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Why do student perceptions of academic performance improve? The influence of acquired competences and formative assessment in a flipped classroom environment

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Abstract

The university system must be able to respond to the growing demand for graduates with certain skills that guarantee their employability. A key requirement of this goal is the use of different teaching-learning methods, such as the flipped classroom methodology. However, although some studies have shown the advantages of this model, more research is needed to identify the reasons for these positive effects and the contexts in which it works best. In this paper, we analyse the perceptions of students of six undergraduate subjects at the University of Jaén (Spain) concerning their acquired competences and the formative assessment received in a flipped classroom environment. In addition, we analyse whether these two variables influence these student perceptions of achieving better academic outcomes. The results show that both aspects explain student perceptions of better performance and are key elements in the provision of a better learning environment. In this way, these results contribute to the literature concerning the positive effects of a flipped classroom on the teaching-learning process in higher education.

Keywords

academic outcomes, competences, flipped classroom, formative assessment, student perceptions

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Introduction

The educational environment has undergone important changes in recent years. The use of teaching-learning platforms, virtual classroom environments and mobile learning tools are merely a few examples of how both teachers and students assimilate new technologies.

However, despite constant pedagogical and technological innovation, in the current university education system, the students role is predominantly passive and it doesn't favour the exercise and development of the essential competences required in the labour environment (Murillo-Zamorano et al., 2019). Proposals for methodological reform of university system point to the need to rethink the traditional model based on lectures (Bok, 2017) in order to develop activities that help students to exercise those competences that will increase their employability (Prieto et al., 2021). These situations point towards active methodologies in which responsibility for their own learning is shifted to students. Within this framework, the flipped classroom model has shown to be appropriate to that end (O'Flaherty and Phillips, 2015; Prober and Heath, 2012).

The flipped classroom is a pedagogical model in which the instructor shares predetermined digital resources with students through a platform outside the classroom; related content is also taught asynchronously through this outside platform. Thus, prior to attending class, students engage individually with educational content, often via prerecorded lectures or prescribed readings and in-class pedagogies such as interactive engagement, just-in-time teaching and peer instruction (Bergmann and Sams, 2012). They then build on this prepared learning to construct knowledge using, for example, presentations, discussions, roleplaying exercises and debates (Abeysekera and Dawson, 2015; O'Flaherty and Phillips, 2015; Sohrabi and Iraj, 2016). The main objective of this model is to develop the higher-level skills of Bloom's taxonomy (i.e. creation, analysis and evaluation) by requiring the student to adopt an active learning attitude in the learning process (Santiago and Bergmann, 2018a).

The need to focus on efficient active methodologies is reflected in the exponential growth in the number of publications concerning the use of flipped classrooms in universities (Han and Røkenes, 2020; Lo, 2020; Prieto et al., 2021). Studies such as those by O'Flaherty and Phillips (2015) and Lundin et al. (2018) show the advantages or positive effects of a flipped classroom from the point of view of both students and teachers. Other studies suggest that flipped classroom reinforces relationships between peers and teachers (Roach, 2014; The Flipped Classroom, 2019), enhances the willingness of students to follow their learning process with innovative and collaborative teaching methods (Strayer, 2012), improve the acquisition of knowledge and skills (Murillo-Zamorano et al., 2019) and produce a better understanding of the specific needs of individual students (Roehl et al., 2013).

Despite the claimed advantages and positive effects of a flipped classroom, Goodwin and Miller (2013) point out that evidence concerning the flipped classroom model remains underdeveloped and note that there is currently no large-scale scientific research concerning the precise level of effectiveness of classrooms that follow this model. Fisher et al. (2018) point out that research into flipped classrooms has generated mixed results. Additionally, Fadol et al. (2018) and Lopes and Soares (2018) note that further studies taking into account different subjects and instructional contexts are needed to gain a better understanding of this new flipped classroom technique. Moreover, as Estriegana et al. (2019) points out, research examining the acquisition or development of key competences using a flipped classroom approach is scant. Thus, with this study, we analyse why flipped classroom dynamics may improve students' learning outcomes, taking into account their perception. More specifically, we research the acquisition of key competences, the students' assessment of the degree to which they are able to acquire content, and the students' expected results.

The rest of the paper is organized as follows. The next section reviews the concept and characteristics of flipped learning and the results of different empirical works. At the end of this section, we formulate our research hypotheses. The third section presents the course context, participants and information regarding the development of flipped experience. The next section presents the research methods used and is followed by a section detailing our results. Finally, we include a discussion of the results. In the conclusion section, future research directions and limitations of the study are presented.

Theoretical framework

The flipped classroom model is based on active blended learning, which relies on students' prior non-classroom preparation and subsequently on interactive classes. In the traditional model, students 'sit and receive content'; they expect the teacher to explain what, how and when to learn and how to demonstrate what they have learned after the fact. The flipped classroom shifts the teacher away from the centre of the educational process and places the responsibility for learning onto students. Thus, prior to a class session, the teacher provides students with information (in audiovisual or written form) to allow them to analyse, study and understand the content independently. Students study individually and prepare for the class. This process saves time spent in the classroom that can now be devoted to resolving doubts, to collaborative teamwork and discussion or to applying and reinforcing what has been learned with the potential use of various digital tools. Creative and meaningful learning situations are thus created within the classroom through interaction between students themselves and teachers (Lundin et al., 2018).

This methodology has been demonstrated to motivate higher-order thinking skills (Bergmann and Sams, 2012) and is more effective that other methodologies in terms of learning achievement (Galindo-Dominguez, 2021).

One of the objectives of flipped learning is to promote self-directed learning, and this is done often with the help of digital technology. The advantages of using mobile learning in education include: the ease of developing personalized learning, immediate feedback, productive use of classroom time, support for student diversity and improved communication (UNESCO, 2015). Some studies indicate that the ease of access to information, resulting from the use of mobile learning in the flipped classroom, improves the learning process (Francl, 2014; Lasry et al., 2014). According to Martín and Tourón (2017), incorporating mobile learning in flipped classroom is a support that significantly improves the student perceptions of him/her competence development.

The flipped environment enhances the acquisition of key competences (specific knowledge, knowledge of scientific methods, systematic competence, (self-)organizational competence and social competence), as reported by Schaeper (2009), and the competence acquisition may be a key issue in higher education (Estriegana et al., 2019).

Some works regarding the effect of the flipped classroom on the acquisition of competences have focused on analysing competences concerning managing online tasks and activities or teamwork and peer interaction (Foldnes, 2016; Zanuiddin and Perera, 2017). Estriegana et al. (2019) demonstrate how the flipped classroom environment plays a key role in the acquisition and development of systematic (e.g. problem-solving skills), personal (e.g. motivation and commitment) and cooperative competences (e.g. cooperation skills). Studies by Van Vliet et al. (2015), Al-Zahrani (2015) and Chen et al. (2015) show how working in a flipped classroom environment improves critical thinking skills, promotes creativity and facilitates the acquisition of problem-solving skills. In addition, Murillo-Zamorano et al. (2019) confirm that a flipped classroom has positive effects on student engagement, resulting in improved knowledge and skills acquisition.

Another important element of the flipped classroom model is assessment (Flores et al., 2016). The work of Otero-Saborido et al. (2018) indicates that in higher education, it is necessary to complement the summative assessment system (focusing on the final test and marks) with systems aimed at improving learning. For this reason, formative assessment, understood as assessment that 'aims to improve teaching-learning processes', contributes to student qualification which is appropriate in a higher education context (Zabalza, 2006). Boston (2003) considers that assessment becomes formative when teacher encompasses observation, classroom discussion and analysis of student work, including homework and tests, and uses all this information to adapt teaching and learning to meet students' needs. In this sense, the objective of formative assessment is to help students to track their progress and identify their strengths and weaknesses in specific areas, in order to be able to improve and correct them (Hortigüela et al., 2019; Othman et al., 2022), favouring the understanding of content and focusing on educational aspects of assessment beyond mere qualification (Otero-Saborido et al., 2020).

Some studies evidence a productive relationship between flipped classroom and formative assessment. In this way, Lovvorn and Timmerman (2019) demonstrate that, in a flipped classroom environment, traditional evaluation systems are not appropriated, arising formative assessment as the most appropriated assessment method for this teaching paradigm. Cabiscol (2015) points out that the combination of flipped model with formative assessment, allows to receive feedback on the knowledge acquired by students and the learning process. This fact enhances the improvement, autonomy and implication of students. Othman et al. (2022) indicate that the process of providing feedback should occur during the process of teaching and learning in a flipped environment. This assessment is used to inform in-process teaching and allows teachers to personalize their courses to meet the students' needs, which in turn leads to improving student's competence. Similarly, Hew et al. (2021) find empirical support showing that flipped learning is more effective when formative assessments (e.g. quizzes or reviews) are used before and/or during class time.

The flipped classroom environment allows teacher to practice continuous assessment while providing a helpful feedback through formative assessment. The latter involves a feedback process among all educational agents without being associated with a grade, and the aim of this process is to improve both student learning and teaching practices themselves (Hortigüela et al., 2019). In this sense, formative assessment allows students to be aware of what they learn and to self-regulate their learning. Thus, Hattie (2009) mentions the positive impact of formative assessment on learning outcomes due to self-assessment and feedback. Students prefer replacing memorization-based assessment with assessment based on practical application (Hattie, 2009). Therefore, formative assessment can enhance learning and thus contribute to students' future professional development (López and Sicilia, 2015).

All the aspects discussed above contribute to several positive effects of the flipped classroom, widely discussed in the literature (Baepler et al., 2014). Flipped learning improves the understanding and retention of what is learned, making it meaningful (Prieto et al., 2021), increases motivation (Abeysekera and Dawson, 2015) and contributes to the instillation of deep content knowledge and critical thinking skills (Fisher et al., 2018) and to improved attendance and study effort (Chen et al., 2014).

In the case of academic outcomes, the flipped classroom leads to improved assessment results when coupled with active learning (Jensen et al., 2015). The use of the flipped classroom method offers students the opportunity to interact on an early and robust manner with the academic materials. This, together with the reinforcement provided by classroom activities, will lead to improved learning and better student academic outcomes (Prieto et al., 2021; Strelan et al., 2020). Martín and Tourón (2017) point out that improvement of students' learning is explained by the interactions

between teacher and students, the activities developed in the classroom and the incorporation of different teaching strategies.

However, there is limited understanding concerning why students benefit from flipped learning (Chen et al., 2014; Nouri, 2016). Moreover, although a number of studies have researched the impact of learner-centred pedagogies on learning outcomes using objective measures, the number of surveys analysing student perceptions of learning outcomes in business-related courses remains limited (Garnjost and Lawter, 2019).

Therefore, our paper aims to contribute to the academic literature by adding scientific evidence for the determinants of this positive effect. Why do student perceptions of academic results improve in a flipped classroom environment? Could aspects such as the improvement observed in acquired competences or the application of formative assessment influence this relationship? To answer these questions, the following research hypotheses are proposed:

H1. Competences acquired in a flipped classroom environment have a positive effect on student perceptions of their academic outcomes.

H2. Formative assessment, when applied in a flipped learning environment, has a positive effect on student perceptions of their academic outcomes.

The flipped experience

During the first semester of the 2020–2021 academic year, this flipped classroom approach was used by four teachers in six different courses. All subjects had a teaching load of 60 hours (four weekly class sessions over 15 weeks).

Teachers met before the beginning of the semester to organize the necessary methodological change for the flipped classroom environment (class dynamics and the selection of resources and activities). Such preparation was even more important for this course because, due to the COVID-19 situation, many teaching methods had been modified. Due to the pandemic, the semester started with a hybrid teaching system: half of the students attended courses in person on alternating weeks and the other half followed the lessons online. However, we believe that the flipped classroom allowed us to make these changes more bearable, since we were accustomed to working in a technological environment (e.g. with video lessons and the use of mobile applications).

At the beginning of the semester, students were briefed concerning the changes to the teaching method that would be applied. The ‘rules of the game’ for both individual and group spaces were explained. This topic is important because the flipped classroom involves a change of roles (for both teachers and students), and this fact should be made clear from the beginning. Unlike the traditional model, in which direct instruction is conducted by the teacher while the student plays a passive role and needs homework to consolidate what has been learned, in a flipped classroom, students assume more active roles and develop new skills.

The organization of each class session was:

1. Before class. Instructional content (prerecorded video lectures, readings, research, online presentations) was assigned as homework. For each subject, we prepared a video as an introduction to each unit’s main theoretical concepts. Previously, we explained to the students how to work on each video at home. Students could also find an online presentation concerning each unit’s content. Finally, for certain units, we added two or three microreadings. In general, the average amount of prior work scheduled for each class was intended to take 15–30 minutes.

2. In-class time. In the first 10–15 minutes of each class, we presented the objectives and structure of each specific session and reviewed related theoretical concepts. Then, we worked on problems and engaged in collaborative learning in forms such as roleplaying, project-based learning, concept mapping, simulations, group discussions and group presentations. We also used interactive online exercises and gamification tools (Kahoot!, Socrative or Quizziz) to monitor students' learning progress. Thus, both individual and group activities were performed.

Some authors (e.g. Lovvorn and Tinmmerman, 2019) recognize the need to complete summative assessment with formative assessment. In this sense, before and/or when finishing each lesson, strategies of formative assessment such as self-assessment, co-assessment and peer-assessment or peer instruction, were adopted. Those strategies favor the understanding of the teaching-learning process and focus educational aspects of assessment beyond the mere grades. As Boston (2003) explains, using this formative assessment, teachers knew how students were progressing and where they were having trouble. Then, we used this information to make necessary instructional adjustments, such as reteaching, trying alternative instructional approaches or offering more opportunities for practice (Just-in-time teaching). As assessment tools, we used classroom performance, homework assignments and quizzes. We completed this assessment process with different pre-

Table 1. Courses and number of students.

Course's name	Bachelor's year[a]	Number of students participating in the experience
Strategic management I	Fourth	19
Management accounting II	Third	48
Human resources management	Second	15
Work organization and human factors	Third	27
Business organization and administration	First	37
Business administration	First	26

[a]In Spain, the bachelors are 4 years length. Therefore, this column shows the year of bachelor in which this subject is included.

established criteria or rubrics, which took into account competences and learning results.

Methodology

The flipped learning experience has been developed at the University of Jaén (Spain) and with 172 students. Table 1 shows the subjects in which the flipped learning system has been applied. Table 1 includes the name of the subject, the Bachelor's year in which the subject is included and the number of students, by subject, that participated in the flipped experience.

As previously described, this study aims to empirically analyse the effect of formative assessment and competence acquisition in a flipped classroom learning environment on student perceptions of their expected academic outcomes. To carry out the analysis, we need to model the relationship between two independent variables (formative assessment and competences) and a dependent variable representing student perceptions on learning outcomes (results perception). These three variables are defined as follows:

FA: FORMATIVE ASSESSMENT. This variable concerns student perceptions of the degree of utility to their studies of having followed a formative assessment approach.

C: COMPETENCES. It represents the ability of flipped learning to develop a series of educational competences that improve learning outcomes. In Spain, universities and faculties have carefully defined for each bachelor the competences that students must achieve. These competences are incorporated by the professor in the teaching guide.

R: RESULTS PERCEPTION. It refers to student perception that participating in the flipped experience may help him/her to become more efficient in terms of learning process and to improve learning outcomes.

Because these variables are not directly observable, we will represent them with the student opinion on several aspects that are related to the theoretical concept that these variables represent. This study, hence, uses primary data, collecting the opinions or perceptions of students who participated in the flipped experience. The survey was carried out using an ad hoc questionnaire, included at the end of the paper as a Supplemental Appendix and based on the questionnaire developed by Santiago and Bergmann (2018b). The questionnaire was validated by experts on the subject, who reviewed the questions and their wording to check that they were appropriate for each of the aspects evaluated. The Cronbach's alpha of this instrument was 0.83. The survey was voluntary and anonymous and was completed on the last day of the course by 107 students (62.21% response rate) with ages

Table 2. Variables description.

Latent variables	Type of variable	Empirical indicators	Question in questionnaire (items)
R: results perception	Dependent	R.1 = 'Learning self-evaluation'	I was able to have a self-assessment of my learning process.
		R.2 = 'Marks'	I think this methodology, which is more active, will allow me to improve my grades.
FA: formative assessment	Independent	FA.1 = 'Theoretical understanding'	This methodology has allowed me to better understand the theory.
		FA.2 = 'Learning more and better'	I learnt more and better with this method.
		FA.3 = 'Learning efficacy. Study materials'	The activities that were carried allowed me to understand the study material more efficiently.
		FA.4 = 'Working day by day'	This methodology allowed me to prepare the content on a continuous way and not let everything until the very last days prior to the exam.
C: competences	Independent	C.1 = 'Comprehension'	I was able to work at my own pace and have a greater autonomy in my learning process.
		C.2 = 'Critical thinking'	I was able to develop my critical thinking (give opinion, propose ideas. . .).
		C.3 = 'Collaboration-cooperation'	I was able to participate, collaborate and interact more and better with my classmates and with the teacher.
		C.4 = 'Communication (oral-written)'	This methodology allowed me to develop and improve my oral and writing expression.
		C.5 = 'Creativity'	This methodology allowed me to be more creative.

ranging between 18 and 31 (average age: 22.8). Sample distribution meets gender equality, with 53 men and 54 women.

To empirically represent the variables, the aspects that are associated to each variable (indicators), as well as the questions in the questionnaire with which we have measured those aspects (items), are summarized in Table 2. All questions were designed following a Likert scale from 1 (totally in disagreement) to 5 (totally in agreement).

Because our variables are not directly observable and we are analysing people's behaviour, classic estimation techniques, such as ordinary least squares (OLS), are not sufficient to measure unobservable variables. As a solution, more modern statistical techniques, which are called second-generation methods, have been developed. Particularly, partial least squares (PLS) is appropriate when the variable object of study is a behavioural object because this approach allows for the incorporation of observable variables (classic econometric analysis) and non-directly observable variables based on attitudes and behaviours (psychometric analysis) (Fornell, 1982; Fornell and Larcker, 1981; Nitzl, 2016). Moreover, PLS has the advantage of modelling multiple relationships simultaneously, and its final effect results pertain to the combination of them (Gefen et al., 2000). Henceforth, we maintain that PLS is the most suitable technique for our study.

The next step is modelling the relationship between the variables. In PLS we have to observe the relationship between both the theoretical (latent) variables to each other, and between the latent variable and the indicators that empirically represent it. To facilitate understanding, Figure 1 rep-

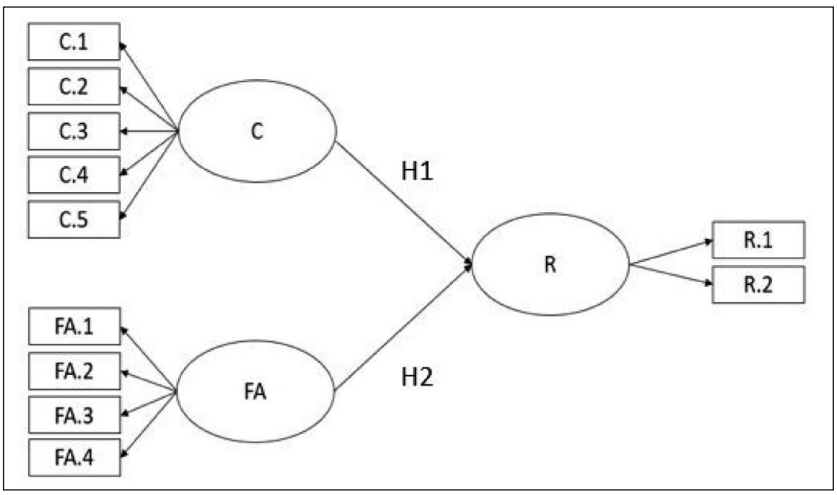

Figure 1. Model representation.
C: competences; FA: formative assessment; R: results perception.

resents schematically the PLS-SEM model that is empirically analysed, following the classical scheme used in PLS models. The behavioural aspects (theoretical and latent variables) to be analysed (C: competences; FA: formative assessment; and R: results perception) are represented by a circle. The indicators (responses of the questionnaire) are represented by a rectangle and were detailed in Table 2. The hypothesis H1 and H2 are also presented in the model.

Results

Using a double-step process, we first find that the appropriate measurement of each construct (results perception, competences and formative assessment) is appropriately measured by the items in the questionnaire that are indicative of those factors (measurement model valuation). In a second phase, we analyse the relationships among the latent variables, examining whether those relationships occur as expected in the hypotheses (structural model valuation; Chin, 1998, 2010; Hair et al., 2016).

Measurement model valuation

A series of requirements must be fulfilled in the context of PLS to ensure that the constructs are appropriately measured, that is, to ensure their validity. First, because several items are assigned to empirically represent theoretical concepts (latent variables), one should determine whether each of these items appropriately reflects those concepts. This measurement is called individual indicator reliability (Chin, 1998, 2010) and is represented by indicator loadings that, in general, should have values of at least 0.7. Second, because there are several indicators, it is crucial to ensure that all

Table 3. Results from the measurement model valuation.

Latent variables and indicators	Indicator loadings	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
C: competences		0.858	0.898	0.639
C1. Comprehension	0.712			
C2. Critical thinking	0.783			
C3. Collaboration-cooperation	0.826			
C4. Communication (oral-written)	0.842			
C5. Creativity	0.828			
FA: formative assessment.		0.907	0.935	0.784
FA.1. Theoretical understanding	0.901			
FA.2. Learning more and better	0.935			
FA.3. Learning efficacy. Study materials	0.917			
FA.4. Working day by day	0.780			
R: results perception.		0.755	0.899	0.816
R.1. Learning self-evaluation	0.897			
R.2. Marks	0.910			

items in aggregate represent the same theoretical concept, that is, that they explain a high proportion of the behaviour of the concept that they measure. For that purpose, two measures are used: the composite reliability (CR) index and Cronbach's (1951) alpha (Hair et al., 2016), with values above 0.7 being the threshold for these measures to be acceptable. Finally, the average variance extracted (AVE) index is indicative of the extent to which the variance of the combined indicators of the theoretical concept explains variance in this concept. Values of AVE above 0.5 are considered to be sufficient for the appropriate construct validity (Chin, 2010; Hair et al., 2016; Roldán and Sánchez-Franco, 2012). The estimation results of the aforementioned indices are presented in Table 3.

As can be seen in Table 3, all indicator loadings are above 0.7. It means that each indicator correctly and empirically represents the concept that it measures. Even more, construct reliability is

assessed, as observed in the values of CR and Cronbach's alpha, which are above 0.7 for the three variables. That allows us to conclude that the combined indicators appropriately represent the concepts with which they are associated, moreover if we take into account that CR is stricter in terms of the requirements for reliability at the construct level (Hair et al., 2016). Furthermore, with respect to the AVE, the values clearly exceed the threshold of 0.5, for all three variables, and were especially

Table 4. Fornell and Larcker matrix for discriminant validity assessment.

	FA	C	R
FA	0.799		
C	0.723	0.885	
R	0.709	0.660	0.903

C: competences; FA: formative assessment; R: results perception.

high for the constructs 'Formative assessment' and 'Results perception'. This means that the majority of variation in the latent variables is explained by the combined variation of their indicators.

The last step for measurement model valuation is analysis of discriminant validity, that is, whether the constructs are truly different from each other. To this end, the test developed by Fornell and Larcker (1981) is the most commonly used criterion (Nitzl, 2016). Adequate levels of discriminant validity are identified when the correlations of every pair of variables are lower than the square root of their AVE. Table 4 presents the matrix of the Fornell-Larcker discriminant validity assessment for the latent variables, showing in the diagonal elements the square roots of the AVE and displaying in the rest of the cells the correlation between the pairs of variables.

From Table 4, we can conclude that the three constructs are perfectly distinguishable from the others because the correlation values are below their respective AVE square root values.

Additionally, we ran other (untabulated) discriminant validity tests to reinforce our results: a test of the cross loadings and the heterotrait-monotrait (HTMT) test. From the cross loadings test, we can conclude that discriminant validity is sufficiently achieved (every indicator has a greater loading on the construct that it represents compared to its loadings on the other two constructs). On the other hand, the HTMT test, more accurate and stricter (Hair et al., 2016; Henseler et al., 2015; Nitzl, 2016), indicates that appropriate discriminant validity is also met because the untabulated values for HTMT are lower than 0.9 for all pairs of combinations, following the general rules pro-

Table 5. Results from the structural model valuation.

Hypothesis	Structural relationship	Predicted sign	Estimate coefficient	*p*-Value	Result	R^2 (R^2 Adj)
H1	C >> R	+	0.466	<0.001***	Supported	0.548 (0.540)
H2	FA >> R	+	0.309	0.018**	Supported	

C: competences; FA: formative assessment; R: results perception. Significant at the 1% level (***) and 5% level (**).

posed by Henseler et al. (2015). Henceforth, the three tests indicate that the discriminant validity assessment is appropriate for all three variables.

Structural model valuation

We now determine whether the relationships among these variables behave as expected in H1 and H2. We observe the sign and magnitude of the coefficients from the PLS regression as well as their

statistical significance, and we also consider the estimation power of the model in terms of R^2 and adjusted R^2. All these values are presented in Table 5.

The results offer empirical evidence that the hypothesized relationships are in existence. The variable that has the greater effect on the improvement of perceived learning outcomes is the acquisition of educational competences (coefficient = 0.466). The sign is, as expected, positive and the measure has a high magnitude. This means that students who efficiently develop the competences associated with their learning process improve their perceptions of higher learning outcomes. In addition, the coefficient is statistically significant even at the 1% level ($p < 0.001$), thereby supporting H1.

On the other hand, providing students with feedback concerning their learning process via formative assessment evaluation also helps to reinforce student perceptions about learning outcomes, as shown by the positive sign of the coefficient of the construct of the formative assessment, as expected, and by the considerable magnitude of this measure (coefficient = 0.309). This coefficient is statistically significant at the 5% level ($p = 0.018$), confirming that H2 is also supported.

Finally, we also analyse the estimation power of the whole model, investigating whether formative assessment and competences are able to explain the student perceptions of learning outcomes sufficiently. By reference to the R^2 and adjusted R^2 values in Table 5, we can confirm that the model is sufficiently explicative and exhibits medium-high estimation power. Moreover, the fact that the adjusted R^2 is so close to R^2 indicates that the inclusion of both independent variables in the model simultaneously adds information to explain the dependent variable.

Discussion

This study seeks to provide evidence concerning the reasons why the flipped classroom has positive effects on student perceptions of achieving better academic outcomes. Specifically, this work focuses on analysing certain 'key' variables (competences and formative assessment) that can be identified as explaining student perceptions of the improvement of their academic results.

Our hypotheses are confirmed and the results described above show that student perceptions of obtaining better results in the final assessment of a subject is simultaneously positively correlated both with the acquired competences and with the formative assessment throughout the course.

Specifically, in relation to the achievement of competences, results show that participating in this flipped classroom experience enhances student perceptions with respect to their educational competences. In detail, students rate highly the achievement of competences related to understanding theory; critical thinking; cooperative and collaborative relationships; oral and written communication; and creativity. This improvement in competences is positively related to the student perceptions of being more efficient in the learning process and achieving better marks.

These results are consistent with those of researchers who have found that flipped classroom facilitates and improves the acquisition of competences. For example, Fadol et al (2018) demonstrate that accessing online material (specifically videos) improves students' understanding and critical thinking skills. As indicated by Chen et al. (2014) and Galway et al. (2014), our students perceive that flipped classroom dynamics (group activities and teamwork) allowed them to engage in more and better interactions with both their classmates and the teacher. Our results also show how the flipped classroom can stimulate students' creativity. In line with the results of Al-Zahrani (2015), we find that creativity is fostered and stimulated when students have to analyse alternatives, find solutions to real situations and solve problems. Our students also value pre-class work positively, as this work helps them better understand the content of the subject.

Regarding the assessment process, our results reflect that a learning experience using a flipped classroom approach, and its formative assessment tools, is perceived as positive by students who increase their theoretical understanding of the subject. In the same way, students positively value the fact of having learned more and better, having a higher learning efficiency when studying the materials and the fact of having worked day by day, during the whole semester. All these aspects are positively correlated with students' expectations concerning their learning outcomes.

These results are consistent with those of Gikandi et al. (2011), which indicate that in higher education, there is a growing need to complement summative assessment with tools aimed at assessing the whole teaching-learning process. Flipped teaching is committed to providing continuous assessment throughout the course to achieve an assessment intertwined with the learning process, to promote the generation of better questions and to encourage learning from mistakes (Martín and Tourón, 2017). As Salas and Vicente (2020) point out, to achieve good results, we must distribute tasks and activities equally so that students can work continuously and take responsibility for their own learning throughout the course. Thus, our students reported that continuous work enabled them to maintain a steady learning pace. Because of this approach and of the received feedback through formative assessment, students were able to assimilate the contents better and to learn more information. Hew et al. (2021) state that there is an extensive literature documenting the effectiveness of feedback in education, being one of the most powerful contributors to learning. They also argue that it is possible that feedback is also a key mechanism underpinning the effectiveness of the flipped classroom.

Similarly, our students reported better perspectives concerning the results of the final assessment of the subjects. Therefore, our results agree with those of López and Sicilia (2015) that formative assessment can enhance learning and thus contribute to the development of future professionals.

Conclusion

By way of a final conclusion, we can say that student perceptions of obtaining better results in the final assessment of the subject depends positively on both acquired competences attained by these active methodologies and the formative assessment that feeds back into this process, which helps students work better throughout the course. We have seen how the flipped classroom approach facilitates the acquisition of skills (comprehension, critical thinking, collaboration, communication and creativity), thus improving the competitiveness of our students.

The results of this study provide further evidence for the literature concerning the positive effects of the flipped classroom on the teaching-learning process of students at the university level and which elements could be more effective to improve student perceptions about academic results. Then, we respond to Brewer and Movahedazarhouligh (2018), who noted that more research is needed to identify which elements of the flipped learning model can most effectively be implemented.

As limitations of this work, we know that although this experience has been implemented in a relatively large number of courses, we collected a low number of questionnaires. This limitation makes it difficult to infer results. For this reason, the process should be repeated in other degrees and courses. Additionally, there was no control group. Both limitations affect the external validity of the results.

Because of these limitations, and to encourage future lines of research, this study must be considered an initial approach and more course data and more perceptions by students and professors must be taken into consideration. Furthermore, future studies might focus on in-depth descriptions of students' and educators' lived experiences with flipped learning. Additionally, it would be

interesting using a control group (students of the same subject, with the same teacher, who follow a traditional teaching learning methodology) and compare whether the student perceptions of academic results are different. Another interesting future line of research would be to check whether final grades actually improved as a result of the implementation of this methodology. In this way, we would contrast whether the perception that students have that their grades will be better, is really fulfilled with higher results or not.

Data availability statement

Data are available at Open Science Framework: https://osf.io/fu2wz/

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Supplemental material

Supplemental material for this article is available online.

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