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Research Status and Trends in the Flipped Classroom Model for Learning with Technology: A Systematic Review of Peer-reviewed Empirical Studies Published in Different Journals up to 2022

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Abstract: The current study aims to investigate research trends in the flipped classroom model (FCM). To achieve this, 823 peer-reviewed empirical studies published in different journals up to 2022 were selected and systematically reviewed. According to the data, FCM research receives more scholarly attention each year. The trend that was found in FCM research is that participants are generally chosen from the undergraduate level, and the majority of participants were found to be students. Furthermore, FCM researchers have applied various research methods during the past years; however, they have shown a preference for the quantitative design. The findings of this review show that research on the FCM is more commonly conducted in the fields of medical and health sciences and language than in other disciplines. These findings are expected to provide a better understanding of the status and trends associated with the FCM and help to visualize future practice and research directions.

Keywords: Educational technology; Flipped classroom model; Flipped learning; Teaching/learning strategies; Systematic reviews.

حالة البحث وتوجهاته في نموذج الفصل المقلوب للتعلم باستخدام التكنولوجيا: مراجعة منهجية للدراسات التجريبية المحكمة المنشورة في مجلات مختلفة حتى عام 2022

د/ هناء عيد الحربي

كلية التربية | جامعة طيبة | المملكة العربية السعودية

المستخلص: هدفت الدراسة الحالية إلى استكشاف حالة البحث وتوجهاته في نموذج الفصل المقلوب باستخدام أسلوب المراجعة المنهجية. وقد تكونت عينة البحث من 823 دراسة تجريبية محكمة نُشرت في مجلات مختلفة حتى عام 2022. أظهرت النتائج أن أبحاث نموذج الفصل المقلوب قد حظيت باهتمام أكاديمي متزايد كل عام. كما أظهرت النتائج أن غالبية المشاركين في هذه الأبحاث هم من فئة الطلاب ومن المستوى الجامعي. علاوة على ذلك، قام باحثو نموذج الفصل المقلوب بتطبيق طرق بحث مختلفة خلال السنوات الماضية؛ إلا أن نتائج البحث أظهرت تفضيلاً للمنهج الوصفي الكمي. أظهرت النتائج أيضاً أن أبحاث نموذج الفصل المقلوب أكثر شيوعاً في مجالات العلوم الطبية والصحية واللغات من التخصصات الأخرى. من المتوقع أن توفر هذه النتائج فهماً أفضل للاتجاهات المرتبطة بأبحاث نموذج الفصل المقلوب مما يساعد على تصور الممارسات المستقبلية واتجاهات البحث.

الكلمات المفتاحية: تكنولوجيا التعليم، نموذج الفصل المقلوب، التعلم المقلوب، استراتيجيات التدريس/ التعلم، مراجعات منهجية.

1. Introduction

Modern technology has played a vital role in reforming learning and teaching practices in modern classrooms. Specifically, technology has transformed the style of teaching and how in-class time can be best used to support students' learning (Bicen & Taspolat, 2019). Unlike the traditional classroom environment, where students are taught to passively accept lecture content, teachers can avail new opportunities through technology and adopt new teaching methods to interact with students in a more active atmosphere (Deng, 2020). The flipped classroom model (FCM) is an emerging technology-based teaching method that helps teachers move away from traditional in-class direct lecture-based instruction as their primary pedagogical approach and toward a more engaging and effective student-centered approach (Güler et al., 2023; Strelan et al., 2020).

Typically, in traditional instructor-centered classrooms, teachers deliver lectures during class time and give students homework to be done after class, so that they can practice what they learned. One of the disadvantages of this approach might be the lack of time left for one-on-one personal engagement between teachers and their students, which makes it difficult to differentiate students according to their learning level (Rosen et al., 2017). Teachers would have time to engage with students more and support their learning needs if they make changes regarding what happens in class and outside class. This is where the basic idea of the FCM can be used as a solution (Bergmann & Sams, 2014b). Teachers can give class lectures or set instructional content as homework for students to watch before class — that is, at home — thus freeing class time for delivering targeted instruction to students, answering their questions, helping struggling students, and challenging those who have mastered the content, ultimately allowing for differentiated teaching approaches (Bergmann et al., 2013).

1.1. Background of the Flipped Classroom Model

The FCM was developed in 2007 by two high school science teachers, Jonathan Bergmann and Aaron Sams, in Colorado Rocky Mountain School in the United States (Bergmann & Sams, 2012). It started when both teachers realized that they needed to be responsive to the needs of students who often missed classes for some reason (e.g., outdoor activities). They began searching for an alternative to enable these students to watch lessons at home, so they could catch up and stay on track. They decided to video record their lessons and post the videos on YouTube, so that students who missed classes could watch them and learn what they had missed. While the teachers only intended for the videos to be watched by students who had missed classes, they noticed that even students who had been present in the classroom would watch their videos at home to study and review the content they had not understood face to face (Bergmann & Sams, 2016). Soon, the in-class direct lectures were replaced by the videos, and the teachers were able to use the freed-up time to increase the amount of guidance they provided to their students during active learning activities completed in class time. They were able to spend more time on more intense teacher-to-student mentoring and on facilitating constructive project-based activities such as

collaborative and problem-solving projects for which they rarely had time for before. Soon after, it framed as the FCM (Chellapan et al., 2018).

However, the elements of the underlying principles of the FCM were not new. They have been around for many years in various forms, known by terms such as "classroom flip" (Baker, 2000) or "inverted classroom" (Lage et al., 2000). Nevertheless, Bergmann and Sams popularized and solidified the phrase "flipped classroom" as a model in the last decade. They wrote a number of articles and publications, including their first book in 2012, titled "Flip Your Classroom: Reach Every Student in Every Class Every Day." Since 2012, the FCM has increasingly attained interest and acceptance and has become a strongly advocated approach in education to foster students' active learning (Giannakos et al., 2018; Strelan et al., 2020).

The flipped class is most often characterized by teacher-created videos that students watch before coming to class (Baker et al., 2013; Bishop & Verleger, 2013; Deng, 2020; Ekmekci, 2017). According to Bergmann and Sams (2014c) there is misinformation about the main purpose of the flipped classroom. They asserted that although they created this new method of teaching by incorporating videos as the preferred means of instruction, videos are not necessarily the primary tool when it comes to flipping a classroom. In the FCM, not every classroom has to deliver content via video. Rather, the premise is that the FCM aims to optimize the effectiveness of teachers' in-class time with students (Baker et al., 2013; Bergmann & Sams, 2014c). It "is more about a mindset: redirecting attention away from the teacher and putting attention on the learner and the learning" (Bergmann & Sams, 2012, p. 11). What distinguishes the FCM is that it requires students to be prepared to participate when they come to class, which requires that they take charge of their individual learning experiences before class and arrive to class ready to participate. This pre-class preparation typically involves the use of a variety of technologies that the teacher provides by posting lessons for students to access (Prust et al., 2015). The FCM could be defined as a "set of pedagogical approaches that (1) move most information-transmission teaching out of class; (2) use class time for learning activities that are active and social; and (3) require students to complete pre- and/or post-class activities to fully benefit from in-class work" (Abeysekera & Dawson, 2015, p. 3).

The FCM has been widely and increasingly adopted in recent years to meet the changing demands in many educational settings (Strelan et al., 2020). At the same time, a growing body of relevant empirical studies on the FCM have been conducted in different settings to investigate its effects on students' learning relative to traditional teaching approaches (Al-Samarraie et al., 2019). However, a comprehensive review of empirical studies on the FCM is still lacking (Strelan et al., 2020).

1.2. Previous Reviews of Flipped Classroom Model Research:

A recent Google Scholar search (conducted in May 2022) indicated that Bergmann and Sams' (2012) first book has been cited 4,664 times since its publication, and the term "flipped classroom model" appeared in more than 50,000 results. Despite the fact that research on the FCM has flourished recently,

only a few attempts have been made to review the literature on this emerging approach. This section briefly reviews some of the prior research reviews related to the FCM and discusses their contributions and limitations.

A few recent reviews and meta-analyses have been conducted to synthesize the findings of studies on the FCM. Some reviews limited their search to focus on mapping the effectiveness of the FCM at the higher education level (Al-Samarraie et al., 2019; Al-Sudais, 2019; Dweikat, 2019). For example, Al-Samarraie et al. (2019) carried out a review of the literature by interpreting the findings of 85 research studies on the utilization of the FCM across multiple disciplines in a university context. In their review, Al-Samarraie et al. (2019) reported and discussed the findings from the reviewed research studies, classifying them according to discipline: engineering and technology, mathematics, education, arts, humanities and social sciences, natural sciences and medical and health sciences. The study's results showed that the FCM was mostly used in teaching medical and health science courses. Furthermore, the adoption of this model in diverse disciplines is generally advocated to enhance students' achievement, performance, understanding, attitude, metacognition and engagement. Al-Samarraie et al. (2019) did not provide any information concerning the sample types or the research design of the reviewed research studies. Similarly, Dweikat (2019) systematically reviewed 50 research papers published in 2012-2018, applying content analysis to explore the benefits of using this approach. The reviewed papers were randomly selected using the Google search engine, but no inclusion criteria were described. Furthermore, the study did not present any detailed information regarding the selected papers, such as sample/population type, methodological approach, or field of study. The results of this review showed that (84%) of the research papers indicated that the FCM had positive effects on students' performance and achievement. In addition, some of the reviewed papers indicated a positive impact on participating students' attitudes toward and perceptions of using this model. In his study, Dweikat (2019) recommended that the FCM has the potential to reach all learners, facilitating differentiation and redefining teaching.

While (Al-Samarraie et al., 2019) and (Dweikat, 2019) reviews focused on higher education, Lo and Hew's (2017) review included studies conducted in K–12 classroom settings. Their study analyzed 15 journal articles about K–12 flipped classrooms, published between 2013 and 2016, in terms of student achievement, students' attitudes, learning activities, as well as challenges encountered. Lo and Hew's study showed that the flipped pedagogy had either a "neutral" or a positive impact on students' learning. Among the reviewed studies, the results regarding students' attitudes were mixed. The authors also discussed and categorized a number of challenges associated with implementing flipped learning: student, faculty, and operational challenges. The authors formulated ten guidelines to address these potential challenges.

Other reviews have focused on the effects within specific disciplines. For instance, Yousufi (2020) presented a review of FCM research on teaching English-language skills and components to justify the model's implementation in the classroom. The author suggested that the FCM can be an effective method

to facilitate language learning and development among learners, as it improves their language proficiency and content learning through collaborative and independent work. Similarly, Liu (2018) analyzed the current application of the FCM and discussed its positive significance in college English teaching. His paper promotes the model's use and advises that teachers shift away from the traditional teaching approach and concept in favor of applying the FCM to teaching college English. Wen, Harun, et al. (2015) reviewed the literature and identified and critically analyzed the social constructivism aspects of applying the FCM to promote students' active learning in information and communication technology (ICT). Based on social constructivism theory, the authors developed active flipped learning activities that may promote students' active learning to improve their ICT skills. In another review, the same authors (Wen, Zaid, et al., 2015) conducted a meta-analysis to identify the benefits of using the FCM to construct students' ICT social collaborative knowledge and reported that the FCM can indeed contribute to building that knowledge.

Njie-Carr et al. (2017) conducted an integrative review of 13 empirical studies published between and 2013 and 2016 on the application of the FCM among nursing students to evaluate the state of evidence concerning the model's effectiveness. The study provided an evidence-based foundation to inform nurse educators and researchers on the implementation of flipped classrooms. The study suggested that the FCM improved students' critical thinking, bolstered their motivation to learn, and promoted collaborative learning and teamwork. Ward et al. (2018) conducted a literature review of 14 studies in nursing education to explore and discuss the effectiveness of using the FCM on students' learning outcomes and improvements, and documented that only five studies (out of 14) measured students' learning outcomes, four reported positive results, and one showed non-significant results.

Some studies have reviewed research in certain countries. For instance, Hu et al. (2018) conducted a meta-analysis to evaluate the effectiveness of using a FCM in nursing education in China. Eleven randomized controlled trials were included in this review. The trials were published in Chinese journals between 2015 and 2017. Hu et al. (2018) reported that the FCM was more effective at improving students' knowledge and skills scores than traditional classes.

Other studies reviewed research on the FCM in education in general, without focusing on a specific discipline or education level. For example, Zainuddin and Halili (2016) used content analysis to investigate the most frequently employed methodologies, technological tools, areas of study, and impacts on students' learning. However, their study only reviewed 20 journals over three publication years (2013–2015). Interestingly, Zainuddin and Halili (2016) stated that the instruments that have been used the most in flipped classroom research are "surveys (28%), testing course (28%), interviews (14%), observation (7%), existing test scores (5%), document analysis (5%), and log system analysis (2%)" (p. 321). In addition, the authors reported that the flipped classroom has been implemented in various fields of study using diverse technological tools and online platforms. Subsequently, Zainuddin, along with other colleagues, reviewed and analyzed 48 studies published in 2017 and 2018 to examine the positive effects and the challenges encountered in flipped classroom implementation (Zainuddin et al., 2019).

More recently, Strelan et al. (2020) explored the impact of the FCM on student performance. He conducted a comprehensive meta-analysis study analyzing 198 studies across disciplines and educational levels. The reviewed studies were published prior to January 2018 and derived from seven electronic databases: PsycINFO, ERIC, Scopus, Academic Search Complete, Education Research Complete, Teacher Reference Center, and PubMed. Strelan and colleagues found that comparing to traditional teaching methods, the FCM was beneficial regardless of discipline or education level. The study reported that the FCM had a moderate positive impact on student performance, as it greatly contributed to structured active learning and problem solving. The author of the present study is also aware of some other published reviews and meta-analyses (Betihavas et al., 2016; Chen et al., 2017; Cho & Lee, 2018; DeLozier & Rhodes, 2017; Gillette et al., 2018; Hew & Lo, 2018; Lo et al., 2017; Lundin et al., 2018; O'Flaherty & Phillips, 2015; Tang et al., 2018; Velegol et al., 2015), but these do not focus specifically on Bergmann and Sams' (2014c) FCM.

1.3. Justification for the Current Study:

Although previous research has sought to review the existing literature on the FCM, most reviews and meta-analyses have focused on the model's effectiveness in various educational settings. It is evident that a few attempts have been made to review the research on the FCM from different perspectives, with a focus on examining and documenting this emerging model's impact on learning. Previous research reviews of various kinds have provided strong support for embracing the FCM, as it tends to have a positive impact on learning. However, these reviews typically have covered short publication range, and mostly focused on only one type of learner, particular aspects of students' learning, and/or specific academic disciplines. No previous review has examined the status of and trends in FCM research, and there has been no detailed investigation of these with regard to the emerging research. It has been found that previous studies have also reported some conflicting claims that need to be addressed further. That is, some studies have reported that FCMs are still underutilized and that empirical research at the higher education level is limited (Bishop & Verleger, 2013; Chen et al., 2014), while others have stated that most existing research has been conducted in higher education settings to the relative neglect of other educational levels (Juliana, 2017; Snyder et al., 2014; Strelan et al., 2020).

As the literature on the FCM has accumulated over the past decade, a more systematic review will help to depict the big picture. Analyzing the research status of and trends in FCM research would help educators and researchers understand the latest progress and provide important information for selecting appropriate research topics for further investigation. Unlike most previous reviews, the current study aims to investigate research trends related to the FCM by systematically reviewing relevant peer-reviewed empirical journal studies, covering a larger number of databases and a longer publication range than earlier reviews, without limiting the search to specific population types or fields of study. It is important to note that the current review does not attempt to touch on or discuss the results of the reviewed studies;

rather, it quantitatively examines their characteristics to understand the status and progress of the emerging research on the FCM. Hence, the results could be beneficial in terms of identifying gaps in the literature and areas that require further attention.

1.4. Research Questions:

To understand the research status of and trends in the FCM, peer-reviewed empirical studies published in different journals up to 2022 were selected and systematically reviewed. To this end, this study aims to answer the following research questions:

1. What is the status of and what are the trends in empirical research on the FCM published in different journals up to 2022?
2. Which educational levels have been searched in empirical studies on the FCM published in different journals up to 2022?
3. Which research methods were adopted in empirical studies on the FCM published in different journals up to 2022?
4. Which subject domains have been addressed in empirical studies on the FCM published in different journals up to 2022?
5. What sample groups were selected in empirical studies on the FCM published in different journals up to 2022?

2. Method.

The researcher undertook a systematic review of FCM research in three stages: (1) literature search in databases, (2) data abstraction and coding, and (3) data analysis.

2.1. Literature Search in Databases:

At the first stage, the Saudi Digital Library (SDL) interface was searched as the literature source for the review. The SDL was chosen because it provides access to more than 300 subscription databases, including Education Research Complete, Complementary Index, Academic Search Ultimate, Scopus, EBSCO, Elsevier, Taylor & Francis, ERIC, Applied Science & Technology Source, Web of Science, Springer, Wiley Online Library, among others. The search was conducted on the 13th of May 2022. The keyword employed was "flipped classroom model." The initial search yielded approximately 9,060 references. Then, duplicate records were removed both automatically and manually, yielding a list of 5,016 unique references. The studies were then filtered based on the inclusion and exclusion criteria (see Table 1). First, the search was limited to peer-reviewed academic journal articles, yielding a list of 1221 records. Full-text articles were obtained and screened manually and systematically to identify those that could be included in the analysis. That is, only empirical studies that explicitly discussed the adoption of the FCM and provided information about context, sample, and measurements were included in the review. Thus, 823 empirical peer-reviewed journal articles were retained for in-depth analysis.

Table (1) Inclusion and Exclusion Criteria

Inclusion criteria	Exclusion criteria
Studies must be peer-reviewed articles published in academic journals.	Editorials, conference papers, books, and other publications were excluded.
Only empirical articles that explicitly focused on the flipped classroom model were selected.	Articles that were exclusively theoretical studies, discussions, or policy analyses were excluded.
The studies needed to provide information about context, sample, and measurements.	Articles that mentioned the term "flipped classroom model" but were actually about other topics were excluded.

2.2. Data Abstraction and Coding:

At the second stage, the researcher further screened full-text versions of the 823 studies to formally abstract each study's characteristics. That is, she entered information about each study into her database, following a protocol developed to analyze and categorize the studies according to year of publication, educational level, research design and methods, subject domain(s), and sample group(s). After the coding process, to determine the robustness of the analysis, a random sample of 20 studies was coded independently by another researcher with meta-analysis experience. The percentage agreement for each coding category is 99%.

2.3. Data Analysis:

At the third stage, the researcher analyzed data obtained from the 823 articles using the SPSS statistical program package (v25). Data were categorized according to the following variables: year of publication, educational level, sample group, subject domain, and research method. The year of publication variable is the date on the article that indicates the year in which it was published. The educational level variable was divided into eight categories: preschool, primary school, high school, K–12, undergraduate, postgraduate, professional development, and training institution. Sample group variables were divided into four categories: students; teachers; students and teachers; and students, teachers, and others (as some studies used more than two sample groups, e.g., teachers, students, and their parents or school principals). With regard to the subject domain, data were categorized into 15 major disciplines: medical and health sciences, mathematics, science, social sciences, technology, industry, engineering, education, language, library competencies, business, law, politics, multiple domains, and unspecified. Finally, the variables related to research design and methods were divided into three categories: quantitative, qualitative, and mixed methods. Section 3 presents and discusses the results of this review.

3. Results and Discussion.

3.1. Status of and Trends in Empirical Research/Journal Studies on the FCM Published up to 2022

The distribution of empirical journal articles on the FCM was analyzed across the publication years. In general, starting in 2012 and going up to 2022, there has been a steady increase in the annual

number of FCM studies (see Figure 1). This indicates more research interest in this model. This increase in research shows that the FCM has become a popular topic of discussion among scholars and practitioners alike. The rise in research and interest in the FCM could be attributed to a few factors. These factors could include the fact that FCM is a relatively new approach in education and there is much left to be explored in terms of how it can be applied in different contexts. A closer look at Figure 1 shows that research in this area has significantly increased since 2014 (with a noticeable jump after 2016). Among the 823 studies, only 32 were published between 2012 and 2014, while the majority (about 96%) was published between 2014 and 2022 (see Table 2). The beginning of this noticeable increase coincided with the timeframe in which Bergmann and Sams (2014a) published their second book, *Flipped Learning: Gateway to Student Engagement*, in which the authors define and describe the FCM in detail. In their second book, Bergmann and Sams assert that the FCM is a "revolutionary education philosophy" that is truly student-centered and explain that teachers who adopt it are individualizing learning in order to engage each student. Throughout the book, the authors urge educators to keep one main question in mind as the core of the FCM: "What is the best use of face-to-face time with students?" The book offers educators a general guide to covering and clarifying common concerns and misconceptions about the FCM. In addition, in 2016, Bergmann and Sams expanded this idea in a book series dedicated to supporting flipped learning in five different subject areas: English, mathematics, science, social studies, and elementary classrooms. The series could encourage more educators to adopt the FCM in their practices and inspire researchers to conduct more related research in order to provide empirical evidence in support of the flipped learning approach.

Table (2) Number of Empirical Journal Articles on the FCM Published up to May 2022

Year of publication	Frequency	Percent
2012	2	0.2
2013	5	0.6
2014	25	3.0
2015	72	8.8
2016	75	9.1
2017	98	11.9
2018	100	12.2
2019	105	12.8
2020	106	12.9
2021	131	15.9
2022	104	12.6
Total	823	100.0

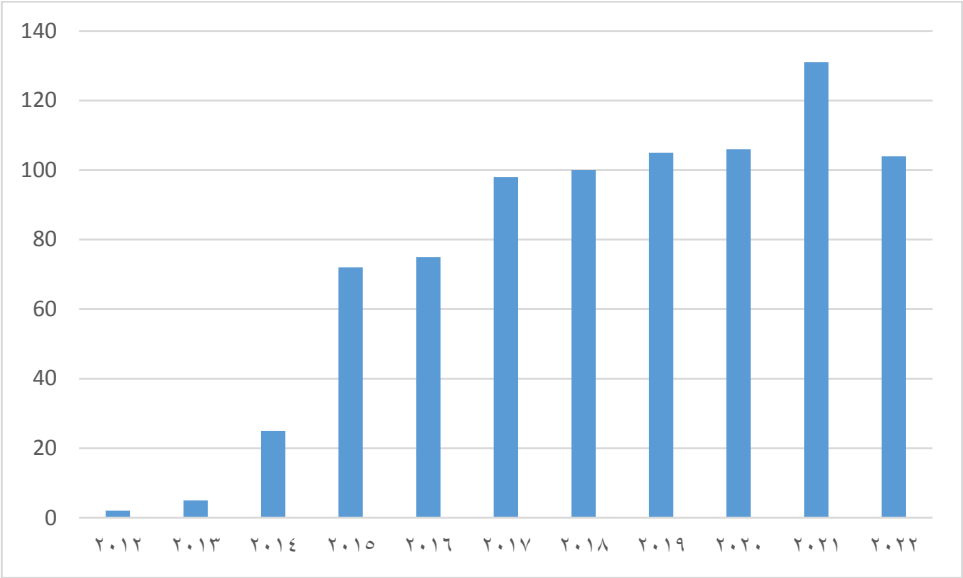

Figure (1) Distribution of Empirical Journal Articles on the FCM Published up to May 2022

Another possible explanation for this increase is that learning via technology has become widespread and has also intensified over the last ten years. The advances in and growing availability of technology (e.g., the Internet, mobile devices, e-learning software programs, and applications) have made it easier to create and share learning resources. That is, recent development in e-learning authoring tools has enabled teachers to create deliverable interactive learning content using pre-made simple templates, without needing to know standard programming languages. At the same time, the Internet and its applications have become more available, and mobile devices (e.g., smartphones and tablets) have become simpler and more portable, which, in turn, has allowed students to access learning content more easily.

In general, Figure 1 shows that FCM research intensified during the last six years. This result provides supporting evidence for other researchers' observations that the FCM has been widely and increasingly adopted (Strelan et al., 2020). Moreover, the number of empirical journal articles published on the FCM after 2019 is relatively high, which suggests that a similar level of interest in the flipped classroom will continue in 2022 and beyond.

3.2. Educational Levels Searched in Empirical Journal Studies on the FCM Published up to 2022:

Figure 2 shows the distribution of the educational levels searched in empirical journal studies on the FCM published up to 2022. Most of the reviewed studies were conducted at the undergraduate level. Table 3 shows that the undergraduate level has been the most popular (72.2%), followed by high school (9.6%), postgraduate (7.3%), professional development (5%), primary school (2.5%), training institution (2.1), and K–12 (1.3%). None of the reviewed studies was conducted at the preschool level. These results are consistent with recent reviews that have noted that the FCM has been studied more extensively in higher education settings than at other education levels (Akçayır & Akçayır, 2018; Juliana, 2017; Strelan et al., 2020). One possible explanation for this is that undergraduate students are expected to show greater

self-regulation abilities than K–12 students and are also easier for researchers to access, as many academic teachers at higher education levels are also researchers, and conducting research is part of their profession (Strelan et al., 2020).

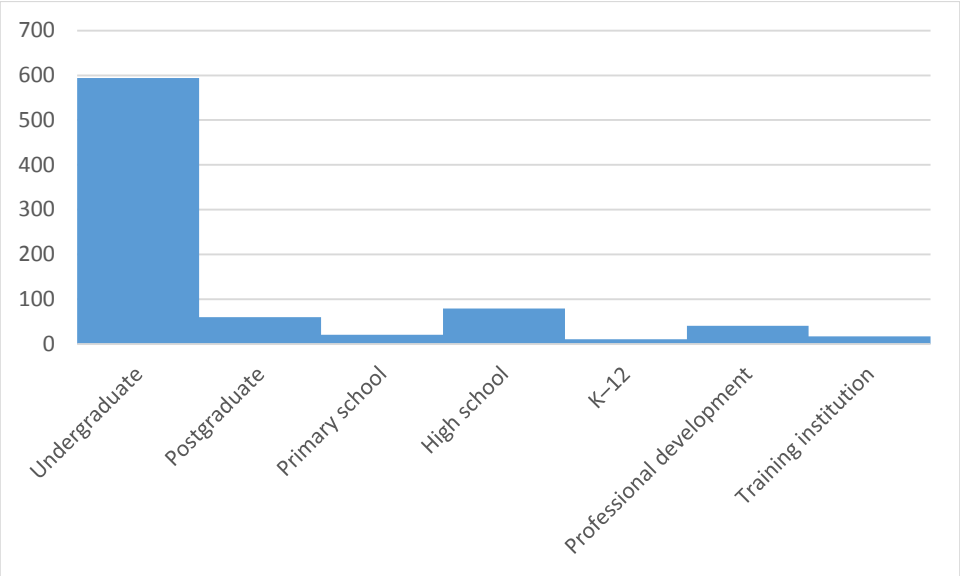

Figure (2) Educational Levels Searched in Empirical Journal Studies on the FCM Published up to May 2022

Table (3) Educational Levels Searched in Empirical Journal Studies on the FCM Published up to May 2022

Educational level	Frequency	Percent
Undergraduate	594	72.2
Postgraduate	60	7.3
Primary school	21	2.5
High school	79	9.6
K–12	11	1.3
Professional development	41	5.0
Training institution	17	2.1
Total	823	100.0

A closer look at the data (see Figure 3) shows that even before 2016, the number of empirical studies on the FCM at the undergraduate level is remarkably high compared to the other levels. This result is contrary to studies that have claimed that the FCM is still underutilized and that empirical research at the higher education level is limited (Bishop & Verleger, 2013; Chen et al., 2014). In fact, these claims could be another reason the number of empirical studies conducted at the undergraduate level has increased significantly, as more researchers have perhaps responded to those claims by encouraging scholarly focus on the higher education level in general.

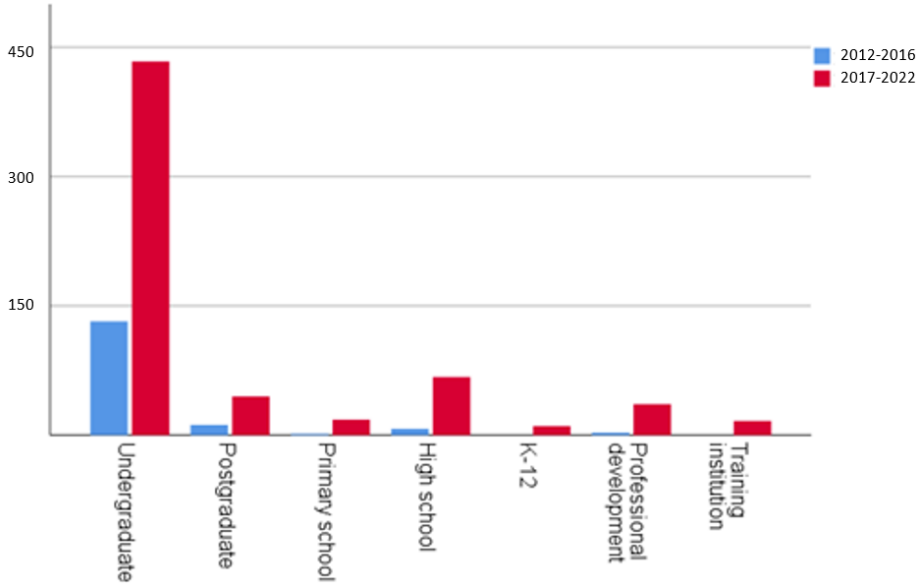

Figure (3) Educational Levels Searched in Empirical Journal Studies on the FCM Published up to May 2022 (Two Periods)

With regard to general education, the results (see Figure 2) reveal that empirical research on the FCM is limited, as only 13% of the reviewed studies focused on the primary school, high school, or K–12 levels (see Table 3). In addition to the explanations given in the previous two paragraphs, this could also be due to some of the challenges and issues previous studies have reported related to the FCM in general education (Lo & Hew, 2017). For instance, applying the FCM to school environments might be limited by technological constraints in schools. In addition, due to their age, students at the general education level may have less control over their technology usage; that is, they may have limited access or time to use technology for out-of-class learning.

Moreover, the results also reveal that the training institution level is one of the sample groups that has been employed the least in empirical studies on the FCM. Specifically, only 2.1% of the reviewed studies applied the FCM at the training institution level. This result is consistent with Akçayır & Akçayır (2018), who pointed out a notable absence of teachers or adults as sample groups in flipped classroom research. However, it has been suggested that the flipped classroom could potentially be effective for teaching these groups of learners because it is similar to the *andragogy* approach in the sense that it is flexible and supports self-determination (Betihavas et al., 2016).

3.3. Research Methods Adopted in Empirical Journal Studies on the FCM Published up to 2022:

With regard to research methods adopted in empirical journal studies on the FCM published up to 2022, Figure 4 reveals that most of the reviewed studies adopted quantitative methods (57.1%) at a noticeably higher rate than both qualitative methods (13.6%) and mixed methods (29.3%). Table 4 presents the number of publications and the percentages representing the frequency of the usage of each research method for the two periods. It is evident that from 2012 to 2016, almost half of the empirical studies adopted quantitative methods, compared to qualitative methods (19.2%) and mixed methods

(32.7%). While the number of empirical studies has escalated in general since 2017, quantitative methods have been more frequently adopted; the proportion of studies that used quantitative methods has increased by more than 10%, while the proportion that used either qualitative or mixed methods has decreased. This indicates that empirical studies on the FCM tend to use quantitative methods over qualitative or mixed methods. That is, most FCM research is quantitative. This result is consistent with previous reviews' findings (Zainuddin & Halili, 2016). However, while quantitative methods (e.g., surveys) can be employed to study a large number of participants for any hypothesis within a short timeframe, thus allowing researchers to reach accurate generalized conclusions, the collected data are likely to lack depth with regard to the topic being studied.

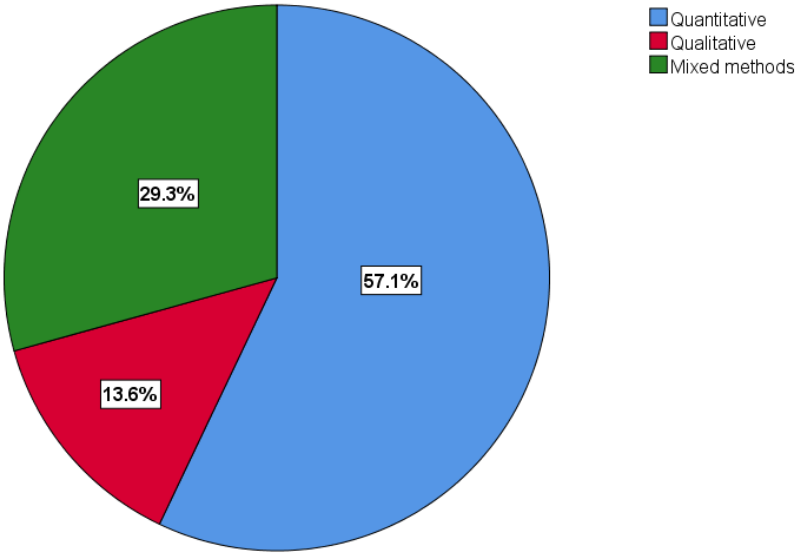

Figure (4) Research Methods Adopted in Empirical Journal Studies on the FCM Published up to May 2022

Table (4) Research Methods Adopted in Empirical Journal Studies on the FCM Published up to 2022 (Two Periods)

	Quantitative	Qualitative	Mixed methods
2012–2016	50 (48.1%)	20 (19.2%)	34 (32.7%)
2017–2022	426 (59.3%)	88 (12.2%)	205 (28.5%)
Total	476 (57.1%)	108 (13.6%)	239 (29.3%)

3.4. Subject Domains Addressed in Empirical Journal Studies on the FCM Published up to 2022:

Figure 5 shows the distribution of the subject domains addressed in empirical journal studies on the FCM published up to 2022. It is evident that empirical research on the FCM is spread across various subject areas such as medical and health sciences, mathematics, science, the social sciences, technology, economy, engineering, education, language, research methods and library competencies, business, law, and politics. However, medical and health sciences is the leading research area, accounting for 202 publications and 24.5% of the total, followed by the language subject domain with 113 publications and 13.7% of the total (Table 5). These results are consistent with the previous reviews presented earlier in this study. As clarified in Section 1.2, some previous reviews focused on specific disciplines, and the most frequently addressed disciplines were found to be medical and health sciences (Njie-Carr et al., 2017;

Ward et al., 2018) and language (Liu, 2018; Yousufi, 2020). In addition, the FCM has tended to be used in applied science courses but has been used less in other disciplines. This could be because instructors in other disciplines, such as the humanities, might have found it difficult to adopt the FCM due to a lack of available resources or other contextual factors.

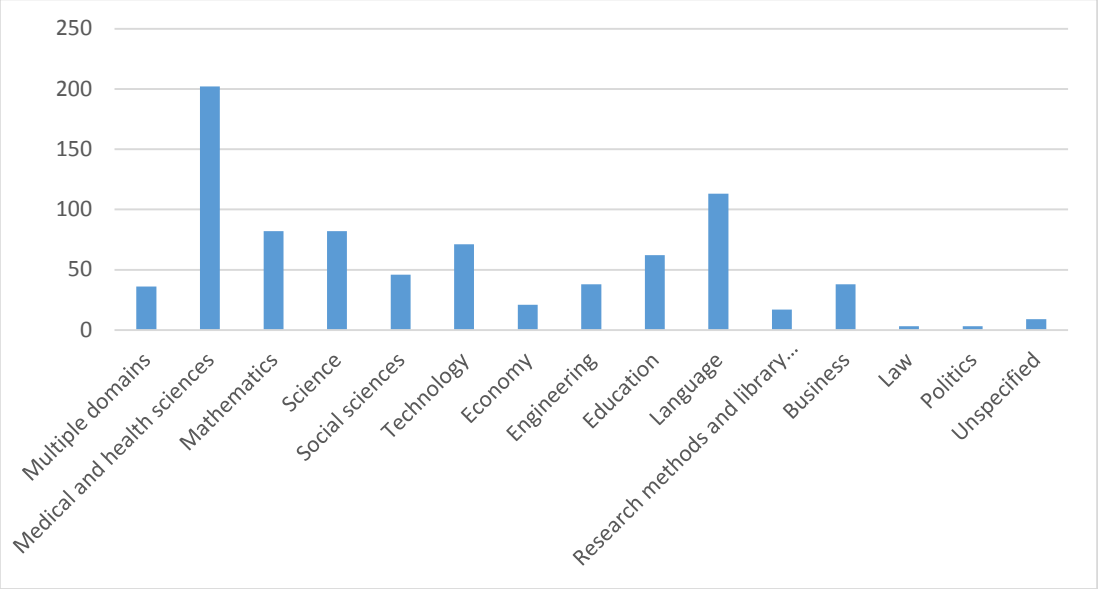

Figure (5) Subject Domains Addressed in Empirical Journal Studies on the FCM Published up to May 2022

Table (5) Subject Domains Addressed in Empirical Journal Studies on the FCM Published up to May 2022

Subject domains	Frequency	Percent
Multiple domains	36	4.4
Medical and health sciences	202	24.5
Mathematics	82	10.0
Science	82	10.0
Social sciences	46	5.6
Technology	71	8.6
Economy	21	2.5
Engineering	38	4.6
Education	62	7.5
Language	113	13.7
Research methods and library competencies	17	2.1
Business	38	4.6
Law	3	0.4
Politics	3	0.4
Unspecified	9	1.1
Total	823	100.0

3.5. Sample Groups Selected in Empirical Journal Studies on the FCM Published up to 2022:

Most empirical research on the FCM has selected students as the main participants. Figure 6 shows that students comprised the most popular sample group, accounting for nearly 90%. On the other hand, only 6.32% of the reviewed studies selected teachers as the sole research sample group, while a very

small percentage focused on both teachers and students (3.26%) or teachers and principals (1.34%). These results are consistent with the previous reviews discussed in Section 1.2. Due to the relative recency of the FCM's emergence, most recent research on this model has focused on examining and documenting its impact on students' learning through experimental or correlation studies, or by exploring students' perceptions and attitudes, as well as the challenges encountered. Understanding this model from educators' perspective seems to have received less attention.

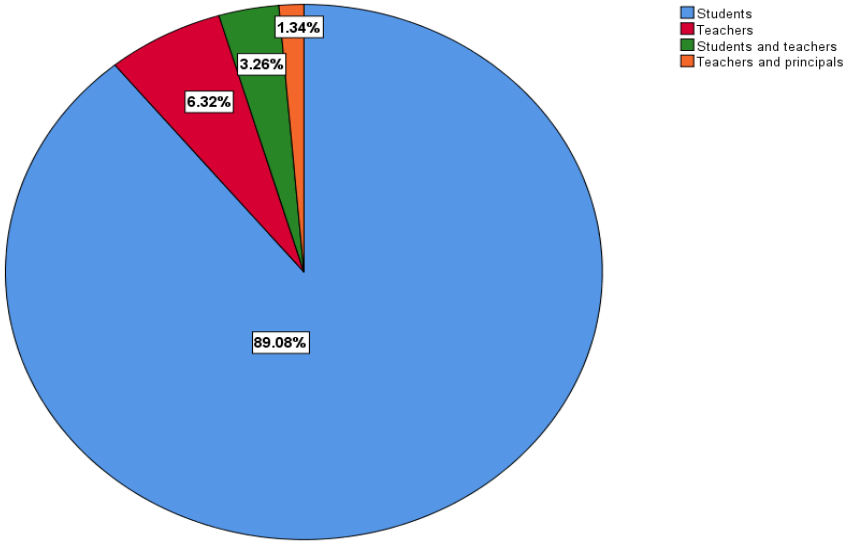

Figure (6) Sample Groups Selected in Empirical Journal Studies on the FCM Published up to May 2022

4. Conclusion, Recommendations, and Limitations.

This paper reviewed the research status of and trends in FCM research. A total of 823 peer-reviewed empirical studies published in different journals up to 2022 were selected and systematically reviewed. The analysis revealed that the FCM has received increased scholarly attention with each passing year. As this approach continues to grow in popularity, it is expected that more research will be conducted in the future. The trend in FCM research is that participants are generally chosen from the undergraduate level. This could indicate that the flipped model has been applied less in other learning settings. Therefore, policy makers and administrators should allocate more effort and resources to developing better FCM implementation plans. For example, teacher education and training programs should aim to educate teachers about the FCM, specifically how it can be implemented to support high-quality instruction. In addition, more empirical studies should focus on addressing the FCM in K–12 and postgraduate learning contexts. In addition, it is worthwhile to pay more attention to investigating the application of the FCM in professional development and training institution settings. The potential of the flipped classroom model to create new learning experiences and opportunities for learners has yet to be fully explored.

Furthermore, the analysis in this study indicated that researchers have employed various research methods during the past few years. However, the quantitative method design has been preferred thus far in FCM research. The lack of qualitative research on the FCM is notable. This could indicate a research trend that is more outcome-oriented. That is, empirical studies on the FCM might be leaning toward

testing the model's effectiveness (i.e., by measuring outcomes), while neglecting to understand the process involved. Therefore, future studies should consider qualitative approaches. Although some of the reviewed studies utilized a mixed methods design, these studies' qualitative aspects might only have been incorporated to complement the quantitative results. This issue could be investigated in future studies.

The analysis conducted in this study also showed that research on the FCM in the fields of medical and health sciences and language is more common than in other disciplines. While it is important to support flipped classroom applications in medical and health sciences and language, new applications to and research on the FCM in different fields should also be envisioned. The results of this review further revealed that the majority of FCM research participants have been students, and there is a notable absence of other sample groups (e.g., teachers and/or principals). This implies that research on the FCM is based mostly on students' perspectives, which provides another opportunity for future investigation to consider educators or other sample groups such as parents. Further studies might also consider analyzing the continued use of the FCM to determine what sustains its applicability for educational purposes.

Finally, this study excluded relevant conference proceedings and other types of publications such as theses and books from the analysis. It is highly recommended that future reviews expand the data sources to yield broader, more accurate findings.

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