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GENERAL TRENDS OF STUDIES ON FLIPPED CLASSROOM MODEL: BIBLIOMETRIC MAPPING AND CONTENT ANALYSIS

Review Study

Elif Meral (0000-0002-2560-0120). (Corresponding author) Atatürk University elif.meral@atauni.edu.tr Dilek Teke (0000-0001-7407-2806). Atatürk University dilekteke68@hotmail.com	Muhammed Güler (0000-0001-5353-2690). Ağrı İbrahim Çeçen University mhmmdguler@gmail.com Zeynep Başcı Namlı (0000-0003-2865-5976). Atatürk University zbasci@atauni.edu.tr

Elif Meral is an assistant professor doctor at the Department of Turkish and Social Sciences Education in Kazım Karabekir Faculty of Education at Atatürk University. She works on social studies teaching, argumentation, writing-to-learn, augmented reality, flipped classroom, and technology in social sciences. Dilek TEKE is a PhD student at the Department of Chemistry Education in Kazım Karabekir Faculty of Education at Atatürk University. She works on chemistry education, material design, visual impairment, inclusive education, discourse analysis and academic discourse of chemistry education	Muhammed Güler is currently a Lecturer at the Department of Computer Programming. He is continuing Phd. degree in the Department of Computer Education and Instructional Technology at Ataturk University, Turkey. He works on computer-based instruction, mobile learning, human computer interaction, instructional design, augmented reality, and research methods. Zeynep Başcı Namlı is an assistant professor doctor at the Department of Primary Education in Kazım Karabekir Faculty of Education at Atatürk University. She works on social studies teaching, education, and values education.

GENERAL TRENDS OF STUDIES ON FLIPPED CLASSROOM MODEL: BIBLIOMETRIC MAPPING AND CONTENT ANALYSIS

Elif Meral
elif.meral@atauni.edu.tr
Dilek Teke
dilekteke68@hotmail.com
Muhammed Güler
mhmmdguler@gmail.com

Zeynep Başcı Namlı
zbasci@atauni.edu.tr

Abstract

This study, which was based on qualitative research design, aimed to examine the research trends and results of bibliometric mapping analyses of articles about the Flipped Classroom Model (FCM) in education in the past ten years. For this purpose, 126 articles published with the keywords; flipped classroom, education, social science, science, chemistry, biology, and physics between the years of 2010- 2019 were accessed through the Web of Science database. Out of these 126 articles, 63 were selected using criterion sampling model for the bibliometric and the content analysis. As a result of the bibliometric analysis, it was seen that the most frequently mentioned keywords were flipped classroom, active learning, and chemical education with many of them focusing more on "motivation". The result of the content analysis showed that the variables included not only "motivation" and "perception" but also "academic achievement/performance" as the most common topics in the studies. The results also revealed that the most commonly used data collecting instruments were achievement tests, questionnaires and scales; the most commonly preferred sample groups were university students; and the most commonly utilized research design was the quantitative method.

Keywords: *Flipped classroom, education, technology, content analysis, bibliometric mapping analysis*

1. Introduction

Just like students desiring to acquire more information, teachers are willing to give more information; however, a lot of practice is required so that what is given and acquired will become permanent. Yet, not enough time is left for practice at schools. For this reason, teachers may be provided with the opportunity to practice more with their students by ensuring that students do the work that needs to be done at school, at home instead. In order to offer this opportunity, appropriate educational settings must be available. Flipped Classroom Model (FCM) can, thus, be considered one of the educational settings to offer this opportunity to teachers and students. With the FCM, the subjects to be covered in the classroom are given as pre-class preparation at home, while the tasks or homework that should be done at home are discussed and executed in the classroom.

The FCM is a new and popular teaching model in which the activities traditionally carried out in the classroom become home activities and the activities that normally constitute

homework become classroom activities (Bergmann & Sams, 2012; Sohrabi & Iraj, 2016) In the FCM, teachers both inform and guide students in the learning process. Students, on the other hand, are responsible for their own learning processes and manage their own learning speed (Lai & Hwang, 2016). By learning the information at home in this model, students have time to discuss the subject in the classroom, to do practical activities, and to interact more with teachers, who are in a guiding position.

The literature shows that the FCM increases not only students' motivation (Bicen & Beheshti, 2019; Dooley, Frankland, Boller, & Tudor, 2018; Winter, 2018) and achievement (Davies, Dean, & Ball, 2013; Ferreri & O'Connor, 2013; Li, Zheng, & Yang, 2017; Lo, Lie, & Hew, 2018; Mooring, Mitchell, & Burrows, 2016; Pierce & Fox, 2012; Tune, Sturek, & Basile, 2013), but also teachers' motivation and success (Yough, Merzdorf, Fedesco, & Cho, 2019). The literature indicates that the FCM influences students' achievements and motivations as well as their capacity of perceptions (Baepler, Walker, & Driessen, 2014; González-Gómez, Jeong, & Rodríguez, 2016; Santikarn & Wichadee, 2018), and attitudes (Li et al., 2017; Rau, Kennedy, Oxtoby, Bollom, & Moore, 2017).

The FCM is an essential model as it increases out-of-class learning performance of students (Akçayır & Akçayır, 2018). This model appears to have been widely used in the disciplines of chemistry, science, medicine and technology education in recent years (Figure 1). Using the FCM proves to enable students to easily learn the abstract concepts in chemistry and science classes (Donnelly & Hernández, 2018; Mooring et al., 2016; Robert, Lewis, Oueini, & Mapugay, 2016), and facilitate learning the subjects that require memorization in medical and pharmacy education (Ferreri & O'Connor, 2013; Tune et al., 2013; Williams, Perlis, Gaughan, & Phadtare, 2018; Xiao, Thor, Zheng, Baek, & Kim, 2018). Various studies conducted on the FCM are presented in Figure 1.

Author(s)/ Year of Publication	*Field of Study*	*Author(s)/ Year of Publication*	*Field of Study*
Pierce & Fox (2012)	*Pharmaceutical Education*	Green & Schlairet (2017)	*Nursing Education*
Ferreri & O'Connor (2013)	*Pharmaceutical Education*	Roehling, et al. (2017)	*Psychology Education*
Tune, et al. (2013)	*Medical Education*	Capone, et al. (2017)	*Physics Education*
Davies, et al. (2013)	*Computer Education*	Li, et al. (2017)	*Mathematics and Science Education*
Mason, et al. (2013)	*Engineering Education*	Matthew, et al. (2018)	*Veterinary Education*
Kong (2014)	*Human Sciences*	AlJarrah, et al. (2018)	*Science and Technology Education*
Chen, et al. (2014)	*Computer Education*	Williams, et al. (2018)	*Medicine*
Teo, et al. (2014)	*Chemistry Education*	Lo, et al. (2018)	*Mathematics, Physics and Language Education*
Baepler, et al. (2014)	*Chemistry Education*	Jensen, et al. (2018)	*Biology Education*
Weaver & Sturtevant (2015)	*Chemistry Education*	Styers, et al. (2018)	*Science Teaching Education*
Gross, et al. (2015)	*Physics and Chemistry Education*	Donnellya & Herna´ndez (2018)	*Physics and Chemistry Education*

Moraros, et al. (2015)	*Technology Education*	Gostelow, et al. (2018)	*Medicine*
Touchton (2015)	*Statistics Education*	Srinivasan, et al. (2018)	*Chemistry Education*
Evseeva & Solozhenko (2015)	*Language Education*	Hea, et al. (2018)	*Chemistry Education*
Ryan & Reid (2016)	*Chemistry Education*	Zeng, et al. (2018)	*Engineering Education*
Hibbard, et al. (2016)	*Chemistry Education*	Dooley, et al. (2018)	*Veterinary Education*
Gonza´lez-Go´mez, et al. (2016)	*Science Education*	Xiao, et al. (2018)	*Medicine*
Mylott, et al. (2016)	*Physics and Biomedical Education*	Blackburn (2018)	*Chemistry Education*
Shattuck (2016)	*Chemistry Education*	Winter (2018)	*Social Science Education*
Ferrer-Torregrosa, et al. (2016)	*Anatomy Education*	Santikarn & Wichadee (2018)	*Language Education*
MuNoz-Merino, et al. (2016)	*Computer Education*	Chang & Hwang (2018)	*Science Education*
Reid (2016)	*Chemistry Education*	Ye, et al. (2018)	*Science Education*
Mooring, et al. (2016)	*Chemistry Education*	Zhang (2018)	*Language Education*
Robert, et al. (2016)	*Chemistry Education*	Loveys & Riggs (2019)	*Science Education*
Zainuddin & Attaran (2016)	*Language Education*	Jeong, et al. (2019)	*Science Education*
Aidinopoulou & Sampson (2017)	*History Education*	González-Gómez, et al. (2019)	*Science Education*
Sezer (2017)	*Science Education*	Yough, et al. (2019)	*Teacher Education*
Morton & Colbert-Getz (2017)	*Anatomy Education*	Murillo-Zamoranoa, et al. (2019)	*Economics Education*
Goff, et al. (2017)	*Biology Education*	Bicen & Beheshti (2019)	*Computer Education*
Rau, et al. (2017)	*Chemistry Education*	Rodriguez, et al. (2019)	*Health Science*
Christiansen, et al. (2017)	*Chemistry Education*	Maloy, et al. (2019)	*Biology Education*
Lax, et al. (2017)	*Biology Education*		

Figure 1. Studies in the Literature on the FC Approach

Many review articles have been written on the FCM, and are generally based on teaching health (Chang & Hwang, 2018; Chung, Lai, & Hwang, 2019; Xu et al., 2019), science (Karabulut-Ilgu, Jaramillo Cherrez, & Jahren, 2018) and technology (Chung et al., 2019). Such studies aim to explore the impact of the FCM on students (Låg & Sæle, 2019; Zainuddin, Haruna, Li, Zhang, & Chu, 2019), its use in the teaching process and its development (Little, 2015; O'Flaherty & Phillips, 2015). Figure 2 presents the related studies.

Author(s)	Study Titles	Author(s)	Study Titles
Seery (2015)	*Flipped Learning in Higher Education Chemistry: Emerging Trends and Potential Directions*	Chen et al. (2018)	*Academic Outcomes of Flipped Classroom Learning: A Meta-Analysis*
Little (2015)	*The Flipped Classroom in Further Education: Literature Review and Case Study*	Al-Samarraie et al. (2019)	*A Flipped Classroom Model in Higher Education: A Review of the Evidence Across Disciplines*
O'Flaherty & Phillips (2015)	*The Use of Flipped Classrooms in Higher Education: A Scoping Review*	Zainuddin et al. (2019)	*A Systematic Review of Flipped Classroom Empirical Evidence from Different Fields: What Are the Gaps and Future Trends?*
Lo (2018)	*Grounding the Flipped Classroom Approach in the Foundations of Educational Technology*	Låg & Sæle (2019)	*Does the Flipped Classroom Improve Student Learning and Satisfaction? A Systematic Review and Meta-Analysis*
Lundin et al. (2018)	*Higher Education Dominance and Siloed Knowledge: A Systematic Review of Flipped Classroom Research*	Chung et al. (2019)	*Roles and Research Trends of Flipped Classrooms in Nursing Education: A Review of Academic Publications from 2010 to 2017*
Akçayır & Akçayır (2018)	*The Flipped Classroom: A Review of its Advantages and Challenges*	Chen, et al. (2019)	*Findings and İmplications of Flipped Science Learning Research: A Review of Journal Publications*
Lin & Hwang (2018)	*Research Trends of Flipped Classroom Studies for Medical Courses: A Review of Journal Publications from 2008 to 2017 Based on the Technology-Enhanced Learning Model*	Xu et al. (2019)	*The Effectiveness of A Flipped Classroom on the Development of Chinese Nursing Students Skill Competence: A Systematic Review and Meta-Analysis*
Karabulut-Ilgu et al. (2018)	*A Systematic Review of Research on the Flipped Learning Method in Engineering Education*	Cheng, et al. (2019)	*Effects of the Flipped Classroom İnstructional Strategy on Students' Learning Outcomes: A Meta-Analysis*

Figure 2. Reviews on the FCM in the literature and their results

Figure1 and Figure 2 show that the FCM is generally influential on students. This study draws attention to the general trends of the studies about the FCM, especially in the field of education, conducted between 2010-2019. Related articles were evaluated with content analysis in terms of variables examined, research approaches used, sample groups, data collection tools, and methods of data analysis. The current study employed a bibliometric analysis with the purpose of identifying the most frequently mentioned keywords in the articles, words in abstracts, and the most cited authors as well as journals. Content analysis was limited to the variables included in the article classification form used in the study, while variables in the bibliometric analysis were confined to the analyzes presented by the VOSViewer. It is believed that this study can be a guide for future studies on the FCM. As a matter of fact, the model is considered very important during the pandemic period currently

happening all over the world. It is anticipated that the FCM will make great contributions to the distance learning process, especially by preventing the education from being limited to the classroom by creating out-of-class education packages and activities.

Based on the points stated above, the purpose of the study was to reveal the tendencies towards the effective use of the FCM through the articles released between the years of 2010-2019. In line with this purpose, the research questions of the study were formulated as in the following:

In the articles published related to the FCM between the years of 2010-2019,

1. What is the frequency of the key words used?
2. What is the frequency of the vocabulary used?
3. Who are the most cited authors?
4. What are the most cited journals?
5. What variables are mostly preferred?
6. What are the methodological trends?
7. What are the most frequently used data collection tools?
8. What is the most commonly preferred study group?
9. What are the most commonly utilized data analysis methods?

2. Method

In the study qualitative research design was adopted, and the details are as in the following:

2.1. Sampling

In the sampling process purposive sampling method was used. The articles published regarding the Flipped Classroom Model (FCM) between 2010 and 2019 were scanned in the Web of Science database under the indices of SSCI and SCI-EXPANDED. The key words for the search were flipped classroom, education, social science, science, chemistry, biology, and physics. Relevant articles were examined via content and bibliometric mapping analysis as presented below.

2.1.1. Content analysis process

The articles included in the analysis were those published between the years of 2010 and 2019. The language of the articles selected from among journals is English. A total of 126 articles on the flipped classroom were evaluated in the first literature review. Four academics checked each article to determine those to be included in the analysis. The total number of articles selected for the content analysis is 79. In determining the articles to be included in the analysis, those related to education and flipped classroom model were particularly selected. Articles that did not contain those two criteria and reviews were excluded from the analysis. Finally, 63 articles published in different journals were selected for the content analysis. Figure 3 presents the summary of this process.

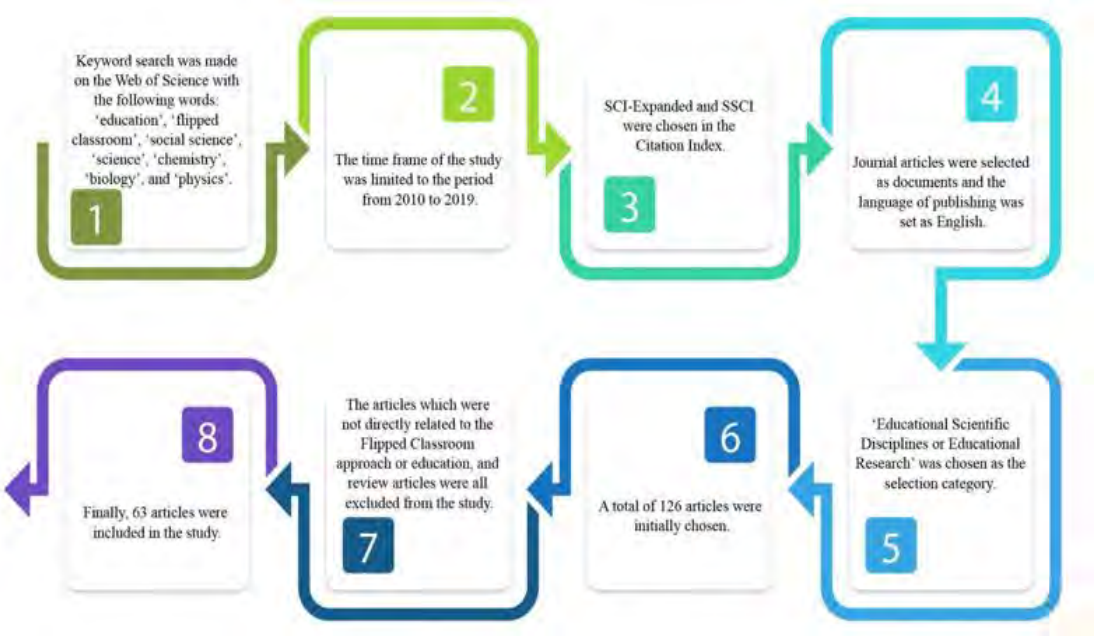

Figure 3. Selection process of the articles analyzed in the study

2.1.2. Bibliometric Analysis via VOSViewer program

The disciplines in the field of education, namely, 'Social Sciences, or Science, or Chemistry, or Biology, or Physics' were used as keywords within the context of the 'flipped classroom' model. As a result of the literature review, 63 articles were downloaded from tab-delimited (Win) with the citation reference list file, which was then uploaded to the VOSViewer program, in which a bibliometric mapping analysis was performed for 'the most frequently mentioned keywords in the articles', "the most frequently mentioned words in the abstracts", "the most cited authors" and "the most cited journals".

2.2. Data Coding and Analysis

The content analysis of the current study was conducted, considering the criteria in the 'Article Classification Form', developed by Sözbilir, Kutu, and Yaşar (2012). The form comprises six parts: the tag, subject, method, data collection tools, sampling and data analysis methods of an article. VOSViewer program was used in bibliometric analysis. With the VOSViewer program, network visualization was performed for the most frequently mentioned keywords in the articles, the choice of words in the abstract sections, the citation analyses, and the reference analyses. The descriptive statistics were also included in the analysis of the results.

3. Results

3.1. Results for Bibliometric Mapping Analysis

3.1.1. The most frequently mentioned keywords in the articles about the FCM

Figure 4 presents below the process followed for each analysis during the analysis in the VOSViewer.

Figure 4. Analysis process on VOSviewer

3.1.1. The most frequently mentioned keywords in the articles about the FCM

Considering the analysis results (Figure 5), what is significant is that the most frequently mentioned keyword appears to the 'flipped classroom' (f = 26). Besides this, 'active learning' (10), and 'blended learning' (f = 6) are also among the most frequently mentioned keywords, whereas the least used keyword has turned out to be 'learning analytics' (f = 2). The studies conducted on the FCM have become more intense since 2015. Considering the distribution of the keywords used by years, what is remarkable is that that more articles appear to have focused on 'motivation' (Figure 6) in recent years.

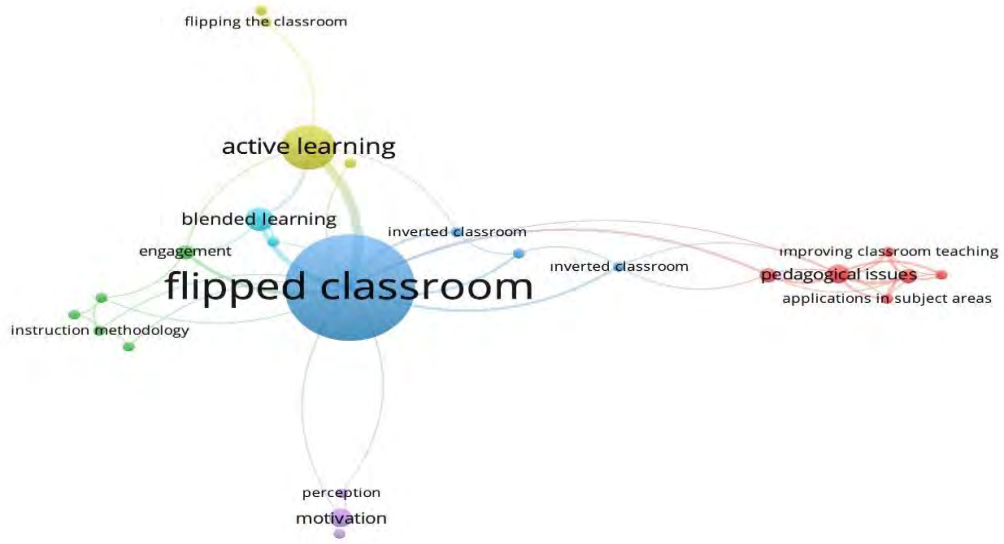

Figure 5. Most frequently mentioned keywords in the articles about the FCM

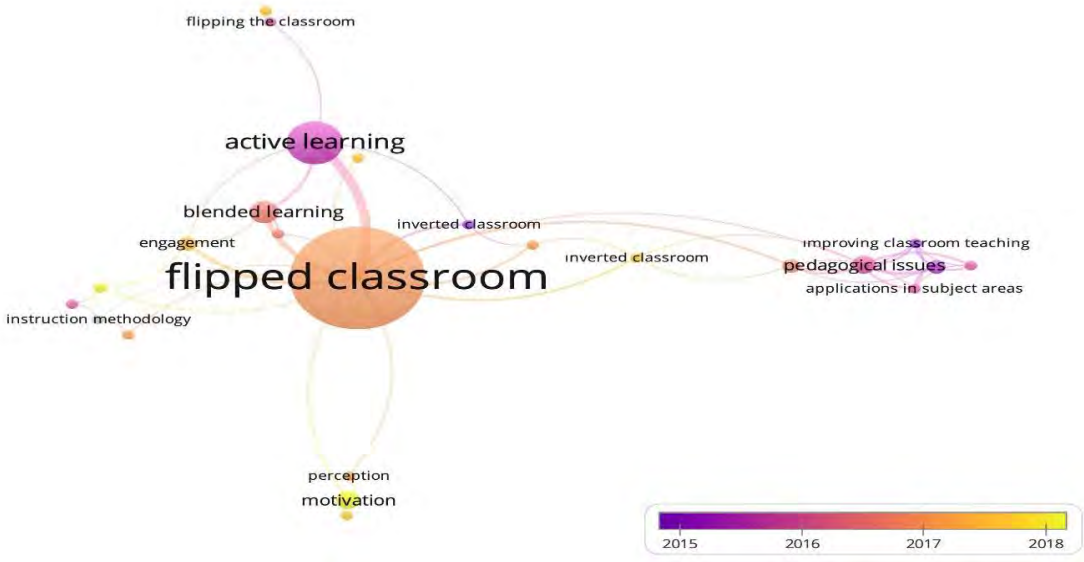

Figure 6. The distribution of the most frequently mentioned keywords in the articles by years

3.1.2. The most frequently mentioned words in the abstract sections

The analysis results (Figure 7) indicate that the most frequently mentioned word is 'student' (f = 58). Moreover, 'study' (48), 'course' (f = 36), 'classroom' (f = 35), and 'flipped classroom' (f = 30) are also among the most frequently mentioned keywords. The distribution of words by years (Figure 8) clearly indicates that the words 'practice', 'difference', 'effect', 'education', and 'session' have been intensively emphasized in recent years.

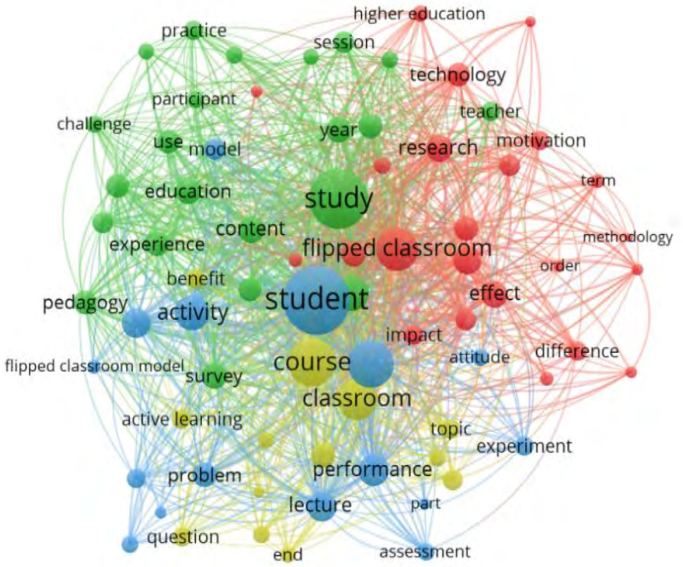

Figure 7. Most frequently mentioned words in abstracts

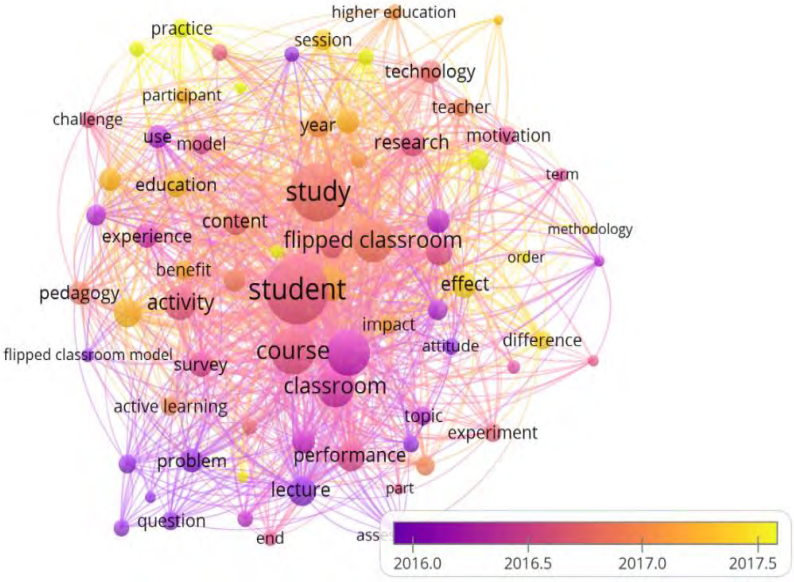

Figure 8. The distribution of the most frequently mentioned words in abstracts by years

3.1.3. The most cited authors

The analysis results (Figure 9) also show that the most cited authors are Reid Scott (91 citations), Canada Canada Florentina (61 citations), and Gonzalez-Gomez David (61 citations). The analysis results (Figure 10) demonstrate that Bergmann (40 citations), Lage (26 citations), and Strayer (21 citations) are the authors whose papers have most been cited together (co-citations).

Figure 9. Most cited authors (citation analysis)

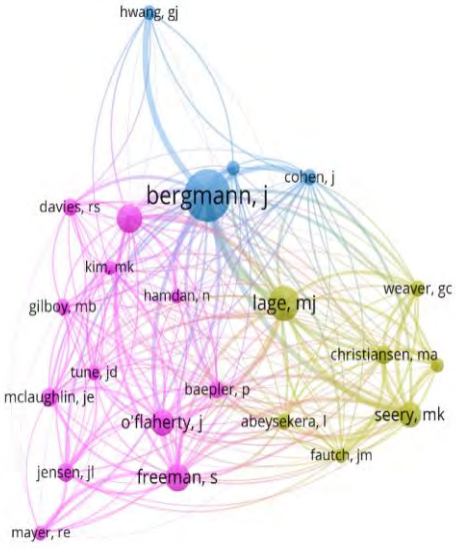

Figure 10. Most co-cited authors (co-citation analysis)

3.1.4. The most cited journals

As can be seen in Figure 11, Computers & Education (585 citations, 7 documents), Journal of Chemical Education (301 citations, 9 documents) and Cbe-Life Sciences Education (91 citations, 4 documents) are the most cited journals. Figure 12 demonstrate that the Journal of Chemical Education (159 co-citations), Computers & Education (105 co-citations), Chemistry Education Research and Practice (67 co-citations) appear to have the most frequency of co-citations.

Figure 11. Most cited journals (citation analysis)

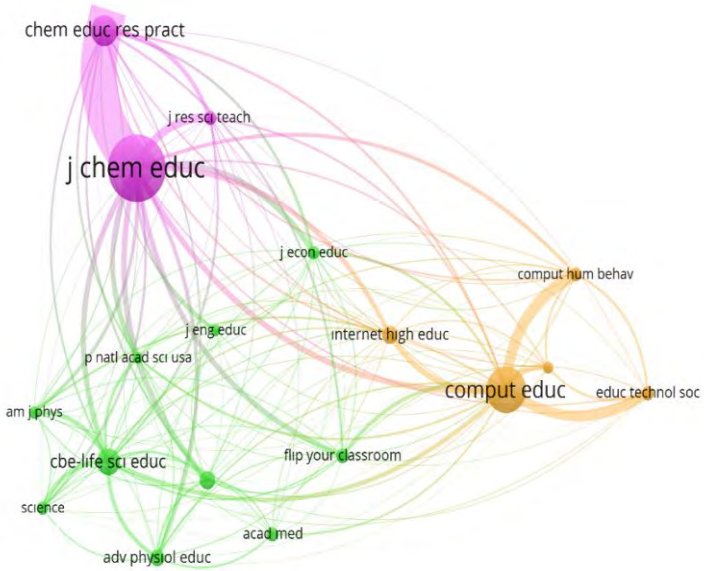

Figure 12. Most cited journals (co-citation analysis)

3.2. Results of the Content Analysis

3.2.1. Variables examined in articles on the FC

The variables in which the effect of the FCM was investigated were examined and the results are presented in Table 1. Since one of the studies examined more than a single variable, a high frequency level was found in total. The most frequently examined variable in the studies was 'academic achievement/performance' (f = 47), 'Motivation' (f = 13), and 'Perception' (f = 12), respectively. Such other variables as critical thinking, active learning, responsibility, self-efficacy, and peer teaching were also examined.

Table 1. *The frequency of variables found in the articles*

Variables	No of Articles	%
Academic achievement/ performance	47	74.60
Motivation	13	20.63
Perception	12	19.04
Active learning	5	7.93
Critical thinking	4	6.34
Responsibility	3	4.76
Self-efficacy	3	4.76
Peer teaching	3	4.76
Satisfaction	3	4.76
Attitude	2	3.17
Recall of knowledge	1	1.58
Thinking ability	1	1.58
Information literacy	1	1.58
Creative and analytical thinking	1	1.58
Autonomy	1	1.58

3. 2. 2. Methodological trends in the articles

As shown in Figure 13, the quantitative approach has been used in 76% of the articles, the qualitative approach in 9%, and the mixed approach in 9% of the articles conducted in the last decade. It is also noteworthy that the rate of case, action, and phenomenological studies is only 2%. Table 2 presents the methodological trends of the articles, and Figure 14 presents the distribution of the articles by years.

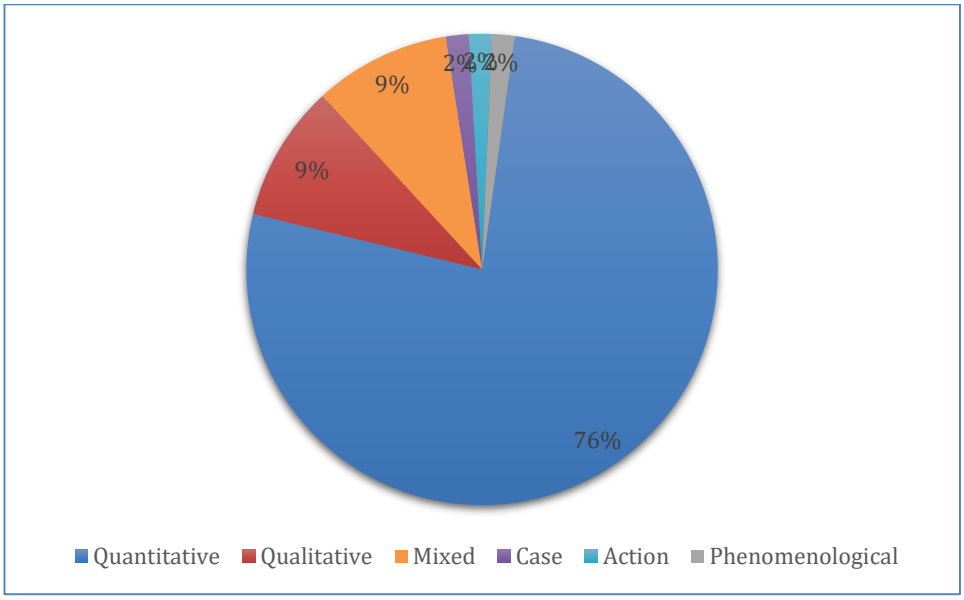

Figure 13. Frequency of the research approaches in the last decade

Table 2. *Methodological trends of the studies on the use of the FCM*

Research Approaches	2010-2012	2013-2015	2016-2019	2010-2019	
	f	F	f	f	%
Quantitative	1	10	38	49	77.77
Qualitative	-	2	3	5	7.93
Mixed	-	2	4	6	9.52
Case Studies	-	-	1	1	1.58
Action Research	-	-	1	1	1.58
Phenomenological	-	-	1	1	1.58
Total	1	14	48	63	100

Figure 14. Distribution of research approaches by years

The distribution of research approaches by years (Figure 14) demonstrates that the most preferred research approach between the years 2010-2019 was the quantitative approach. It was also determined that qualitative, mixed, case, action and phenomenological research approaches began to be used after 2014.

3. 2. 3. Data collection tools of the articles

Table 3 shows that the most used data collection tool between 2010 and 2019 was the "Achievement Test" (f = 36). In addition, data collection tools such as scales, questionnaires, interviews, observations, focus group interviews, diaries, rubrics, and prior knowledge assessment tests were also used in variety of studies. In some studies, the total frequency was calculated high due to the use of more than one data collection tool.

Table 3. *Data collection tools in studies on the FCM*

Data Collection Tools	2010-2012	2013-2015	2016-2019	2010-2019	
	f	f	f	f	%
Achievement Test	1	9	26	36	57.14
Scale	1	1	18	20	31.74
Questionnaire	-	2	11	14	22.22
Interview	-	3	8	11	17.46
Observation	-	2	2	4	6.34
Focus Group Interview	-	-	2	2	3.17
Diary	-	-	1	1	1.58
Rubric	-	-	1	1	1.58
Prior Knowledge Assessment Test	-	-	1	1	1.58

Figure 15 presents the frequency of the use of data collection tools and their distribution by years.

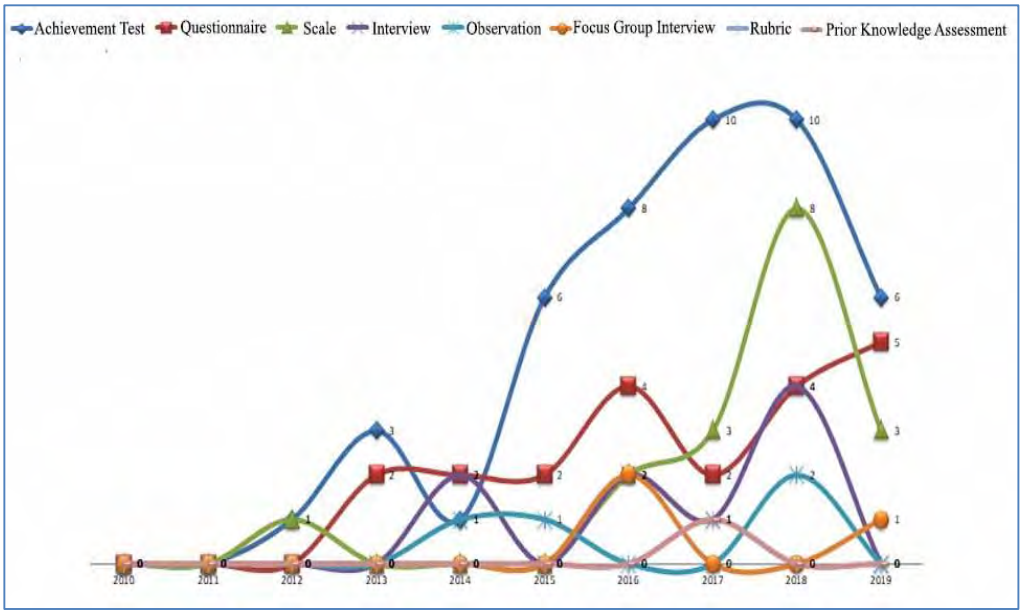

Figure 15. The distribution of data collection tools by years and their frequency of use

As can be seen in Figure 15, achievement tests were widely used throughout the years from 2010 to 2019. It is also seen that the use of scales and surveys has started to increase as of 2016 and that interviews and observations were used the most in 2018.

3. 2. 4. The sample group

Based on the studies examined, it is remarkable that university students (f = 47) were mostly preferred as a sample group between 2010 and 2019. In addition, secondary school students (f=7), graduate students (f=5), educators (teachers and academics) (f=3), and primary school students (f =1) were also selected as sample groups. As is seen, studies conducted especially with secondary school students increased in 2018. The table below (Table 4) presents the most selected sample group as well as its distribution by years (Figure 16).

Table 4. *The Distribution of sample groups in articles*

Sample Group	2010-2019	
	f	%
University Students	47	74.60
Secondary School Students	7	11.11
Graduate Students	5	7.93
Educators (Teachers and Academics)	3	4.76
Primary School Students	1	1.58

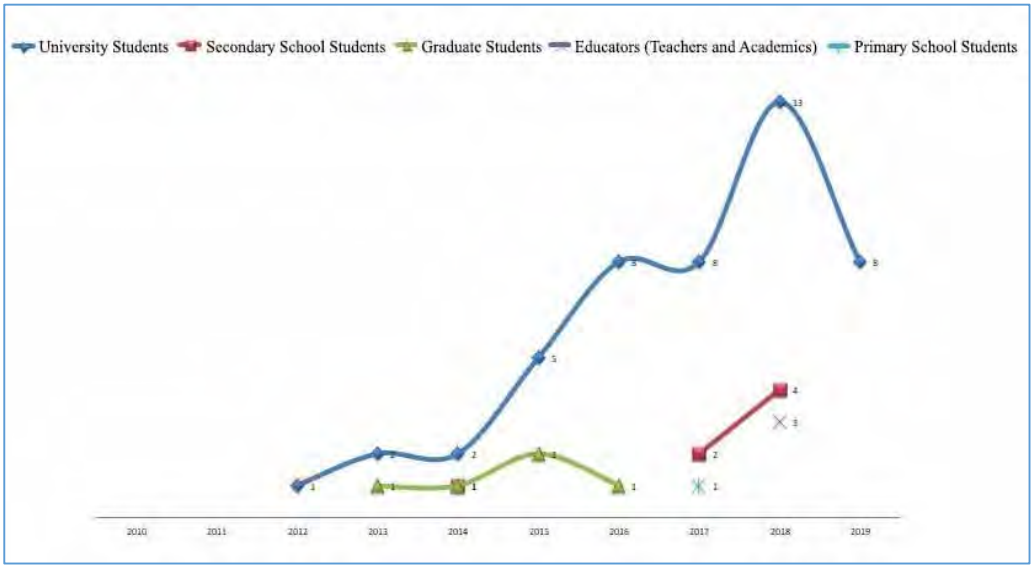

Figure 16. Distribution of sample groups by years

3. 2. 5. The Selected Methods of Data Analysis

The review of the studies revealed that inferential analysis and descriptive analysis methods were generally used in the relevant studies (Figure 17). T-tests (18%) and ANOVA (f=13) analysis methods were found to be used frequently among inferential analysis methods. It was also noted that the most used qualitative data analysis method was the content analysis method. In some studies, the total frequency was calculated high as more than one data analysis method was used. Table 5 presents the detailed information on data analysis methods.

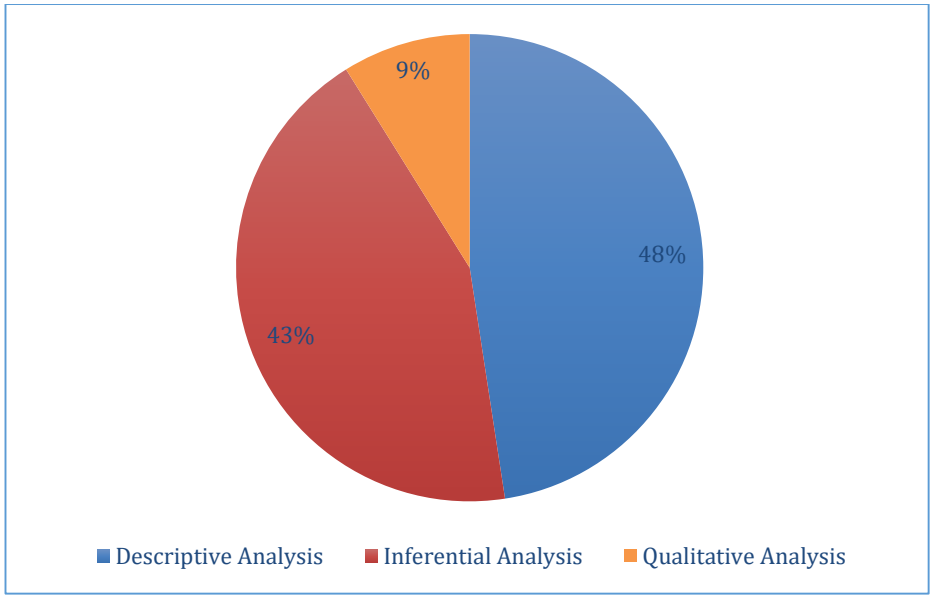

Figure 17. Frequency of the use of data analysis methods in the last decade

Table 5. *The distribution of the selected methods in the analysis*

		2010-2012	2013-2015	2016-2019	2010-2019	
		f	f	f	f	%
Descriptive Analysis	Frequencies, percentages, tables, mean, standard deviations Graphs	1	12	46	59	93.65
Inferential Analysis	T tests	1	3	14	18	28.57
	ANOVA	-	2	11	13	60.63
	ANCOVA	-	2	7	9	14.28
	Chi Square	-	-	5	5	7.93
	Mann-Whitney U test	-	-	3	3	4.76
	MANOVA	-	-	3	3	4.76
	MANCOVA	-	-	1	1	1.58
	Correlation	-	-	1	1	1.58
	Regression	-	-	1	1	1.58
Qualitative Analysis	Content Analysis	-	4	7	11	17.46
	Descriptive Analysis	-	-	-	-	

4. Conclusion and Discussion

This study aimed to present the bibliometric mapping analysis results and methodological trends of the articles related to the FCM in the last decade. The analyses made in the VOSwiever program revealed that the most mentioned keywords in the articles about the FCM are flipped classroom, active learning, chemical education research, collaborative / cooperative learning, internet / web-based learning. Considering the distribution of keywords by years in recent years, articles appear to have emphasized motivation in particular. However, it is also seen that the most frequently mentioned words in the abstracts include students, study, course, classroom and flipped classroom, indicating that the articles mostly try to reveal how effective the FCM is on students in different courses. Over the years, it draws attention that articles have tended to focus on such words as practice, difference, effect, education, and session. According to the citation analysis, Reid, Canada Canada and Gonzalez-Gomez appeared to be the most cited authors, while Bergmann, Lage and Strayer appeared to be the most co-cited authors when looking at the co-citation analysis in this field. According to bibliometric analysis results, Computers & Education, Journal of Chemical Education, and CBE-Life Sciences Education journals are the most cited journals.

Content analysis indicated that the variables of academic achievement/performance, motivation and perception were the most examined variables. Likewise, the relevant literature shows that the most frequently mentioned variables are academic achievement/performance (K. S. Chen et al., 2018; Lin & Hwang, 2019; O'Flaherty & Phillips, 2015; Zainuddin et al., 2019), motivation (Zainuddin et al., 2019), and perception (Lo, 2018). The research by C.-K. Chen et al. (2019), on the other hand, stated that the most studied variables were performance, attitude and perception, while the least studied was self-regulation. Considering the importance of investigating whether various practices in the field of education have an effect on students' learning, it can be regarded as an expected result that such variables become prominent. When examined, the methodological trends of the articles indicate that the quantitative approach appears to have been used in 62% of the articles in the last decade. A similar attribution was made in the review by K. S. Chen et al. (2018) and Lundin et al. (2018). However, the percentage of studies using mixed and qualitative approaches was found to be low. Similarly, Lin and Hwang (2019) indicated that very few studies had been conducted by using mixed and qualitative approaches. In addition, Chung et al. (2019) stated that the most used approach in research studies was the quantitative approach. In the light of the results, achievement tests, scales and questionnaires appear to be primarily preferred data collection tools. In this context, it can be argued that it is an inevitable result to use achievement tests, scales, and questionnaires as the most used data collection tools, given the fact that the studies in the articles examined were mostly conducted with a quantitative approach with the academic achievement/performance being the most frequently used variable. There are a great many studies in the literature that support this result. Drawing on the results obtained by O'Flaherty and Phillips (2015), academic achievement/performance is primarily preferred as a variable, in addition to achievement tests, scales and questionnaires, which are especially favored as data collection tools. It has also been determined that interviews and observations have been used since 2014, and that mostly university students have been preferred as the sample group, reaching the highest number in 2018, while the percentage of involvement by postgraduate students, teachers and primary school students have remained low. Furthermore, the number of studies conducted especially with secondary school students are found to have increased in 2018. The study by and Akçayır and Akçayır (2018) shows that the highest number of participants are often university students, while the lowest participation is by teachers. As the data analysis method, descriptive statistics

(frequencies, percentages, tables, mean, standard deviations) has been mostly used in the last decade. T-tests (17%) and ANOVA (f=13) analysis methods were found to be most frequently used ones among inferential analysis methods, and the most commonly used qualitative data analysis method was the content analysis.

Based on the results, some recommendations are presented below:

- ✓ The studies on the FCM mostly deal with academic achievement/performance, motivation and perception variables. Future studies may be conducted by considering various variables such as collaboration, self-regulation and higher-order thinking skills.
- ✓ Since it draws attention that achievement tests, scales and questionnaires are the most preferred tools to collect data in the studies reviewed, other suitable alternative measurement tools can be employed to make more detailed measurements.
- ✓ Most studies have been conducted with university students as a sample group. Future studies may involve high school, middle school, primary school and preschool students.
- ✓ A considerable number of the studies have been conducted using a quantitative approach. Qualitative and mixed approaches can be employed in order to reach more detailed results.
- ✓ Video contents are generally used in the studies. More studies can be conducted by integrating different technological applications to the FCM applications.

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