REVIEW OF INTERNATIONAL GEOGRAPHICAL EDUCATION

ISSN: 2146-0353 • © RIGEO • 11(9), SPRING, 2021

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Research Article

# Flipped Classroom in Higher Education —A Bibliometric Analysis

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**Abstract**

This review aims to have a better understanding of the flipped classroom's research status and trends in higher education from 2012 to 2021. This review will be accomplished by bibliometric analysis of 670 papers collected from the Scopus database on 2021 July 14th. The purpose of this research is to examine the publishing trend and geographic distribution, the contribution and collaboration of various nations, the most influential authors and publications, and the most often repeated author keywords and under-explored issues. The data indicated an increasing trend in overall publication production from 2012 to 2020, with 72 nations publishing publications on flipped classroom research in higher education. Among them, the United States, Spain, Australia, and China have all contributed significantly to publishing studies on flipped classroom research. Additionally, the US, Australia, and China were the three nations with the highest level of collaboration with other countries when overall connection strength was considered. Additionally, O'Flaherty and Phillips were identified as the most influential writers of highly referenced publications in the poll. The most frequently repeated author keywords were flipped learning, active learning, blended learning, MOOC, and e-learning, indicating that these were the primary themes of flipped classroom research in higher education over the previous nine years, while less frequently repeated author keywords included academic performance, learning experience, and self-regulation. The findings may aid academics in determining the state of the study and identifying research hotspots in the field of flipped classrooms in higher education. Additionally, it may assist in identifying some future study directions for flipped classroom higher education and guide future flipped classroom higher education research.

**Keywords**

Flipped classroom; Higher education; Bibliometric analysis; Research trend

**To cite this article:** Linling, Z and Abdullah, R, B. (2021) Flipped Classroom in Higher Education —A Bibliometric Analysis. *Review of International Geographical Education (RIGEO), 11*(9), 1464-1480. Doi: 10.48047/rigeo.11.09.126

**Submitted:** 07-09-2021 • **Revised:** 09-10-2021 • **Accepted:** 11-11-2021

# Introduction

Traditional teaching and learning techniques have been unable to keep up with the rate of societal growth in recent years, and considerable changes have happened in a wide range of sectors. Likewise, traditional educational approaches are no longer enough to address the demands of passive learners (Fernández-Martín, Romero-Rodríguez, Gómez-García, & Ramos Navas-Parejo, 2020). Thus, the progress of information and communication technologies (ICT) becomes critical to the long-term development of education (Carrión-Martínez, Luque-de la Rosa, Fernández-Cerero, & Montenegro-Rueda, 2020), and the education system is in a stage of constant change (Fernández-Martín, Romero-Rodríguez, Gómez-García, & Ramos Navas-Parejo, 2020). In higher education, universities need to adjust the educational tasks (Pérez-Sanagustín, 2020), which refers to changing traditional education to flipped instruction to access educational resources conveniently and rapidly (Ahmad, 2020). On that whole, the flipped classroom is offered, a novel classroom mode designed to improve the traditional learning environment and its activities (Gómez-García, Hinojo-Lucena, Cáceres-Reche, & Ramos Navas-Parejo, 2020). It entails inverting the conventional learning technique by transmitting most of the learning information online before class, allowing learners to actively participate in problem-solving or cooperative learning assignments guided by professors during class time (Zou, Xie, Wang, & Kwan, 2020), which can maximize the in-class time (Al-Samarraie, Shamsuddin, & Alzahrani, 2019).

The beginning of the flipped classroom idea started in the 1990s. To prevent students from copying the contents of slides in class without really understanding the meaning of concepts, Baker used the school's network platform to upload videos of the primary contents of the course for students to study before class (Baker, 2000). Bishop and Verleger gave a more specific description for flipped classrooms, which includes using technology to deliver new content outside of face-to-face classroom time (Bishop & Verleger, 2013).

Since the turn of the present century, more instructors have been implementing flipped classroom design (Bishop & Verleger, 2013). It was initially approved and widely embraced by Euro-American educational groups and gained traction in Asian universities (Kvashnina & Martynko, 2016). It is growing in popularity as an instructional innovation that disrupts the conventional study technique and cultivates students' capacity for self-regulated learning (Bergmann & Sams, 2012a; Bergmann & Sams, 2012b; Bergmann & Sams, 2014; Green, 2015), and it provides an innovative option for a large number of instructors and students in a variety of subject classrooms (Escudero, 2020; Moreno-Guerrero, Romero-Rodríguez, López-Belmonte, & Alonso-García, 2020), and is widely adopted in accounting, biology, business, and education at different educational levels in many countries and students report positive feedback for this flipped classroom (Seyedmonir & Seyedmonir, 2014). It subverts the conventional classroom, and students must self-learn a large amount of information before class (Lestari, 2021). This kind of adjustment corresponds to the development of ICT. Additionally, it is a fresh opportunity for students since it will impact their learning process and outcomes (Bernacki, Greene, & Crompton, 2020). Numerous studies have demonstrated the efficacy of flipped classrooms in terms of student engagement and overall learning results (O'Flaherty & Phillips, 2015; Sergis, Sampson, & Pelliccione, 2018; Zainuddin & Halili, 2016), such as students' academic performance, motivation, and self-regulated learning (Arslan, 2020; Awidi & Paynter, 2018; Moreno et al., 2020).

Despite the flipped classroom's prominence, little effort has been made to collect statistics on the global scientific output of flipped classroom research (Yang, Sun, & Liu, 2017). There has not yet comprehensive bibliometric analysis of flipped classroom education (Julia, 2020). Before conducting the research, the main search query using: TITLE-ABS-KEY(("flipped classroom") OR("flipped learning") OR("flipped course")OR ("flipped model") OR("flipped approach") OR("flipped environment") OR("flipped teaching") OR("flipped instruction") OR("inverted classroom") AND("higher education") AND("bibliometric analysis")) was executed on 2021 July 14th, for obtaining a few insights on the extent to which bibliometric analysis has been conducted in this research area before. The query has three results, and all were published in 2021, which represents the attention about this field has been paid more in recent years. According to the title and abstract, the paper of Sobral (2021) is a bibliometrics analysis about the tactics on teaching how to do computer programming in tertiary education. The paper categorizes existing strategies, including flipped classrooms, but not related to flipped classroom research. The paper conducted by Inga, Inga, Cárdenas, & Cárdenas (2021) is not a bibliometric analysis. It presents a system for academic administration that will ensure a student-centered education (Inga, Inga, Cárdenas, &

Cárdenas, 2021). Meanwhile, only Limaymanta, Apaza-Tapia, Vidal, and Gregorio-Chaviano (2021) reviewed 782 documents from the Web of Science Core Collection and Scopus in the period 2012 to October 2020 on flipped classrooms in the context of higher education, which means thus far, there was only one bibliometric analysis review on flipped classroom in higher education. This bibliometric analysis covers 2012 to October 2020, focusing on scientific production, the most prolific authors, cooperation indicators, a network of keyword co-occurrences, and a framework proposal. It didn't cover some aspects such as country contribution. Additional bibliometric analysis evaluations of flipped classrooms in higher education are required to assist academics in comprehending the worldwide flipped classrooms in the higher education landscape of research status and trends. Thus, this paper attempts to fulfill this gap of knowledge and it involves the following research questions:

RQ 1. What is the publication trend, geographic distribution, country contribution, and collaboration of flipped classrooms in higher education research?

RQ 2. What are the most influential authors and articles on flipped classroom in higher education research?

RQ 3. What are the most frequently repeated author keywords and under-explored themes involving flipped classrooms in higher education?

This paper attempts to review the knowledge accumulation in the field of flipped classrooms in tertiary education on a particular line of inquiry, followed by chapters of materials and methods, results, and discussion.

# Materials and Methods

Bibliometric analysis is the process of examining bibliographic data associated with published research to ascertain the knowledge base's features (Van Eck & Waltman, 2017). It has been conducted in education (Hallinger, 2019), which is considered an accurate tool to measure the contribution of papers to academic progress (Yang et al., 2012). It is critical for comprehending the state of research and its trends, as well as for giving essential information on scientific accomplishments (Glänzel, 2012), to assess trends and impacts, including publishing countries, research fields, journals, and author keywords (Chen & Ho 2015; Dong, Xu, Luo, Cai, & Gao, 2012).

## Identification of Materials

The possible and common sources of searching and extracting bibliometric analysis data include Web of Science and Scopus. In this bibliometric analysis, the data used were based on the Scopus database. It covers the relevant peer-reviewed documents in the field of education more comprehensively than Web of Science (Hallinger 2019). Scopus contains a broader range of journals than Web of Science, and its citation analysis speed is faster (Falagas, Pitsouni, Malietzis, & Pappas, 2007). The Scopus database indexes over 14,000 journal articles and social science titles from 4000 publishers, the biggest single abstract and indexing database ever (Burnham, 2006). Therefore, it was regarded as the most appropriate database from which this study reviewed the documents.

Data were extracted using the following Boolean expression: TITLE-ABS-KEY(("flipped classroom") OR("flipped learning") OR("flipped course")OR ("flipped model") OR("flipped approach") OR("flipped environment") OR("flipped teaching") OR("flipped instruction") OR("inverted classroom") AND("higher education")), in order to confirm all the publications that were available in the Scopus database. The data were derived from the Scopus database as of 2021 July 14th. This search yielded 708 documents. The timespan was set as "all year" to trace related data from the foretime thoroughly. Only those publications published in English were considered. This reduced the corpus to a hybrid set of 670 documents (i.e., articles and reviews), consisting of nine document types. Articles (373) comprised 55.67% of the total publication, followed distantly by conference paper (193; 28.81%), book chapter (51; 7.61%), review (23, 3.43%), conference review (21; 3.13%), note (3; 0.45%), book (2; 0.3 %), erratum (1; 0.15%) and undefined (3; 0.45%). The reason why including all document types is that the authors try to retrieve related data thoroughly to get accurate analytical data. Articles from Hong Kong, Macao, and Taiwan Province were not included in Mainland China because, in the VOSviewer program, these areas in China were counted separately.

## Data Analysis

Bibliographic data related to these 670 files were derived from Scopus and synthesized quantitatively by Excel and VOSviewer program, which is a software application for building a visual document measurement network (Van Eck & Waltman 2017). All publication details collected from the Scopus database, including paper types, publication year, countries, titles, author keywords, abstracts, author affiliation, and varieties of citation data, have been exported into comma-separated values (.csv). Then, the data obtained from Scopus were uploaded to the VOSviewer program for data analysis and data visualization (Van Eck & Waltman, 2014). The bibliographic research depends on descriptive statistics, citation, and co-citation analyses to gain a detailed insight into a knowledge base (Zupic & Čater 2014). It can also reveal the framework and dynamics of the research field through the author's co-citation analysis (Cobo, López-Herrera, Herrera-Viedma, & Herrera, 2011).
In this review, data and graphs produced by Microsoft Excel were used to illustrate the publishing trend, geographic distribution, country contribution, most influential authors and articles, and most frequently studied author keywords, and under-explored themes. Meanwhile, the VOSviewer program analyzed the country collaboration, most influential authors, intellectual structure of the flipped classroom knowledge base in tertiary education, most frequently studied author keywords, and under-explored themes. In author keywords analysis, a 'thesaurus file' was created and adopted to remove duplicate author keywords, such as the author keywords "flipped classroom" and "flipped classrooms" were found redundant, so "flipped classrooms" were replaced by "flipped classroom." As an enlightening means, this analysis can measure the survival status of flipped classroom literature in higher education and provide practitioners and researchers with the latest progress in pedagogy.

# Results and Discussion

## Publication Status of Flipped Classroom in Higher Education Research

To answer research question 1 (What is the publication trend, geographic distribution, country contribution, and collaboration of flipped classroom in higher education research?), the researchers analyzed the publication trend about flipped classroom in higher education using total publications by year. As for the geographic distribution and country contribution, the analysis was based on the complete publications by the countries and the number of citations. The VOSviewer analyzed the country's collaboration by data visualization.

## Publication Trend

The number of total publications of flipped classroom in higher education from 2012 to 2021 July 14th is clarified in Figure 1. According to the figure, the first publication was proposed in 2012. The earliest paper was written by Janz, Graetz, Kjorlien (2013). It was a conference article with seven-time citations, and it presented a reproducible method for the development of a collaborative technology learning environment in higher education (Janz, Graetz, & Kjorlien, 2013). Few studies were indexed in the Scopus database from 2012 to 2013 with a total of 7 documents. The publication volume has demonstrated a significant growth trend since 2014. The yearly number of publications increased notably from 21 in 2014 to 65 in 2015, marking the rapid development of flipped classroom in tertiary education. One of the reasons for this kind of growth was that the ICT development became more mature. Then, steady growth from 2015 to 2017 was observed. The growth rate from 2017 to 2020 was significantly higher than that from 2015 to 2017. Since the data extraction date is 2021 July 14th, the number of publications (72 documents) in 2021 was only half a year's data. However, based on the growth of the total number of publications, the estimated number of publications might be a little more than 2020. Therefore, based on published paper status, flipped classrooms in higher education are trending in research and publications.

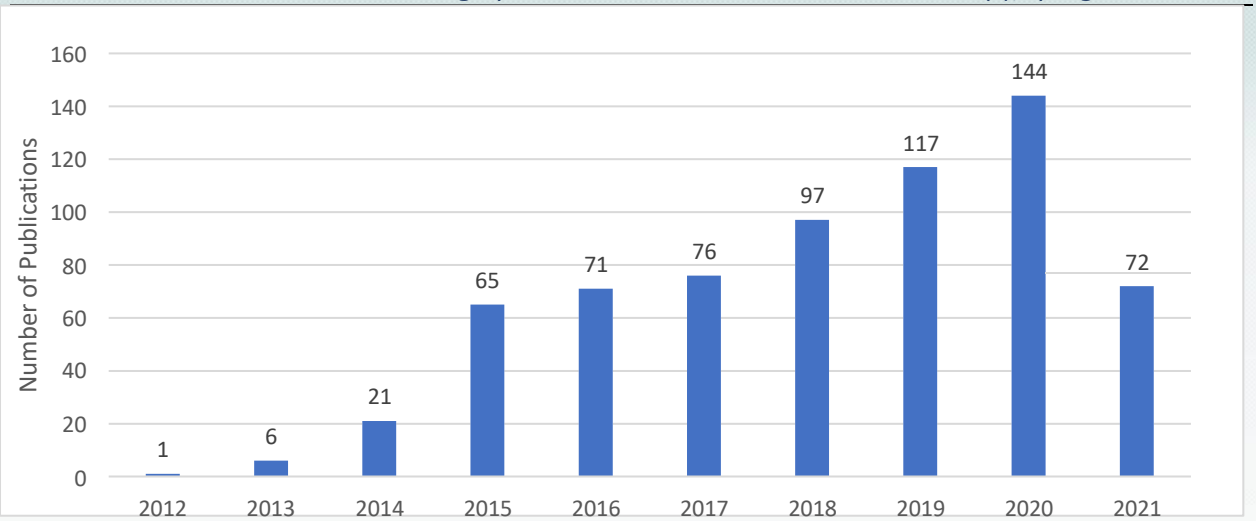


**Figure 1**: Total number of publications from 2012-2021 (July 14th)

**Geographic Distribution**

There were 72 countries involved in flipped classroom in higher education research based on the affiliation, thus affirming the global interest in this field. When extracting the data, names including group, communications, and centennial college libraries were excluded because they are not countries. Figure 2 shows the geographic distribution of the research publications on flipped classroom in higher education since 2012. According to the figure, the four leading countries in this field were the United States, Spain, Australia, and China. The United States was the most productive country with 129 articles (accounting for 17.36%), followed by Spain with 58 articles (accounting for 7.81%), Australia with 51 articles (6.86%), and China with 48 articles (6.46%). The publications from these four countries accounted for nearly half of the knowledge base for this review. The United States was far ahead in the number of articles. It is not surprising that the United States is leading the publications because the flipped classroom originated from the United States as early as 2000 (Lage & Platt 2000).

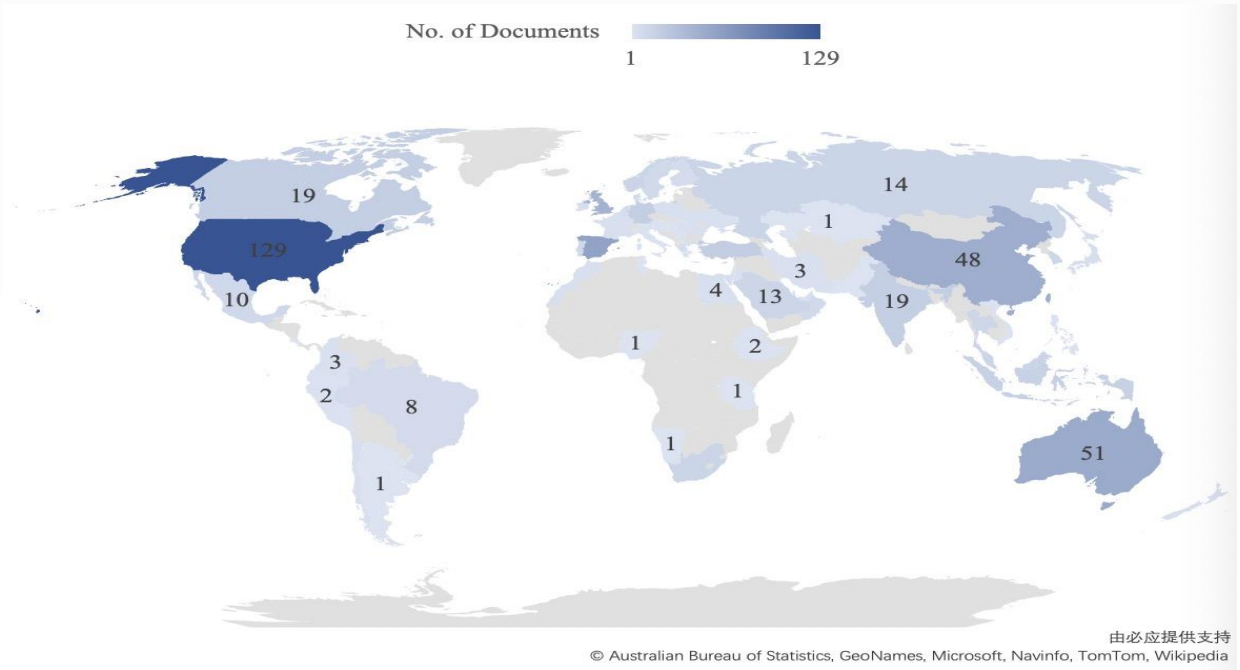


**Figure 2**: Geographic distribution of the research publications

The number of articles of the remaining three countries in the top four was close. All the countries with high productivity were developed countries except China, which means that flipped classroom is highly related to the ICT distribution. Meanwhile, scholars from many other countries have also made positive contributions to this field of educational research, including those from Britain, Turkey, Canada, Germany, and India. Canada, Germany, Hong Kong, and India

contributed the same publications, with 19 productions. As the flipped classroom is related to technology distribution, by inference, developing countries such as India are relatively advanced in educational technology. However, there was still a severe imbalance in the research of flipped classroom in higher education. According to geographic distribution, few scientific articles were reported in some countries or regions during the research period. Some countries were completely no contribution from the knowledge base, which often represented the developing society, and these countries often lacked information and advanced communication technology. Therefore, the research and development of flipped classroom in higher education worldwide are still facing significant challenges.

## Country Contribution

Figure 3 shows the countries' contribution to the highly cited articles of the flipped classroom in tertiary education, demonstrating the figure of citations received by respective country. The citation attribute presents the number of citations received by papers published by source, author, organization, or country (Van Eck & Waltman 2017).

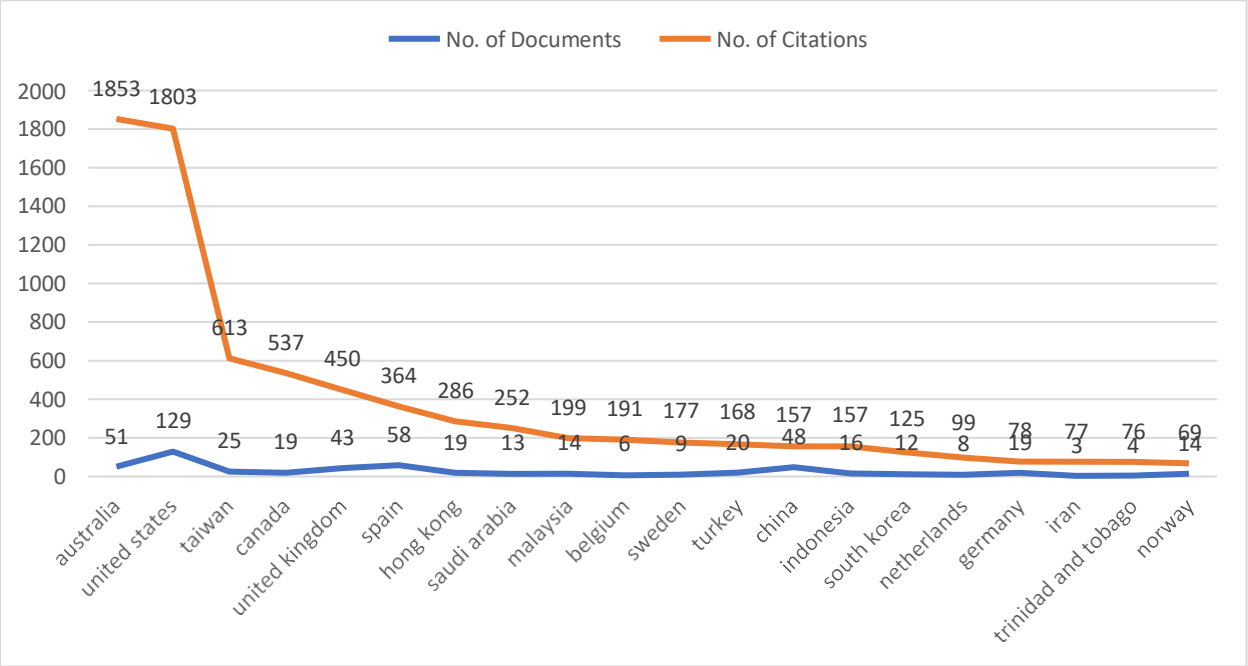


**Figure 3**: The 20 most cited countries during 2012-2021 (July 14th)

The result showed that Australia and the United States' contributions were more significant than other countries, with the number of citations 1853 and 1803 respectively, accounting for 21.93% and 21.34%, nearly half of the total number of citations. It was worth noting that compared with 129 articles in the United States, the total number of articles in Australia was 51. Regarding the number of citations, the citation rate on flipped classrooms in higher education research in Australia far exceeded that in the United States, with an average citation of 36.33%, ranking the first. In comparison, that in the United States was only 13.98%. It proved that the research in this field in Australia had a high reference value. Followed by Taiwan, with 25 articles cited 613 times, accounting for 7.26%, and Canada, with the number of citations 537, accounting for 6.36%. Other contributing countries for the most cited academic publications included the United Kingdom, Spain, Hong Kong, and Saudi Arabia, with more than 200-time citations. It can be concluded that western countries still occupy a particularly dominant position in the high citation of this subject.
This review also found that among the top 20 countries. However, the number of papers and the overall number of citations were lower than the United States, Taiwan Province, Canada, Hong Kong, Saudi Arabia, Malaysia, Belgium, Sweden, Iran, and Trinidad and Tobago all surpass the United States in the average citation, which means that with the progress of the ICT, the research on flipped classroom in tertiary education in Asian societies has also progressed, with more significant influence.
In addition, some countries also have international research publications on flipped classrooms in

higher education, such as Mauritius, Tanzania, and Tunisia in Africa, Uruguay, Argentina, and Peru in South America, but the number of citations is 0. This result further demonstrated that this research field was closely related to technology distribution. As a result, its research has not been referential. International scholars, especially those outside the developed societies, needed to strengthen the research depth of this subject, and improve the popularity of their research publications through the academic sharing network, to obtain more references and enhance their contribution to this subject.

## Country Collaboration

The VOSviewer was used to analyze the country collaboration and displayed in Figure 4, which was based on a country's five minimum number of documents. A total of 31 countries have been in conformity with the thresholds out of 72 countries, but the most significant connected items consisted of 26 countries.

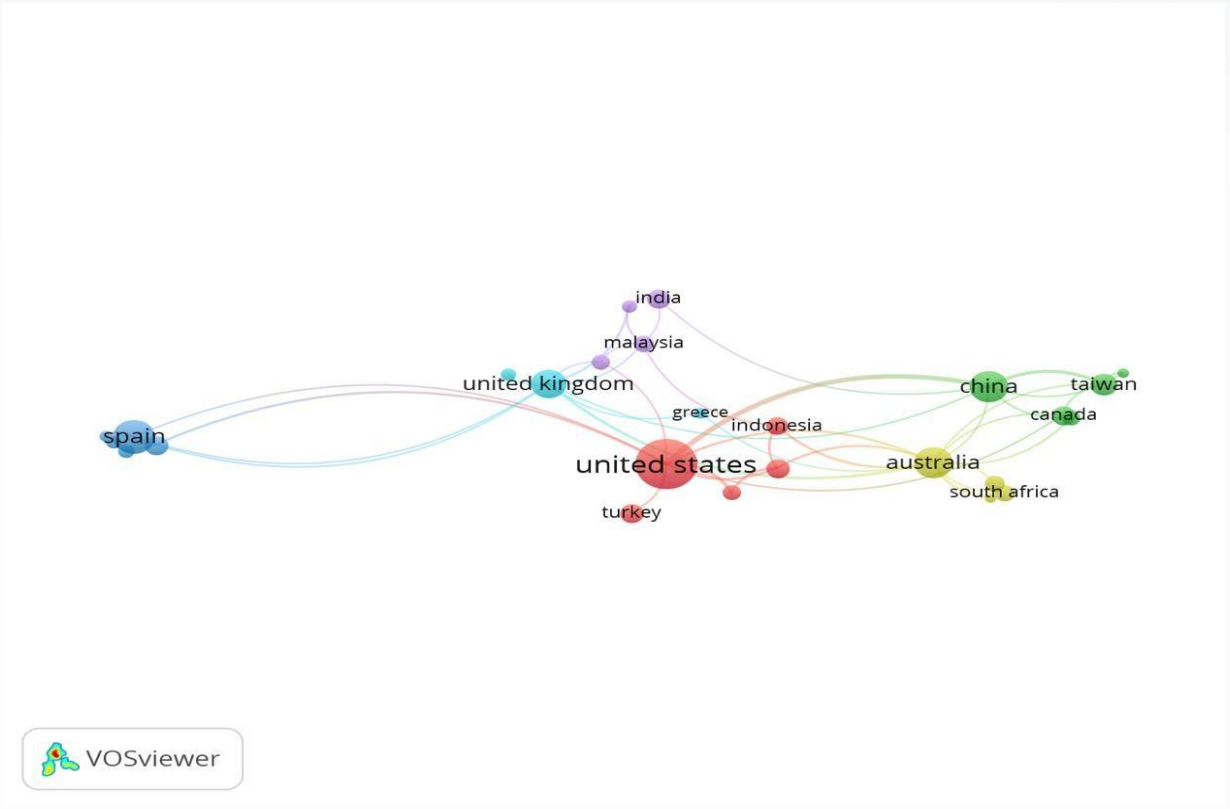


**Figure 4**: Country collaboration network (threshold 5, display 26 countries, 6 clusters)

The figure showed that all the 15 contributing countries cited more than 100 times appear in the country collaboration network. The results of the figure also showed that the United States represents the most extensive collaboration among countries, cooperating with nine countries to research the flipped classroom in tertiary education, with the highest total link strength of 22, with 129 collaborative publications. In addition, Australia's total link strength ranked second (total link strength=18), cooperating with 12 countries to produce 51 publications. These two countries are also the two countries with the highest number of citations.

Considering the total link strength of country collaboration, China became the top three in country collaboration (total link strength=17) and cooperated with 7 countries, producing 48 publications, which was very close to Australia. The United Kingdom ranked fourth (total link strength=12) and collaborated with 9 countries with 43 articles. However, according to the total amount of publications of each country, Spain, which ranked the second with 58 cooperated publications, exceeding that of the United States and China, has not been the top four in the country collaboration network, and the total link strength was only 5 with the total number of citations ranked 6. This finding indicated the value of country collaborations between countries in varieties of subjects of the world to produce many citations on this subject. This review also stands up for previous observations that there is an effective association between international

collaboration and the cited publications (Moosa & Shareefa, 2020).

## The Most Influential Authors and Articles

The objective of the RQ2 (What are the most influential authors and articles that have the most significant impact on flipped classrooms in higher education research?) was to determine the most influential authors and articles of flipped classrooms in tertiary education from the data in Scopus. One of the strengths of bibliometric analysis is identifying critical scholars and documents in the research field (McCain, 1986). This section analyzed the number of citations of both the authors and the articles and presented the network visualization map of authorship patterns. The researchers measured the influence of the articles on the flipped classroom in tertiary education through Microsoft Excel and VOSviewer software using the number of citations of each article.

## The Most Influential Authors

Citation analysis and authors were selected using the VOSviewer program to produce a visualization map of authorship patterns to identify the most influential authors in flipped classroom in higher education literature. The least number of documents of an author was put to two, and the least number of citations of an author was put to 50. Twenty-eight authors met the thresholds, and 22 authors related to among the total 1536 authors (see Figure 5). Among those, six scholars have published more than five papers, while 154 scholars published at least two papers, which implied that this field had attracted many scholars to do research. In addition, several networks were fixed around the most cited authors in Figure 5, and it presented collaboration positively impacting scholarly citations.

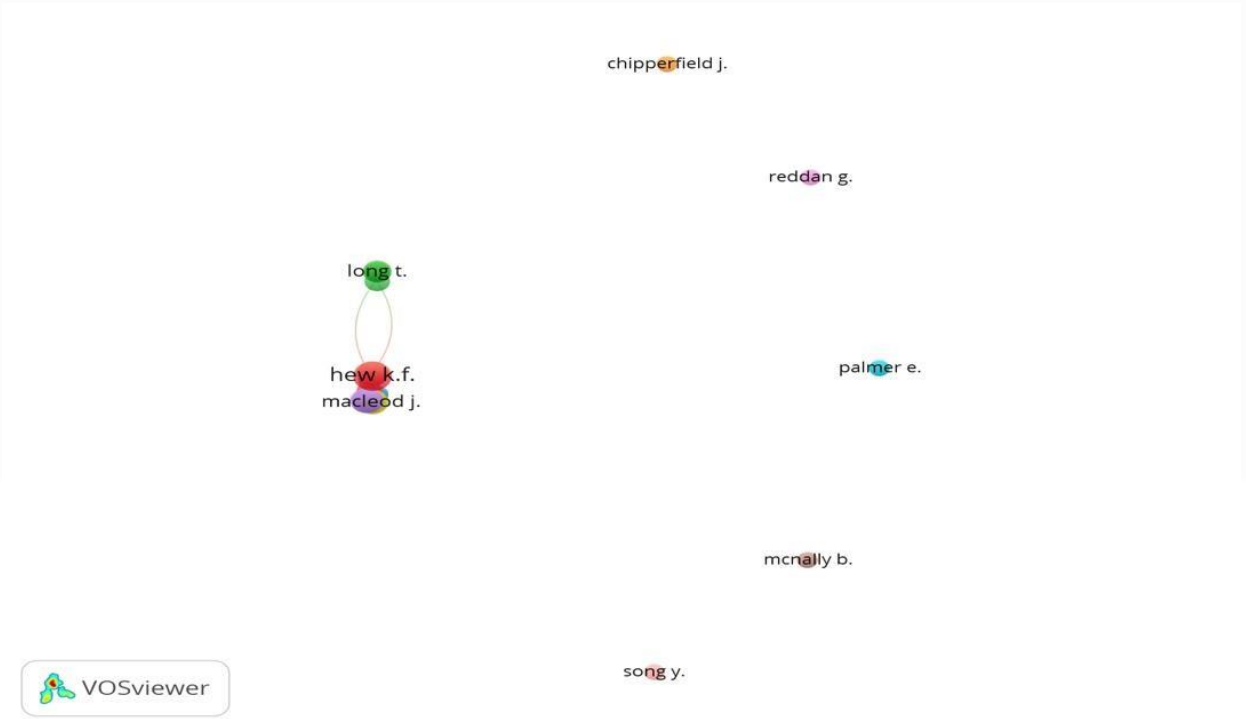


**Figure 5**: Visualization map of authorship patterns

The 28 authors who contributed most to the research topic are demonstrated in Table 1, analyzing the figure of documents, the figure of citations, and citations per document. The data presented that O'Flaherty and Phillips (2015) were the most-cited authors in this field with 819 citations, followed by Wang (255), Hew (205), Palmer (168), and Wanner (168). The most paper written by the cited author, O'Flaherty, and Phillips (2015), is a scoping review, offering a complete overview of relevant studies on the emergence of the flipped classroom and the connection with the future design and evaluation of pedagogy and educational achievements. However, there are authors such as Hew ranking the fourth the most-cited authors, whose citations per document is much lower than those lower ranked authors in Table 1, which meant that the citation impact of these

authors in Table 1 is relatively low. Besides, the citations in Table 1 were only on citations of each author's documents in Scopus. In addition, because researchers put the least number of files of an author in this analysis, Table 1 ignores several other highly cited authors who authored a single influential document. When the threshold changed to "at least 1 document" with more than 50 citations, there were 97 results, which indicated that 69 authors were also contributing much to this field based on the citations per paper.

| Rank | Author | Number of Publications | Number fo citations | Citations per document |
|---|---|---|---|---|
| 1 | o'flaherty j. | 2 | 819 | 409.5 |
| 2 | phillips c. | 2 | 819 | 409.5 |
| 3 | wang y. | 3 | 255 | 85 |
| 4 | hew k.f. | 7 | 205 | 29 |
| 5 | palmer e. | 2 | 168 | 84 |
| 6 | wanner t. | 2 | 168 | 84 |
| 7 | lo c.k. | 5 | 167 | 33.4 |
| 8 | de wever b. | 2 | 163 | 81.5 |
| 9 | valcke m. | 2 | 163 | 81.5 |
| 10 | zainuddin z. | 3 | 151 | 50.3 |
| 11 | galway l.p. | 2 | 142 | 71 |
| 12 | lee j. | 3 | 102 | 34 |
| 13 | huang b. | 2 | 97 | 48.5 |
| 14 | cummins j. | 3 | 93 | 31 |
| 15 | long t. | 4 | 93 | 23.25 |
| 16 | waugh m. | 3 | 93 | 31 |
| 17 | gonzález-gómez d. | 5 | 87 | 17.4 |
| 18 | jeong j.s. | 5 | 87 | 17.4 |
| 19 | lim c. | 2 | 87 | 43.5 |
| 20 | chipperfield j. | 2 | 80 | 40 |
| 21 | mcnally b. | 2 | 80 | 40 |
| 22 | reddan g. | 2 | 80 | 40 |
| 23 | cañada-cañada f. | 3 | 77 | 25.7 |
| 24 | chen n.-s. | 2 | 72 | 36 |
| 25 | song y. | 2 | 59 | 29.5 |
| 26 | macleod j. | 4 | 56 | 14 |
| 27 | yang h.h. | 5 | 56 | 11.2 |
| 28 | chen l. | 2 | 50 | 25 |

**Table 1**: Top 28 most cited authors (with more than 50 citations in total)

## The Most Influential Articles

Further analysis of the most influential articles on flipped classroom in higher education research was conducted by citation analysis. In citation analysis, the number of citations was adopted to measure literature's impact on flipped classrooms. The full dataset of 670 articles yielded 7,311 citations (see Table 2). Table 3 listed the most highly cited articles, and as it was shown, 4 articles achieved more than 200 citations (Betihavas, Bridgman, Kornhaber, & Cross, 2016; Chen, Wang, Kinshuk, & Chen, 2014; Gilboy, Heinerichs, & Pazzaglia, 2015; O'Flaherty & Phillips, 2015), and 9 articles reached 100 to 200 citations (Al-Zahrani, 2015; Arnold-Garza, 2014; Galway, Corbett, Takaro, Tairyan, & Frank, 2014; Hao, 2016; Mehta, Hull, Young, & Stoller, 2013; Seery, 2015; Thai, De Wever, & Valcke, 2017; Wanner & Palmer, 2015; Zainuddin & Halili, 2016). The top-cited

publications were all produced around 2014 to 2016. Based on the publication trend, there was a significant growth trend between 2014 and 2015, which means during that period, both the number and the impact of these publications were growing.

Table 2: Citation impact based on Scopus citations as of 2021 July 14th

According to Table 3, three reviews were ranked in the top 13 most highly cited papers (more than 100 citations). The most highly cited document produced by O'Flaherty and Phillips (2015) was a scoping review. O'Flaherty and Phillips are also the most cited authors, which means they pioneered the comprehensive overview of relevant research regarding the relationship between flipped classroom and pedagogy and educational achievements. It found that flipped classroom can enhance learning achievement and the satisfaction of students, but there was a lack of evidence of flipped classroom supporting lifelong learning in higher education (O'Flaherty & Phillips, 2015). The subsequent two empirical publications by Gilboy et al. (2015) focusing on how to accomplish the flipped classroom and to depict students' notions in undergraduate nutrition courses, and Chen et al. (2014) proposed a practical model that can be the basis for further study and exercise of flipped classroom in tertiary education. The following two reviews in order in the

| Citation Information | Total |
|---|---|
| Total citations | 7,311 |
| Mean citations per paper | 10.9 |
| Uncited papers | 237 |
| Papers with 200+ citations | 4 |
| Papers with 100+ citations | 13 |
| Papers with 50+ citations | 33 |

**Table 3:** were about flipped classroom in nursing and the health care system (Betihavas et al., 2016; Mehta et al., 2013).

Students reported positive attitudes towards flipped classroom, and it had a effective impact on students' study prectices, such as achievement and engagement based on the other publications ranked in the most cited articles about flipped classrooms in tertiary education (Galway et al., 2014; Seery, 2015; Thai et al., 2017; Wanner & Palmer, 2015; Zainuddin & Halili, 2016).

| Rank | Authors | Title | Year | Cited by | Document Type |
|---|---|---|---|---|---|
| 1 | O'Flaherty J., Phillips C. | The use of flipped classrooms in higher education: A scoping review | 2015 | 813 | Article |
| 2 | Gilboy M.B., Heinerichs S., Pazzaglia G. | Enhancing student engagement using the flipped classroom | 2015 | 371 | Article |
| 3 | Chen Y., Wang Y., Kinshuk, Chen N.-S. | Is FLIP enough? or should we use the FLIPPED model instead? | 2014 | 254 | Article |
| 4 | Betihavas V., Bridgman H., Kornhaber R., Cross M. | The evidence for 'flipping out': A systematic review of the flipped classroom in nursing education | 2016 | 215 | Review |
| 5 | Mehta N.B., Hull A.L., Young J.B., Stoller J.K. | Just imagine: New paradigms for medical education | 2013 | 168 | Review |
| 6 | Wanner T., Palmer E. | Personalising learning: Exploring student and teacher perceptions about flexible learning and assessment in a flipped university course | 2015 | 167 | Article |
| 7 | Thai N.T.T., De Wever B., Valcke M. | The impact of a flipped classroom design on learning performance in higher education: Looking for the best "blend" of lectures and guiding questions with feedback | 2017 | 161 | Article |
| 8 | Seery M.K. | Flipped learning in higher education chemistry: Emerging trends and potential directions | 2015 | 151 | Review |
| 9 | Zainuddin Z., Halili S.H. | Flipped classroom research and trends from different fields of study | 2016 | 149 | Article |
| 10 | Galway L.P., Corbett K.K., Takaro T.K., Tairyan K., Frank E. | A novel integration of online and flipped classroom instructional models in public health higher education | 2014 | 141 | Article |
| 11 | Hao Y. | Exploring undergraduates' perspectives and flipped learning readiness in their flipped classrooms | 2016 | 137 | Article |
| 12 | Al-Zahrani A.M. | From passive to active: The impact of the flipped classroom through social learning platforms on higher education students' creative thinking | 2015 | 117 | Article |
| 13 | Arnold-Garza S. | The flipped classroom teaching model and its use for information literacy instruction | 2014 | 105 | Article |

**Table 3**: Rank order of the top 13 flipped classrooms in higher education publications with more than 100 Scopus citations

## The Most Frequently Repeated Author Keywords and Under-Explored Themes Involving Flipped Classrooms in Higher Education

The analysis was based on the author keywords extracted from the Scopus database. The co-occurrence analysis was conducted by the VOSviewer program to answer RQ4 (What are the most frequently repeated author keywords and under-explored themes involving flipped classrooms in higher education?). When two keywords appear in an article simultaneously, co-occurrence occurs, indicating a relationship between these two concepts. Conducting co-occurrence and keyword evaluation can help researchers get some insights into the content of the articles because the author keywords sufficiently stand for the content of an paper (Comerio & Strozzi, 2019). In addition, practical information on the research trends can be found for researchers through author keyword analysis, so it is essential to monitor the development of research topics (Wen & Huang, 2011).

## Most Frequently Repeated Author Keywords

Author keywords are of much concern for researchers to gain some insights about the research trends (Wen & Huang, 2011), and it can measure the development of research themes in a field because the concepts behind these keywords are closely related when keywords co-occur in documents a lot (Zupic & Čater 2014). After deleting the duplicates occurring from subject differences (such as flipped classroom and flipped classrooms; MOOC and MOOCs), Table 4 presented the most repeated author keywords during 2012 to 2021 July 14th on the topic of flipped classrooms in tertiary education. According to the data, 1420 author keywords were used. Except for the search terms flipped classroom (311) and higher education (191), the other most used keywords were flipped learning (83), active learning (70), blended learning (68), MOOC (29), e-learning (19), online learning (19), inverted classroom (18), and collaborative learning (17). Synthesis of these author keywords suggested four broader themes, which were flipped classroom, ICT, collaborative learning, and higher education. Great efforts have been focused on this field.

| Rank | Keywords | Number of Occurrences | Avgerage publication year |
|---|---|---|---|
| 1 | flipped classroom | 311 | 2018.2669 |
| 2 | higher education | 191 | 2018.4869 |
| 3 | flipped learning | 83 | 2018.6988 |
| 4 | active learning | 70 | 2018.6143 |
| 5 | blended learning | 68 | 2018.3529 |
| 6 | mooc | 29 | 2017.4483 |
| 7 | e-learning | 19 | 2018.3158 |
| 8 | online learning | 19 | 2018.2632 |
| 9 | inverted classroom | 18 | 2018.1111 |
| 10 | collaborative learning | 17 | 2019.0588 |
| 11 | learning | 15 | 2018.4667 |
| 12 | teaching | 12 | 2018.0833 |
| 13 | education | 11 | 2018.2727 |
| 14 | gamification | 11 | 2019.2727 |
| 15 | engineering education | 10 | 2017.9 |
| 16 | learning analytics | 10 | 2019.2 |
| 17 | motivation | 10 | 2018.4 |
| 18 | self-regulated learning | 10 | 2018.7 |
| 19 | student engagement | 10 | 2018.3 |
| 20 | technology | 10 | 2018 |

Table 4: The most repeated author keywords

Further analysis is carried out by mapping author keywords provided for each document using the

VOSviewer program. Considering the frequency of appearance of each keyword, the least figure of occurrences of a keyword is five, and based on this threshold, 53 keywords were identified. Figure 6 demonstrates the network visualization of VOSviewer author keywords. As displayed in the results, significant concepts derived from the keywords were categorized into 10 clusters. There were three significant clusters based on the color, recurrence dimension, letterform dimension, and concentration of the connecting lines, which indicate the strength of the correlation between these keywords (Sweileh et al., 2017). According to the co-occurrence power of keywords obtained by the VOSviewer program, each cluster was composed of keywords with the most vigorous intensity. The green cluster outlined flipped classroom with ICT and self-regulated learning. The red cluster represented the role of flipped learning in academic performance, including science, mathematics, and students' reflections. The blue cluster portrayed higher education and ICT.

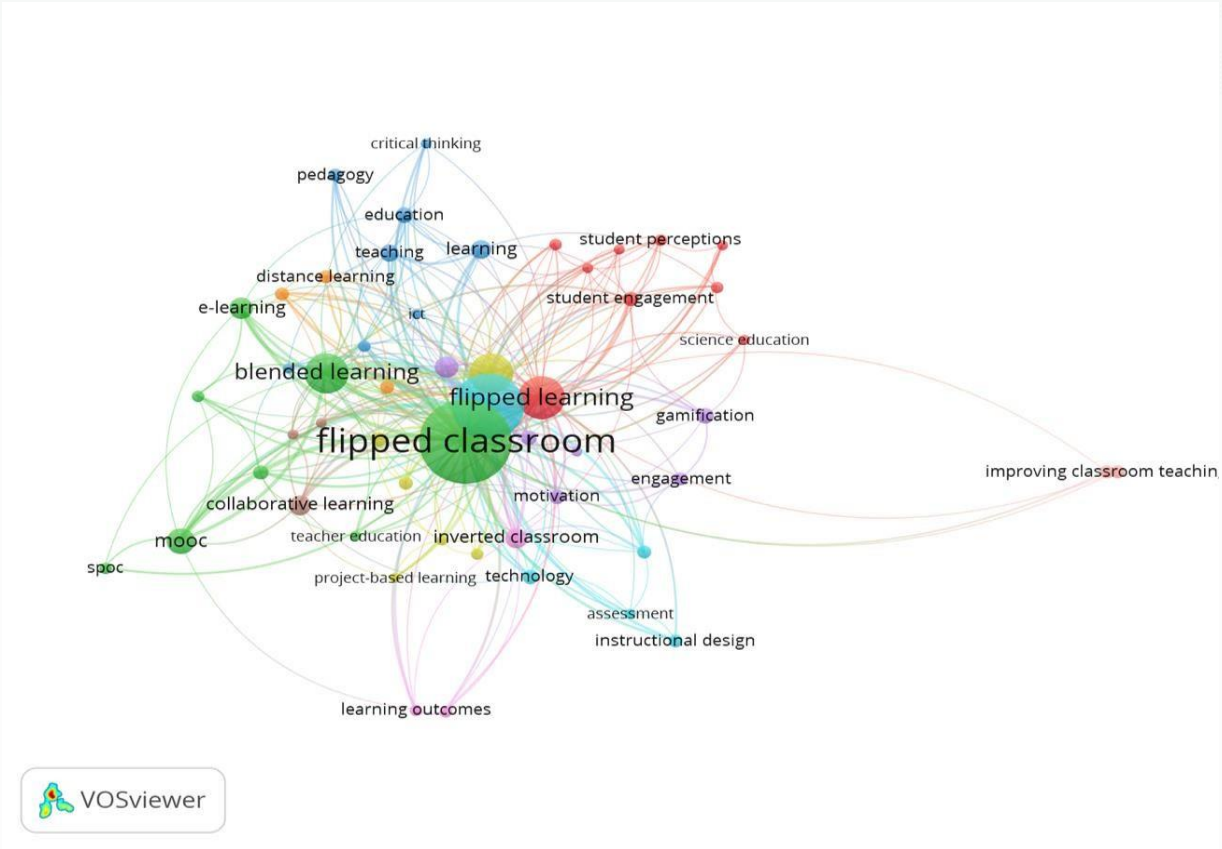


**Figure 6**: Co-occurrence map of keywords (1420 keywords; threshold five co-occurrences, display 53 keywords).

## Under-explored Themes

The under-explored themes analysis of flipped classroom in higher education was conducted by Excel and VOSviewer program. Figure 7 shows the overlay visualization for the keyword co-occurrence map to identify the research front in this field. Overlay visualization map analysis (threshold 5 co-occurrences) determined the latest and trendy topics of interest according to the yellow color or light hue and its co-occurrence frequency based on node size. Then, the researchers combined the data in Table 5, which demonstrated keywords with low co-occurrence frequency and rank-ordered the themes based on time. Since the setting of the minimum number of co-occurrences is 2 in this analysis, so Table 5 ignores other themes that appeared only once in a document. According to Figure 7, the four themes that represent the under-explored in flipped classrooms in higher education are academic performance, learning experience, learning outcomes, and self-regulation. These themes were trendy and under-explored. On the data basis of Table 5, bibliometrics, co-regulation, EFL learners, performance, threshold concepts were the top four themes that needed more attention.

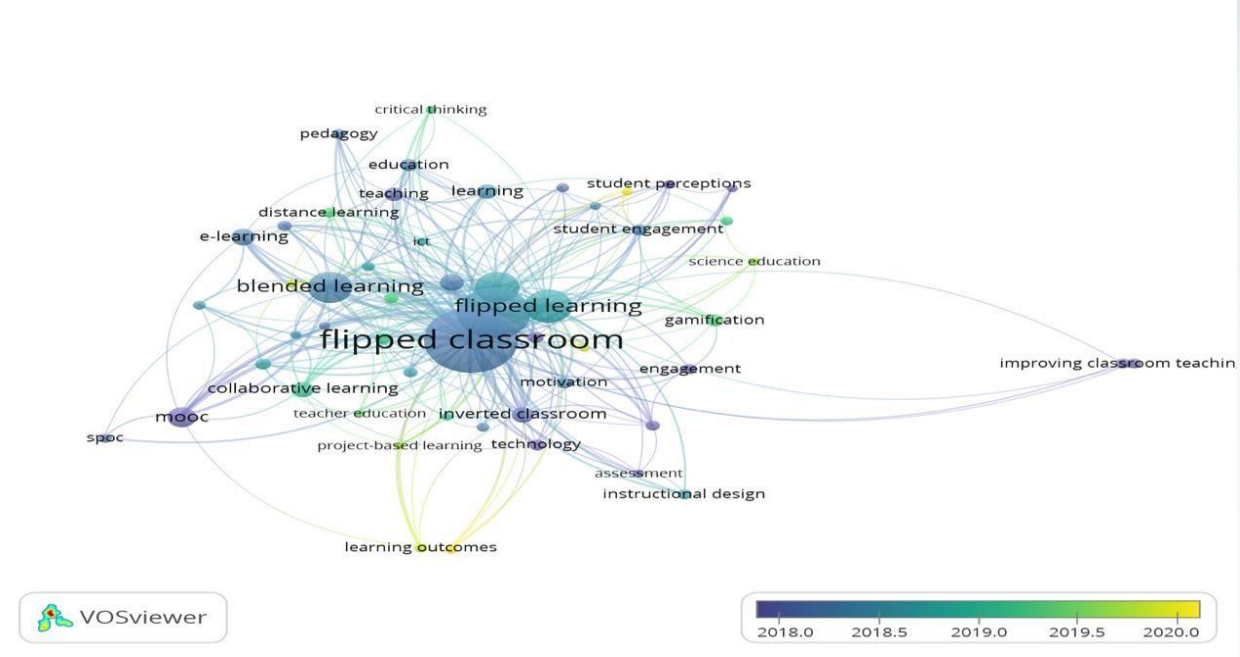


**Figure 7**: Overlay visualization for the keyword co-occurrence map (1420 keywords; threshold five co-occurrences, display 53 keywords)

**Table 5**:
Latest themes with low co-occurrence frequency

| Rank | Keywords | Number of Occurrences | Avgerage publication year |
|---|---|---|---|
| 1 | bibliometrics | 2 | 2021 |
| 2 | co-regulation | 2 | 2021 |
| 3 | efl learners | 2 | 2021 |
| 4 | performance | 2 | 2021 |
| 5 | threshold concepts | 2 | 2021 |
| 6 | active methodology | 2 | 2020.5 |
| 7 | content-based | 2 | 2020.5 |
| 8 | feedback | 2 | 2020.5 |
| 9 | interactive learning | 2 | 2020.5 |
| 10 | learning object | 2 | 2020.5 |
| 11 | learning recommender system | 2 | 2020.5 |
| 12 | learning videos | 2 | 2020.5 |
| 13 | meaningful learning | 2 | 2020.5 |
| 14 | pedagogical innovation | 2 | 2020.5 |
| 15 | professional development | 2 | 2020.5 |
| 16 | time management | 2 | 2020.5 |
| 17 | virtual learning | 2 | 2020.5 |
| 18 | web-based learning | 2 | 2020.5 |
| 19 | academic achievement | 2 | 2020 |
| 20 | behavioral engagement | 2 | 2020 |
| 21 | classroom teaching | 2 | 2020 |

## Limitations

There are some limitations in this study. First, the purpose of the bibliometric analysis is different from traditional review methods. It aims to reveal the intellectual structure of a knowledge base instead of synthesizing research findings. Therefore, bibliometric analysis is intended to supplement, not replace, other review methods.

Another limitation concerns this review's bibliographic databases, which use a single database only from Scopus. The Scopus index presents finite data source coverage, meaning some possibly essential data may be omitted.

Furthermore, although bibliometric analysis is strict in quantity, the production and explanation of co-citation maps are not always precise. Diverse co-citation analysis thresholds can produce different results.

## Conclusion

This study explores the research trends of flipped classrooms in higher education, including publication trends, geographic distribution, country contribution, and collaboration, the most contributing authors and articles, the most frequently repeated author keywords, and under-explored themes. This paper adopted the bibliometric analysis method.

There are some contributions to the scientific literature from the 670 refereed documents on the flipped classroom in higher education (2012-20201.7.14). The number of publications was growing firmly in the data analyzed, which was found the same in Julia, Tsai, and Wu, and Yang, Sun, and Liu (Julia, 2020; Tsai & Wu, 2020; Yang et al., 2017). It demonstrates that this research field is developing. This growing development is due to the new proposal of education methodology in higher education and the need for a student-centered approach since flipped classroom is a student-centered pedagogy (Michalsky & Schechter, 2013). It implies that flipped classrooms will continue to be trendy in the coming decades.

The analysis of country distribution, contribution, and collaboration shows that countries from almost all continents participated in the research of flipped classrooms in tertiary education, demonstrating the value of this topic at the global level. It could help scholars gain some insights of the flipped classrooms worldwide.

According to the analysis of the most influential authors and articles, the most cited paper is from O'Flaherty and Phillips (2015) on the relationship between flipped classrooms and academic achievement, with 819 citations. In addition, the flipped classroom is very popular in the field of nursing and health care.

Based on the co-occurrence of keywords analysis, flipped classroom in higher education is closely related to active learning, blended learning, MOOC, e-learning. This co-occurrence of keywords analysis represents that flipped classroom is closely associated with information and communication technology (ICT). Through this keyword analysis, the emphasis on flipped classrooms in tertiary education research in the past nine years has become apparent because it responds to the current educational needs with ICT. The rapid development of ICT has expanded students' learning participation. It accelerates people's acceptance of the flipped classroom, which might help deal with the potential difficulties in the future education environment. At the same time, it is also found that there is a lack of bibliometric analysis in this field, and the research on its application in EFL is not enough, and these two themes are also the latest. Bibliometric research could become a solution for researchers, and EFL flipped classroom could be a solution to improve students' EFL ability worldwide.

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