Blended teaching through flipped classroom in higher education

La enseñanza híbrida mediante *flipped classroom* en la educación superior

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Abstract

Dramatic changes are expected in higher education with the emergence of the so-called Industry 4.0, which demands soft-skilled, autonomous practitioners with lifelong active learning capacity. Higher Education Institutions (HEIs) try to respond to this demand by redesigning and optimising learning experiences. Blended teaching will help to achieve these objectives when the methodologies required to deploy its full potential become available. The objective of this study is to assess effectiveness of blended teaching based on flipped classroom, in terms of student satisfaction and performance, as compared to fully online teaching. For that, the following questions regarding hybrid subjects are analysed: i) preference for hybrid subjects over fully online teaching; ii) satisfaction with flipped classroom as compared to traditional methodology; and iii) academic performance as a function of the learning environment. Research relied on quantitative and qualitative information obtained from closed surveys and focus groups directed to students from different HEIs, where differences among the means were contrasted to identify statistically significant differences regarding academic performance. Results indicate that the students are highly satisfied with the hybrid environment and the *flipped classroom* methodology. Moreover, the studies taught in this type of classrooms yield better success rates and improved retention as compared to fully online teaching. These indicators can assist HEIs

in the choice of teaching modalities and methodologies for use in the different subjects of their programs.

Resumen

La educación superior se dirige a un profundo cambio con la irrupción de la denominada Industria 4.0 que requiere profesionales con competencias *soft*, autónomos y con capacidad para el aprendizaje activo a lo largo de toda la vida. Las Instituciones de Educación Superior (IES) tratan de responder a esta demanda mediante el rediseño y optimización de las experiencias de aprendizaje. La enseñanza híbrida o *blended* puede contribuir a alcanzar estos objetivos si dispone de las metodologías necesarias para desplegar todo su potencial. El objetivo de este estudio es evaluar la efectividad de la enseñanza híbrida con *flipped classroom*, en términos de satisfacción y *performance* del alumno, en comparación con la enseñanza 100% *online*. Para ello, se analizan las siguientes cuestiones respecto de las asignaturas híbridas: i) preferencia de éstas frente a las cursadas 100% online, ii) satisfacción con la *flipped classroom* frente a la metodología tradicional y iii) resultados académicos en función del entorno de aprendizaje. La investigación se ha basado en información cuantitativa y cualitativa obtenida de encuestas cerradas y *focus group* dirigidos a estudiantes de diferentes IES, donde el contraste de medias permite identificar diferencias estadísticamente significativas en relación al rendimiento académico. Los resultados indican que los estudiantes están muy satisfechos con el entorno híbrido y la metodología *flipped classroom*. Además, los estudios que se imparten en este tipo de aulas ofrecen mejores tasas de éxito y una mejor retención en comparación con la enseñanza totalmente *online*. Estos indicadores pueden guiar a las IES en la elección de las modalidades y metodologías de enseñanza para las diferentes asignaturas de sus programas.

Palabras Clave: Tecnologías de la información y comunicación, innovación pedagógica, proceso de aprendizaje, satisfacción y abandono de estudios.

Introduction

The 21st century student needs to acquire the skills and knowledge that enable him/her to face the future challenges of organisations. Higher education is now facing the task of training professionals who can

occupy and perform in jobs that have yet to be created in the labour market. Higher Education Institutions (HEIs) are attempting to respond to this by turning teaching environments into hybrid models and applying active and collaborative methodologies based on information and communication technologies (ICT). Hybrid or blended teaching can be defined as an approach that combines face-to-face and online learning with ICT (Graham, 2006). The effective integration of both components in the learning experience is the distinguishing feature of hybrid teaching and what makes it more complex (Garrison & Kanuka, 2004). It involves a reappraisal of the teaching-learning process and of spaces, times and resources for active learning. In this context, a methodology that could be considered is the flipped classroom, which focuses on reorganising teaching time and students' active participation in their learning. Theoretical content is transmitted via online support, with practical application, problem solving, group interaction and debates taking place in face-to-face classes. This focus contrasts with traditional methodology, which may be described as the transmission of knowledge to students who play a passive role and where learning is rarely experiential (Wise, 1996). In the hybrid context, applying this methodology means time in the classroom is dedicated to conducting master classes, while practical development takes place outside.

To improve education, it is necessary to consider the many methodologies that currently exist (Bisquerra, 2012). To this end, the aim of this article is to investigate the suitability in higher education of the flipped classroom approach in hybrid teaching, contrasting it with the relevant indicators for HEI decision making, such as satisfaction, performance and student dropout. Firstly, the students' perceptions have been used as a basis to analyse student satisfaction, given that they are the main stakeholders in this approach. In fact, student satisfaction is a basic element in achieving effective learning (Lizzio, Wilson & Simons, 2002). A twofold focus was used to study this factor: hybrid teaching vs. online teaching and the flipped classroom method vs. a traditional approach.

Secondly, the impact of this methodology on academic performance is analysed, examining the differences between students' scores in the hybrid subjects taught in flipped classroom sessions and those obtained in the 100% online subjects. Finally, the impact of the flipped classroom on levels of student dropout from the subject is estimated. Our study

demonstrates the effectiveness of this methodology in hybrid settings at HEIs, which is a subject that has not been properly addressed in the scientific literature (Pérez-Sanagustín, Hilliger, Alario-Hoyos, Kloos & Rayyan, 2017; Pérez-Sanagustín et al., 2020).

The article uses a methodological triangulation combining quantitative and qualitative research methods to ensure that the results are valid and robust (Aguilar & Barroso, 2015). Closed-ended surveys and focus groups were carried out, contrasting the data from both methods. The sample was made up of degree students in Spain and the United States in hybrid classrooms where the flipped classroom methodology was used.

The results show a high level of student satisfaction with the hybrid setting and the flipped classroom methodology, better marks and lower dropouts in the courses that use this type of classroom when compared to 100% online groups. The contributions of this study to teaching research are as follows: (i) to show the effectiveness of the flipped classroom methodology in hybrid learning as compared to online teaching in terms of satisfaction and performance, (ii) to provide students' perceptions that should be taken into consideration when designing hybrid settings with flipped classroom methodologies and (iii) to provide HEIs with important indicators for decision making about the selection of teaching modalities and methodologies in the subjects that shape their syllabuses.

The article is structured as follows: firstly, the previous literature is reviewed and the research questions are proposed and explained. Then the methodology that was implemented is then described and the results are discussed. Finally, the conclusions and future lines of research are presented.

Hybrid learning and the flipped classroom in higher education

Hybrid teaching is the integration of two forms of learning that develop independently: face-to-face teaching, which has mainly used ICT as a documental repository, and online teaching, which does not have the benefits of a face-to-face class. This necessarily involves redesigning teaching programmes for student-centered learning to further their active participation and increase interaction with the educator, classmates and content (Dziuban, Hartman & Moskal, 2004).

The integration of the face-to-face and online learning experiences in different contexts, programmes, subjects, etc. brings about different blended models, which means that no two blended designs are alike (Garrison & Kanuka, 2004). New research on the validity of hybrid and online teaching is therefore needed to better understand what might be the ideal hybrid approach, the combination of activities in and out of class that best improve students' learning (Arbaugh, 2014; Nortvig, Petersen & Balle, 2018). The aim in this case is to go deeper into the selection and sequencing of content and the structuring of activities to be done by students. Estrada, Zaldívar, Mendoza, Nava and García (2013) identified areas requiring improvement in hybrid programmes such as quality and interactivity of educational materials and highlighted the need for active participation by students. Likewise, Vanslambrouck, Zhu, Tondeur, Phillipsen and Lombaerts (2016) point out the lack of interaction in online periods as a negative factor.

The flipped classroom began to be implemented based on the studies on Peer Instruction carried out at Harvard University by Mazur (1997) in the 90s, and began to take shape in the secondary teaching of professors Bergmann and Sams (2012) in the United States. It is a pedagogical method that uses asynchronous media such as videos, audio and other online resources to transmit master classes and reserve time in the classroom for participant interaction, problem solving and applying the material to real life situations (Bishop & Verleger, 2013). As Rotellar and Cain (2016) remark, the formal implementation of the flipped classroom methodology in higher education is relatively new, and so studies on its effectiveness and best practices are needed. The HEIs and educators require guidance in designing and teaching blended programmes and subjects, and assistance with the methodologies to be applied in such settings.

DeLozier and Rhodes (2016) conducted a review of the literature on the flipped classroom and the variety of existing focuses. They concluded that the utility of the activities depends on their capacity to motivate the students and that the main advantage of using videos resides in the time they provide for active learning. In highly competitive settings such as the one used by Chen and Chen (2016) in a study of IT students in Taiwan, it was found that this type of learning makes it possible to reduce the gap between industry and education.

Implementation of the flipped classroom methodology has been recommended in blended designs in order to deal with the challenges of higher education (Joseph & Nath, 2013; McLean, Attardi, Faden & Goldszmidt, 2016; Thai, De Weber & Valcke, 2017). However, there are few studies that provide relevant indicators for HEIs (Pérez-Sanagustín et al., 2017). It is therefore necessary to further investigate the effectiveness of the flipped classroom in hybrid education by analysing its impact on performance and student retention levels where studies are less common (Blair, Maharaj y Primus, 2016; Kerr, 2015). Our aim is to show that this methodology is suitable and provide indicators for decision making. One particularly important indicator is the student's perception. One of the main characteristics of the flipped classroom is the active participation and involvement of students in their own learning (Rotellar et al., 2016). Previous studies mention the advantage of students being able to work at their own pace (Hinojo, Aznar, Romero & Marín, 2019), better use of time, greater interaction with the teacher and working classmates (O'Flaherty & Phillips, 2015). On the other hand, there are also some difficulties, such as problem solving (Bognar, Sabli & Škugor, 2019), or factors such as the family context, autonomy, or students' motivation and self-esteem that may have an effect on the implementation of this type of active methodology (Mengual-Andrés, López Belmonte, Fuentes Cabrera & Pozo Sánchez, 2019).

It therefore becomes necessary to contrast students' opinions about the flipped classroom methodology in a hybrid setting. The first research questions are: what are students' preferences when comparing a hybrid setting with a 100% online one? Is it preferable to apply the traditional methodology or the flipped classroom in this hybrid setting?

Another issue to be considered in reviews of the literature is the impact on student performance. O'Flaherty and Phillips (2015) found only a small number of studies that had robust evidence to back up the hypothesis that the flipped classroom improves performance in learning. Zuber (2016) also found insufficient evidence in this regard. Likewise, Uzunboylu and Karagozlu (2015) reached similar conclusions about the application of the flipped classroom in many areas of health sciences, actuarial sciences, English and linear algebra. This in turn leads us to ask the following research question about the performance of the methodology analysed in the hybrid context: do students who study

in hybrid settings with a flipped classroom methodology obtain better academic results and lower dropout rates?

Methodology and Sample

The sample used for this study consisted of students from *Laureate Universities Inc.*, an institution that decided to progressively implement hybrid teaching in the syllabuses of its international network of higher education centres. For that, it was decided to encourage research in this field to know more about the impact of different practices in digital learning and teaching on learning outcomes. Several professors of the Faculty of Social Sciences and Communication of the Universidad Europea, who had been working on the flipped classroom methodology, prepared a research project to study the implementation of hybrid teaching with flipped classroom approaches in two HEIs from their international network: Universidad Europea (Madrid, Spain) and Kendall College (Chicago, United States). The activities for the 2017-2018 period were scheduled in detail, and the teaching staff of both institutions coordinated on a fortnightly basis. Part of this process consisted of a workshop in Chicago with the teaching staff of Kendall College, where results were discussed.

A methodological triangulation was used in this research project, with quantitative and qualitative research methods. According to Aguilar and Barroso (2015) these methods are complementary, crossing data to analyse the convergence of conclusions between one and the other, so their combination boosts their strengths while reducing their weaknesses.

The main objective for the first part of the research is to discover the perceptions of students in two educational settings (hybrid vs. online) and in two learning methodologies (flipped classroom vs. traditional). For that, we used two information-gathering techniques: closed-ended surveys and semi-structured group interviews. Firstly, the students participating in the study had to respond to a closed-ended questionnaire about their level of agreement with different statements, using a Likert scale with four response options (completely disagree, partially disagree, partially agree and completely agree). The main questionnaire, validated

by educational experts[1], consisted of a total of 14 main questions, with which up to 58 questions could be formulated depending on the level of agreement with the main question. More specifically, the questions in the questionnaire were organised into the following main blocks:

- Preference for hybrid or exclusively online settings, and for flipped classroom or traditional methodologies.
- Distribution of face-to-face and online time with the hybrid format of learning-teaching.
- Specific characteristics of the learning process in each setting and methodology that was studied.

Secondly, focus groups were organised to complete and validate the information obtained in the surveys with a total of 19 participants (12 students in the Spanish institution and 7 in the American institution). The groups were directed by an external moderator who supervised and guided the session and asked open questions taken from a previously designed script that matched the questions used in the previous survey. Three group interviews were conducted, two with groups of the Spanish institution and one with students from the American centre. Once they were completed, qualitative research techniques based on discourse analysis were used to complement the results obtained in the quantitative surveys.

The population of this first part of the research consisted of university students who were studying subjects that used the hybrid teaching format, with a reduced number of face-to-face classes and where flipped classrooms were applied in over 80% of the classes. A random sample was run on the population, which is a widely used technique in educational research, on those subjects that met both conditions. The total sample was made up of 15 lecture groups in Spain and the United States, with 164 students (see Table I).

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[1] The questionnaire was validated by the consultancy firm Telling Insights S.L.

TABLE I. Distribution of number of respondents by location, sex and age

	Sex			Age		
	Male	Female	DK/DA	≤ 25 years	>25 years	DK/DA
Madrid	59.1%	38.2%	2.7%	59.1%	38.2%	2.7%
Chicago	48.1%	40.7%	11.1%	79.6%	9.3%	11.1%

Note: The total number of respondents was 164, of whom 110 were studying in Madrid and 54 in Chicago.

The second part of the research project set out to evaluate the possible existence of statistically significant differences in the students' performance (measured as academic output, pass rates and/or dropout levels) from the different teaching-learning formats: the hybrid and the exclusively online settings. To do so, the academic results of students who had studied with hybrid resources were compared with those obtained by students who had studied the same subject with a completely online format. Only the groups in the Spanish centre were used for this second part of the analysis, as the American centre did not have equivalent subjects with a 100% online approach, which hindered the comparison between both groups. The total sample size for this second part of the research project was 302 students.

Results and Discussion

To analyse the level of satisfaction with the hybrid setting and the flipped classroom methodology, eleven subjects at Universidad Europea de Madrid were selected from three different areas of knowledge (economics, business and law), and four subjects were selected at Kendall College, all of which were included in the area of General Education. The wide selection of subjects made it possible to incorporate heterogeneity into the subsequent analysis. The results of the first and second wave of surveys conducted during the second and third terms of the academic year 2016/17 showed a total participation of 164 students, with 67.1% of the surveys completed by students of the Universidad Europea de Madrid and the other 32.1% by students of Kendall College in Chicago.

Satisfaction with the hybrid setting versus 100% online.

To assess the level of student satisfaction with the hybrid learning environment, students had to state their level of agreement with the following statement: "I prefer to work in a hybrid setting (face-to-face and online) rather than working in a 100% online environment".

The results obtained showed that 79.3% of the students who took the survey preferred to work in a hybrid setting to working in a purely online one. Specifically, 51.2% of students completely agreed with this statement, while 28.1% partially agreed. Only 9.75% completely disagreed with this statement. After refining their preference, students had to indicate the main reasons for their choice. Table II shows the results of the percentage of agreement or disagreement with each of the reasons shown for the students who preferred hybrid courses. As shown below, the students pointed out that studying in this setting enabled them to make better use of face-to-face time and more effectively resolve their doubts, which generally provided them with more learning capacity. When results of this analysis are divided into the two HEIs, there is no evidence of statistically significant differences between the percentages of agreement or disagreement of both institutions, although it is true that the students of the Chicago centre did not consider the hybrid setting to create better use of their own time.

TABLE II. Reasons for preference: hybrid vs. 100% online setting

Reasons	Agree (%)	Disagree (%)
Better use of face-to-face time	89.2	10.8
Better resolution of doubts	88.5	11.5
Greater learning capacity	86.2	13.8
More active participation	86.2	13.8
Greater proximity to lecturer	83.1	16.9
Greater autonomy	73.1	26.9
Better use of student's time	70.8	29.2

Source: Compiled by authors

Likewise, the students who preferred a completely online setting also had to give the reasons for their opinion. As Table III shows, the results obtained did not appear to be very conclusive as they show a reduced level of agreement with the reasons given in the survey for not preferring the hybrid setting. They only suggested that the proposed reasons are not reasons with sufficient weight for inference because the students do not prefer the hybrid learning setting when compared to a 100% online environment.

TABLE III. Reasons for not preferring a hybrid environment to a 100% online setting

Reasons	Agree (%)	Disagree (%)
Less autonomy	38.2	61.8
Do not understand the setting	35.3	64.7
Lower learning level	32.4	67.6
The online part is enough (without face-to-face classes)	29.4	70.6

Source: Compiled by authors

The results for preferences in the hybrid setting were also widely discussed in the students' focus group. Most of the students interviewed expressed a preference for this format over an exclusively online one ("*The hybrid environment combines the strong points and the best of online and face-to-face, and that's a good thing*"). They also stated that they learnt better because it increased proximity to the teacher, which enabled them to resolve their doubts more effectively while their learning process could be more effectively monitored ("*A teacher can realize that a student needs more support, because they don't notice that online*"). Students also highlighted the role played by face-to-face contact in improving the pace of study ("*The fact that there's face-to-face contact forces you to maintain a more constant pace*") and encourages contact with classmates. These aspects are greatly reduced in the online setting ("*Another very important thing, apart from the teaching itself, from a personal point of view, is the bonds you create with other people and with the university itself. After all, if you do everything online, there's no university life*"). All these factors therefore contribute towards increasing their motivation and perception of greater learning with the hybrid format ("*I've spent no time on the 100% online studies, they don't get*

you hooked"). Finally, they also showed a greater preference for using blending in complex subjects that required understanding more difficult concepts and operations.

Satisfaction with the flipped classroom methodology

Students had to agree or disagree with the statement "*I liked the system of studying the theoretical aspects of the subject online and using the face-to-face sessions to clarify doubts and do practical work*", to show their level of satisfaction with the flipped classroom methodology. The results obtained showed that 66.4% of the students agreed with implementing the new educational methodology. Only 13.4% completely disagreed with it.

Once the students' preference for this methodology was identified, the following set of questions set out to identify the main reasons for their choice. As Table IV shows, the main advantages identified by the students were the greater amount of practice-centered learning, and better motivation regarding the subject and its study. At the opposite end of the scale, the reasons for the dissatisfied students' choice included a preference for traditional methodologies and the increased workload that using the method implied (Table V).[2]

TABLE IV. Reasons for preferring the flipped classroom methodology as opposed to traditional approaches

Reasons	Agree (%)	Disagree (%)
Improves my capacity to pass the subject	92.10	7.90
Improves practical application of the course	89.50	10.50
Improves my interest in the subject	84.21	15.79
Improves my motivation in comparison to traditional approaches	84.21	15.79
Improves my individual relationship with the teacher	81.58	18.42
Improves relationships with my classmates	71.05	28.95
Improves my teamwork skills	63.16	36.84

Source: Compiled by authors

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[2] Once again, the results obtained after dividing them by the location of the HEI showed no statistically significant differences in the agree/disagree percentages between the centres.

TABLE V. Reasons for not preferring the flipped classroom methodology to traditional approaches

Reasons	Agree (%)	Disagree (%)
I prefer more traditional methodologies	87.55	12.55
It means more work and effort for me	62.55	37.45
I prefer to do the practical work at home	50.00	50.00
I didn't like the course material	31.25	68.75
I didn't understand the methodology	12.55	85.55

Source: Compiled by authors

The students were also asked about the advantages they could identify in implementing the flipped classroom approach in the classroom itself. In this regard, 83% said that it provided greater autonomy for studying in comparison to traditional approaches thanks to the master classes and practical work outside the classroom. This result is very interesting, given that it is often considered that one of the main advantages of online teaching is the greater student autonomy resulting from asynchronous learning (Vanslambrouck et al., 2016). Therefore, the flipped classroom would maintain this increased autonomy in learning, while using the face-to-face sessions to reinforce and consolidate the knowledge acquired.

The above results were also confirmed and supplemented in the students' focus group. There, the main advantage of the flipped classroom methodology gleaned from the participants' comments was related to the option of better time management: dedicating face-to-face classes to more difficult tasks that require a teacher's presence, and using personal time, more autonomy, for simpler tasks. All this contributed towards making classes more enjoyable, which increased the students' involvement and motivation ("*There's more interaction in a flipped classroom, because there are always conversations between the teacher and students. It's like a ball being passed around again and again*"). Clarification of doubts is also faster with this methodology since questions can be asked in class with the teacher present and, although students work more in face-to-face sessions, the results are better ("*You make more of an effort, but it's more productive, because it obliges you to prepare in advance because if you don't, you end up in a dynamic of the person who goes, listens and has no obligation*"). The main disadvantage students commented on was

the difficulties of working on the theoretical aspects of the subject alone ("*I like to have the theory explained to me, because you can go to a class and cover a complete topic in an hour, and at home I can't do the same thing in one hour*"). They also emphasised the importance of having good quality materials to be able to correctly prepare the face-to-face sessions ("*Sometimes I had to look for information on my own because I felt that something was missing, that I didn't understand regarding something I'd been theoretically taught. The teacher ought to give you more complete and more specific material*").

These results are also backed up by research on students' perceptions in the flipped classroom (Awidi & Painter, 2019; Blair, 2016; Hernández Nanclares & Pérez Rodriguez, 2016), although our study has the unique feature of being applied in hybrid courses that reduce the number of classroom hours. The greatest difficulty in the flipped classroom is that of student responsibility, especially in work outside the classroom, which is crucial if the face-to-face time is to be effectively used (Bognar et al., 2019; He, Holton, Farkas & Warschauer, 2016; Touron & Santiago, 2015). In our case, where the hybrid classroom reduces time in class, students perceived "more effort", which meant that the teaching staff had to redesign materials and activities to provide greater support to student learning. This has been the goal of such HEI initiatives as including problem-based activities for learning (Çakıroğlu & Öztürk, 2017) or the integration of MOOCs into traditional courses (Joseph & Nath, 2013; Pérez-Sanagustín et al., 2017).

Distribution of face-to-face and online time in hybrid subjects

The survey also set out to analyse student perceptions of the proportions of face-to-face and online time in the hybrid subjects of the sample. In this regard, the subjects that participated in the study had 50% attendance in face-to-face classes and 50% online. The survey results show that almost 80% of the students prefer to spend more time in face-to-face classes. Table VI shows the main reasons for this larger percentage of face-to-face time. The main reasons are related to the possibility of more time for explaining practical concepts and to learn to manage their own resources more efficiently.

TABLE VI. Reasons for preferring more face-to-face time

Reasons	Agree (%)	Disagree (%)
More practical explanations	94.7	5.3
Learn to manage my resources more efficiently	90.1	9.9
More practice in the subject	88.5	11.5
More individual work with the teacher	85.5	14.5
Acquire teamwork experience	81.7	18.3
More interactions with my classmates	79.4	20.6
More theoretical explanations	75.6	24.4

Source: Compiled by authors

We found similar results to those in previous studies, with the most recommended balance being 50%-50% for implementing hybrid teaching courses, although this proportion may be affected by other factors related to the subject area and the students' characteristics (Donnelly, 2010; Demirer & Sahin, 2013; Thai et al., 2017). The general opinions of the focus continued with the same arguments of demanding more face-to-face hours, because it promoted greater commitment to the subject and offered a better chance to interrelate with the teacher and other classmates. However, students who balanced their studies with a full-time job stated that more face-to-face time made it more difficult to attend classes, and also took away study time. Discussions in the group interviews not only focused on the most adequate proportion of hours between face-to-face and online time, but also on the fact that the students also wanted more rational organisation of the time dedicated to face-to-face sessions.

Academic results depending on the learning environment (hybrid and exclusively online)

This Section considers the statistically significant differences between the students' academic results, depending on the learning environment where they studied the subjects. To this end, the students' final marks in each

subject were used, in the hybrid and exclusively online schemes[3]. It should be mentioned that the evaluation content and systems for each subject considered in each setting are the same. The total sample of students was 302, of which 49.01% studied in a hybrid teaching setting and 50.99% in an exclusively online environment. However, the final sample was reduced to 261 students, since 41 (10 in hybrid courses and 31 in online courses) dropped out of the subject and therefore did not have a mark in either of the two exams taken (first and second sitting of exam).[4]

According to the first analysis of Table VII, the students who took subjects in hybrid settings showed a higher average mark than those who studied in solely online environments (7.39 against 7.22 out of 10, respectively). However, this difference is not statistically significant (p-value >0.05).

TABLE VII. Students' performance in hybrid settings compared to online settings

		Obs.	Mean	Standard deviation	P-value Ha:diff.≠ 0
Average mark	**Online**	123	7.219	1.810	
	Hybrid	138	7.386	1.412	
	Total	261	7.307	1.611	
	Diff. Online-Hybrid		–0.167		0.4107
% Passed	**Online**	123	0.935	0.248	
	Hybrid	138	0.993	0.085	
	Total	261	0.966	0.183	
	Diff. Online-Hybrid		–0.058		0.0150
Success rate	**Online**	154	0.747	0.436	
	Hybrid	148	0.926	0.263	
	Total	302	0.834	0.372	
	Diff. Online-Hybrid		–0.179		0.0000

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[3] The marks of Kendall College were not included in the student's performance analysis, as there were no marks for the same subject taught online. However, the final marks of the hybrid subjects were available in Grade Point Averages (A, B, C, D, E and F).
[4] If the student did not pass or dropped out of the subject in the first sitting and took it in the second, the second mark was the one to be used.

Dropout rate	**Online**	154	0.201	0.402	
	Hybrid	148	0.068	0.252	
	Total	302	0.136	0.343	
	Diff. Online-Hybrid		0.134		0.0006

Source: Compiled by authors.

The second analysis set out to evaluate the statistically significant differences between the average percentages of students who passed the subject, again depending on the learning environment in which the subject was taught. For that, a dummy variable was created that was assigned a value of 1 if the student obtained a final mark that was the same as or better than five points, and 0 if the mark was below 5. As Table VII shows, the average percentage of successful grades in the exclusively online setting was 93.5%, while this rate in hybrid settings was 99.3%, which was a statistically significant difference at the 2% level. This result shows that the hybrid teaching system generates a higher percentage of passes than the online system.

However, the first two analyses have a major limitation in that they do not include students with a score of "not present", when it is evident that such students should be taken into account since they have not passed the subject. To overcome this limitation, the third analysis contrasts the existence of statistically significant differences between the success rates of passing the subject in each learning environment. To do this, a new dummy variable was constructed that took the value 1 if the final mark was greater than or equal to five, and 0 when the student failed the subject or did not take the exam in either sitting.

As Table VII shows, the percentage of students who successfully passed the subject was significantly higher in the hybrid setting than in an exclusively online environment. Specifically, the success rate in hybrid environments was 92.6%, compared to 74.7% in purely online settings. Likewise, the results show that the difference between both rates is statistically significant at the 1% level. This result would therefore support the implementation of subjects in hybrid settings, given that they lead to a higher number of students who successfully pass the subject.

Finally, the last analysis set out to statistically contrast the difference between student dropout rates depending on the two learning formats used. A new dummy variable was constructed that was assigned the

value of 1 if the student abandoned the subject (e.g. their final mark was "Not present"), and 0 if they had a score in their final mark (regardless of whether the score was more than, equal to or less than 5 points). The results showed that students who studied in hybrid settings had a lower dropout rate that those who studied in purely online settings. More specifically, the average dropout rate in the hybrid learning environment was 6.8% compared to 20.1% in the purely online setting, making this difference once again statistically significant at the 1% level. Such results would therefore support increasing the use of hybrid subjects over purely online ones, since they lead to a statistically significant reduction in the dropout rate of students.

To sum up, the results of this section show that there are statistically significant differences in student performance, in terms of passing/failing the subject, successfully/unsuccessfully passing and dropping out/not dropping out. However, no statistically significant differences were found in the average mark of students according to the learning environment used for the subject.

The results obtained may well suggest that the application of flipped classrooms in hybrid subjects generates a learning environment that improves the students' performance, which matches the results of more recent studies (Hinojo et al., 2019). The reasons for this affirmation are that they promote active learning and the acquisition of soft skills such as autonomy and teamwork, which improves student performance in hybrid subjects that have a lower number of face-to-face classes. The results show that HEIs that replace online methodologies with blended ones that include flipped classrooms can obtain better success rates and lower dropout rates from subjects, which has a positive impact on student retention levels.

Conclusions

HEIs need indicators to enable them to select teaching modalities and methodologies that can optimise their value proposal for Industry 4.0 and that help students acquire soft skills, autonomy and the capacity for active learning throughout their lives. In this study, we have used student satisfaction and performance indicators to evaluate the effectiveness of an active methodology, the flipped classroom, in blended or hybrid designs.

The research took place in two HEIs, a university in Spain and a college in the United States, to make the results more relevant and transferable.

Results indicate that the students show more satisfaction with blended modalities than with 100% online approaches because of the potential for class work where doubts can be clarified, and for active learning and participation. In their opinion, the blended environments enable the strong points of face-to-face teaching and online learning to be combined and they are preferable in more difficult subjects. One of the first consequences of the results from our studies for HEIs is that they should be guided not so much by the area of knowledge but rather by the level of complexity of the subjects taught when selecting the course modality.

A second implication of the results from our study is the need to find an adequate percentage of class hours in relation to the online hours and to redesign the time used for the practical application of the subject and to achieve a more efficient management of resources. In this regard, the students felt it was essential to pay more attention to the quality of the materials for online learning.

Furthermore, the students' opinions showed that the HEIs that implemented blended programmes with flipped classrooms should employ resources that promote autonomous study and class interaction when preparing materials and designing activities. By doing so, one of the main challenges of these programmes - student responsibility for work outside class - could be overcome.

Another important outcome of our study is that success, measured in terms of passing subjects, is significantly higher in hybrid classrooms, with dropout rate being also significantly higher when using exclusively online environments. HEIs should rethink the suitability of keeping purely online courses in their syllabuses.

To summarize, this study provides evidence that blended teaching in flipped classrooms promotes active learning and the acquisition of soft skills, such as teamwork and autonomy, and boosts student performance. For all these reasons, we consider that this teaching modality can help HEIs to increase their value proposal, reducing the gap between industry and education.

Finally, one limitation of this study is the availability of data from one academic year alone, together with the fact that the academic results pertain to only one of the two HEIs. We would recommend replicating

this study in future academic years and other HEIs to contrast the findings obtained over time. For future studies, it would be a good idea to add relevant indicators for the HEIs such as the costs and benefits of blended designs with flipped classrooms and extend the study to a larger number of HEIs.

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