

## Article

# Global Evidence on Flipped Learning in Higher Education

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**Abstract:** The teaching dynamic has positioned flipped learning as a pedagogical model, a methodology that helps teachers prioritize active learning during class time by assigning students reading materials and presentations to view at home or outside of class. The objective was to determine the original stages, expansion and current situation of the flipped learning methodology. A bibliometric analysis of 654 documents was carried out. The results reveal that scientific productivity follows an increasing linear trend, with the main categories being Social Sciences and Computer Science. The lines of research developed in this period related to learning, online learning, teaching, distance education, higher education and educational innovation were identified. It was found that the research topic has a growing and dynamic interest in scientific activity at the international level. The analysis documented a rapidly growing knowledge base, primarily written by scholars located in developed societies. This study supposes an analysis of the scientific production and of the actors who stimulate the investigation, as well as the identification of the lines of investigation.

**Keywords:** flipped learning; higher education; teaching; scientific production



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## 1. Introduction

In recent years, flipped learning (FL) has become a methodology that helps teachers prioritize active learning during class time by assigning students reading materials and presentations to view at home or outside of class. FL is based on the idea that students learn more effectively by using class time for small group activities and individual attention, thus prioritizing active learning. [1]. In this context, teachers assign students reading materials and presentations to read or view outside of the classroom. [2].

FL refers to the creation of opportunities for active participation, since it is a pedagogical approach in which direct instruction moves from the group learning space to the individual learning space, and the resulting group space is transformed into a learning environment, dynamic and interactive, where the educator guides students as they apply concepts and creatively engage with the topic [3].

The origins and history of FL center on two U.S. high school teachers, Jonathan Bergmann and Aaron Sams, who were exhausted by the need to repeat lessons for students who had been absent. Thus, using screen capture software, they began to record their lessons. They made their lessons available online for their students to view on their own time. Hence, they soon discovered that their students could access their recorded lessons at a time that was most convenient for them, whether at home on their computers or laptops or during free periods at school from their portable devices such as smartphones and tablets [4,5].

In this context, the question arises as to what is the key meaning of FL for teachers. First, they can spend more time with struggling students while allowing more advanced students the freedom to work ahead of time. It is large-scale differentiated instruction integrated into the curriculum [6,7].

Teachers explain a concept to students on video or through voice-over presentation software. Students can view content before class and prepare for the day's activities [8].

This gives freedom on how, when and where they learn, and allows them to interact with the video content in the way that suits them best, i.e., an online resource that helps teachers move from traditional classroom teaching to a flipped model [9,10]. Technology enables teachers to make the most of class time and encourage student-led learning. Currently, both secondary schools and higher education institutions are leading the adoption of the FL model [11,12]. In general, FL is most often put into practice by experienced educators [13].

Because students are already familiar with the material when class begins, they can spend their time collaborating with their teacher and other students to enhance their understanding, either individually or in small groups. The flipped model makes class time more enjoyable, productive, and interesting for students and teachers. With a flipped classroom, students absorb content on their own time, watch video lectures, and access their readings through a learning management system [14,15].

Educational systems have been based mainly on the criterion of grouping students by age. This orientation makes it difficult for teachers to attend to the individual needs of each student, which must be addressed to maximize personal development. The more above or below the profile of the standard age group the students are, the more problematic the situation is. For example, this happens in the case of the most capable students, whose specific cognitive and non-cognitive abilities are revealed through differentiated attention, with special mention to the earliness and pace of learning [16,17].

Teachers observe an improvement in student test scores after using the FL model, as well as an improvement in student motivation [18,19]. Hence, teachers understand that the model benefits numerous students, from the academically advanced to those with special needs [2,20]. In this sense, teachers also benefit from applying this pedagogical model, because they have greater job satisfaction after applying the model in their classrooms, and they tend to apply the methodology again in the following academic years. In this way, flipped instruction is beneficial to the overall learning and teaching experiences [21].

One of the most important benefits of adopting FL methods is that students can learn more deeply and better retain the material [22]. Because they have more ownership over the learning process and receive more frequent feedback, students are able to gain a more complete understanding of the content. Additionally, classrooms that incorporate FL offer more opportunities to interact and learn from other students [23]. With the guidance of their teachers, students work together to solve problems and apply new concepts. This creates a stronger learning community [24].

A basic principle of FL is to take advantage of technology and allow students to use their own time and technology for the beginning of the lesson. This means that class time can be used more effectively to encourage and reinforce learning [14]. In a flipped classroom, class time will be used for more exercises or controlled practice, going over main ideas and key points, or working on a project in groups or as a whole class [15]. The main idea is that the students put into practice what they have learned outside the class inside the class, with the teacher at their side to support them [2,10].

The use of the FL approach is gradually increasing, since numerous teachers apply it in their classes and recommend other educators to apply it in their classes. Thus, it follows that FL inspires teachers to update traditional methods and include new technology in their classrooms.

Table 1 shows the main documents reviewed on the research topic, helping to establish a framework for the theoretical basis and terminology of FL in higher education. Its analysis has allowed us to determine the problem, the purpose and the objective of the research, as well as to obtain the key terms to apply the methodology specified in Section 2.

**Table 1.** Main documents initially reviewed to determine the objective of the research.

Reference	Year	Document Title
[25]	2021	To Flip or Not to Flip? A Meta-Analysis of the Efficacy of Flipped Learning in Higher Education
[26]	2020	Examining the effect of flipped learning model in flute education on motivation and performance of students
[27]	2020	Students' experience with flipped learning approach in higher education
[11]	2020	Flipped learning and teaching as an opportunity for innovative and flexible implementation of student groupings in higher education
[28]	2019	Student views on the use of flipped learning in higher education: A pilot study
[29]	2018	Flipped learning and online discussion in higher education teaching
[8]	2018	Flipped learning in higher education: Problems and contradictions
[14]	2018	Successful stories and conflicts: A literature review on the effectiveness of flipped learning in higher education
[3]	2017	Development of an instructional design model for flipped learning in higher education
[10]	2015	Reflections on the use of iterative, agile and collaborative approaches for blended flipped learning development

The purpose of this work is to carry out an analysis of the main contributions of FL to the scientific literature. Consequently, the objective of the study is to determine the original stages, expansion and current situation of the flipped learning methodology, from 2013 to 2021, that is to say, from the first article published until the last full year. It is essential to know the state of scientific activity in the field of knowledge to continue with the most appropriate lines of research. The rest of this study is structured as follows. Section 2 details the methodology applied, Section 3 consists of the empirical findings and their discussion in a comprehensive context, and the conclusion is presented in Section 4.

## 2. Materials and Methods

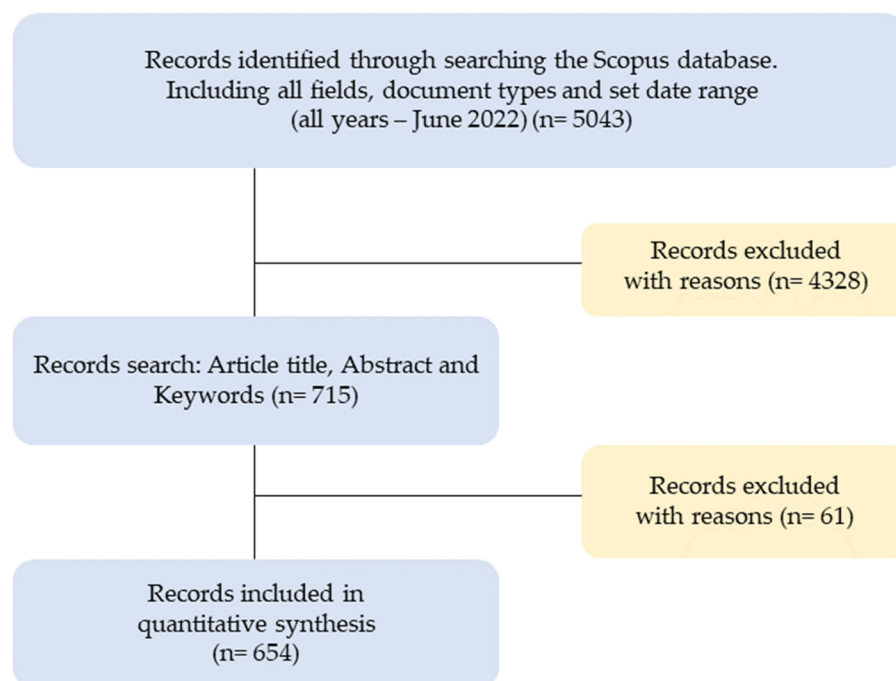
Bibliometrics is a part of scientometrics that applies mathematical and statistical methods to scientific literature and the authors who produce it, with the aim of studying and analyzing scientific activity. The instruments used to measure the aspects of scientific activity are bibliometric indicators, which are measures that provide information on the results of scientific activity in any of its manifestations. It was introduced by E. Garfield in the middle of the 20th century, and since then it has become widespread in scientific research and has contributed for decades to revising knowledge in multiple disciplines [30]. Bibliometrics has evolved from the reflection on scientific development and the availability of numerous databases for the researcher. This methodology has recently been successfully applied in other analyses, so that it has contributed to the review of scientific knowledge [31,32].

The objective of this work is to show a vision of the general dynamics of research and the state of the art of the projection of FL in the field of education. To achieve the proposed objective, a quantitative analysis was carried out, using bibliometrics. Likewise, the objective of this method is to identify, organize and analyze the trends of the research topic. Bibliometrics allows knowing the main promoters of a field of research, such as authors, journals, institutions or countries, as well as the collaboration relationships between them.

The method used was to perform a complete search in the Scopus database, using a search string, with the terms "flipped learning" and "education", to examine the subfields of the title, abstract and keywords, in a period of nine years, from 2013 to 2021, as reflected in other bibliometric works [33,34]. Scopus (Publisher: Elsevier, Amsterdam, Netherlands) is an international database of scientific information and was chosen to carry out this analysis. Scopus is the largest data repository for citations and abstracts of peer-reviewed research literature. In addition, this database ensures the representativeness of the sample of documents and the quality of the data collected.

The process followed in the selection of the sample is adjusted to the flow chart of Figure 1.

1. Phase 1: 5043 records from the Scopus database were identified, considering all fields for each of the key search terms (flipped learning and education), all document types, and all data in the data range (all the years to June 2022). Descriptive terms were identified from the first literature review (Table 1).
2. Phase 2: In the field of each term, the option “article title, abstract and keywords” was chosen, so 4328 records were excluded.
3. Phase 3: Of the 715 records, 61 documents from the year 2022 were excluded, so the final sample included 654 articles (in open and non-open access), conference papers, reviews, book chapters, conference reviews, books, letters, notes, editorials and short surveys. There are no duplicate records, as each one has a unique DOI (Digital Object Identifier), because it is a unique alphanumeric string created to identify a piece of intellectual property. It is also necessary to clarify that a different query can give a different sample and different results.



**Figure 1.** Flowchart to determine the data sample.

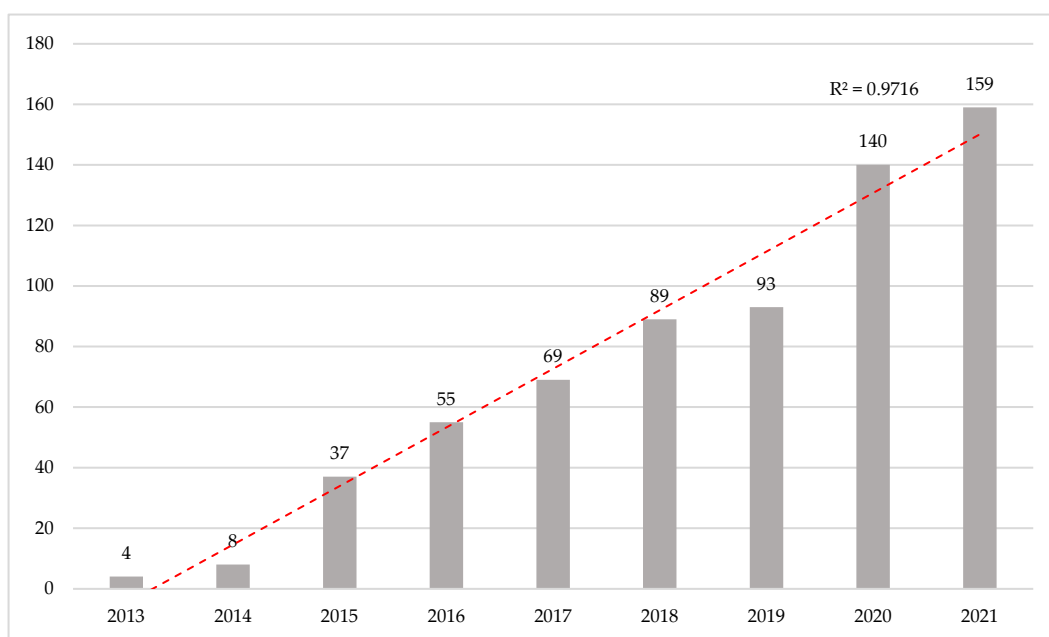
The variables analyzed were the year of publication, subject area, journal, author, author’s country of affiliation, research institution where the author is affiliated, funding sponsors and keywords that define the publication. The indicators of the collaboration structure, which measure the links between authors and countries, have been analyzed through the processing tools and network maps due to their reliability and suitability in bibliometric analysis.

For the visualization of maps, VOSviewer software (version 1.6.18, Center for Science and Technology Studies, Leiden University, Leiden, The Netherlands) was used [35]. The use of mapping tools allows the identification of areas of collaboration between some actors. Thanks to these tools, the bibliographic information of a database can be displayed, as well as the main research trends. This application has been useful and relevant in areas where international collaboration is essential, such as the educational sector.

### 3. Results and Discussion

Figure 2 shows the evolution of scientific production on FL worldwide. Analysis of the number of papers published in 2013–2021 shows that research on this topic has attracted

increased attention over the years. The publication follows a linear trend (see dotted line in Figure 1), where the number of documents has increased from four published in 2013 to 159 in 2021. This line shows its goodness of fit with an  $R^2$  of 0.9716, referring to the proportion of variance in the variable dependent (number of documents) which is predictable from the independent variable (year of publication). The number of records has been increasing each year of the analyzed period. The evolution in the number of publications is especially outstanding from 2020 onwards.



**Figure 2.** Evolution of scientific production (2013–2021).

From the sample of documents extracted from Scopus, 59.02% were articles, followed by documents presented at conferences, with 28.90%. The rest of the document types, which add up to 79, did not individually reach 5% (Table 2). In general terms, research on the FL model is published in specialized academic journals, mainly through articles evaluated by the peer review or arbitration method, to guarantee their reliability, integrity and consistency.

**Table 2.** Document type (2013–2021).

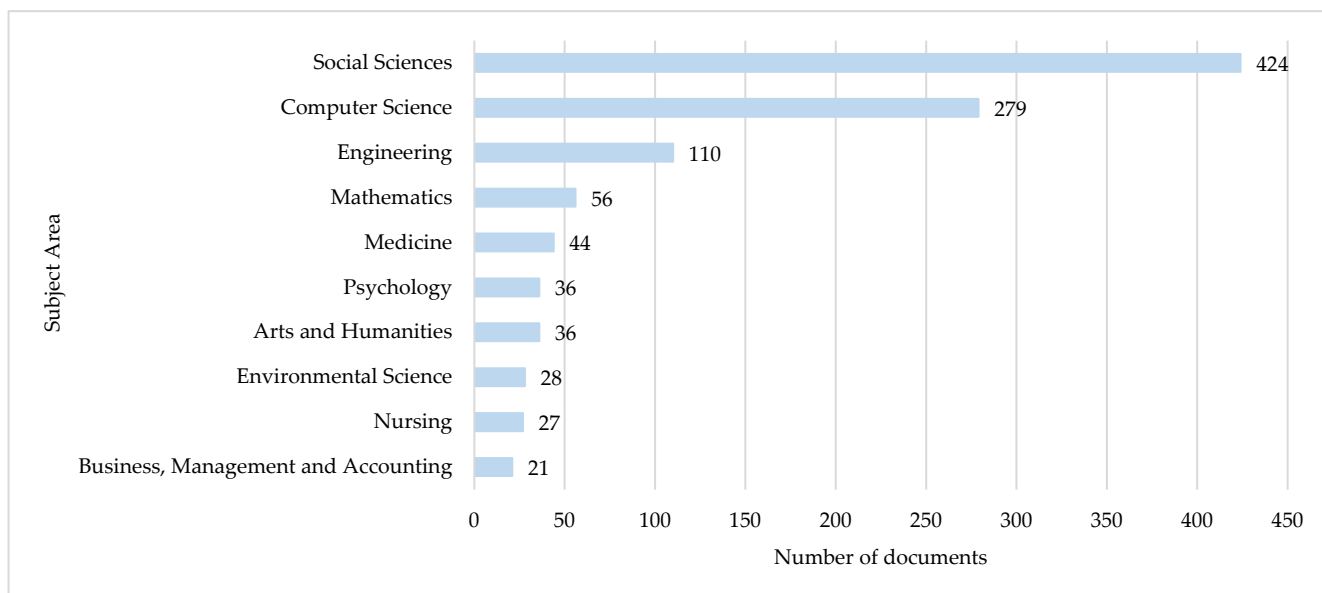
Document Type	Number	%
Article	386	59.02%
Conference Paper	189	28.90%
Review	32	4.89%
Book Chapter	24	3.67%
Conference Review	15	2.29%
Book	2	0.31%
Letter	2	0.31%
Note	2	0.31%
Editorial	1	0.15%
Short Survey	1	0.15%

%; percentage of total.

The sample documents were published in 11 languages. Most (617; 93.77%) were written and published in English, as is typical in scientific production globally.

Likewise, the published documents were classified into 26 different categories. It is necessary to consider that the same article can be classified simultaneously in different thematic areas. Throughout the study period, the main categories were Social Sciences and

Computer Science, which published 64.83% and 42.66% of the total number of published documents, respectively (see Figure 3). These were followed by Engineering with 16.82%, Mathematics with 8.56%, Medicine with 6.73% and Arts and Humanities and Psychology with 5.5% each. The rest of the category did not reach 5%. The FL methodology is an intrinsically multidisciplinary concept, which requires the observation of its application in the rest of the knowledge areas for its analysis [2].



**Figure 3.** Main subject areas (2013–2021).

Table 3 includes the twenty-four most productive authors in FL. Hew, K.F. (Southwest University, Faculty of Education, Chongqing, China) is the author with the highest number of published documents (17), with eight articles, five conference papers and three reviews. His works on the theoretical and practical analysis of the FL model are the most relevant at an international level, where he applies them mainly to both education computing and mathematics education [36,37].

**Table 3.** Top authors (2013–2021).

Rank	Author	Documents	Rank	Author	Documents
1	Hew, K.F.	17	13	Cho, M.K.	4
2	Lo, C.K.	12	14	Huang, W.	4
3	López-Belmonte, J.	12	15	Hung, H.C.	4
4	Belmonte, J.L.	10	16	Hwang, G.J.	4
5	Sánchez, S.P.	9	17	Jeong, K.O.	4
6	Moreno-Guerrero, A.J.	8	18	Jia, C.	4
7	Cabrera, A.F.	7	19	Kim, M.Y.	4
8	Fuentes-Cabrera, A.	7	20	Pozo-Sánchez, S.	4
9	Hwang, G.J.	6	21	Rodriguez-Paz, M.X.	4
10	Núñez, J.A.L.	6	22	Tsai, C.W.	4
11	Parra-González, M.E.	5	23	Wu, W.C.V.	4
12	Segura-Robles, A.	5	24	Zamora-Hernandez, I.	4

Table 4 shows the ten most cited documents in relation to the research topic during the 2013–2021 period. It was observed that the article with the most citations was from 2016 (318). This suggests that the integration of the self-regulation strategy in FL, its planning strategies and the use of study time can improve students' self-efficacy, so that this will have repercussions on effective learning and better learning achievement [13].

**Table 4.** Most cited documents (2013–2021).

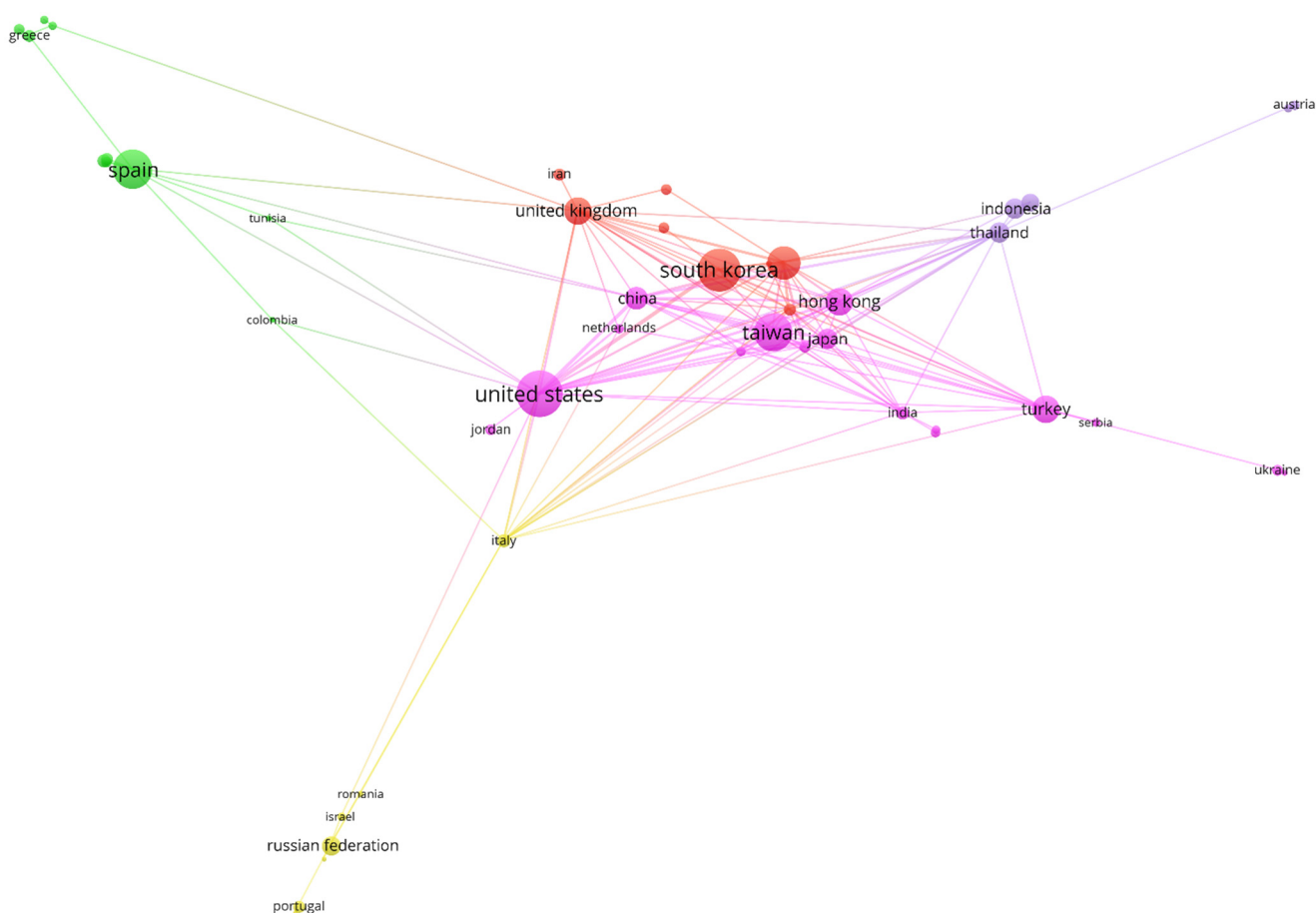
Reference	Year	Document Title	Citations
[13]	2016	A self-regulated flipped classroom approach to improving students' learning performance in a mathematics course	318
[6]	2014	Is FLIP enough? or should we use the FLIPPED model instead?	305
[7]	2018	Flipped classroom improves student learning in health professions education: A meta-analysis	289
[5]	2018	A systematic review of research on the flipped learning method in engineering education	224
[21]	2016	Flipped classroom research and trends from different fields of study	181
[38]	2015	Flipped learning in higher education chemistry: Emerging trends and potential directions	177
[39]	2017	A critical review of flipped classroom challenges in K-12 education: possible solutions and recommendations for future research	170
[24]	2016	Exploring undergraduates' perspectives and flipped learning readiness in their flipped classrooms	166
[40]	2016	Performance and Perception in the Flipped Learning Model: An Initial Approach to Evaluate the Effectiveness of a New Teaching Methodology in a General Science Classroom	126
[36]	2017	Toward a set of design principles for mathematics flipped classrooms: A synthesis of research in mathematics education	117

Year: year of publication.

Figure 4 shows the visualization map of the collaboration between the main countries/territories based on the co-authorship method. Likewise, the colors correspond to the different clusters of countries, while the diameter of the circle varies depending on the number of documents published by each country/territory. The VOSviewer tool grouped them into five clusters. The publications of the main countries/territories are linked to the thematic axes that analyze the educational aspects of FL. At a world level, research is led by the United States, South Korea, Spain, Taiwan, Australia, Hong Kong, Turkey and the United Kingdom. The rest of the countries contributed less than 30 documents. Fundamentally, between the countries of each cluster, collaborations are produced by agreements between institutions and affinities on study topics.

Table 5 shows the publication sources with more than six documents published on FL (2013–2021), according to the Scopus database, in which progress on research on the topic is collected, including reports and updates about new research. The first six journals have published 78 documents, that is, 11.93% of the total. In this ranking, the journals *Interactive Learning Environments*, *Lecture Notes in Computer Science*, *Sustainability* and *Education Sciences* stand out as the main promoters in the publication of peer-reviewed academic articles.

Figure 5 shows the keyword network from the co-occurrence analysis; the VOSviewer tool has associated them into six clusters. The lines of research detected have developed the following concepts and their different approaches: learning, online learning, teaching, distance education, higher education and educational innovation.



**Figure 4.** Network of countries/territories (2013–2021).

**Table 5.** Publication sources (2013–2021).

Publication Source	Documents	%
<i>Interactive Learning Environments</i>	17	2.60%
ACM International Conference Proceeding Series	15	2.29%
<i>Lecture Notes in Computer Science</i>	15	2.29%
<i>Sustainability</i>	11	1.68%
CEUR Workshop Proceedings	10	1.53%
<i>Education Sciences</i>	10	1.53%
<i>Computers and Education</i>	9	1.38%
<i>International Journal of Environmental Research and Public Health</i>	9	1.38%
<i>Journal of Physics Conference Series</i>	7	1.07%
<i>Computer Applications in Engineering Education</i>	6	0.92%
<i>International Journal of Engineering Education</i>	6	0.92%
<i>Journal of Chemical Education</i>	6	0.92%
<i>Mathematics</i>	6	0.92%

%; percentage of total.

Below are the keywords that define each of the six groups and that represent the topics that have been analyzed in the 2013–2021 period:

- Cluster 1 (pink): learning, problem-based learning, motivation, procedures, self-directed learning, educational measurement, satisfaction, ability, academic performance, teacher, technology, COVID-19, educational model, perception, psychology, simulation, performance academic, achievement, comparative efficacy, university, communication, outcome evaluation, randomized controlled trial, self-efficacy, university education, creativity and learning style.





Table 6 includes the ten most important keywords by the number of documents that appear in each of the years of the period studied, that is, from 2013 to 2021. The term “students” is the most representative in all years, except in 2014, when it was the second most representative, and this indicates that student learning is the center of the FL model. They also highlight the term or concept of “flipped classroom” due to its conceptual similarity with flipped learning. The term “teaching” has also been among the top positions since 2014.

**Table 6.** Top 10 keywords per year (2013–2021).

2013		2014		2014	
Keyword	D	Keyword	D	Keyword	D
students	3	students	4	students	4
adaptive content	1	teaching	4	teaching	4
adaptive content review	1	education computing	3	education computing	3
adaptive user interface	1	blended learning	2	blended learning	2
brain computer interface	1	computer aided instruction	2	computer aided instruction	2
computational thinking	1	e-learning	2	e-learning	2
computer operating systems	1	learning systems	2	learning systems	2
deep learning	1	motivation	2	motivation	2
e-learning	1	classroom environment	1	classroom environment	1
engineering education	1	collaborative learning hubs	1	collaborative learning hubs	1
2016		2017		2018	
students	27	teaching	21	students	28
teaching	23	students	16	teaching	28
flipped classroom	16	flipped classroom	15	flipped classroom	21
computer aided instruction	8	e-learning	12	engineering education	13
engineering education	8	engineering education	10	higher education	13
e-learning	7	blended learning	5	education computing	11
higher education	7	learning	6	e-learning	10
learning	7	education computing	5	learning	9
active learning	6	learning systems	5	active learning	7
education computing	6	collaborative learning	4	blended learning	6
2019		2020		2021	
students	29	students	35	students	42
flipped classroom	21	flipped classroom	27	flipped classroom	33
engineering education	17	learning systems	27	teaching	25
teaching	17	teaching	26	education computing	21
education computing	14	education computing	23	e-learning	20
higher education	14	blended learning	19	learning systems	20
learning systems	11	higher education	19	engineering education	17
e-learning	9	engineering education	13	blended learning	16
active learning	7	educational innovation	12	higher education	16
educational innovation	5	e-learning	11	active learning	12

D: number of documents.

Figure 6 together with Table 6 allow us to observe the original stages of the research, that is, when the concepts that mark the different approaches are established (2013 to 2015). Subsequently, in the following triennium, a linear increase in the publication is observed globally. Finally, in the years 2019 to 2021, it is observed how the pioneering terms of the previous stages (students, teaching or flipped classroom) have been established, and others emerge that will contribute new approaches within this theme (active learning, artificial intelligence (cluster 3 of Figure 5) or augmented reality).

In practical terms, the research confirms that in relation to the FL pedagogical model in the educational field, there is a greater opportunity for feedback. Because class time is dedicated to practical work and thinking critically, teachers can more easily detect knowledge gaps and work to address them in real time rather than waiting until test day to see how much a student understands. FL offers the opportunity for more meaningful and

creative activities within the classroom, where you can give students the opportunity to practice and develop their skills, leaving the most essential part of learning to be performed at home with the use of modern technology, thereby encouraging autonomous learning.

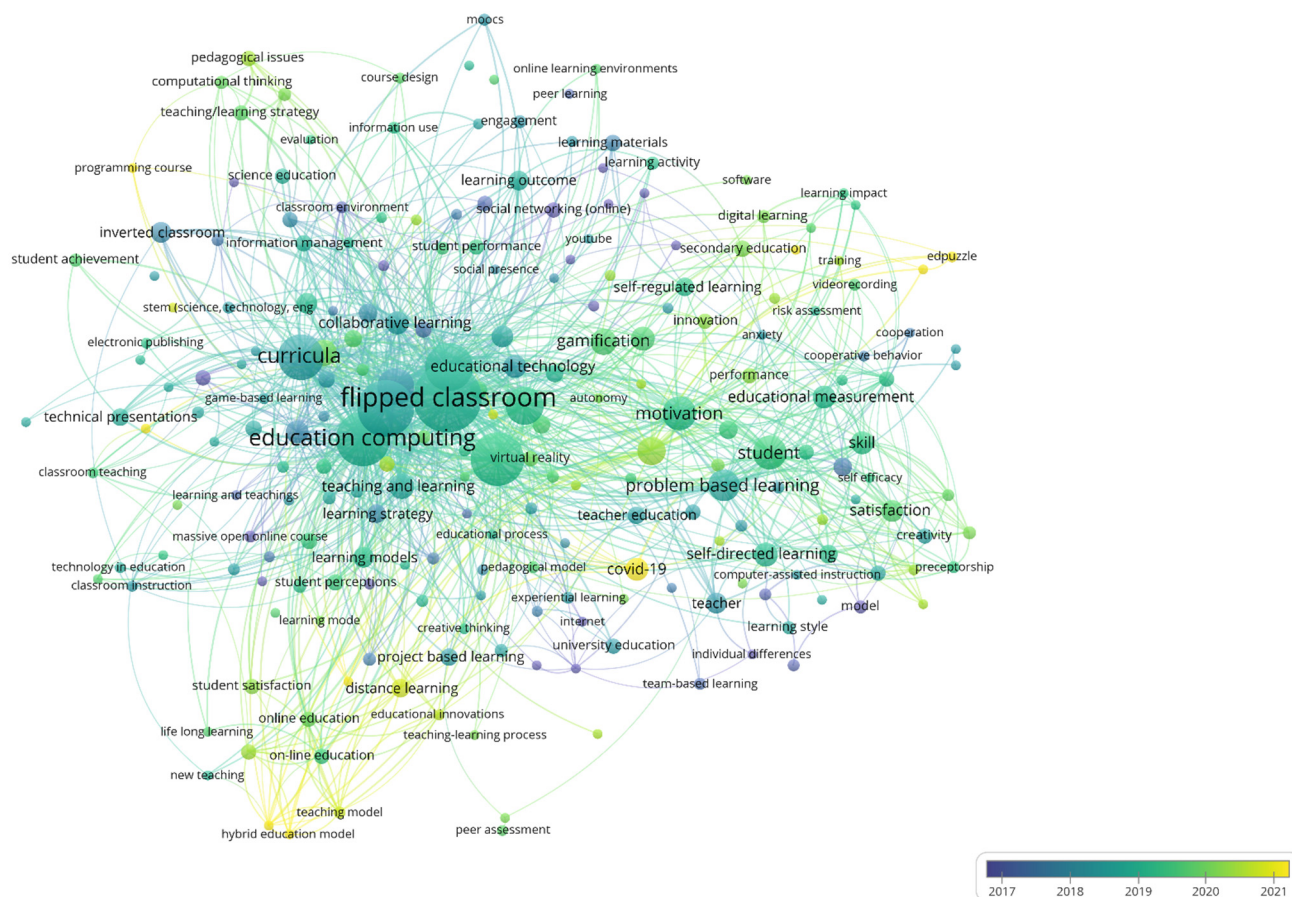


Figure 6. Evolution of keywords per period (2013–2021).

#### 4. Conclusions

The objective has been to determine the original stages, expansion and current situation of the FL methodology. Analyzing the number of publications on FL in the educational field from 2013 to 2021, an increase in evolution is shown, which demonstrates the growing scientific interest in this area of research. A bibliometric analysis was carried out on a sample of 654 documents obtained from the Scopus database.

The evolution of the number of documents, the thematic areas where they are classified, the journals where they are published, the authors, the research institutions and the most productive countries have been identified. The keywords of each subperiod into which the analyzed period is divided have also been identified, which has led to the detection of the original stages, expansion and current situation of the FL methodology. The lines of research developed in this period related to learning, online learning, teaching, distance education, higher education and educational innovation.

It has been observed that the general trend in research on FL in the field of education worldwide has followed a growing evolution and has stabilized with optimal publication rates in recent years; this indicates that the evolution in the number of publications is especially outstanding from 2020 onwards.

In practical terms in the educational field, the study has made it possible to determine that in the FL pedagogical model there is greater feedback than with other models. In this way, FL supposes for the teaching-learning process the opportunity of more significant and creative activities within classes.

The methodology has several limitations, which could be the basis for future research: (1) the study could be extended with other quantitative tools (other than bibliometrics) or qualitative ones, to search for different approaches; (2) because some authors publish relatively few scientific documents, but with influence and impact in a specific field, only the relevant ones could be selected; and (3) in future analyses, other databases could be used to select the sample data.

The results showed the contributions in this field of research, identifying the main driving agents and current and potential trends. The results obtained are useful for researchers and academics, since scientific activity in this field of research has been evaluated. Research helps generate new qualitative insights, and serves as an entry point for future discussions.

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