BIBLIOGRAPHIC REVIEW OF THE FLIPPED CLASSROOM MODEL IN HIGH SCHOOL: A LOOK FROM THE TECHNOLOGICAL TOOLS

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ABSTRACT

Aim/Purpose	The purpose is a bibliographic review that seeks to offer a clearer vision of the impact of technological tools on the implementation of the flipped classroom model.
Background	This document reviews the flipped classroom and secondary education literature to analyze what technological tools are used to implement this model in secondary education settings and their impact on students.
Methodology	For the review, an analysis of 61 articles found in SCOPUS and WOS was carried out, processed with a scientometric tool, where the implementation of the inverted classroom model in high school is evident, and, according to these, an in-depth analysis was carried out on which tools are most used and in which contexts they are applied.
Contribution	This document offers new researchers a more unobstructed view of what type of technological tools have been implemented in the flipped classroom model in the context of high school and how students perceive them.
Findings	This review analyzes the following aspects:
	• Analysis of the leading countries where the flipped classroom model is applied in secondary education.
	• Analysis of the subjects where the flipped classroom model has been implemented.
	• It offers an analysis of the most used technological tools and in which contexts they are applied (online or offline).
Impact on Society	This document helps new researchers make a conscious decision about the type of tool to implement to support the flipped classroom model and shows the importance of developing technological tools that are not limited by the use of the internet so that they can reach a more significant number of people.
Future Research	Carry out research that focuses on applications that support low connectivity contexts, in order to improve the implementation of the flipped classroom model.
Keywords	flipped classroom, high school, technology platforms

INTRODUCTION

At present, the speed with which technology advances is increasing and has permeated almost all areas of daily life has helped solve problems and meet the needs that society currently faces (Méndez, 2012), producing innovation and constant change in all social fields. The area of education is no exception (Adell & Castañeda, 2012; Cabero Almenara, 2015), and the use of information and communication technologies (ICTs) has been implemented gradually and made available to educational tools that contribute to improving the participation and implementation of different learning models (Sotelo et al., 2015). Also, in recent years, new ways of teaching have been sought to improve and deal with the problems of traditional educational models. (Jiugen et al., 2014) and go beyond a simple transmission of knowledge (Adell & Castañeda, 2012; Sosa & Manzuoli, 2019), seeking to provide more interactive classes and broader educational resources. From these perspectives, new learning strategies that make use of ICTs are booming (Alkoudmani & Elkalmi, 2015; Kostaris et al., 2017;

Méndez, 2012); these include b-Learning, e-Learning, MOOCS and the flipped classroom model, which has been gaining strength in recent decades (Akçayır & Akçayır, 2018; Lage et al., 2000). In the flipped classroom model, videos, readings, or any other academic activity that students can do independently at home are used, and the classroom is transformed into a meeting point where practical activities are carried out, doubts are resolved, and consolidated knowledge. Studies have shown that the flipped classroom model has proved to be more effective compared to traditional teaching models and has positively impacted student academic results (Bishop & Verleger, 2013). This is reflected in studies such as Dawood et al. (2017), Y. Li & Daher (2016), McBride (2015), and Triantafyllou et al. (2015); they demonstrated that when applying the flipped classroom model, better results were obtained in the evaluations in comparison with the courses of the traditional class, in addition to improving motivation and promoting self-directed and self-regulated learning in students. (Akçayır & Akçayır, 2018).

Although the definition of the flipped classroom model does not require the use of technology (Abeysekera & Dawson, 2015; Kim et al., 2014), many authors see this as an opportunity to improve the learning process (L. Cheng et al., 2019; Lo et al., 2017), since it allows us to minimize the time and geographical restrictions that are commonly presented (Soares & Lopes, 2016). However, the literature does not show how the use of technological tools and platforms impact the flipped classroom model. Therefore, this literature review aims to provide potential researchers with condensed information on the tools that have been used to implement the flipped classroom model in the context of secondary education. For this purpose, the tools found in the review are described, their characteristics, the context in which they are applied, and how students and teachers use and perceive them.

THEORETICAL BACKGROUND

FLIPPED CLASSROOM

The flipped classroom model is a teaching model whose main objective is that the student assumes an active role during the learning process. This model reverses the processes and roles that occur in traditional teaching models (Berenguer-Albaladejo., 2016; Lage et al., 2000); that is, it uses time outside the classroom to teach the lessons through multimedia tools, and class time is used to solve doubts, carry out practices, open discussion forums and reinforce learning; through interactive methods of collaborative work and problem-based learning (Martínez Olvera et al., 2014).

This learning model reverses the proposed model in Bloom's taxonomy (Conklin, 2005), which divides the learning process into cognitive processes, some of a lower order and others of a higher order from the level of complexity (Churches, 2009). In the lower level are processes such as the acquisition and understanding of knowledge, while in the higher-order processes are the processes that have to do with the use of knowledge, analysis, synthesis, and evaluation (Berenguer-Albaladejo, 2016). Under this premise, the flipped classroom model proposes that lower-order cognitive processes take place outside the classroom; that is to say that the students study the theoretical concepts for themselves through the various tools that the teacher makes available, such as videos or podcasts recorded by the teacher or other people, and class time is used to answer questions related to the material provided and deepen the issues (Soares & Lopes, 2016; Triantafyllou et al., 2015; Ureña et al., 2007).

Based on the concepts proposed by the flipped classroom model, several studies have been carried out that aim to show the results obtained when using the model in the academic context. In Pereira and Figueiredo (2010) a model with three lines of action is proposed. The first is to involve students in learning tasks using a technological platform, which allows the integration of the main concepts of the topic to be discussed. The second line of action involves discussions on topics relevant to the course, using forums available at the platform. The third line of work tries that each student shows an individual reflection on the course; however, a quantitative analysis is not presented that allows verifying the efficiency of the platform in this proposed model.

Another model is found in Peres et al. (2017) and in Zhao and Gao (2010), this consists of six levels or stages. In the first stage, knowledge is presented, which includes behaviors that underline the importance of remembering ideas. In the second stage, the teacher delivers the subject to the student; In the third stage, the use of technological tools is proposed to promote the teaching in students. As a fourth stage, a verification method is proposed where the acquired knowledge is evaluated. In a fifth stage, the development of synthesis is proposed where each student can unite the parts of a context and obtain a complete and different point of view of the evaluation of critical learning. In the final stage, an assessment is proposed for the student to have comprehensive, analytical, and creative abilities on their own. However, the investigations do not show the use of any specialized platform for the implementation of this type of model; only the use of repositories is proposed. This avoids the existence of a two-way communication mechanism with the student and the teacher.

In Wang (2016), a "Chinese Learning" system is used, which seeks to encourage students and read course materials before class to obtain prior knowledge. It allows teachers to change their role from informants to instructors, and students can make full use of the developed system. This type of methodology aims to show a positive effect on student learning performance, facilitating the application of the flipped classroom model. Although it is a system developed at the University of Tamkang, in China, it is not evident if the system is capable of operating in low connectivity environments.

In other investigations such as Y. Li et al. (2018), an adaptation of the concept of teaching CDIO (Conceive - Design - Implement - Operate) (Takemata et al., 2013) is proposed to introduce a model of teaching projects, cases, and learning of practices, through the use of a flipped classroom using Massive Open Online Courses (MOOC) (Andone & Mihaescu, 2018). This flipped classroom model has three stages: In the first stage, they propose the construction of a MOOC; In a second stage, the advantages of blended learning are adapted for the acquisition of knowledge by teachers, with the aim of technological modifications; As a final stage, the teacher focuses on changing the class model in real environments, where the teacher does not use class time. Still, each student learns independently at home and arrives at the classroom with doubts and solving exercises to strengthen their knowledge. Changing the learning status of students from passive to active to increase communication between teachers and students; however, the use of MOOC is restricted to online environments, which excludes the population that does not have an internet connection.

In Overmyer (2015), the use of the flipped classroom is studied in an algebra course, based on a teaching model that consists of taking advantage of the use of technologies and time at home, of interacting with the teacher solving doubts or exercises. This study seeks to compare and make an analysis of traditional teaching methods through a test or evaluation of both approaches. The article proposes the use of the Blackboard platform to manage the resources required for the home, this to have a record of the students; however, the study suggests that the use of this type of private application generates costs overruns for the academic year.

It is possible to conclude that all the flipped classroom models shown above are based on the premise of creating interactive and active student-centered learning strategies. For this, the flipped classroom model inverts what is typically done in the traditional model providing significant advantages in academic achievement. Additionally, in most studies, they do not detail the characteristics of the platforms used, nor is the possibility of introducing them in contexts with low internet connectivity evident.

PURPOSE OF THE STUDY

The flipped classroom model has proven to be a trend that arouses academic interest in recent years (Akçayır & Akçayır, 2018; Bishop & Verleger, 2013); this, added to recent technological advances, have made this an attractive field of research. Many studies have shown how the implementation of the flipped classroom model backed by technological tools and platforms has improved learning outcomes and practices compared to traditional teaching. But, so far, no study focuses on reviewing the

technical means used to implement the model and how they impact the teaching and learning process. This review is intended to provide researchers with a more unobstructed view of how technology tools are used to influence the flipped classroom model. This research will allow making more conscious decisions about the type of tool that will be used for the implementation of the model. This review will detail the current state of knowledge around the classroom model in secondary education. To achieve this purpose, we identify all the articles that investigate the flipped classroom model in the WOS and Scopus databases as of September 30, 2019. To answer the following two questions:

- Identify the technological tools used in the implementation of the flipped classroom model.
- What are the characteristics of these tools, and in which contexts are they used (online or offline)?

METHOD

The proposed method is based on Linares-Espinós et al. (2018). It proposes four phases to carry out a systematic review. The first, identification, consists of finding the articles according to a topic, carried out in different article search bases; a second phase called screening consists of filtering to exclude equal articles from different bases; in the third phase consists of filtering methods in order to reduce the number of articles and focus on a more specific topic; finally, a last phase called included allows obtaining the majority of articles according to the specific topic chosen for the review.

For this literature review, a bibliometric review of the flipped classroom model was carried out using the ScientoPy tool (Ruiz-Rosero et al., 2019). As a search strategy systematic searches were carried out in online databases from 1999 to September 30, 2019. This period was considered adequate since the term of flipped classroom arose at the end of the nineties (Lage et al., 2000). The search in the database of SCOPUS and WOS (web of science) was carried out using the following search string "(Flipped classroom) AND (Inverted learning)". For its subsequent analysis, with the ScientoPy scientometric tool with the following criteria.

- Repeated studies within the databases were eliminated.
- To do this, all the files downloaded from the databases are grouped together and duplicate files within this pool are removed.
- The keywords were selected within the context of the flipped classroom in high school.
- Using the ScientoPy tool, the first 500 most repeated words within the articles found were selected, and from them, the ones that are framed within the context of a flipped classroom in high school were selected. The studies that were chosen must be framed within the contexts of high school.

After searching the databases, pre-processing with ScientoPy was performed to eliminate duplicate elements; of the 12,684 original samples, duplicates were identified by title and identical authors; studies published in WOS were maintained and those that were in Scopus were subtracted, which yielded the number of 5400 studies. Table 1 shows a summary of this process.

Subsequently, the first 500 keywords of the studies were identified, and a pre-selection of those containing keywords related to the context of high school was made; 10 articles that are related to the keyword colleges and universities were also included since their content was related to the topic to be dealt with in this review. In total, 61 reviews were found under the theme of flipped classroom framed within the high school as can be seen in Table 2 and Figure 1.

Table 1: Preprocessing process.

Information	Number	Percentage
Total documents found	12684	100 %
Number of documents WOS	2557	20.2 %
Number of Scopus documents	10127	79.8 %
Duplicate documents	7284	57.4 %
Number of Documents after pre-processing	5400	100 %
Number of documents WOS	2316	42.9 %
Number of Scopus documents	3084	57.1 %

Table 2: Selected Studies by keyword.

|	Keywords	Total	AGR	ADY	PDLY	H-Index
1	secondary education	14	0.0	3.5	50.0	5
2	colleges and universities	10	-1.5	1.0	20.0	1
3	High School/Introductory Chemistry	6	-0.5	0.0	0.0	4
4	K-12 education	5	-1.0	0.0	0.0	3
5	High School	4	0.0	1.5	75.0	1
6	Middle School	4	0.5	1.5	75.0	1
7	High school students	3	0.0	0.5	33.3	2
8	colleges	2	0.0	1.0	100.0	0
9	secondary mathematics	2	0.0	0.5	50.0	1
10	High school education	1	0.0	0.0	0.0	0
11	K-12 teaching	1	-0.5	0.0	0.0	0
12	Middle school science	1	0.0	0.5	100.0	1
13	Secondary	1	-0.5	0.0	0.0	1
14	Secondary Biology	1	0.0	0.0	0.0	1
15	Secondary School Teacher	1	-0.5	0.0	0.0	1
16	Secondary English	1	-0.5	0.0	0.0	0
17	Secondary inverted indexing	1	0.5	0.5	100.0	0
18	Secondary school mathematics	1	-0.5	0.0	0.0	1
19	k-12	1	-0.5	0.0	0.0	1
20	secondary school students	1	0.0	0.5	100.0	1
21	education k12	0	0.0	0.0	0	0
22	lower secondary	0	0.0	0.0	0	0
23	upper secondary	0	0.0	0.0	0	0
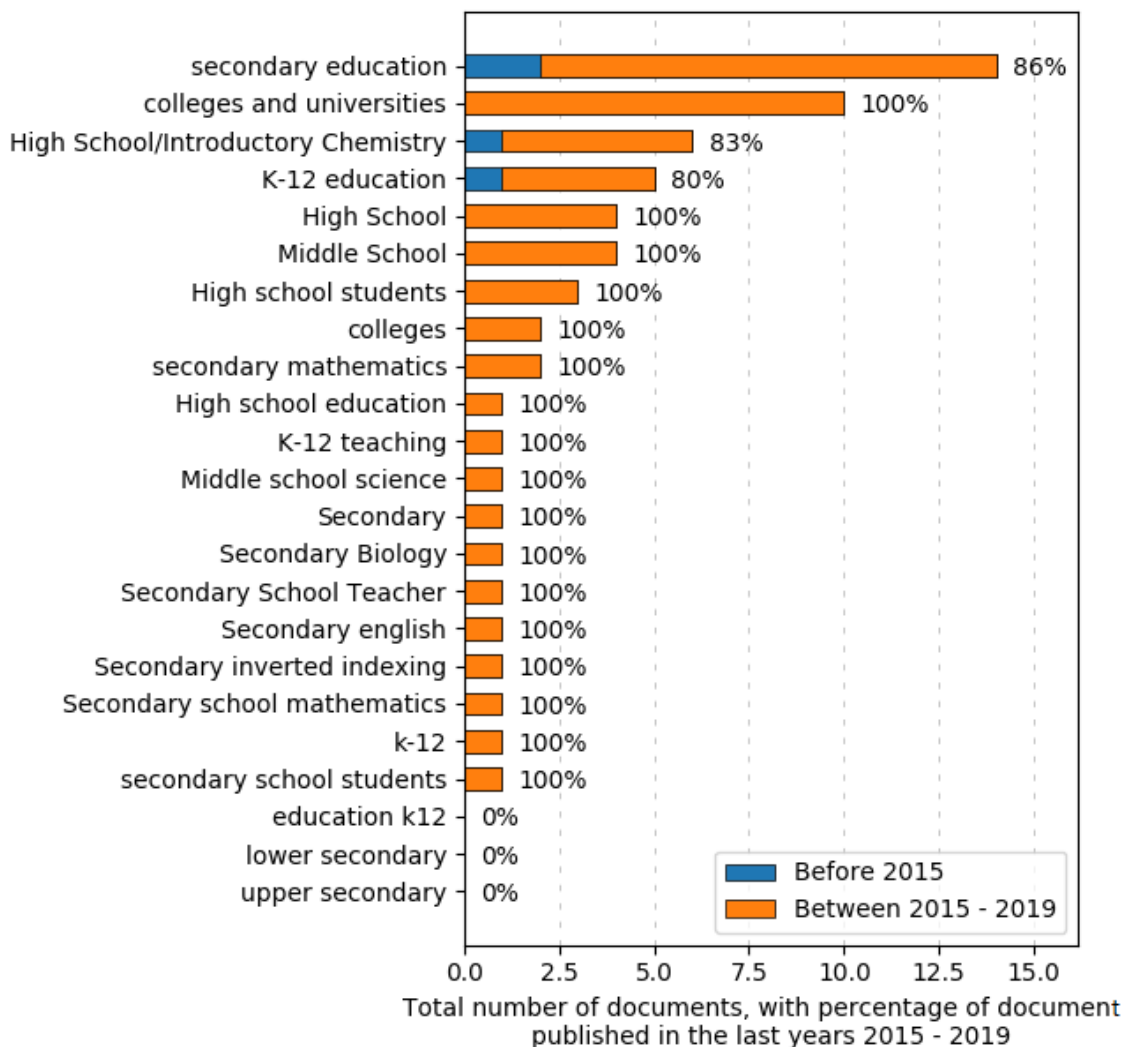
Figure 1: Studies found in recent years (The percentages shown in the figures correspond to the number of articles published between the years 2015 and 2019).

RESULTS

Studies found about a flipped classroom in the context of high school are mostly a recent issue. From the analysis in Figure 1, it can be seen that 93.4 % of the selected articles have been published in the last five years. The first article found is titled "Using Lean in the Flipped Classroom for At Risk Students" and dates from 2013. This article shows the need for the traditional educational system to continually improve, and how the use of educational technology can help achieve this task. The article recounts an example of discussion of what a high school did to improve educational practice using continuous improvement and educational technology through the flipped classroom model, which resulted in an improvement in class dynamics and positively impacted student performance (Flumerfelt & Green, 2013). For the year 2019, five studies were found, among them G. Cheng and Ng (2019) where it is indicated that secondary school students have a positive attitude towards the flipped classroom model since it allows them to learn at their own pace, promoting interactions of class between the teacher and the students. In Almasseri and AlHojailan (2019) a study was conducted with eighth-grade students to determine the effect of the flipped classroom approach

based on the cognitive theory of multimedia learning and its relationship with the academic achievements of the students, which led to positive results in terms of academic achievement. Likewise, most of the studies found show that the implementation of the flipped classroom model generates advantages over the traditional learning model (Kong, 2014, 2015; Lo & Hew, 2018).
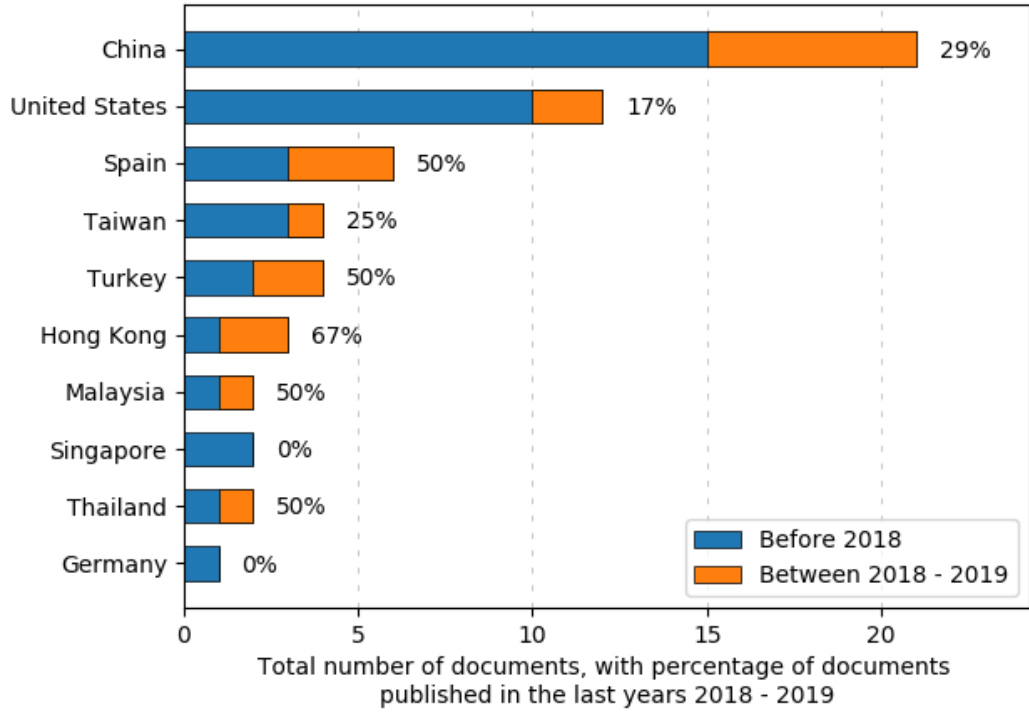
COUNTRY ANALYSIS

A list was generated with the ten countries that have the most considerable number associated studies within the general context of flipped classroom (Figure 2), to contrast with the countries where more studies have been carried out within the context of high school (Figure 3), where it can be observed that the first four countries that have published within the context of high school are among the top ten of the countries with the highest number of publications within the general context of the flipped classroom model. The country with the most significant number of publications is China with a total of 21 studies which correspond to 34.4 % of the reviews found for high school; followed by the United States with 19.6 %; Spain with 9.8 % and Taiwan with 6.5 % of the selected studies.
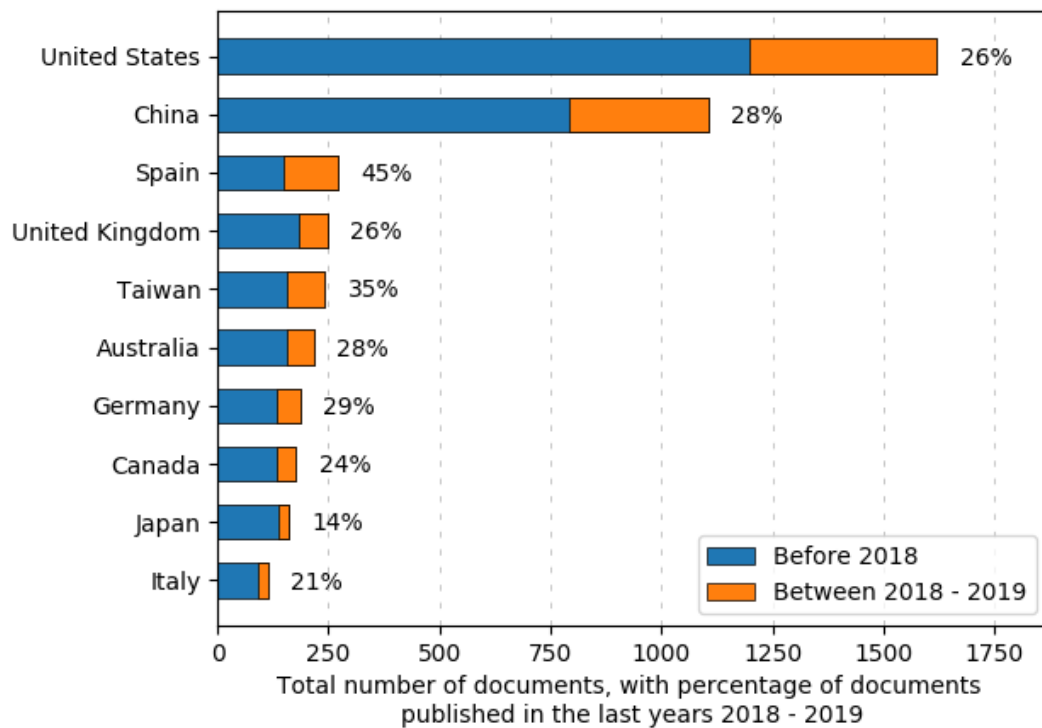
Figure 2: Analysis by countries in the context of the flipped classroom. (The percentages shown in the figures correspond to the number of articles published between the years 2015 and 2019).

Figure 3: Analysis by countries in the context of high school.
(The percentages shown in the figures correspond to the number of articles
published between the years 2015 and 2019).

Within the context of high school, publications from a total of 18 different countries (Table 3) are identified. These countries are classified based on the human development index (HDI); which is a summary measure of human development that measures the progress made by a country in three basic dimensions of human development (enjoy a long and healthy life, access to education, and decent living standards) and are classified as very high, high, medium, and low. According to the ranking published by UNDP (2018), at the very top, it is the United States, Norway, Australia, Spain, Argentina, Taiwan, Hong Kong, Malaysia, Singapore, Greece, Germany, Italy, and Saudi Arabia. In the high classification is Turkey, Thailand, Brazil, Mexico, and China. In the medium and low ranking, no study was found. From this information, it is possible to deduce that the countries in which human development is highest are those that are in the continuous search for mechanisms that allow changes to be made that improve the traditional educational process. It is also possible to infer that the absence of studies and applications of the flipped classroom model in high school environments in countries with medium or low HDI is because they do not have the technological conditions for its implementation (Dawood et al., 2017; Kashada et al., 2017).

Table 3: List of countries with publications in the context of high school.

Country	Total	Country	Total
China	21	Argentina	1
United States	12	Australia	1
Spain	6	Brazil	1
Taiwan	4	Germany	1
Turkey	4	Greece	1
Hong Kong	3	Italy	1
Malaysia	2	Mexico	1
Singapore	2	Norway	1
Thailand	2	Saudi Arabia	1

STUDY MATTER ANALYSIS

The flipped classroom model has been implemented in different contexts, and diverse case studies have been carried out to prove its effectiveness (Davies et al., 2013; Fautch, 2015; Mason et al., 2013). In this section, the keywords of the articles selected for this study were analyzed since most authors include their research topic in the keywords of the document; this to obtain the subjects or academic areas that have been studied the most; Figure 4 summarizes the results found. In the context of high school, different case studies have been evaluated in various academic subjects, which proves that the flipped classroom model is capable of transforming the learning model of almost any area. This model has been implemented in traditional areas such as mathematics (Bhagat et al., 2016; Lo & Hew, 2018), where promising results have been obtained by reversing traditional learning processes, as can be seen in the study conducted by (Bhagat et al., 2016) which aims to show the effectiveness of the flipped classroom model in math learning in high school. For this, a trigonometry course was taught and the results were compared between a control group and another where the flipped classroom model was implemented. This resulted in the experimental group having a better performance at the end of the course, which suggests that the flipped classroom environment improves learning achievement. This learning model encourages motivation in math students. Another area where the flipped classroom model has been successfully implemented is in the teaching of a foreign language (Ayçiçek & Yanpar Yelken, 2018; Martínez-Olvera Olvera & Esquivel-Gámez, 2018; Huang & Hong, 2016; Yang, 2017). In this last study (Yang, 2017), it was possible to see that the flipped classroom model for learning English as a foreign language is a powerful teaching strategy when used with high school students since it promotes autonomy and motivation, which resulted in a greater understanding of the language by the students. We must also include that the inverted model has also been implemented in little known areas such as music (Palazón-Herrera, 2018), the sports dance (Y. Li, 2015), and even for the teaching of pre-laboratories, which is atypical. However, it was shown that the implementation of the inverted model making use of videos had made the learning process more stimulating (Fung, 2015).
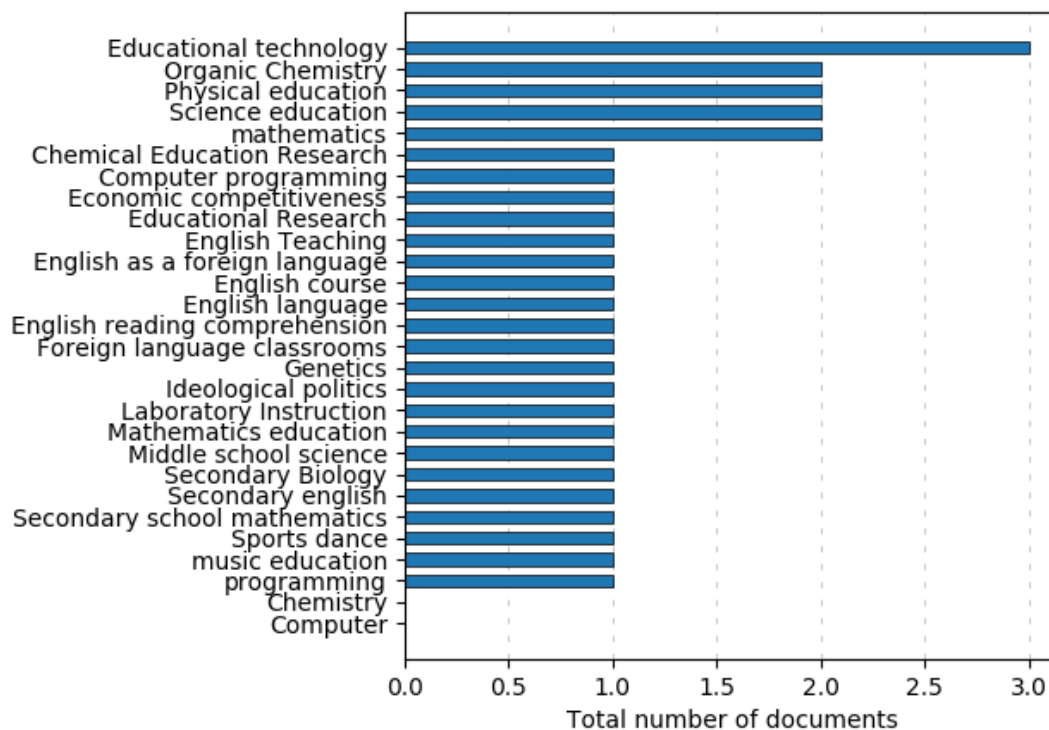

Figure 4: Analysis of the subjects where the flipped classroom has been implemented.

To generate the graph in Figure 4, the ScientoPy tool was used to identify the keywords of the sample. To identify each of the subjects the synonyms search function was used and from this information the graph was obtained.

TOOL ANALYSIS

In this section, the technological tools used to implement or support the flipped classroom model in the context of high school were manually identified; For this analysis, we excluded seven studies from the original sample because they were not accessed.

Digital technologies represent an essential aspect of the flipped classroom methodology since they allow the teacher to produce, use, reuse, and share learning materials; They also enable students to access it, when and where it is convenient. (Soares & Lopes, 2016). Under this premise, most of the research carried out within the context of the flipped classroom in high school makes use of technological tools to implement this model. The most used technological tools are the online learning elements that are mostly used in pre-class activities. However, some tools and platforms do not support the flipped classroom model. Below are the tools used to implement the flipped classroom environment within the context of high school. The graph (Figure 5) summarizes the most used technological tools in the context of high school.
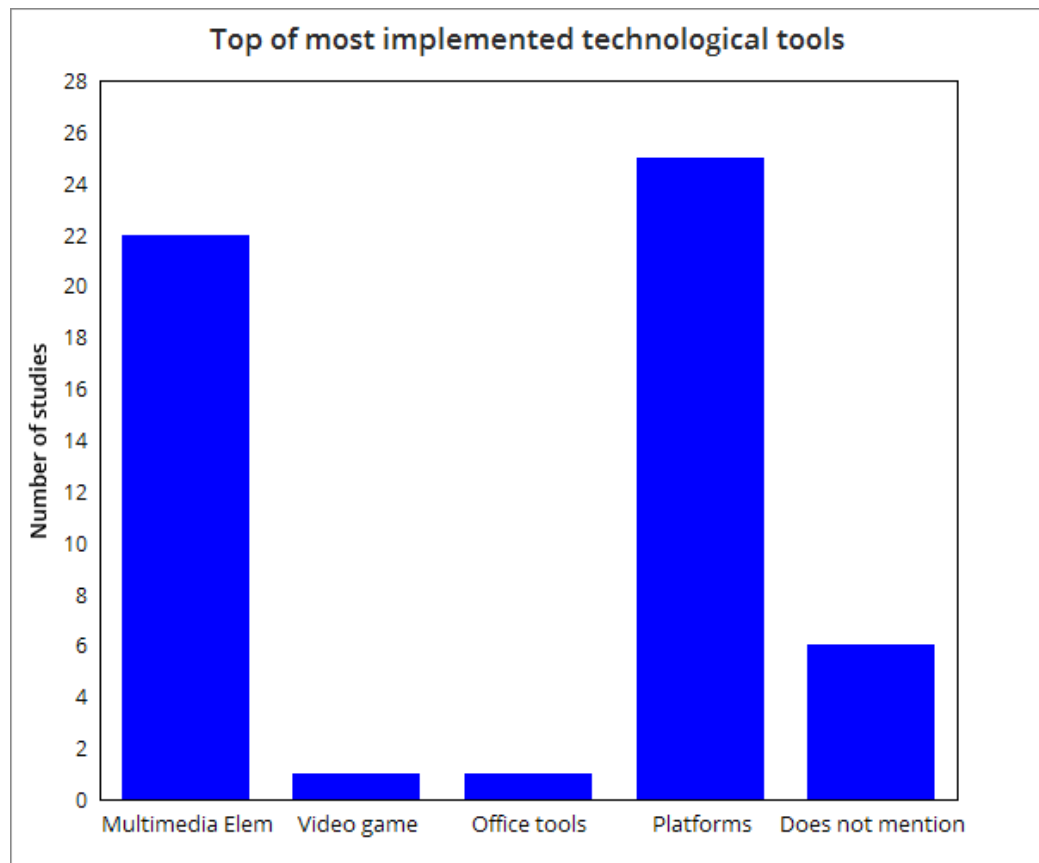
Figure 5: Top of most implemented technological tools

From the study of the articles, it was identified that 22 mention only the use of multimedia elements for the implementation of the flipped classroom model, which corresponds to 43.7% of the studies analyzed. 25 studies refer to the use of platforms for content management, which corresponds to 46.3% of the studies surveyed. The use of office tools such as Google-Docs was also mentioned in a

study which corresponds to 1.8% as well as the use of commercial video games for the implementation of the flipped classroom model. Finally, 11.1% of the studies do not mention any implementation tools. The technological tools found are detailed below.

Multimedia elements

In most of the selected studies, videos, presentations, or micro-conferences are used to instruct students about the contents that will be studied in the class. It was found that the use of this type of content had a positive impact on students, since they are able to see, pause, and rewind the material, which promotes students to learn at their own pace and promotes self-directed learning and self-regulated (de Araujo et al., 2017; Kashada et al., 2017; Z. Li, et al., 2017; Shao et al., 2016). As evidence of it, Flumerfelt and Green (2013) conducted a study where, with the help of a screen capture software for the creation of videos, the learning elements were created and subsequently delivered to the students so that they can be accessed before class. This implementation showed advantages compared to the traditional model since it allows students to review the content, as necessary, what was perceived by the students as a more pleasant task that they could control. In Yan and Cheng (2017) a study is presented where online videos and questionnaires were used as pre-class activities for teaching programming in a secondary school, which yielded positive results regarding the implementation of the model and showed that the flipped classroom could improve acceptance of the students of the programming. In Palazón and Giráldez (2018) online videos were used, which were accessed through QR codes associated with videos on YouTube. The study resulted in the group that implemented the flipped classroom model using this method obtaining better results in contrast to those in which more traditional resources were used. In Fung (2015) first-person videos recorded with go-pro were used for a pre-laboratory. It was concluded that with this element, the student could observe the scientific experiment before class, as if he were in the laboratory classroom, improving the understanding of scientific experiments. Finally, another number of studies also use videos and presentations to implement the flipped classroom model, showing similar results to the previous ones (Ayçiçek, & Yanpar Yelken, 2018; Hodgson et al., 2017; Huang & Hong, 2016; Y. Li, 2015; Lo et al., 2018; Zheng, 2016).

Video game

In Ye et al. (2018) a study is shown that uses commercial video games as learning elements before class for students in a physics group. The video game "Ballance" (published by Cyparade in 2004) was used; in this game, players must ensure that a ball they control (wood, rock, or paper, depending on the player's choice) reaches their destination within a limited time frame. The players must consider mass, gravity, and inertia when moving balls along the tracks. Also used was "Angry Birds" in which players must shoot birds from trenches to attack pigs that steal eggs. This game used knowledge such as oblique, horizontal, projectiles, collisions, and inertia. This study resulted in the use of these video games having the potential to improve student motivation and help them develop a better understanding of pre-class concepts, as they encouraged exploration and experimentation activity by combining based learning in games and the flipped classroom model.

Online office tools

In Kong (2014, 2015) Google tools such as Google-Docs were used to create collaborative discussion groups and create worksheets that allow students to work collaboratively with group members. In Almasseri & AlHojailan (2019), Schultz et al. (2014) and Winter (2018) the Google-Forms tool is used in which teachers carry out questionnaires to evaluate the content seen by students in the class.

Platforms

Of the 25 studies that mentioned the use of platforms to manage the content delivered to students (Figure 6), Moodle stands out as the most implemented with a total of 7 reviews, followed by the Khan-Academy, Edmodo, Google-Classroom, and Ed-puzzle with two studies each. Finally, the

OpenHPI, Google-Drive, Open-edX, Gocort, code.org, and Dropbox platforms were implemented in one study each. The following section provides a description of the technological platforms identified in the investigation.
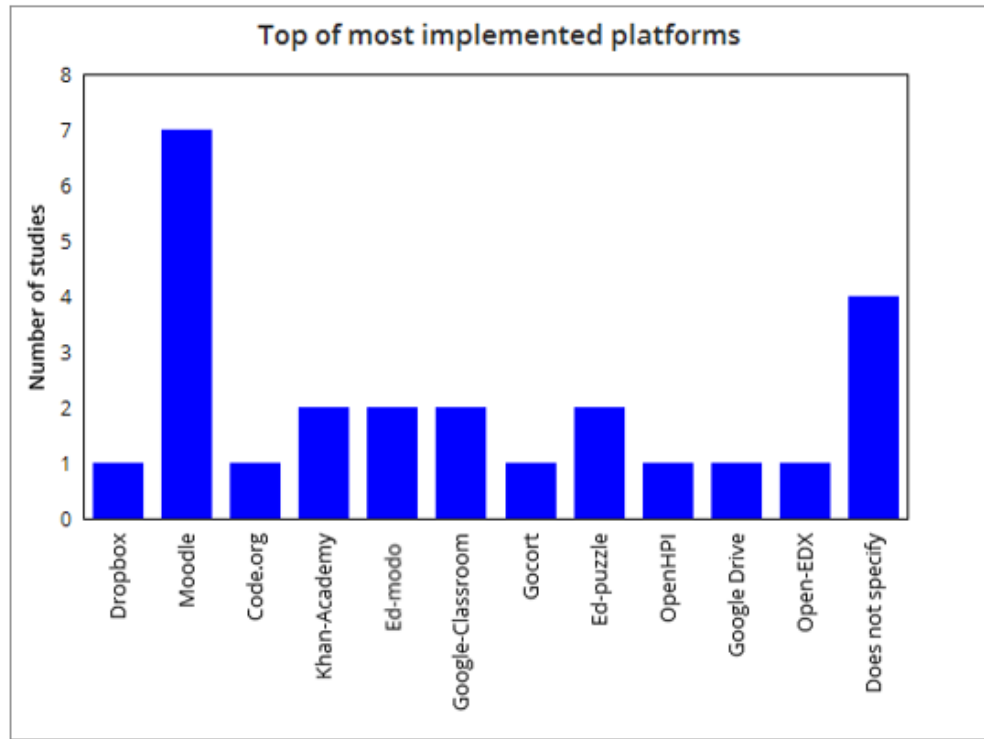

Figure 6: Platforms found in the reviewed articles

PLATFORMS

This section describes the main characteristics of the technological platforms used to implement the flipped classroom model in the context of high school.

Moodle

Moodle (https://moodle.org/?lang=en) is an open-source learning platform that allows you to create personalized and robust learning environments for teachers and students by making available a robust set of student-centered tools and collaborative learning environments.. In the study presented by Lo and Hew (2018), the Moodle platform is used so that the ninth grade students can access the content before class, in addition gamification elements such as digital points, badges, levels with a progress bar through the Moodle platform were made available, although the perception of the platform by the students is not evaluated; The results obtained by the students in the inverted class were better than those in which the model was not applied.

The studies carried out by Kostaris et al. (2017), Leo and Puzio (2016), and Slemmons et al. (2018) propose the use of the Moodle platform for the presentation of educational videos and evaluation questionnaires to the pre- class session, so that students become familiar with the concepts before the class section. The platform allows the integration of evaluations with multiple options and selection false or true evaluations that are automatically graded (Leo & Puzio, 2016). In all these studies, the result of the model implementation also produced positive results compared to the teacher-centered models. Finally, in Martínez-Olvera and Esquivel-Gámez (2018), the Moodle platform is also used by integrating the JclicAuthor tool, which allows you to create activities simply, and enables you

to obtain an immediate evaluation of the activities carried out. This functionality provides for the teacher to see the students' progress. All the investigations that used the Moodle platform did it in online contexts.

Edmodo

Edmodo (https://www.edmodo.com/) is a free online social network learning platform that allows one to create closed groups between students and teachers to share educational content such as messages, files, links, work calendars, as well as allow one to create tasks and manage them (Edmodo, 2008). In the investigations carried out by García et al. (2015) and Yildiz Durak, (2018) the Edmodo tool for mobile devices was used so that students can receive notifications about course activities, messages, and shared resources. It was possible to identify that the Edmodo environment is appropriate for high school students since it has a structure similar to that of Facebook which facilitates its use by students (Yildiz Durak, 2018). In both studies, the flipped classroom model managed to show improvements in levels of self-efficacy and commitment to the course.

Khan Academy

Khan Academy is a non-profit online platform, where you can upload video lessons. The objective of this platform is to allow the spread of knowledge to anyone in any location, through its repository of resources for flipped classroom (Giglio, 2014). In the studies carried out by Giglio (2014) and Hao (2016), the Khan-Academy platform and YouTube were used for a foreign language class in which PowerPoint presentations integrated with audio and video were delivered as pre-class activities. Even though the academic results were similar to those of traditional teaching methods; the flipped classroom model helps develop collaborative and social skills and promotes student motivation.

Edpuzzle

Edpuzzle is a web tool that uses videos and allows adding questionnaires within them. In Ayçiçek & Yanpar Yelken (2018), a case study for an English class is presented to which a series of video conferences with multiple questions were delivered through the edpuzzle platform. The platform allows the teacher to observe if the student has looked at the video, as well as the number of times the student repeats the video and the answers to the questions. The study resulted in a higher degree of responsibility with the academic commitments of the class in the flipped classroom group compared whit the control group. In a survey by Evangelista et al. (2018), the inverted model was implemented to a high school physics course with the help of the edpuzzle tool since it allows us to verify if the students looked at the content of the videos. This study showed that more than 90 % of the students always carried out the assigned activities. In addition, a general acceptance of the tool and the method used by the students was perceived; they stressed that the use of video conferences is a more dynamic method that saves time while studying.

Gocort

Gocort is a social network developed by private initiative that allows creating an interactive learning environment for students and teachers, with tools that will enable you to create notes about content, mind maps, questionnaires, and exercise lists. Because of its social network architecture, it is easy to use and allows students to search for content in a database that contains great content. In the study carried out Bissoli et al. (2018) this platform is used for teachers to create teaching materials for teaching "Genetics" with the flipped classroom model, demonstrating that this model brings significant advantages as long as teachers are willing to create the content.

Open-edX

Open-edX is a free mass learning software platform, which includes a learning management system (LMS) and the man-system management (CMS) course called Studio, and which provides a friendly

interface for the instructors where they can build the course, to which different content can be linked, such as videos, HTML content, and evaluation activities. On the other hand, the LMS allows showing the contents of the courses. Students and teachers can browse the contents of the course and interact with their peers. In Martínez et al. (2015), a study, a case study was carried out to implement the flipped classroom model in a math MOOC, with the help of the Open-edX platform articulated with the ANALYZE tool, which allows analyzing the information provided by the learning platform. This tool provides a different interface for teachers and students. Students have access to information only about their activities, while teachers can access the report of the entire class and of each student who takes the course individually. This helps students to be aware of how they are progressing on the platform and improve their motivation and helps teachers keep track of the class (Martínez et al., 2015).

Dropbox and Google Drive

Dropbox and Google Drive are online multi-platform file hosting services, allowing you to store, share, and synchronize content with different users. In Rahman et al. (2018), Google Drive was used to share the material of the pre-class moment for the student to interact with the content for 5 to 10 minutes. On the other hand, in Bhagat et al. (2016), Dropbox is used to manage the pre-recorded videos, which lasted between 15 to 20 minutes. At the end of the study, the test showed that students who took the inverted class had better learning and motivation achievements.

Google-Classroom

Google-Classroom is a free online learning platform designed to implement the blended learning model. This platform allows you to manage class content online and enables you to create documents, share information, videos, spreadsheets, presentations, and work collaboratively. In Almasseri and AlHojailan (2019) a study is presented in which Google- Classroom mobile is used so that students can access and interact with the content through their smartphones. The material consisted of video tutorials, homework, and online questionnaires after each lesson. In the case study conducted by Yang (2017) Google-classroom is also used so that students of an English class can access the instructional videos before the class. In this study, it was observed that the students are receptive to this type of methodology, where 79.3% of the students carried out the pre-class activities, and 81% indicated that the invested activities encouraged the development of self-management skills.

OpenHPI

OpenHPI is a platform for MOOC courses that offers content aimed at a broad audience about the fundamentals of computer science, digital technologies, and topics related to computer science in German and English. In Grella et al. (2016) this platform was used for a high school computer course. Short videos, reading material, and questionnaires for students were published on the platform, and course participants can access the learning materials at an appropriate time and as often as necessary. The results of the analysis showed that MOOCs could support high school by providing valuable content for learning.

Code.org

Code.Org is a non-profit organization that is dedicated to expanding access to computer science in elementary and secondary schools, offering open-source resources online. In G. Cheng & Ng (2019) the use of this tool for a programming course is evidenced in which it is sought to observe the opinions of the students about the flipped classroom process; instructional videos of the code.org platform were used for this purpose. The results obtained indicate that students have positive attitudes towards learning programming through the flipped classroom model, compared to traditional models, since it allows them to learn at their own pace.

Each of the tools detailed above allowed us to implement the flipped classroom model more efficiently. Still, it is essential to note that in the studies found there is no analysis of the perception of the tools by students or teachers, only identification of the general perception of the model. But in all the studies analyzed, the results found are positive.

SUMMARY

Table 4 summarizes the characteristics that comprise the tools. The learning elements design module is featured; it allows the teacher to create a specific model for a particular class. The learning elements design module is one of the characteristics that comprise these tools. In addition to this, a gamification module is presented to encourage the student, another module presents in various applications in the assessment module, which allows you to create, view, and perform exams. Another module that is mentioned in the literature is based on the possibility of sharing information in different environments; for this review, only two platforms were found that support this module. This summary is presented below.

Table 4: Characteristics found on the platforms.

Name of Platform	Module of learning elements design	Module of Gamification	Module of Evaluations	Module of Storage	Context Online	Context Offline	Share information	Mobile App	Web App	Content
Moodle	X	X	X	X	X	-	-	-	X	Videos, PDF, Images, HTML, Links, Files
Edmodo	-	X	-	X	X	-	X	X	X	Files, links, messages, work calendars
Khan Academy	-	X	-	-	X	-	-	X	X	Videos
Edpuzzle	-	-	X	X	X	-	-	X	X	Videos
Goconqr	X		X	X	X	-	-	-	X	Videos, PDF
Open EDX	X	X	X	X	X	X	-	-	X	Videos, PDF, Images, Links, Files
Dropbox and Google Drive	-	-	X	X	X	-	X	X	X	Videos, PDF, Images, links, Files

Name of Platform	Module of learning elements design	Module of Gamifica-tion	Module of Evalua-tions	Mod-ule of Stor-age	Context		Share infor-mation	Mo-bile App	Web App	Content
					Online	Of-fline				
Google-Classroom	-	X	X	X	X	-	-	X	X	Videos, PDF, Im-ages, Links, Files
OpenHPI	X	X	X	X	X	-	-	-	X	Videos, PDF
Code.org	-	-	X	-	X	-	-	-	X	Videos

DISCUSSION

In this article, a literary review of the inverted classroom approach within the high school was con-ducted, which shows that the implementation of this learning model is a trend that has been growing in recent years and that its application in high school has brought a number of advantages compared to traditional teaching models, from a teacher-centered learning model to a student-centered one that encourages motivation and self-directed and self-regulated learning, which translates primarily into an improvement in the student's academic performance. Of the inverted implementations in the class-room, this study found that that most of the technological resources are used for the pre-class sec-tions; it was observed that the most used technological resource is the video/conference This ele-ment stands out for its ability to pause, rewind the contents where, and when necessary, what en-couraged individualized learning by students (Schultz et al., 2014). With respect to the use of tools for the management of academic content, it was observed that all the tools found were applied in contexts where Internet service was available. For the most part, these platforms were only used to deliver the content to the students, with the exception of Open-edX in which it was possible to re-ceive comments on the work done on the platform and Edpuzzle that allowed one to observe video management metrics. The other platforms were used only to share educational content with students. This can be a problem since there is no way to verify the actions, participation, or behavior of stu-dents outside the classroom (Hodgson et al., 2017). Finally, with the help of this study, it is possible to infer that the use of technological applications in the context of high school will help teachers in their teaching process and, in the same way, will improve student learning. However, it is not possi-ble to highlight a tool that is the most suitable to implement the model, since there is no evidence that catalogs one above the other. Therefore, work must continue on initiatives that allow technolog-ical tools to fit better the context of the flipped classroom taking into account the conditions of ac-cessibility to technology, environments with low connectivity, and the collection of measurements that allow observing behavior of students during the learning process.

CONCLUSIONS

The conclusions found in this study are described below.

Through this bibliographic review, it was possible to corroborate the importance that ICTs have for the implementation of the flipped classroom model. It was possible to determine that multimedia ele-ments are the preferred resources to teach the students, as well as that educational technology plat-forms play a crucial role in the implementation of this model, since they allow to design and present the different themes to the students, and even to carry out evaluations. Thanks to this review, it is

possible to determine that 45.5% of the articles surveyed used this type of tool, mainly, Moodle, Khan-Academy, Ed-Modo, Google-Classroom, and Ed-puzzle due to their wide diffusion.

It was possible to identify that most of the recognized technological platforms share similar characteristics, such as the learning elements design module, the gamification, evaluation, and storage module. The combined ones allow us to have a robust platform capable of supporting the flipped classroom model. It is also important to highlight that in the analyzed studies, there is no evidence that any of these platforms have been used in offline areas or contexts, which shows that there is a technological gap for the implementation of this model in these conditions. It is also left to see the internet as a limiting factor for the implementation of this model. This is corroborated with the analysis carried out at the beginning of this article, where it was shown that none of the countries with HDI at medium and low levels had carried out studies of the implementation of this model.

We can conclude that the inverted classroom model brings advantages for the educational process, as well as the use of technology, which has the potential to improve the model of traditional classes. But until now most of the technological initiatives that have been developed to implement this model do not allow its implementation in areas with difficult internet access; therefore, it is necessary that the applications, in addition to allowing the support of this model, be able to work in low connectivity environments, so that the use of ICT and the inverted classroom model are not limited to the use of the internet.

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