A Bibliometric and Visualization Analysis of Flipped Classroom Research in Higher Education from 2013 to 2022

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Abstract: As a teaching approach, Flipped Classroom has been studied extensively since its emergence, despite the widespread use of flipped classrooms across different disciplines, few attempts have been made to systematically analyze the worldwide scientific production of Flipped Classroom studies in higher education using bibliometric methods. The objective of this study is to provide an overview of the current landscape of Flipped Classroom research in higher education. Data was collected from the Web of Science core collection, from articles published between 2013 and 2022, resulting in a total of 760 documents. The data was analyzed using CiteSpace for visualization and interpretation. Results showed that the USA and China are the primary research countries in the field of Flipped Classroom, with Hwang, Gwo-Jen being the most prolific researcher. Keywords such as "active learning", "performance", and "student engagement" were frequently utilized across the analyzed documents. With the rapid growth of Internet mobile technology, "online learning" in the context of Flipped Classroom has become a significant area of interest in recent years. These findings have important implications not only for educators but also for researchers in various disciplines, including nursing education, mathematics education, English language learning and teaching, mechanical engineering, and more. The outcomes of this study may support relevant researchers in seeking potential collaborators and reviewing current topics and frontiers in Flipped Classroom studies, while also providing insights for further in-depth research. Overall, this bibliometric and visualization analysis provides valuable insights into the current state of research on the Flipped Classroom in higher education and highlights areas for future exploration.

Keywords: Flipped Classroom; Higher Education; Bibliometric; CiteSpace

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1 Introduction

Flipped Classroom is a teaching approach that involves assigning lectures outside of class and utilizing class time for various learning activities. [1] Although there are no standard models for implementing flipped classrooms, key features generally involve providing content in advance (often through pre-recorded lectures such as video courses), assessing student understanding, and facilitating higher-order learning during class time. Effective implementation of the flipped classroom approach should aim to promote critical thinking and improve engagement both inside and outside the classroom. [2] This student-centered approach to learning has generated substantial interest in higher education and has been applied in fields such as nursing education, mathematics education, English language learning and teaching, mechanical engineering, and others. [3-6] Studies have

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indicated mixed results for academic outcomes and student satisfaction in the nursing field, but positive engagement was achieved when instructors rationalized the purpose of the flipped classroom approach to students. [3] Additionally, current research trends in flipped language classrooms focus on integrating e-tools and learning content into language teaching and learning activities. [7]

Despite the widespread use of flipped classrooms across different disciplines, few attempts have been made to systematically gather data and summarize the worldwide scientific production of Flipped Classroom studies in higher education using bibliometric methods. Bibliometric analysis, which utilizes mathematical and statistical methods, can objectively measure research productivity and publication contribution to knowledge advancement in an academic discipline. [8] Therefore, this study employs bibliometric and visualization analysis to examine Flipped Classroom studies in terms of countries/regions, authors, and keywords. This paper seeks to answer the following research questions:

1. What is the publication trend in Flipped Classroom studies?
2. Which countries/regions and authors have contributed most to Flipped Classroom studies, and what connections exist among them?
3. What are the most frequent keywords and main research areas in Flipped Classroom studies over the past decade?
4. What are the most frequently explored themes and topics related to Flipped Classroom studies?

2 Methodology

The data used for this study were obtained from the Web of Science core collection database, created by Clarivate Analytics (United States) in 1997. The search focused on studies with “flipped classroom” and “higher education” as keywords in their title, abstract, or keywords. After screening, the first relevant literature appeared in 2013, and we conducted this study in 2023. As a result, the time frame for inclusion was set as 2013 to 2022. The data were further refined by language (English) and document type (article, meeting abstract, or review article). A total of 760 documents were collected for bibliometric analysis.

In this study, Excel and CiteSpace 6.1R6 were used to analyze publication output, countries/regions, keywords, and authors. Excel was utilized for drawing diagrams. CiteSpace, a scientific visualization software package developed by Dr. Chaomei Chen at Drexel University (USA), was also used as an analysis tool. CiteSpace enables the creation and analysis of co-occurrence networks of keywords and subject categories (co-word analysis), as well as co-citation networks of authors, documents, and journals (co-citation analysis). [9]

3 Results

3.1 Publication Output and Document Types

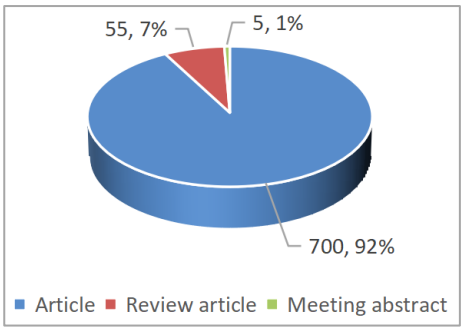

Figure 1 Distribution of document types

As illustrated in Figure 1, the majority of the documents collected for analysis were articles (92%, n=700), followed by review articles (7%, n=55) and meeting abstracts (1%, n=5) published between 2013 and 2022. Figure 2 displays the annual number of documents on Flipped Classroom within higher education, indicating a steady increase in publication output within this field. The growth rate is particularly noteworthy from 2013 (4 publications) to 2022 (157 publications), representing a surge of 39.25 times that demonstrates the increasing amount of research conducted and discussions being held related to flipped classrooms in higher education.

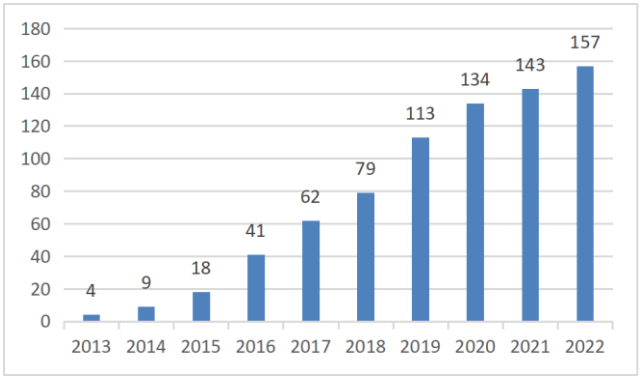

Figure 2 Distribution of publications by years

3.2 Countries/Regions

The results indicate that Flipped Classroom studies have been conducted in 73 countries/regions worldwide. Among these, the top 20 with respect to the number of documents published include the United States (169), China (166), Spain (83), Taiwan (80), Australia (52), Turkey (41), England (31), Germany (25), Netherlands (20), South Korea (19), Canada (18), Malaysia (14), Iran (14), Saudi Arabia (12), Belgium (9), Chile (8), India (8), Japan (8), Norway (8), and Scotland (8).

Table 1 summarizes the top 10 contributing countries/regions, highlighting the United States and China as leading contributors with a total count of 335 publications over the past decade. Furthermore, Spain demonstrated strong growth in research activity in the past decade, ranking third with a total of 83 publications by the end of 2022.

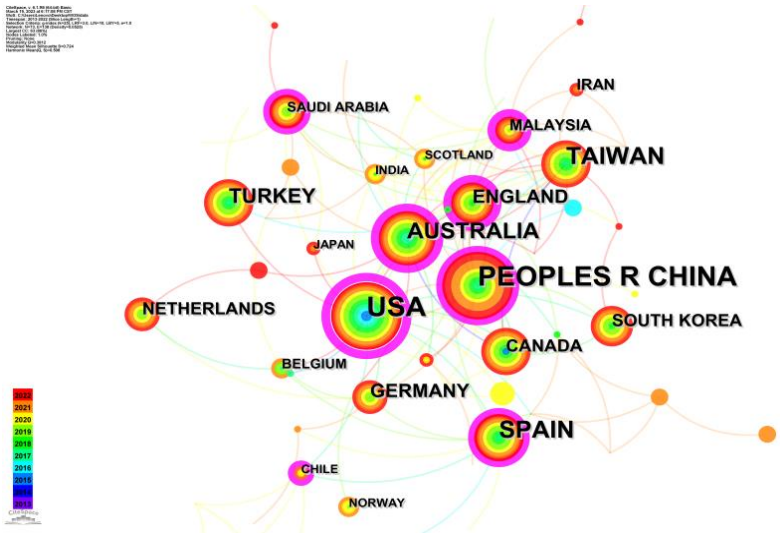

Figure 3 The co-occurrence network of countries/regions

Table 1 Top 20 most productive countries/regions (2013-2022)

R	Country/region	P	R	Country/region	P
1	The USA	169	11	Canada	18
2	China	166	12	Malaysia	14
3	Spain	83	12	Iran	14
4	Taiwan	80	14	Saudi Arabia	12
5	Australia	52	15	Belgium	9
6	Turkey	41	16	Chile	8
7	England	31	16	India	8
8	Germany	25	16	Japan	8
9	Netherlands	20	16	Norway	8
10	South Korea	19	16	Scotland	8

R: Rank, P: Publication

Figure 3 displays CiteSpace's visualization of the number of publications and cooperation networks between countries/regions. Each node denotes a country/region with the size of the label representing the number of publications in proportion to the size of the circle. The links represent cooperation between countries/regions, with different colors representing different years. It is apparent that the United States has significantly contributed to the research of flipped classrooms, while China and Spain are prominent players in more recent years. Other countries such as Australia and England have also demonstrated sustained research interest in the field.

3.3 Authors

In total, 290 authors contributed to Flipped Classroom studies over the past decade. Among them, Hwang, Gwo-Jen had the highest number of publications (18), followed by Hew, Khe Foon (8), Gonzalez-gomez, David (5), Lo, Chung Kwan (4), Canada-canada, Florentina (4), Li, Xiaodong (3), Albers, Casper J (3), Jeong, Jin Su (3), Bosker, Roel J (3), Macleod, Jason (3), Mei jer, Rob R (2), Liu, Yang (2), Zhu, lin (2), Guan, Xianren (2), Calimeris, Lauren (2), Janssen, Jeroen (2), Lin, Chi-Jen (2), Alario-hoyos, Carlos (2), Ng, Lui-Kwan (2), and He, Jie (2). Moreover, Hwang, Gwo-Jen was not only the most productive author but also the one who collaborated closely with other researchers. For instance, Hwang, Gwo-Jen and Lin, Chi-Jen et al. [10] employed a flipped contextual game-based approach to enhance EFL students' reflective behaviors and English business writing performance in 2018. Furthermore, Hwang, Gwo-Jen and Chen, Mei-Rong Alice et al. [11] explored a reflective

thinking-promoting method to improve graduate students' flipped-learning engagement, reflective thinking, participation behaviors, and project learning outcomes in 2019. In addition, Hwang, Gwo-Jen and Hisa, Lu-Ho [12] provided a reflective-thinking promoting approach to enhance students' dance performance, self-efficacy, and task load in flipped learning in 2020. Lastly, Hwang, Gwo-Jen and Zhao, Jiahua et al. [13] analyzed the impact of gamified interactive e-books on students' flipped-learning performance, motivation, and metacognition tendency in a mathematics course in 2021.

Table 2 Top 20 most productive authors (2013-2022)

R	Author	D
1	Hwang, Gwo-Jen	18
2	Hew, Khe Foon	8
3	Gonzalez-gomez, David	5
4	Lo, Chung Kwan	4
4	Canada-canada, Florentina	4
6	Li, Xiaodong	3
6	Albers, Casper J	3
6	Jeong, Jin Su	3
6	Bosker, Roel J	3
6	Macleod, Jason	3
11	Mei jer, Rob R	2
11	Liu, Yang	2
11	Zhu, lin	2
11	Guan, Xianren	2
11	Calimeris, Lauren	2
11	Janssen, Jeroen	2
11	Lin, Chi-Jen	2
11	Alario-hoyos, Carlos	2
11	Ng, Lui-Kwan	2
11	He, Jie	2

R: Rank, D: Document

3.4 Keywords

Using CiteSpace software, co-occurrence network and clusters of keywords related to Flipped Classroom were analyzed and visualized (Figure 4 and Figure 5). From a total of 429 keywords, 127 (29.60%) appeared only once. Notably, the high-frequency keywords, including "flipped classroom", "performance", "higher education", "student", "classroom", "education", "impact", "student engagement", "student perception", and "model", are shown in Figure 4 and listed in Table 3. The top 50 most frequently used keywords provided in Table 3 may represent current research trends and popular topics.

The circle colors in Figure 4 represent the period when these keywords first appeared, while the size of the circle indicates the frequency of these keywords. Some keywords emerged within ten years, while others appeared later. For instance, "performance", "student engagement", and "model" first appeared in research around 2015, whereas "student perception" and "impact" first appeared around 2018. These keywords continue to be hot topics of research today.

Table 3 Top 50 most frequent keywords (2013-2022)

R	Keywords	Oc
1	Flipped classroom	430
2	Performance	245
3	Higher education	244
4	Student	126
5	Classroom	122
6	Education	109
7	Impact	105
8	Student engagement	104
9	Student perception	103
10	Model	99
11	Flipped learning	81
12	Design	66
12	Active learning	66
14	Blended learning	64
15	Experience	63
16	Technology	62
17	Online	58
18	Science	57
19	University	55
20	Instruction	53
21	Motivation	45
22	Achievement	44
23	Satisfaction	39
24	Outcome	37
25	Medical education	36
26	Skill	34
27	Lecture	28
28	Implementation	26
29	Self-efficacy	23
29	System	23
31	Teacher	22
31	Knowledge	22
33	Strategy	20
33	Learner	20
35	Online learning	18
36	Attitude	17
36	Environment	17
38	Academic performance	16
39	Organic chemistry	15
40	Proving classroom teaching	14
40	English	14
40	Nursing student	14
43	Course	13
43	Medical student	13
43	Collaborative learning	13
43	Efficacy	13
43	Principal	13
43	Team-based learning	13
43	Intrinsic motivation	13
43	Self-determination theory	13

R: Rank, Oc: Occurrence

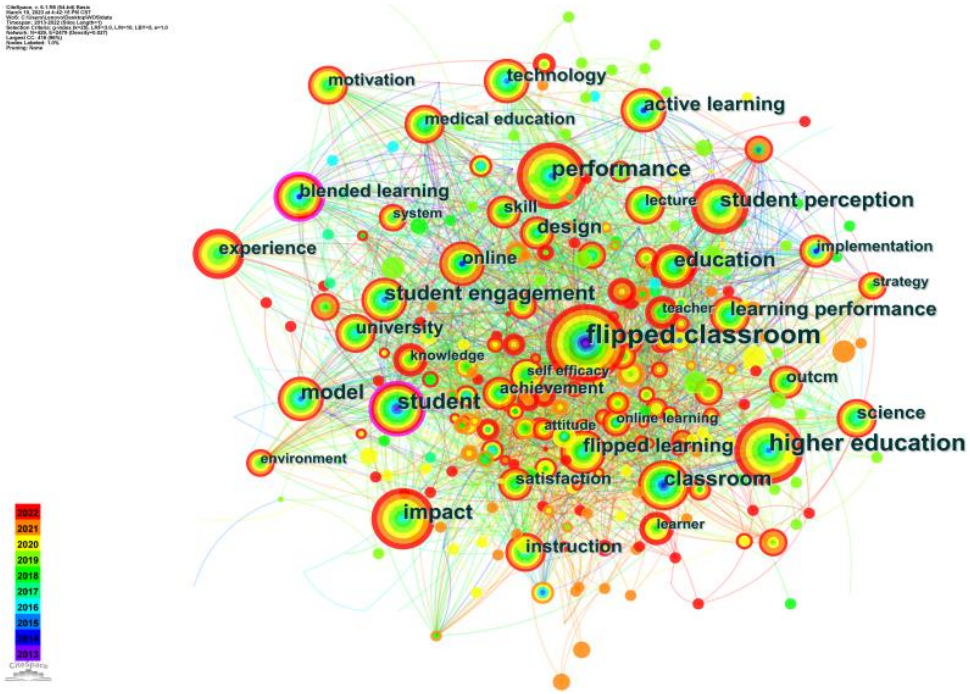

Figure 4 The keywords co-occurrence network from 2013-2022

Figure 5 displays the clusters of keywords. By utilizing CiteSpace's keyword clustering function, all keywords can be classified, revealing the main areas of focus within Flipped Classroom research. As shown in Figure 5, ten clusters emerged, including "teaching/learning strategies", "medical students", "active learning", "model", "higher education", "first-year undergraduate/general", "structural equation modeling", "learning management systems", "educational innovations", and "computer science".

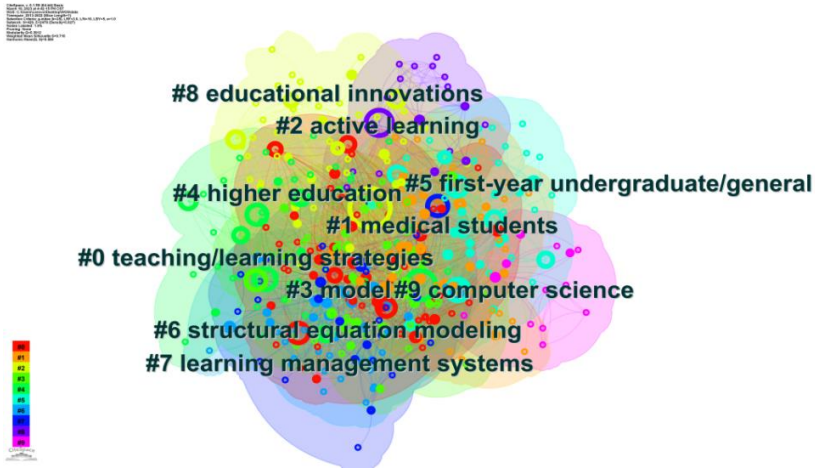

Figure 5 Clusters of keywords from 2013-2022

Combined with Figure 4 and Table 3, the research on Flipped Classroom over the past decade can be broadly divided into two primary aspects: first, research on the development of the flipped classroom itself, demonstrated by keywords such as "teaching/learning strategies", "model", and "online learning"; second, research on student feedback, represented by keywords such as "performance", "student engagement", and "student perception". Additionally, the results suggest that a significant portion of Flipped Classroom research has been conducted within the field of medical higher education.

Keywords	Year	Strength	Begin	End	2013 - 2022
active learning	2014	3.58	2014	2018	
interactive learning environment	2014	2.81	2014	2016	
student engagement	2015	5.68	2015	2018	
organic chemistry	2015	3.93	2015	2016	
redesign	2015	3.87	2015	2017	
learning performance	2013	5.93	2016	2017	
lecture	2016	4.88	2016	2018	
school	2016	2.8	2016	2017	

Figure 6 Top 8 keywords with the strongest citation bursts from 2013-2022

4 Discussion

As shown in Figure 6, eight keywords with the strongest citation bursts were identified. Active learning was identified as the most popular research topic, maintained its high levels of attention for four years over the past decade. Moreover, combined with the figures and Table 1, we can identify four critical research areas worth our attention:

Active learning: The Flipped Classroom (FC) model aims to change traditional lectures or passive learning to active learning that promotes cognitive skills such as analysis, synthesis, and evaluation by learners. [14, 15] However, some studies suggest that the flipped classroom does not result in higher learning gains or better attitudes compared to the non-flipped classroom when both utilize an active learning, constructivist approach. This suggests that learning gains in either condition are most likely a result of the active-learning style of instruction rather than the instructor's participation order in the learning process. [16] Therefore, further research is needed to investigate how instructors can maximize their effectiveness in the active learning model.

Performance: Many researchers from various disciplines have investigated whether the Flipped Classroom improves student performance. For instance, Chiu-Lin Lai et al. [17] verified that a self-regulated flipped classroom approach can improve students' learning performance in a mathematics course. Similarly, Johnathan D. Tune et al. [18] confirmed that the Flipped Classroom model can improve graduate student performance in cardiovascular, respiratory, and renal physiology. While it is generally agreed that flipped classrooms can improve student performance, more studies are required to examine how to take into account other factors such as student satisfaction while improving student achievement. Kathy Missildine et al. [19] found that, compared to traditional lectures, flipped classrooms did enhance student performance but that students were less satisfied with the flipped classroom method than with other methods.

Student engagement: Student engagement has always been the focus of educational researchers because it closely relates to educational outcomes. Studies have shown that compared to traditional pedagogical strategies, using the Flipped Classroom can enhance student engagement. [20] Recent research focuses on how to encourage students' engagement in pre-class activities, such as developing various types of video lectures for pre-class activities. Research has demonstrated that student-engaged video lectures had a slight impact on the attention variable regardless of students' grades. [21] In medical education, gamification has become a new trend over the last few years. Christina Cantwell et al. proposed a new educational method to improve the engagement and satisfaction of medical students, namely escape box and puzzle design. The research shows that this method can achieve higher scores compared to traditional Flipped Classrooms, which may provide insights for researching education in other disciplines. [22]

Technology: With the rapid development of Internet mobile technology, the forms of pre-class activities in the Flipped Classroom have become more diverse. In the past, pre-class asynchronous activities consisted of pre-recorded lectures made by podcasts/vodcasts, screencasts, annotated notes, or captured videos. [2] Now, the combination of online learning such as MOOCs, computer-supported collaborative learning, and distance learning is always a hot topic in this field. [23]

Smartphone apps or social software can also be used as an educational tool, such as WeChat. Research has revealed that the use of WeChat in a MOOC-based Flipped Classroom approach leads to better performance in terms of watching video lectures and completing online exercises before class. [24] The development of science and technology has brought great convenience to education, and more educational tools need to be developed. Additionally, exploring the association between Flipped Learning readiness, engagement [25], or other aspects of online Flipped Classrooms can be a future research direction.

Limitations exist in this study. First, data was collected only from the Web of Science core collection. This study did not index articles from other databases such as EI Compendex and Scopus. Second, due to information delays, the latest accepted but not yet published articles have not been included in this study. Therefore, future studies require a wide range of data sources to obtain more accurate research results. Besides, this study considers the research of Flipped Classroom in higher education, which involves numerous disciplines. In the future, bibliometric analysis on this topic can focus on a specific discipline such as language learning, computer education or medical education. By this means, the development tendency of flipped classroom in a certain discipline can be accomplished.

5 Conclusion

This study conducted a bibliometric and visualization analysis of the research on the Flipped Classroom in higher education over the past decade. Our findings demonstrate a steady increase in the number of documents related to Flipped Classroom studies each year, with the United States and China being the two most productive countries. Moreover, Hwang, Gwo-Jen was identified as the most prolific author in the past decade, collaborating most closely with other researchers. Alongside Hwang, many other productive authors from various countries have contributed significantly to this field. The most frequent keywords identified were "performance," "student engagement," "student perception," and "active learning."

The rapid development of Internet mobile technology has led to "online learning" with different technologies in Flipped Classrooms becoming a hot topic in recent years. This paper's findings may assist relevant researchers in identifying potential collaborators and reviewing the latest trends and frontiers of Flipped Classroom studies, providing directions for in-depth research. Overall, our bibliometric and visualization analysis provides valuable insights into the current state of research on the Flipped Classroom in higher education and highlights areas for future exploration.

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