

## A Bibliometric Investigation of Flipped Classroom Research during 2000-2015

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**Abstract**—The paper analyzed the global growth and development of flipped classroom research productivity in terms of publication output as reflected in SCI/SSCI for the period 2000-2015. Publication types and languages, characteristics of articles outputs, countries, subject categories and journals, and the frequency of keywords were analyzed using bibliometric methods. There are 149 articles in 78 journals listed in 41 SCI/SSCI subject categories. A sharp growth trend of publication output was observed during 2011-2015. USA played a predominant role in flipped classroom research. Education educational research, chemistry and medical were the top 3 categories and “active learning” and “blended learning” recent major topics of flipped classroom research during the past 16 years. The results could help researchers understand the characteristics of research output and search hot spots of flipped education field.

**Keywords**—flipped classroom; active learning; blended learning; bibliometric

### 1 Introduction

There has been a growing interest in using the flipped classroom in both K-12 education and higher education [1]. In the flipped classroom, what is traditionally done in class and as homework are switched or flipped [2]. It was reported that flipped classroom was successful for both faculty and students [2]. There have been a number of published papers which have reported the investigation and application of flipped classroom. Some of them reviewed the trends of flipped classroom development. Tomory and Watson [3] explains how issues regarding dual credit and Advanced Placement high school science courses could be mitigated via a flipped classroom instructional model. Leung et al. [4] gave a short review on flipped

classroom approach and O'Flaherty and Phillips [5] reviewed the applications of flipped classrooms in higher education.

Despite the importance of flipped classroom, there have been few attempts to gather data about the worldwide scientific production of flipped classrooms research. Bibliometric studies provided an accurate and presumably objective method to measure the contribution of a paper to the advancement of knowledge [6, 7]. Bibliometric indicators including publication countries, research fields, journals, and author keywords have been frequently used to analyze the trends and performance [8-11]. The objective of this study is to analyze the status and trends of flipped classroom research in the last 16 years in order to help researchers understand the panorama of global flipped classroom research.

## **2 Methods**

The data used in this study were based on the database of the SCI and SSCI published by Thomson Reuters Web of Science, Philadelphia, PA, USA. “Flipped classroom” and “inverted classroom” were used as the string to search titles, abstracts, and keywords from 2000 to 2015. The records were then downloaded to a compact disc. Care has been exercised to examine the data collected to assure their identity. Subsequently, the data were analyzed by Microsoft Excel. Articles from Hong Kong, Macao, and Taiwan were not included in Mainland China. The investigation was conducted to analyze the research trends and performance that including characteristics of article output, publication outputs of countries and institutions, distribution of outputs in subject categories and journals, and frequency of author keywords, from 2000 to 2015. HistCite software developed by Garfield and colleagues [12] was used to figure out the total global citation score (TGCs).

## **3 Results and Discussion**

### **3.1 Document types, publication output**

There were 149 papers related to flipped classroom research in the database, including 6 document types. Articles (101) comprised 67.78 % of the total production, followed distantly by meeting abstracts (28; 18.79%), editorial materials (13; 8.72 %), news item (3, 2.01%), reviews (2; 1.34 %) and letter (2; 1.34%). English was the most frequently used language, making up 97.32 % of all the published articles. The publications devoted to flipped classroom research from 2000 to 2015 are illustrated in Fig. 1. Although flipped teaching was firstly proposed in 2000, few studies were indexed in SCI/SSCI database. Actually a sharp growth trend of publication output was observed until 2011. The yearly number of articles increased notably from 1 in 2011 to 83 in 2015.

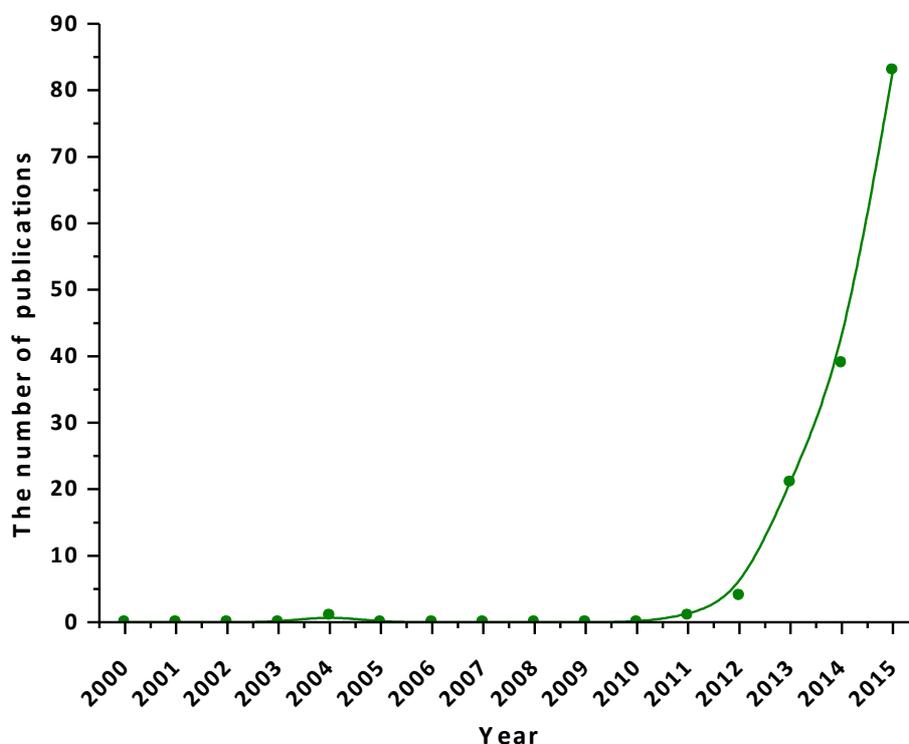


Fig. 1. The number of articles on flipped classroom during 2000-2015

### 3.2 Publication distribution of countries and institutes

149 articles were published by authors from 25 countries/territories. The most productive countries/territories are listed in Table 1. Two North and Central American countries, three European countries, four Asian countries/territories, and Australia were ranked in the top 10. The domination role in publication of USA was obviously found from Table 1, taking a share of 68.456%. Actually, USA acts as the origin country of flipped classroom, which firstly introduced by Lage MJ and Platt G [13]. A large amount studies focusing on flipped classroom were conducted by various American scholars [4, 5]. In addition, various related conferences were held in USA. The Spring 2014 ConfChem conference, Flipped Classroom, was held from May 9 to June 12, 2014, and contained 8 papers and a poster session discussing a variety of ways to engage students within a flipped learning approach to the classroom [14]. By contrast, other countries/territories published fewer research articles during the study period.

Besides, the 10 most productive institutions are presented in Table 2. It can be seen from the table that 9 of top 10 institutions were from USA and only one was from PR China. Univ N Carolina has published 5 publications ranked first, as the leading

institution in both of article quantity and TGCS. The results showed a good agreement with countries/territories. USA played a predominant role in flipped classroom research. It may be attributed to the vigorous development of flipped classroom in United States.

**Table 1.** The 10 most productive countries/territories of articles during 2000-2015.

Countries/Territories	Records	% of 149
USA	102	68.456
Australia	9	6.04
Canada	8	5.369
Mainland China	6	4.027
Taiwan	3	2.013
Spain	3	2.013
Turkey	2	1.342
Singapore	2	1.342
Saudi Arabia	2	1.342
Germany	2	1.342

**Table 2.** The 10 most productive institutions of articles during 2000-2015.

Institutions	Country	Records	TGCs*	% of 149
Univ N Carolina	USA	5	103	3.356
Univ Georgia	USA	4	26	2.685
Yale Univ	USA	3	76	2.013
Univ Florida	USA	3	0	2.013
Purdue Univ	USA	3	8	2.013
Hong Kong Inst Educ	PR China	3	10	2.013
Ctr Coll Danville	USA	3	4	2.013
Cleveland Clin	USA	3	36	2.013
Univ Washington	USA	2	23	1.342
Univ Rochester	USA	2	16	1.342

\*TGCs total global citation score.

### 3.3 Publication patterns: source titles and subject categories

The 149 articles were published in a wide range of 78 journals. The 10 journals with the greatest number of published papers are listed in Table 3. Journal of Chemical Education, Abstracts of Papers of The American Chemical Society, FASEB Journal, Computers Education, American Journal of Pharmaceutical Education, and Academic Medicine published most articles in the 16 years. The top 10 journals published 61 articles, sharing 40.94% of the total amount. The observations indicated that flipped classroom applications on chemistry, medical and computer were paid more attentions.

There was a great diversity including 41 subject categories related to the research topic of flipped classroom in Journal Citation Reports (JCR) of the ISI. Top 10

subject categories with the most articles are listed in Table 4, containing the rank and the percentage of the paper quantities. The five most common categories were education educational research (54.362%), chemistry (14.094%), health care sciences services (10.067%), nursing (8.054%) and pharmacology pharmacy (6.711%) along 16 years. The domination role of education educational research could be explained by increasing studies on educational methods and theories. Benefits and strategies [15], podcasts and video application [16] were studied during the teaching and learning investigation. Long et al. [1] conducted their study to address the instructor's perspective, and instructors' perspectives on technology integration can directly influence their practice of incorporating technology in instruction. Hao and Lee [17] attempted to figure out pre-service teacher concerns about teaching in technology-integrated flipped classrooms. In addition, a study was conducted to determine the effects of a flipped classroom (i.e., reversal of time allotment for lecture and homework) and innovative learning activities on academic success and the satisfaction of nursing students [18]. Except for education educational research, chemistry and medical (contained health care sciences services, nursing and pharmacology pharmacy) also attracted great attention. A large amount of articles focused on both of chemistry and medical teaching. A flipped classroom format was implemented and evaluated by Weaver and Sturtevant in the chemistry majors' sequence at Purdue University over a period of three years to look at quantitative measures of student performance in the flipped versus the traditional lecture approach of this chemistry course [19]. Seery [20] analyzed student engagement with flipped chemistry lectures and aim to build up a profile of how the flipped lecture works for middle stage undergraduate students. Similarly, flipped method has been widely applied on medical courses. Liebert et al. [21] attempted to apply flipped classroom to the surgery core clerkship and observed high learner satisfaction, effective knowledge acquisition, and increased career interest in surgery. A randomised control trial was conducted to evaluate the flipped classroom pedagogy for a freshman year nutritional science module [22]. In addition, flipped classroom has attracted great interest on nursing education [23-26]. Overall, education educational research, chemistry and medical were the top 3 categories in flipped classroom during the past 16 years.

**Table 3.** The 10 most productive journals during 2000-2015.

Journals	IF(2015)	Records	% of 149
Journal of Chemical Education	1.225	13	8.725
Abstracts of Papers of The American Chemical Society	--	8	5.369
FASEB Journal	5.299	6	4.027
Computers Education	--	6	4.027
American Journal of Pharmaceutical Education	1.196	6	4.027
Academic Medicine	3.857	6	4.027
Nurse Educator	0.991	4	2.685
Medical Teacher	2.355	4	2.685
Medical Education	3.369	4	2.685
BMC Medical Education	1.312	4	2.685

**Table 4.** The 10 most productive subject categories during 2000-2015.

Subject categories	Records	% of 149
Education educational research	81	54.362
Chemistry	21	14.094
Health care sciences services	15	10.067
Nursing	12	8.054
Pharmacology pharmacy	10	6.711
Engineering	9	6.04
Computer science	7	4.698
Biochemistry molecular biology	7	4.698
Life sciences biomedicine other topics	6	4.027
Cell biology	6	4.027

### 3.4 Research emphasis: author keywords

As author keyword analysis provides effective information about research trends for researchers, it has proved to be important for monitoring the development of research topics [27]. According to the statistics, 247 author keywords were used from 2000 to 2015. The top 10 most active author keywords in the 16 years are listed in Table 5. Except for the searching word “flipped classroom” and “inverted classroom”, the two most frequently used keywords were “active learning” and “blended learning”. Great efforts have been focused on “active learning” and “blended learning”. Roach[28] studied new methods to increase interaction and active learning in economics and found that an instructional design that is beneficial across student groups. Kakosimos [29] attempted to develop a methodology to improve the effectiveness of flipped classroom, adaptive e-learning, and active learning. Gilboy [2] studied how to enhance student engagement using the flipped classroom within 2 undergraduate nutrition courses. Moreover, “internet/web-based learning” and “computer-based learning” acted as significant research topics in flipped classroom research. For example, blog was applied in a chemical course and proved beneficial for active learning [30].

**Table 5.** The 10 most active author keywords during 2000-2015.

Author keywords	Records	Share (%)
flipped classroom	38	9.20%
active learning	18	4.36%
blended learning	12	2.91%
first-year undergraduate/general	10	2.42%
student-centered learning	8	1.94%
education	8	1.94%
inverted classroom	7	1.69%
second-year undergraduate	6	1.45%
internet/web-based learning	6	1.45%
computer-based learning	5	1.21%

## 4 Conclusions

In this study, some significant points have been obtained on the research trends throughout the period from 2000 to 2015. The number of articles about flipped classroom increased slowly during 2000-2010, but showed a shape growth in 2011-2015. In total, there are 149 articles in 78 journals listed in 41 SCI/SSCI subject categories. The research on the fields of flipped classroom focused on education educational research, chemistry and medical. According the analysis of author keywords, the two most frequently used keywords were “active learning” and “blended learning”. The findings of this study can help relevant researchers understand the performance of flipped classroom research in the world, and suggest directions for further research.

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