

Effectiveness of the flipped classroom model in university education: a synthesis of the best evidence

Eficacia del modelo de aula invertida (*flipped classroom*) en la enseñanza universitaria: una síntesis de las mejores evidencias

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Abstract

This paper explores the historical origin of the flipped classroom (FC) model and synthesizes the literature on the FC effectiveness in incorporating more active learning and creating a student-centred educational environment in Higher Education (HE). To this end, the literature on the FC and other pioneering methodologies has been reviewed, paying special attention to the impacts of the FC on student involvement and academic performance. The FC model is based on different methodological approaches –applied in university teaching since the 1990s– that encourage student preparation before classes: team-based learning, peer instruction and just-in-time teaching, where the teacher sends the information to his or her students through electronic means. This allows more class time to be devoted to active learning and formative assessment. The FC model became popular in secondary education with the use of videos to convey information to students. Recent research shows positive effects of the flipped classroom on multiple elements of the educational process. First, FC increases the motivation and involvement of students in activities outside and

inside the classroom. Second, it improves overall comprehension and retention of the subjects taught, which results in an improvement in performance and a reduction in the failure rate. Third, it improves the development of competences and skills, and finally it increases the satisfaction of the students and teachers who put it into practice. These positive effects have been confirmed in many disciplines and geographical areas.

In addition, the flipped classroom model creates opportunities for students to interact earlier and more sustainably with instructional materials, improving their readiness to apply their understanding to classroom activities. Thus, students with a higher level of completion of preparatory tasks are those who obtain higher performance in the FC.

Key words: flipped classroom (FC); academic performance; active learning; student engagement; team-based learning; peer instruction; just-in-time teaching; skill and competence development; student perceptions; long-term effect.

Resumen

Este artículo explora el origen histórico del aula invertida y sintetiza las evidencias que valoran su eficacia para incorporar más aprendizaje activo en la educación superior y crear un entorno educativo centrado en las acciones que realizan los estudiantes. Para ello se ha revisado la literatura sobre el aula invertida y otras metodologías precursoras de la misma prestando especial atención a los impactos del aula invertida sobre la implicación estudiantil y el rendimiento académico. El aula invertida tiene precedentes en metodologías de fomento del estudio previo que se aplican en enseñanza universitaria desde los noventa: el aprendizaje basado en equipos, la instrucción por compañeros y la enseñanza a tiempo en las que el docente envía la información a sus alumnos mediante medios electrónicos. Así hay más tiempo de clase para dedicarlo al aprendizaje activo y la evaluación formativa. El aula invertida se popularizó en educación secundaria con el uso de vídeos para transmitir la información a los alumnos. La literatura muestra efectos positivos del aula invertida sobre el proceso educativo. Aumenta la motivación y la implicación de los alumnos en las actividades fuera y dentro de clase. Mejora la comprensión y la retención de las materias enseñadas que se traducen en una mejora del rendimiento y una reducción en la tasa de fracaso. Mejora el ejercicio y el desarrollo de competencias y finalmente aumenta la satisfacción de los alumnos y profesores que la ponen en práctica. Estos efectos positivos se han confirmado en múltiples disciplinas y ámbitos geográficos. El aula invertida crea oportunidades para que los alumnos interactúen antes y de manera más sostenida con los materiales instructivos, mejorando su preparación para aplicar lo comprendido en las actividades de clase. Los alumnos con mayor nivel de realización de tareas preparatorias son los que obtienen superiores rendimientos en el aula invertida.

Palabras clave: aula invertida; rendimiento académico; aprendizaje activo; implicación estudiantil; aprendizaje basado en equipos; instrucción por compañeros; enseñanza a tiempo, desarrollo de habilidades y competencias, percepciones estudiantiles; efecto a largo plazo

Introduction

In spite of pedagogical and technological advances, the use of traditional expository methodology predominates in current university curricula (Galway et al., 2014). Most of the class time is devoted to explaining the information on which assessment tests will focus (Moravec et al., 2010). Furthermore, curricula are boring for current university students and barely motivate them to attend. They do not involve students in self-regulated learning and do not effectively promote the development of their skills and competences (Mohr et al., 2017). In other words, traditional methodology and current university curricula do not help our students to develop the competences they will need as individuals and as professionals (Arum and Roksa, 2014, Medina, 2016).

Several studies show that a significant proportion of university students do not learn to reason critically, communicate professionally, or develop the complex reasoning skills that should be at the core of HE (Arum and Roska, 2010, Bok, 2017). University students often graduate without the critical thinking and professional writing skills that employers demand (Arum and Roksa, 2014). In current university education, the role of students is often predominantly passive and, therefore, does not encourage practice and development of the essential skills required in the labor market (Murillo-Zamorano, López-Sánchez and Godoy-Caballero, 2019).

In order to make a class an attractive learning experience for today's university students, we should rethink how and where class time is spent; we should provide students with in-class tasks that connect with their interests and help them to practice those skills that will increase their employability by bringing what they learn in class closer to what is required in their future professional roles and profiles (Lai, Hsiao and Hsieh, 2018). Therefore, the proposals for curricular and methodological

reform in HE highlight the need to rethink traditional models of lecture-based courses and subjects in which teachers typically present the information to be learned (McLaughlin et al., 2014; Bok, 2017) .

To practice these competences and skills, teachers should propose activities in which students could apply the information learned to create solutions to relevant problems (Prieto, Díaz y Santiago, 2014a). This objective can be achieved by fostering out-of-class inquiry-based learning models, as current students are accustomed to searching for information on the Internet and applying it to problem solving (Mohr et al., 2017). If tasks are carried out outside the classroom, the students' interaction with the materials is more continuous throughout the term (Prieto, Díaz, Monserrat and Barbarroja, 2020b). This results in an increased volume of students' out-of-class work, which is currently much lower than the workload legally established in the ECTS credits (Souto-Iglesias and Baeza-Romero, 2018).

In the last decade, the methodological approach that has shown the greatest potential for incorporating more active learning in the university classrooms is the flipped classroom model (Prober and Heath, 2012). The increasing interest in this methodological approach is reflected in the significant growth of the citations about FC in Google Scholar, which have increased from 187 in 2009 to 11,000 in 2019. Over the last decade, the volume of publications about FC has totaled more than 52,000, justifying the need of a study of bibliographical synthesis such as the one offered in this paper on the origins and effects of this methodology.

The flipped classroom model is underpinned on an active blended-learning pedagogy, which fosters the out-of-class preparation of students for interactive classes. In the FC, the teacher first sends the learning materials to students so they can try to study and understand them for themselves. Then, students study individually to be prepared to participate in class activities. Finally, class time is devoted to deepening students' understanding and to assimilating knowledge through active and team-based learning activities, and problem-solving. Thus, learner-centred learning environments are created (Prieto and Giménez, 2020a) such as inquiry-based learning, case-study learning, problem-solving (Chiang, 2017), projects (Liu, Wu, Zhang and Guo, 2017) and formative assessment (Crouch and Mazur, 2001; Michaelsen, Parmelee, McMahan and Levine 2008; Costa, 2016). The flipped classroom may promote a more active approach to learning; transmitting the information to be

learned online, the in-class time is no longer devoted to explaining concepts to students but to incorporating active learning and problem-solving activities in class. This model inverts what is traditionally done in the classroom –transmitting the information to be learned– and what is done outside of class –practicing activities.

The flipped classroom model combines two essential elements necessary to implement a new paradigm in the 21st century university education. On the one hand, it provides an innovative use of ICTs to establish two-way online communication with students. On the other, it fosters a new methodological proposal that requires a change in the way students work in and out of the classroom (Sola, Aznar, Romero and Rodríguez-García, 2019). The FC model is centered on the student (McLaughlin et al., 2014), who is responsible for following the teacher's directions to attend classes with a basic understanding of the learning materials. This will allow him/her to become involved and participate in the in-class activities (Prieto et al., 2017).

In this synthesis of the best evidence, the pedagogical justification, the origin and the evolution of the flipped classroom model from the end of the last century to the present are reviewed. This critical synthesis of the evidence on the effects of the FC implementation on the students' involvement and academic performance will provide teachers with evidence to motivate a change in their teaching methodologies, from traditional expository teaching to the flipped classroom model.

Methods

The objective of this paper was twofold: first, to conduct a knowledge synthesis on the pioneering methods underpinning the flipped classroom method developed in the last decade of the last century; second, to gather information on the impacts that the implementation of the FC in Higher Education may have on students' motivation and involvement, academic performance, development of competencies and skills and on their perceptions of their learning experience. To this end, multiple Google Scholar searches were carried out on documents that included keywords used to name different variants of the flipped classroom method (flipped classroom, inverted classroom, flipped learning, classroom flip, reverse

instruction) and its pioneering methods in English (peer instruction, team-based learning, just-in-time teaching).

In order to carry out a more exhaustive chronological analysis of the bibliographical references found, searches –with the above-mentioned keywords– limited by year were run. Numerical results are shown in Figures 1 and 2. Searches with the Spanish terms “aula invertida”, “aprendizaje invertido”, “enseñanza por compañeros”, “aprendizaje basado en equipos” y “enseñanza a tiempo” were also conducted. Not only original research paper were selected, but also reviews, PhD theses, books and meta-analyses. Bibliographical references of the selected papers were also analyzed to find other studies potentially useful for our review. These papers were located through Google Scholar and PubMed. To select them, abstracts and full articles were reviewed to decide whether the information they contained was relevant to our research. Finally, our research focused on the extraction and thematic organization of relevant data to make a synthesis of the results obtained.

To measure the impact of the flipped classroom on academic performance or motivation, the effect size (ES) is used. The ES represents the number resulting from dividing the observed change by the average value obtained with flipped classroom with respect to the average value obtained with traditional methodology divided by the value of the standard deviation (s) obtained with traditional methodology.

Results

Scientific evidence has shown that introducing more active learning into university classrooms improves students' academic performance (Freeman et al., 2014). However, despite the excellent academic results of active learning, most university teachers have ignored scientific evidence and have not incorporated active learning into their regular methodological practice. Incorporating active learning implies dedicating part of the limited class time to application, reflection and debate; this time should necessarily be subtracted from the time traditionally devoted to the oral transmission of information to students, and this is something that most teachers are not willing to give up (Prieto et al., 2020a). Incorporating more active learning also requires an extra effort on the part of the teacher

and determination to confront the possible resistance of those students who feel more comfortable with the traditional expository method.

For these reasons, the expository method, in which teachers provide information to students in class, has continued to be the most used strategy in university classrooms during the first two decades of the 21st century. In this context, the FC model turns the classroom lessons into interactive learning environments, taking the initial transmission of information outside the classroom and dedicating class time to help students – already prepared for the class– to practice higher-order thinking skills such as problem-solving, discussion or debates proposed, revitalized and supervised by the teacher (Moravec et al., 2010). The FC model is therefore able to promote and enhance higher-order activities that give students a leading role –both in and outside the class– and contribute to making learning meaningful and impactful (Rahman et al., 2014).

Historical development of flipped classroom methodologies

An important fact about the flipped classroom model that is unknown in the literature (even to some FC pioneers) is that this model did not appear suddenly, but has deep historical roots and methodological precedents in the last century (Prieto, Díaz and Santiago, 2014a; Medina, 2016; Prieto et al., 2017). The FC, which combines electronic communication of information to be learned, students' out-of-class preparation of learning materials and introduction of active learning activities in class, has several precedents in different innovative methodologies that emerged in the last decades of the 20th century (Prieto et al., 2018a).

Among the methodological precedents of FC, those used for promoting and verifying previous study (out-of class pre-study) that combine face-to-face teaching with information delivered online to students stand out, that is methodologies used in blended or hybrid learning models (Prieto et al., 2020a). New methodologies such as Just-in-Time Teaching (JITT), Peer Instruction (PI), and Team-based Learning (TBL) were considerably implemented long before the popularization of the term 'flipped classroom' in the second decade of the 21st century (Prieto et al., 2018a). In these methodologies, teachers sent new materials –printed or electronic documents– to students to be studied before classes. They also provided students with indications to guide them in the understanding of

these new materials. Teachers also emphasize the importance of the out-of-class pre-study phase to engage in higher cognitive tasks and apply knowledge in class, anticipating the training activities to be done in class in PI and TBL models and highlighting the completion of pre-preparation tasks –reflective self-assessment questionnaires in the JITT model.

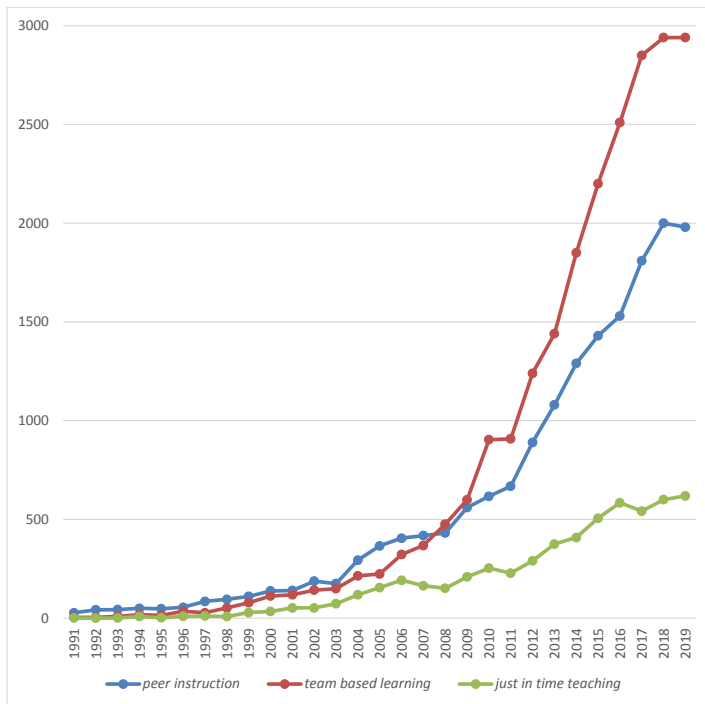
Thanks to out-of-class preparation, active learning activities, formative assessment, and peer discussion could be introduced in the classroom, and students are prepared to receive feedback in class. These methodologies for promoting out-of-class pre-study are the precursors of those which years later incorporated podcast, slidecast or video as forms of online communication and began to be called flipped classroom (Moravec et al., 2010; Bergmann and Sams, 2012).

These methodologies, after prompting out-of-class preparation, used face-to-face class to carry out different types of activities. In the PI model, class time is spent both on answering conceptual questions –which bring out students’ conceptual mistakes– and on discussion, first in pairs and finally in a plenary session (Crouch et al., 2001). In the JITT model, the teacher asks students for feedback on the doubts that remain after having studied the instructional materials. Based on the problems identified, the teacher rethinks his or her classroom activities and provides feedback, examples, and appropriate activities for the resolution of the difficulties identified (Novak et al., 1999). In the TBL model, students are encouraged to do the preparatory study by scheduling a short formative assessment test at the beginning of each unit, and then solving problems and case studies in teams (Michaelsen, Knight, and Fink 2002; Michaelsen et al., 2008).

The use of PI, JITT and TBL was extended in the 1990s, but they did not become very popular, as can be seen in the moderate impact they had on the literature. The impact took almost a decade to be achieved when developments in ICTs made it possible to facilitate communication with students and the electronic monitoring of their activities in and outside the class. During the 1990s and the first years of the 21st century, IP was the most frequently cited methodology in the literature, thanks to its combination with the then-fashionable technology: clickers (Bruff, 2009). However, this situation was later reversed when the popularity of IP was largely overtaken by that of TBL (Figure 1). Over the last decade, TBL has been the pre-study-based methodology most often cited in the literature. In fact, in some leading fields in educational innovation,

such as medicine, TBL has surpassed some well-established innovative methodologies, i.e. PBL, in terms of popularity and effectiveness (Burgess et al., 2017).

FIGURE I. Number of annual citations in Google Scholar in the 1991-2019 period for the methodologies ‘peer instruction’, ‘team-based learning’, and ‘just-in-time teaching’ (precursors of the FC model)



The first references to ‘classroom flip’ and ‘inverted classroom’–referring to blended methods that combine face-to-face teaching with virtual elements– date from the 1990s. In 1995, J. Wesley Baker realized that devoting classes to ‘reciting’ information–that was already on the slides– for students to copy was a waste of time, and asked students to access the materials online before class. He decided to use class time to work in teams from the preparatory tasks made by students outside the

class. Baker began to refer to this teaching model as ‘classroom flip’ and named it so in a lecture he gave in 2000 (Baker, 2015; Talbert, 2017). Lage, Platt and Treglia (2000) developed a similar teaching methodology, in which they asked students to read documents and watch videos on VHS before class and called it ‘inverted classroom’. Later, Strayer (2007) published a PhD thesis on the effects of classroom flip in the learning environment. In this thesis, he uses the term ‘flipped classroom’ three times, becoming the first author to use this term with its current meaning. This term would eventually become the most widely used form to name the inverted classroom model.

In 2007, Aaron Sams and Jonathan Bergmann—secondary school teachers— began recording vodcasts, screencasts, and online videos to provide their students with direct instruction outside the classroom and named their method ‘reverse instruction’. Demetry (2010) successfully combined classroom flip with TBL. With the support of the Gates Foundation, Khan created the Khan Academy, an online repository of instructional videos to supplement in-class problems and activities (Sparks, 2011).

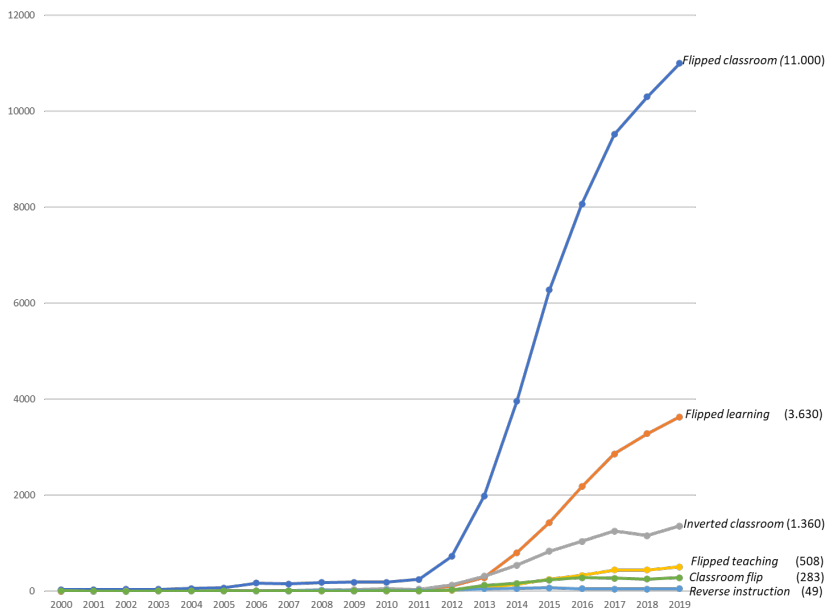
Other authors re-launched the JITT model and applied it to university education (Moravec et al., 2010; Prieto et al. 2014b); some even renamed it (Moravec et al., 2010) and called it LBL (learning before lecture). This name was perfectly in line with the definition of JITT, in which instructional materials were PowerPoint presentations with audio narrations.

The popularity of the FC model and its variants has significantly increased in Higher Education in the last nine years, with the number of papers published on this methodology also increasing (Figure 2). With the success of the term ‘flipped classroom’, a process of creating new methodological variants and terms within the flipped classroom model had begun, which continues today.

In 2012, the term flipped classroom exploded in popularity (Bergmann and Sams, 2012; Tucker, 2012). The success of the term ‘flipped classroom’ was such that authors already using JITT, PI or TBL renamed these methodologies to take advantage of the momentum of this fashionable term. Authors using JITT combined this method with videos and called it ‘flipped classroom with JITT’ (FC/JITT) (Prieto et al., 2014b; Prieto et al., 2017; Prieto et al., 2018b; Toriz, 2019). Authors promoting peer instruction also took advantage of the success of FC and started to refer to their practice as ‘flipping classroom with PI’, in order to associate

their own method to the one that was on the crest of the wave (Schell and Mazur, 2015). Other authors even went further by combining the FC model with TBL and PI (Costa, 2016). Finally, other authors– influenced by classroom flip and inverted classroom– developed the flipped teaching model and its derivatives (Wong et al., 2014).

FIGURE 2. Number of annual citations on Google Scholar in the 2000- 2019 period for the terms related to flipped classroom: ‘flipped classroom’, ‘flipped learning’, ‘inverted classroom’, ‘flipped teaching’, ‘classroom flip’, and ‘reverse instruction’.



At the beginning of this decade, a group of FC pioneers and leaders of the self-styled ‘Flipped Learning Network’ promoted the term ‘flipped learning’ as the ideal outcome of the evolution of the FC model; they developed a formal definition of the term describing the main characteristics and pillar that quality flipped classroom should have in order to be called ‘flipped learning’ (Association of Flipped Learning Network, 2014). Despite the efforts of the promoters of the term ‘flipped

learning' to refer to 'high-end flipped classroom', the term most frequently used in academic publications today continues to be 'flipped classroom' (Prieto et al., 2019). For this reason, we have used FC in this paper, leaving aside less used terms such as: reverse instruction, classroom flip, flipped teaching, inverted classroom, or flipped learning (Figure 2).

Literature on the Impact of the Flipped Classroom Model on University Education

There is an extensive literature on the effects of the flipped classroom model on different elements of the educational process, such as students' motivation, students' involvement in the learning process –overcoming simple initial challenges– and their participation in preparatory and class activities. The effects of the FC on all these elements of the educational process result in achieving a more meaningful learning, with a better understanding and comprehension of what is learned (Prieto et al., 2014a). There is also research focusing on how the FC model influences students' level of achievement and academic performance, in particular learning outcomes, competence acquisition and content learning (Estriegana, Medina and Plata, 2018; Låg , Sæle, 2019; Cheng et al., 2019; Zheng et al., 2020). A third group of works are mainly focused on assessing teachers' and students' level of satisfaction with the methodological change involved in FC (Dafonte-Gómez, García-Crespo, Ramahi-García, 2018; del Arco, Flores and Silva, 2019; Murillo-Zamorano et al., 2019; Awidi and Paynter, 2019).

In relation to the areas in which this methodology has been put into practice in university education, a number of papers on the impact of FC on health sciences, engineering, technological and computer sciences, science, social sciences and mathematics can be found in the literature. In terms of geographical origin, there is a predominance of papers published in the United States and other Western countries; publications on FC are also frequent in Eastern countries that have adopted the Western model of culture and economy, such as South Korea, Taiwan and Singapore. However, given the level of extension of FC methodologies, papers published all over the world can be found (Zheng et al., 2020).

Effects of the Flipped Classroom Model on Students' Motivation and Involvement in Learning Activities in and Outside the Class

The effect of the flipped classroom on learning is based on its ability to stimulate students to do things to learn and to become more involved in their own learning. Therefore, the beneficial effects of the FC depend on its effects on students' motivation and their level of involvement in working in and outside the class (Gilboy, Heinerichs and Pazzaglia, 2015). In order to improve students' involvement with classroom activities and study outside the class, the FC model aims to facilitate and encourage preparatory study, students' engagement in the classroom, and face-to-face and online dialogue between students and teachers. In the FC model, preparatory study is fostered and tested, so that face-to-face class time can be focused on solving problems, doubts, and difficulties that arise during preparatory study. In the case of the adaptive flipped classroom model, students' doubts and difficulties are sent to the teacher by telematic means before the class. This pre-class feedback allows the teacher to choose activities and problems for students to practice with the contents in class and develop a deeper understanding of these contents, in a learning environment where they receive feedback from their peers and their teacher.

Students' involvement can be estimated by measuring their emotional manifestations –i.e. their interest in the topics covered– but especially by measuring their behavioral manifestations: class attendance, percentage of completion of preparatory tasks (Jovanovic, 2019; Wang, 2019, Prieto et al., 2020b), time dedicated to these preparatory tasks (Prieto et al., 2020b), and their participation in discussions and quizzes and in formative assessment questionnaires (Prieto et al., 2020b). In-class activities (problem-solving) motivate preparatory study among students (Wang, 2019); other authors use formative assessment (Michaelsen, et al., 2008, Crouch et al., 2001) and gamification –with small rewards– (Prieto et al., 2014) in exchange for the completion of preparatory tasks, which contributes to more students doing preparatory study regularly.

Evidence shows that students' involvement in both in-class and out-of-class activities improves in the FC model (Murillo-Zamorano et al., 2019). Studies show almost unanimously the positive effect of the FC model on student engagement in educational contexts where the FC has been implemented. Furthermore, the most comprehensive meta-analysis

demonstrates an increase in the level of motivation of an effect size (ES) of 0.661 s for student motivation to learn (Zheng et al., 2020), being s the standard deviation of the level of motivation in the student population without a FC model. The 0.661 s increase equals a 24% percentile increase.

Effects of the Flipped Classroom Model on Students' Performance or Level of Academic Achievement

Most systematic reviews of the impact of the flipped classroom model on students' academic performance in HE have highlighted the positive effects of the FC on students' academic performance and satisfaction (O'Flaherty and Philips, 2015; Hinojo-Lucena, Aznar, Romero and Marin, 2019). The first meta-analysis on the impact of this methodology reviewed 15 studies on FC and found a positive effect on students' performance (Rahman, 2014). Subsequent meta-analyses found that the ES for academic performance was positive, moderate, and significant (Hew and Lo, 2018; Gillette et al., 2018; Van Alten et al., 2019; Låg et al., 2019; Cheng, Ritzhaupt, and Antonenko, 2019).

The most recent meta-analysis on the effect of the FC model on students' academic achievement or performance has demonstrated that the implementation of FC has a positive ES on academic performance at all educational levels studied, including university (Zheng et al., 2020). This meta-analysis included 78 studies in HE and showed that the ES for FC implementation was of 0.646 s at this educational level. This difference means that the median student (50th percentile) of a class taught by FC may obtain the same learning outcomes as the student in the 74th percentile of the same class taught by traditional methodology.

Some of these meta-analyses on the impact of the flipped classroom analyzed the moderating factors of that ES, showing that class size influences the ES achieved. Thus, smaller class sizes achieved higher ES than those observed in larger class sizes. Geographic area also had a moderating effect on the ES (Zheng et al., 2020): it was higher in Africa and Asia, intermediate in Europe, and lower in the United States. This difference shows that the implementation of the FC model may have even greater effects in those areas where the optimization degree of the traditional model is lower.

In relation to the disciplinary domains of the subjects, Zheng et al. (2020) found no differences between the different domains studied. This shows that the FC model has similar effectiveness in the different domains analyzed –sciences, engineering and technological sciences, health sciences and social sciences. However, another meta-analysis found that although the TE for the FC was significant in general terms, the TE values were significantly moderate according to the disciplinary domain in which the FC was applied, reaching maximum values in the branch of arts and humanities (Cheng, 2019).

Regarding the use of technological tools, the meta-analysis by Zheng et al. (2020) showed that the implementation of online discussion forums and online games reached higher ES than the use of online learning platforms. Other meta-analyses incorporating moderating factor analyses showed that the performance of online quizzes increased the ES for academic performance (Hew et al., 2018; Van Alten et al., 2019). In terms of the impact on different types of learning, several works reported that the FC model was associated with an improvement in knowledge acquisition (Love, Hodge Grandgenett and Swift, 2014); however, other works highlighted an improvement in the development of skills and competencies (Elmaadaway, 2017; Zainuddin and Perera, 2017).

Flipped Classroom and Competencies and Skills Development in Students

The effect of flipped classroom on the development of management competences and skills (i.e. the competence to manage online tasks and activities) was studied by Zanuiddin and Perera (2017). They found that students in a flipped learning environment developed management competences and skills to a higher level than students in the control group –who did not learn in a flipped environment. Zanuiddin and Perera (2018) demonstrated that the use of a LMS platform, that provides continuous access to a variety of digital materials, fostered a high degree of interactivity among participants, and made the implementation of FC and self-directed learning easier. For these authors, FC is viewed as a strategy that can help students remain engaged and focused on improving their language skills (Zanuiddin and Perera, 2018). Hu et al. (2018), in a meta-analysis of 11 studies on nursing education, showed

that the flipped classroom model was more effective than traditional lectures at improving students' theoretical knowledge and skill scores.

Estriegana et al. (2018) aimed at analyzing the development of competencies in the FC environment and demonstrated that this environment plays a key role in the acquisition and development of systemic, personal, and cooperative competencies. Their findings also suggested that the acquisition of skills and competencies, although considered a major issue in the HE qualifications framework, does not exactly match the academic outcomes measured during the assessment process. Additionally, Murillo-Zamorano et al. (2019) provided empirical evidence on the causal relationships among knowledge, skills, involvement, and students' satisfaction. This study confirms that the flipped classroom model has positive effects on students' involvement, resulting in an improved knowledge and skill acquisition.

Students' Perceptions on the Methodological Change from Traditional Methodology to Flipped Classroom

Several papers have focused on the effect of the flipped classroom model on students' satisfaction with their learning experience (Dafonte-Gómez et al., 2018; Del Arco et al., 2019). The students' level of satisfaction can be estimated from the students' assessment of the teachers' performance or from a comparison between their level of satisfaction with the FC and with the traditional models (Awidi and Paynter, 2019; Murillo-Zamorano et al., 2019).

McNally et al. (2016) differentiate in their research between students who are flip endorsers and flip resisters. Flip endorsers have positive attitudes toward the performance of activities both in class and outside the class, are involved in the activities, and achieve the best academic results. It is essential that teachers who want to implement the flipped classroom model plan a strategy to convince students who resist participating in class, and to change their attitude and study habits. Teachers should motivate students to study the learning materials before the class, giving them reasons to foster preparatory study and class participation. The use of narrative and game-playing strategies may help teachers to convince more students of the need to change their study habits to succeed in the flipped classroom environment (Prieto et al., 2014b). In addition, it is

very important to quantify and monitor the volume of student workload and provide them meaningful classroom activities (Al-Zhrani, 2015; Prieto et al., 2020b).

Different Models for the Flipped Classroom and their Effects

The traditional flipped classroom –used in secondary education– is focused on reordering and inverting the activities carried out in and outside the classroom (exposure to new materials outside the classroom and completing tasks inside the classroom). However, there are other aspects that can be optimized to further improve learning outcomes achieved through the implementation of the FC model. For example, some studies have compared the different strategies that can be used to produce preparatory learning of the contents before class, i.e. interactive tutorials, video classes and text reading; the result was a small advantage for video classes over the other alternatives studied (Jensen, Holt, Sowards, Ogden and West, 2018).

The methods for promoting previous study (pre-study) in university education in the 1990s –TBL, PI and JITT– already included strategies for improving learning, such as formative assessment, formal (TBL) and informal (PI) teamwork, answering pre-questionnaires and conducting preparation activities (JITT). Twenty years later, as explained above, some authors renamed the JITT method (Moravec et al., 2010) as ‘learning before lecture’. The underlying idea –previously established by Novak– was that students’ answers and activities could be used to redesign classroom activities and materials, taking what students had not understood or misunderstood as a starting point.

Teachers can provide feedback to students, either in class or online collectively, from the students’ answers to questionnaires, creating the possibility of making the flipped classroom an adaptive strategy (adaptive flipped classroom). The teacher will thus be able to adapt the instructional materials and classroom activities to the interests and real needs of the students (Prieto et al., 2020b). In addition, students’ responses also provide information about elements of the instructional material previously provided by the teacher that need to be improved, explained, or otherwise illustrated in order to be better understood (Contreras et al., 2017; Murillo-Zamorano et al., 2019). This two-way

feedback strategy combines the work of the teacher and that of his or her students and intensifies the effect of the FC by providing cohesion to the activities carried out in and outside the classroom (Murillo-Zamorano et al., 2019). This strategy establishes a two-way dialogue that fosters mutual commitment and the establishment of a learning community in which the teacher acts as a coach to his or her students.

Other authors have also advanced this idea of improving flipped classroom outcomes by including additional tasks both in and outside the classroom. Outside the classroom, formative assessment (Robles, 2010) and reflective questionnaires (Prieto, 2014; Porcaro et al., 2016) have been proposed. Within the classroom, team problem-solving (Chiang, 2017) or team projects (Liu, Wu, Zhang and Guo, 2017) have been incorporated, in order to improve student involvement and favor that the class activities achieve more significant learning and develop skills and competences.

Studies on the Impact of the Flipped Classroom in the Different Disciplinary Domains

To evaluate the impact of the flipped classroom methodology in different disciplinary domains, original research and meta-analysis have been carried out focusing on specific disciplines within Higher Education. We summarize below the most outstanding works on the impact of the FC on learning in specific disciplinary contexts.

In the health sciences area, the meta-analysis by Hew et al. (2018) demonstrated a positive and significant ES in learning performance in favor of the FC compared to traditional methodologies. In addition, this meta-analysis showed that the FC increased its effectiveness when formative assessment quizzes were used at the beginning of each class. Students also showed a preference for the flipped class over the traditional class. Similar results were obtained in Chen's meta-analysis (2018). Sezer and Abay (2019) conducted a quasi-experimental design study with control, pre-test, and post-test groups, and demonstrated that first-year medical students who were taught with FC obtained a significantly higher level of academic achievement than the control groups. Students also had positive perceptions of the flipped classroom method. Hu's meta-analysis in 11 nursing studies (2018) showed that theoretical knowledge and skill scores were significantly higher in the groups that were taught by flipped

classrooms than in the control groups that had been taught by traditional classes.

In the engineering and technology disciplines, Kerr's (2015) review showed that almost all studies on flipped classrooms in engineering resulted in high levels of student satisfaction with the new learning environment and improved performance. In science disciplines, Chen's (2018) meta-analysis showed that FC was associated with a higher level of academic achievement than teaching with expository classes. In maths, Lo, Hew, and Chen's (2017) meta-analysis determined a positive and significant effect of the flipped classroom whose value was estimated at 0.298 s over the starting value. In languages, as well as in arts and humanities, the flipped classroom model has also been used –specially in second language teaching– and the results have been positive, improving the motivation and language skills of students who participate in FC experiences (Hsieha, 2016). Finally, in social sciences, Olivan's recent study (2019) showed that FC was more effective in achieving better academic results than expository teaching.

Long-term Effect of the Flipped Classroom Model: Longitudinal Studies

Longitudinal studies that track the effect of the flipped classroom during a series of successive promotions of the same subject to determine its long-term impact are scarce in the literature. The recently published longitudinal study by Prieto et al. (2020b) shows that in four subjects in which the FC has been applied in at least four consecutive promotions, the ES on learning assessment test scores are lower in the first years of implementation ($ES = 0.3$ s), but increase during the second and third year; then, the values remain stable –around 1 s– over the initial values. This study has shown that the impact of the flipped classroom is not immediate, but is proportional to the modification of preparatory study habits over the course of different promotions. Therefore, the ES increases as the preparatory study habits of a greater number of students improve –a process that can last several years. Finally, this study also showed that the ES on the average score in the learning assessment tests correlates directly with the percentage of preparatory tasks carried out by the students; it is also observed repeatedly in different subjects that,

although this percentage of task completion begins being modest in the first attempts, it progressively improves in successive years.

Conclusions

To date there has been a poor understanding of the methodological roots of the flipped classroom; this paper has connected the flipped classroom methodologies developed in the 21st century with the pioneering methodologies that emerged in university education at the end of the previous century. The review of the literature on these pioneering FC methodologies (peer instruction, team- based learning, and just-in-time teaching) shows how these methodologies –developed at the end of the last century– were widely used in the first decade of this century, years before the flipped classroom became popular in 2012. In recent years, the FC model has been increasing its popularity to become an alternative methodology widely used around the world by more university teachers every day.

In the second part of this paper, the review of the literature on the impacts of the FC allows us to conclude that the use of this methodology has multiple positive impacts: it increases student involvement, improves their level of academic achievement, allows the incorporation of more active learning and thus favors the development of skills and competences in students. It has also been demonstrated that the FC model improves students' perceptions of their learning experience. In short, the flipped classroom creates opportunities for students to interact earlier and more sustainably with instructional materials, thereby improving their readiness to apply what is learned to class activities and thus improving their academic performance.

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