, citations, institutions and countries of the studies that have come to the fore especially in recent years on the flipped classroom model. It is believed that the bibliographical examination of the studies in the field of science in which the flipped classroom model is applied will provide information about the trends, deficiencies of the studies and will shed light on other studies to be done in this field. It is thought that this model will contribute to science teachers and academicians in this field in terms of data. In line with the purpose of the study, the problem sentence is determined as

- "How are the bibliographic examination results of the studies on the flipped classroom model in the field of science education?"
    - How are the distribution according to *i)* the study years, *ii)* research areas, *iii)* prominent keywords, *iv)* the most publication magazines, *v)* the most broadcast countries, *vi)* the most contributing to the field, *vii)* the authors' network structure and *viii)* indexes by which studies are scanned?

Method

Research Design

The study, conducted using the bibliographic analysis method. With bibliographic analysis, the current situation and trends of publications are revealed (Alan, Newman, Sughi & Bakhsh, 2013). Bibliographic analysis is a type of analysis that can reveal the latest developments, research aspects and leading issues in the subject area of a particular research (Wang, Pan, KE, Wang and Wei. 2014). In addition, bibliographic analysis is one of the leading analysis methods in the decision-making process of scholar studies, but also widely used to evaluate the performance of the journal, countries and institutions (Van Nunen, Reniers & Ponnet 2017). The reason for the use of bibliographic analysis in this study is to determine the emerging publications such as citation, magazines, country and research areas in accordance with the purpose of the study.

The criteria of the data to collect and include the research

The data of the study consists of 72 articles which were bibliographic analyzed. The data collection process in the study is given below.

- The studies to be examined were obtained by searching Google Scholar, Tr index, Scopus, ERIC and Web of Science databases between January 01, 2010 and December 31, 2020.
- It was taken into account that the studies were directed to the flipped classroom model and the science field.
- Flipped classroom", "Flipped learning", "Inverted learning", Inverted classroom" were used as keywords during the scanning.
- When keywords are written, 1090 studies in Google academic database, 329 studies in Eric index, 101 studies in Web of Science, 51 studies in Scopus index and 18 studies in Tr index have been reached
- As a result of the screening, 72 articles that were determined to be suitable for the purpose of the research were examined. It was taken into account that some of the reviewed articles were in more than one database at the same time. The process of reaching the studies discussed within the scope of the research is given in Figure 1.

Data Analysis

The publications reviewed in this part of the study are analyzed descriptively in line with bibliometrics variables. In this study, bibliometric variables related to the publications in the field of science using the flipped classroom model are determined as; " Distribution of studies by years", "Research area of studies", "Featured keywords in studies", "Top published journals", "Distribution of studies by countries", "The studies contributed the most to the field", "Most prominent organizations", "Research areas of studies", "Collaboration network structure of authors in studies" and "Indexes that studies are scanned". 72 articles in accordance with the criteria determined within the context of the study are analyzed according to the bibliometric variables determined by the researchers.

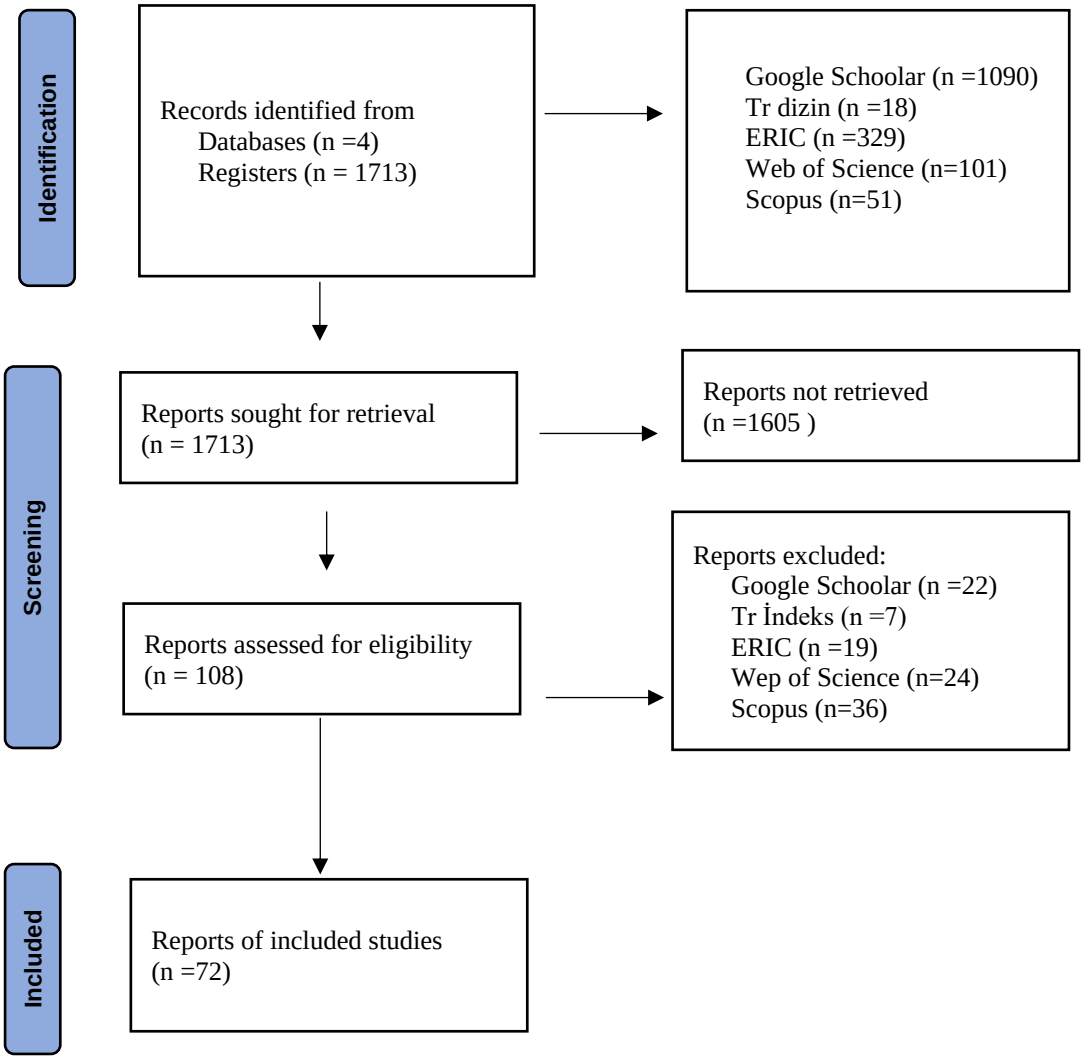


Figure 1. The Process of Reaching the Studies

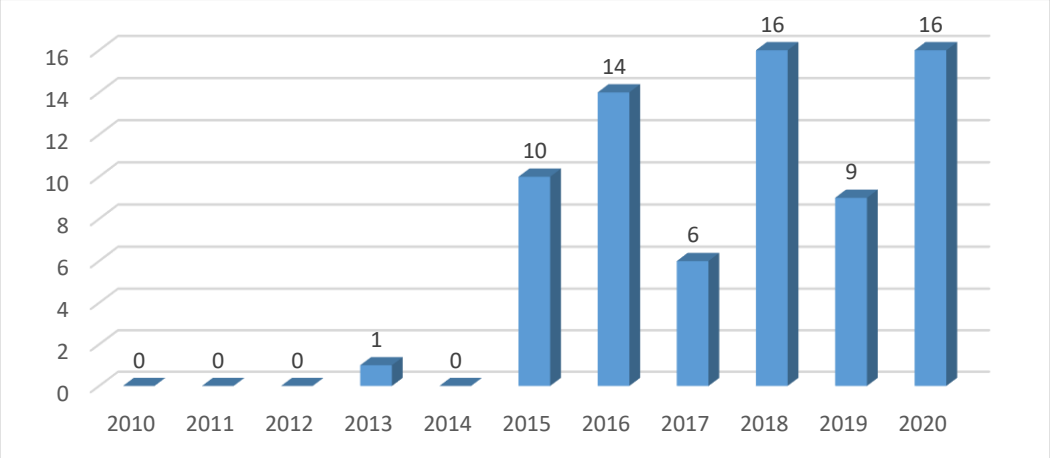
In the study, descriptive analysis method, which is frequently preferred in the analysis of written documents (Patton, 2015), was used. Descriptive analysis have been based on creating theme and category to organize and make sense of the excess information obtained (Fraenkel, Wallen, and Hyun, 2012). Studies in accordance with the criteria determined within the scope of the study have analyzed according to the research review form developed by the researchers and containing bibliometric variables and subcategories. In the study, researcher triangulation has been done to ensure the validity of the data. In this framework, two researchers took part in all processes of data collection, data analysis and data interpretation (Merriam, 2009). During the analysis of the articles, two different researchers have evaluated the identified studies separately, taking into account the categories determined in the form. The researchers have record the findings from the articles in a Microsoft Excel file and categorize them within the framework of the research questions. After the analysis of all the articles was completed, the coding reliability have been checked in order to ensure the reliability of the research (Miles and Huberman, 1994; Patton, 2015). The analyses made by the two researchers have compared and the analysis data are arranged in line with the common opinion. The results obtained have arranged in the form of tables and graphs and presented in the findings section.

Results

The findings of the research are obtained from 72 articles published between the years 2010-2020 in the field of science using the flipped classroom model. The data obtained as a result of the examination of the articles are presented under headings in line with the sub-problems.

Distribution of Studies by Years

The distribution of studies in the field of science using the flipped classroom model according to the years of publication is given in Graph 1.

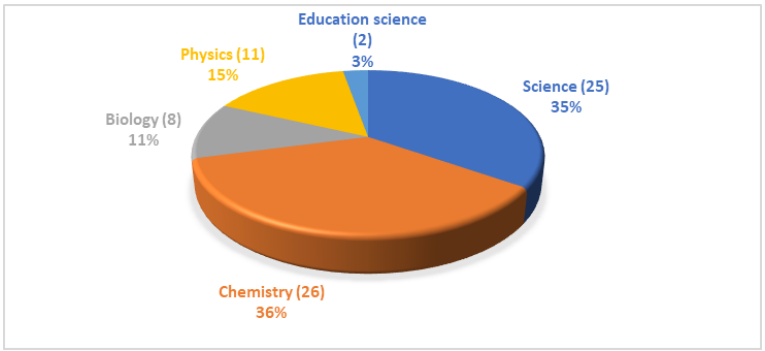


Graph 1. Distribution of Studies by Years

When Graph 1 is examined, it is seen that there were no publications in 2010, 2011, 2012, and the most publications were made in 2018 and 2020 with 16 studies. These years are followed by 14 studies in 2016, 10 studies in 2015, 9 studies in 2019, 6 studies in 2017 and 1 study in 2013

Research Areas of Studies

The distribution of studies in the field of science using the flipped classroom model according to research areas is given in Graph 2.



Graph 2. Distribution of Studies by Research Area

When it is investigated graph 2, it is seen that the most in the field of chemistry education with 26 studies, followed by the field of science education with 25 studies, physics education with 11 studies, biology education with 8 studies, and 2 studies in the field of educational science, respectively.

Keywords Featured in Studies

In this part of the study, the minimum number of repetitions of a keyword is determined as two to determine the prominent keywords in the publications. The prominent keywords in the studies using the flipped classroom model in the field of science are shown in Figure 2.

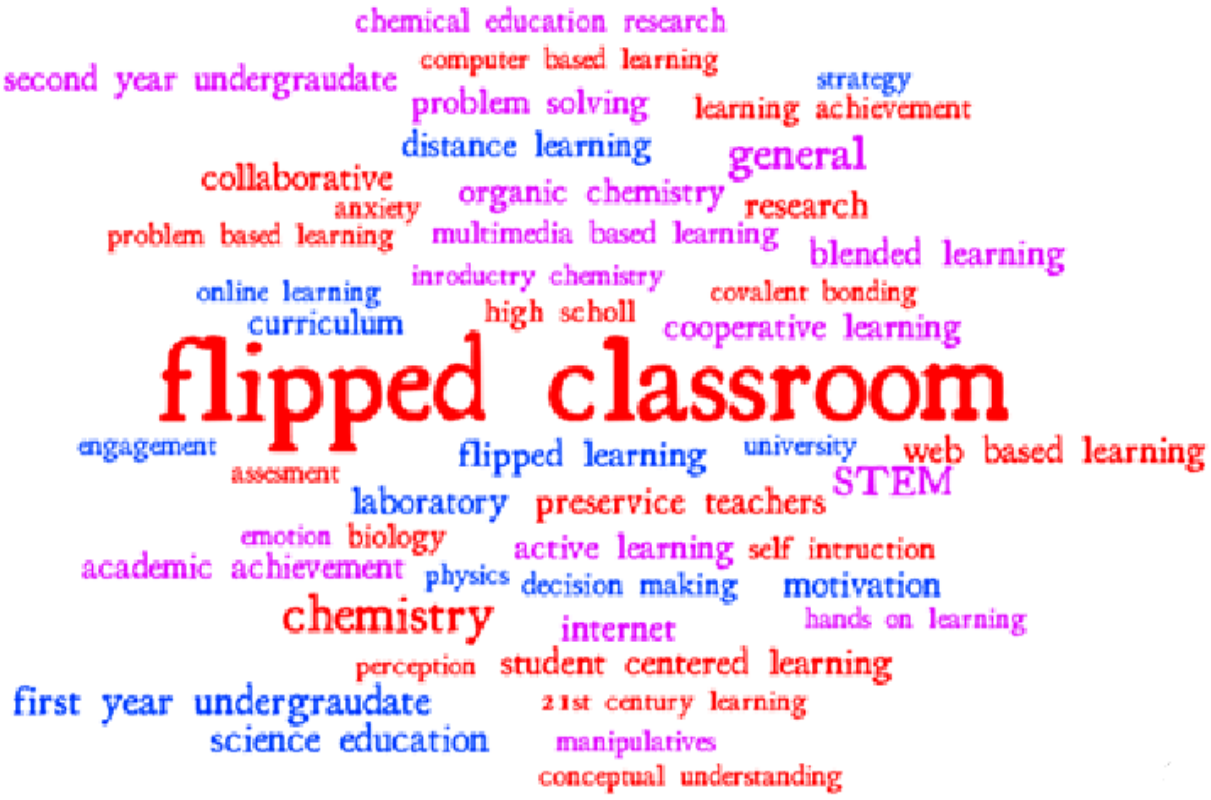


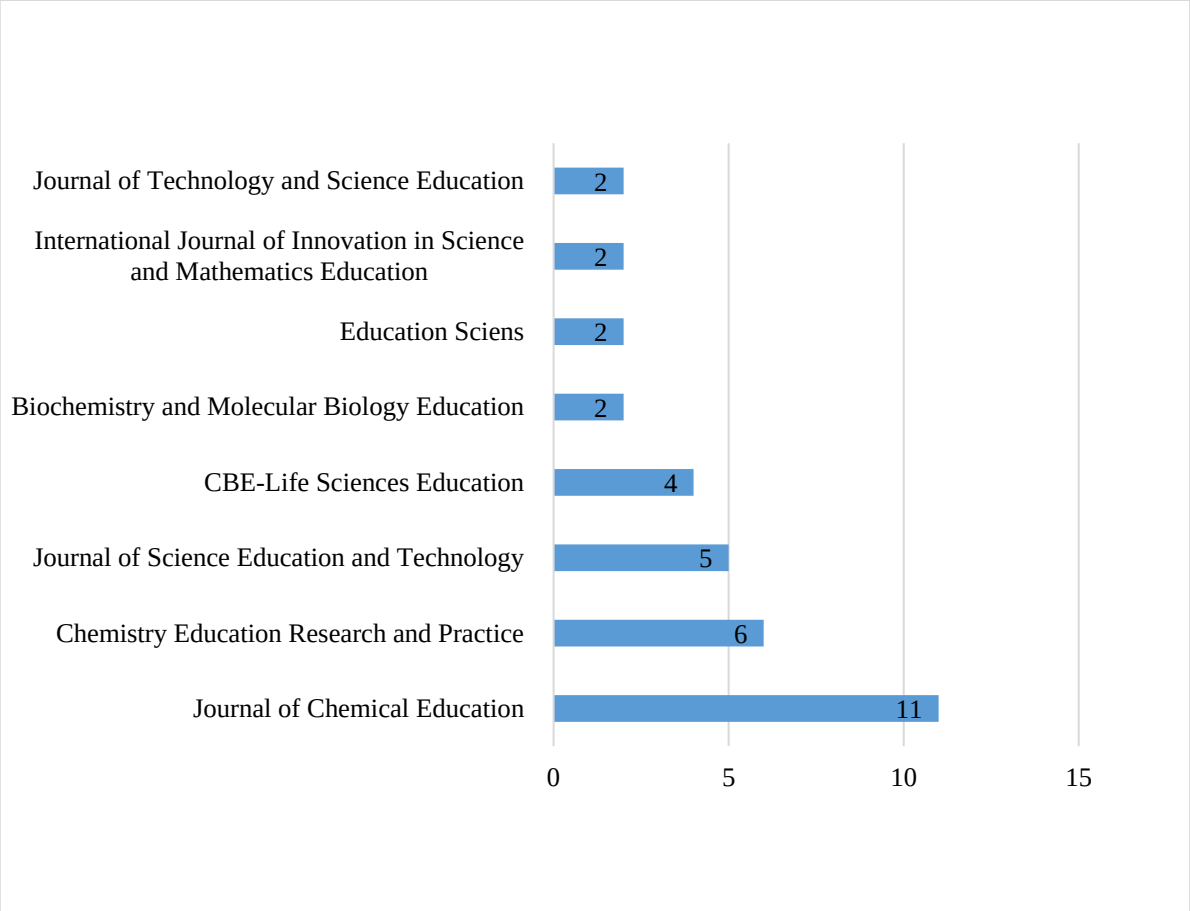
Figure 2. Keywords preferred by the Authors in the Studies

When Figure 2 are examined, it is seen that the most prominent keyword in the studies is “flipped classroom” with 37 repetitions, while the others are “chemistry” with 11 repetitions, “general” with 9 repetitions, “first year undergraduate” with 7 repetitions, “science education”, “STEM” with 6 repetitions, “flipped learning”, “pre-service teachers”, “motivation”, “internet”, “web based” with 5 repetitions, “learning”, “collaborative”, “laboratory”, “student centered learning”, “research” and “blended learning” keywords.

Most Published Journals in Studies

In this part of the study, the minimum number of publications was taken as two to determine the journals with the

most publications. Using the Flipped classroom model in the field of science, the findings regarding the journals that publish the most are shown in Graph 3.

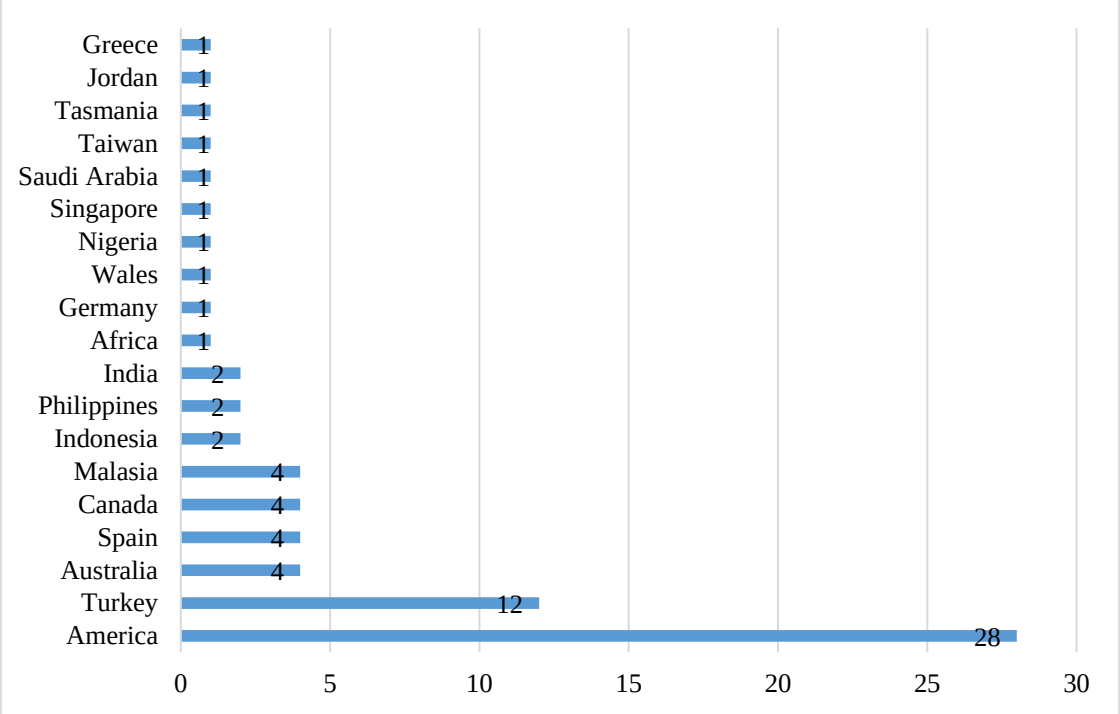


Graph 3. Top Publishing Journals

In Graph 3 it is seen that with 11 publications "Journal of Chemical Education" is in the first place, followed by "Chemistry Education Research & Practice" with 6 publications, "Chemistry Education Research & Practice" with 5 publications, Journal of Science Education & Technology", "CBE-Life Sciences Education" with 4 publications and "Biochemistry & Molecular Biology Education" with 2 publications, "Education Sciences", "International Journal of Innovation in Science & Mathematics Education" and " Journal of Technology & Science Education" is seen to come.

Distribution of Studies by Countries

Using the Flipped Class Model in the field of science, the distribution of the countries with the highest number of studies is shown in Graph 4. When Graph 4 is examined; it is seen that America is in the first place with 28 studies, followed by Turkey with 12 studies, Australia, Spain, Canada and Malaysia with 4 studies each, Indonesia, Philippines and India with 2 studies each. It is seen that Africa, Germany, Wales, Nigeria, Singapore, Saudi Arabia, Taiwan, Tasmania, Jordan and Greece are among the broadcasting countries with 1 study.



Graph 4. Countries with the Most Publications

Studies Contributing the Most to the Field

In this part of the study, the first 10 publications are examined according to the number of citations in the examined publications to determine the studies that contributed the most to the field. The ranking of the publications that contributed the most to the field in the studies carried out is shown in Table 1.

When Table 1 is investigated, it is seen that the study with the highest number of citations of 713 is for the field of biology, written by Jamie L. Jensen and published in 2015. This study is followed by the works of Jessica M. Fautch with 227 citations published in the field of chemistry in 2015, David Gross with 226 citations published in the field of chemistry in 2015, and Michael D. Ryan with 187 citations published in the field of chemistry in 2016. Afterwards, it is seen that there are studies in the fields of chemistry, science, and physics published in 2013, 2016, and 2015, and that the studies in the field of chemistry are in the majority in the first 10 publications according to the citation status.

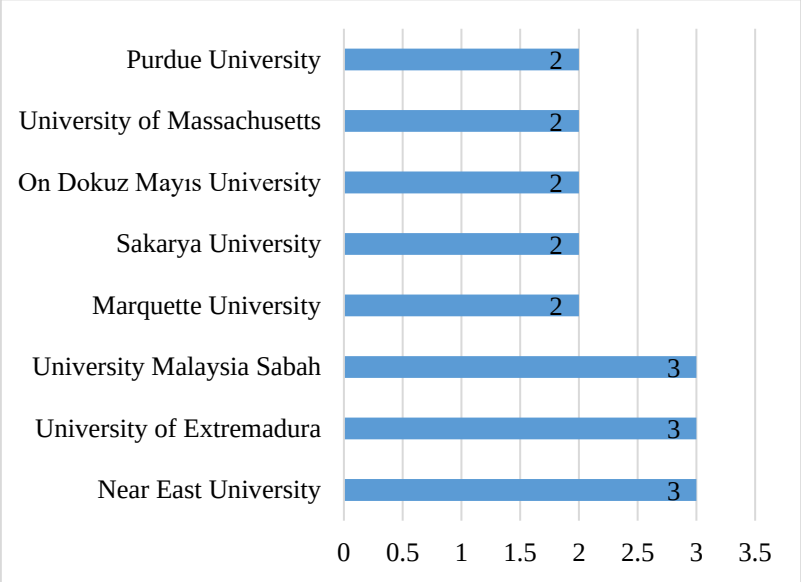
Table 1. Top 10 Most Cited Studies

No	Author	Year of Publication	Journal	Research Arenas	Total Citation
1	Jamie L. Jensen	2015	CBE—Life Sciences Education	Biology	713
2	Jessica M. Fautch	2015	Chemistry Education Research & Practice	Chemistry	227
3	David Gross	2015	CBE-Life Sciences Education	Chemistry	226
4	Michael D. Ryan	2016	Journal of Chemical Education	Chemistry	187

No	Author	Year of Publication	Journal	Research Arenas	Total Citation
5	J. Dominic Smith	2013	Chemistry Education Research & Practice	Chemistry	162
6	David Gonza´lez-Go´mez	2016	Journal of Science Education & Technology	Science	136
7	Gülsüm Aşıksoy	2016	Eurasia Journal of Mathematics, Science & Technology Education	Physics	112
8	Gabriela C. Weaver	2015	Journal of Chemical Education	Chemistry	91
9	Jack F. Eichler	2016	Chemistry Education Research & Practice	Chemistry	64
10	Jerry Chih-Yuan Sun	2016	International Review of Research in Open & Distributed Learning	Physics	57

Prominent Institutions in Studies

The minimum number of studies is taken as two to identify the prominent organizations in the publications reviewed in this part of the study. The distribution according to the most prominent organizations in the studies is given in Graph 5.



Graph 5. Organizations doing the Most Work

When Graph 5 is examined, with three studies each "Near East University", "University of Extremadura", "University Malaysia Sabah" comes first among the institutions that publish the most. Afterwards, “Marquette University”, “Sakarya University”, “On Dokuz Mayıs University”, “University of Massachusetts” and “University of Massachusetts” come with two studies each.

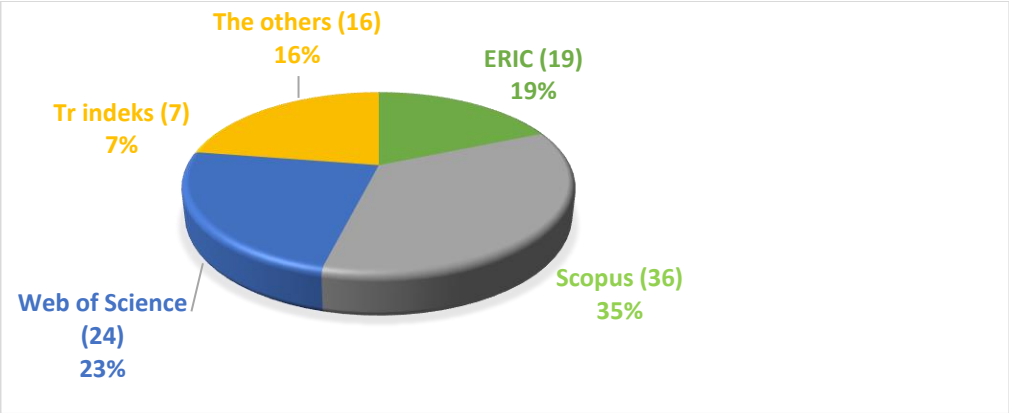
Network Structure of Authors in Studies

In this part of the study, the minimum number of authors with which an author collaborates is taken as three in order to determine the network of cooperation between authors in publications. The network of collaboration between the authors in the studies carried out is shown in Figure 3. When Figure 3 is examined, the most collaborative author is Marie Barnard, followed by Krista Slemmons, Elnetthra Folly Eldy, David J. Hill, David González-Gómez, Nigel Francis, Jin Su Jeong, David Gross and Masila Alias seems to follow the author.

Figure 3. Collaboration Network between Authors in Studies

Indexes by which Studies are scanned

In this part of the study, while the indexes in which the publications are scanned are determined, it is checked whether they are scanned in the SSCI, AHCI, ERIC, Scopus, Web of Science and Tr index databases which have a high usage rate among the databases. Other databases include indexes such as EBSCO, Copernicus, and Education Index. In addition, a publication can be found in more than one database. The distribution of the studies conducted in the field of science for the flipped classroom model, according to the indexes, is given in Graph 6.



Graph 6. Distribution of Studies by Indexes

When Graph 6 is examined, it is seen that the index with the most studies is Scopus with 36 publications, followed by Web of Science with 24 publications, ERIC with 19 publications, Tr index database with 7 publications, and 16 publications scanned in other databases.

Discussion

In the study, 72 articles published between 2010 and 2020 in the field of science using the flipped classroom model is to bibliographically analyses variables such as the year of the studies, research areas, keywords, the most publishing journals, organizations, countries, cited studies, the cooperation network of the authors and the indexes scanned. When the distribution of the examined articles according to the publication years is examined, it is seen that there were no publications in the field of science related to the flipped classroom model before 2013 and there was an increase in the number of publications in the following years. Similarly; Julia et al. (2020) bibliographically reviewed 200 studies on the flipped classroom model between 2010 and 2019 and noted that there has been a significant increase in studies on this model since 2013. The increase in publications for this model, which became widespread after two chemistry teachers started to implement the flipped classroom model in 2007, shows that the flipped classroom model has become popular and awareness of this model has increased.

When the studies in this field are examined, it is seen that the number of studies between 2018 and 2020 is higher than other years and the least number of studies is in 2017. Unlike the results of this study, Çakır, et al., (2021), in their study, bibliographically examined 2955 studies in all areas related to the flipped classroom model between years 2015-2019 and determined that the most studies were published in 2017. Although, there was a general

increase in the studies on the flipped classroom model in 2017, it is seen that there is a decrease in the studies in the field of science with this study. It is thought that the reason why the studies in this field in 2017 are less than in other years is that with the widespread use of this model, the flipped classroom has begun to be implemented in other fields as well as the field of education. In the study of Çakır et al. (2021), studies on the flipped classroom model have begun to be conducted in fields such as computers and engineering, as well as in the field of education since 2015. In addition, while nine studies were found in this field in 2019, nearly twice as many studies were found in 2020. Considering that with the pandemic period that affected the whole world as of 2019, distance education in all countries is considered, it is seen that the flipped classroom model in the field of science has increased its applicability in distance education as well.

When the most used research areas in the examined articles are seen, it is revealed that the studies in the field of chemistry are more than the others. Demirer and Aydın (2016) examined 90 studies in all fields regarding the flipped classroom model between 2011 and 2015 and determined that among the studies conducted in the field of science education; those in the field of chemistry were more than in the field of physics and biology education. Similarly, Köse and Yüzak (2020) examined 16 studies conducted in the field of mathematics and science between years 2009-2019 and found that studies in the field of chemistry education were more dominant than other fields in studies. In the study of Yang, Sun and Liu (2017), the field of chemistry was determined as one of the most studied fields. The reason for the intense studies in the field of chemistry for the flipped classroom model can be shown as the fact that the studies in this field were first made in the field of chemistry. In addition, chemistry is a discipline that is difficult to understand because it contains too many abstract concepts (Kee and Reid, 2000). There are also research results showing that technology-supported rich learning environments such as the flipped classroom model are effective in teaching abstract concepts (Aktaş, 2013; Laney, 1990; Karagöz, 2010; Kimberley & Dana, 2003; Oktay & Çakır, 2013; Yenice, 2003). In this respect, it can be said that the field of chemistry, is more suitable for the flipped classroom model compared to other fields, both in this study and in other studies.

When the articles discussed in the study are examined in terms of the most prominent keywords, it is seen that the most frequently used keywords are "flipped classroom" and then "chemistry", "science education" and "STEM". Keywords are words that reflect the meaning of the whole sentence and contain the essence of the sentence (Hao and Zhao-Hui, 2014). In a research, the keywords used mean that they reflect the essence of the whole study (Julia et al., 2020). In this context, since the articles examined within the scope of the study are for the flipped classroom model in science, the prominent keywords in the studies are “flipped classroom”, “chemistry”, “science education” and “STEM”, which shows that they reflect the essence of the examined articles correctly. Similarly, in bibliographic studies on the flipped classroom model, “flipped classroom” emerges as the most prominent keyword (Julia et al., 2020; Çakır et al., 2021; Yang et al., 2017). In addition, when the research areas of the studies are examined, it is seen that the studies in the field of chemistry are more than other fields, with the keyword "chemistry" among the prominent keywords.

When the most published journals for the flipped classroom model in the field of science are examined, it is seen that the most published journal is "Journal of Chemical Education", followed by "Chemistry Education Research and Practice", "Journal of Science Education and Technology" and "CBE- It is seen that the journals of “Life

Sciences Education" are coming. Basically, the perception of the place when a research is published becomes an important factor in the performance of the research (Campbell, Vick, Murray and Little, 1999; Macdonald, Kam, 2007). Therefore, journals publishing in this field constitute an important part of research. In addition, the most publishing journals show parallelism with the field of chemistry, which is the most research area of the study, and the most prominent keywords. As can be seen here, it is seen that the concepts such as research area, keyword and published journal, which are in the field of science for the flipped classroom model and form the basis of scientific publications, are generally integrated with each other. Julia et al., (2020) between 2010-2019 "Journal of Chemical Education" and "Journal of Science Education and Technology" are among the top 10 most published journals of 200 studies in all fields.

When the analyzed articles are considered according to the countries in which they were published, it is seen that the most studies on the flipped classroom model in the field of science were made in the USA, followed by Turkey, Australia, Spain, Canada and Malaysia. Among these countries, America and Turkey, scientific publications in this field constitute more than 50% of all publications. Similar to the results of this study conducted in the field of science, the United States ranks first and Turkey ranks eighth among the countries that publish the most in 2955 studies that Çakır et al., (2021) examined bibliographically between 2015-2019. Zainuddin et al., (2019) concluded in their study that Taiwan is the country that publishes the most in the field of flipped classroom, followed by the United States and Turkey. Similarly, Julia et al., (2020) stated that the USA ranked first in the articles published between 2010-2019 in their studies, while they stated that, unlike other studies, no studies on the flipped classroom model were found in Russia, Nigeria and Argentina. In this study, which examines the publications in the field of science for the flipped classroom model, Indonesia, the Philippines, India, Africa, Germany, Wales, Nigeria, Singapore, Saudi Arabia, Taiwan, Tasmania, Jordan and Greece have contributed to this field even with a small number of studies (Julia et al., 2020). it was seen that Russia and Argentina did not contribute. In this direction, the USA came to the fore as the partner country in all three studies of the flipped classroom model, and in this study, the awareness of the science in the field of the flipped classroom model is quite high in the USA, and in Russia and Argentina, It can be said that there a few awareness of.

When the journals with the most articles on the flipped classroom model in the field of science are examined, it is observed that the journal with the most articles is "Journal of Chemical Education", followed by "Chemistry Education Research and Practice", "Journal of Science Education and Journal of Science Education and Technology" and It is seen that the "CBE-"Life Sciences Education" journals are coming. Basically, the perception of the place when a research is published becomes an important factor in the performance of the research (Campbell, Vick, Murray and Little, 1999; Macdonald, Kam, 2007). Therefore, journals publishing in this field constitute an important part of research. In addition, the most publishing journals show parallelism with the field of chemistry, which is the most research area of the study, and the most prominent keywords. As can be seen here, the concepts such as research area, keyword and published journal in the field of science for the flipped classroom model and forming the basis for scientific publications are generally used in the studies of. Julia et al., (2020) between 2010-2019 "Journal of Chemical Education" and "Journal of Science Education and Technology" are among the top 10 most published journals of 200 studies in all fields.

Looking at the collaborative network structure of the authors of the reviewed articles, the author with the most collaborative network structure was Marie Barnard, followed by Krista Slemmons, Elnetthra Folly Eldy, David J. Hill, David González-Gómez, Nigel Francis, Jin Su Jeong, David Gross and It is seen that Masila Alias follows this author. Among these authors, David González-Gómez and Jin Su Jeong contributed to the field with more than one study, while David González-Gómez and David Gross are among the most cited authors. The fact that the authors with the most collaboration have the highest number of citations and studies and their contribution to the field shows that these authors focus on studies in the field of science for the flipped classroom model. It is also seen that the studies of these authors are published in the journals "CBE-Life Sciences Education" and "Journal of Science Education and Technology", which are among the journals that publish the most in this field. In this direction, it can be said that the publications of David González-Gómez, Jin Su Jeong and David Gross can be taken as a guide for researchers in their studies in this field.

When we look at the indexes in which studies in the field of science for the flipped classroom model are scanned, it is seen that the index with the most scanning area is Scopus, followed by Web of Science, respectively. Among the articles scanned in these indexes, only 15 studies scanned in Scopus, 3 articles scanned only in Web of Science, and 19 articles scanned together in both have been found. When we look at the indexes in which the studies that contribute the most to the field by making the most references are examined, it is seen that 50% of them are scanned in Scopus and Web of Science. This shows that, like the integrity seen in other variables, there is a strong correlation between the indexes in which the study was scanned and the number of citations.

Conclusions

As a result, it is thought that this study will contribute to the researchers who will work on the flipped classroom model in the field of science in determining the scientific publication policy. In this study, in which bibliographic variables such as different fields of study, country, organization, journal, number of citations, keywords, and search index are evaluated together; the determination of priority areas, prominent keywords, country, journal, author and institutions will guide the studies to be carried out scientifically. With this study conducted in this direction, it has been revealed that the studies on the flipped classroom model in the field of science are increasing day by day, and the bibliographic variables in the studies are interconnected in a holistic way. In this study, the limitation of the study is that the publications in the field of science for the flipped classroom model were obtained by scanning the Tr index, ERIC, Google Scholar, Scope and Web of Science databases. It is recommended for researchers to conduct new studies by using other databases apart from these databases and by considering different bibliographic variables, and to examine the flipped classroom model in studies in different fields other than science. In addition, similar studies can be done by using mapping techniques such as vosviewer and scimat used in bibliographic analysis.

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