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Students' attitude: Key to understanding the improvement of their academic RESULTS in a flipped classroom environment

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ABSTRACT

The flipped classroom model has been shown in recent years to have a positive effect on students' motivation and academic performance. In this paper, we analyze the perception that students of six undergraduate subjects at University of Jaén (Spain) have of the subjects' formative assessment and their attitude towards this new teaching-learning model. In addition, we analyze whether both variables influence their perception of achieving better academic results. The results of our study show that both aspects (formative assessment perception and attitude) explain students' perception of outcomes. It leads us to conclude that students' attitude is a key element of fostering more and better learning that improves their performance. In this way, our results provide further evidence for the literature on the positive effects of the flipped classroom on the teaching-learning process at the university level for students, teachers and scholars.

1. Introduction

The main objective of the education system must be to guarantee that students will achieve adequate training, including knowledge and skills. This will facilitate their access to the labor market under the conditions that companies demand. This achievement is guaranteed if methodologies are applied such that students are confronted with the resolution of complex and real situations in which they must learn to make decisions in the face of certain problems and learn to think for themselves with a critical and analytical attitude. These situations point towards more active methodologies in which the responsibility for one's own learning is transferred to the students. Within this framework, the proposal that has shown the greatest potential for incorporating active learning in the classroom is the inverted classroom model, also known as the inverted classroom model (O'Flaherty & Phillips, 2015; Prober & Heath, 2012; Yabro et al., 2014).

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 (Bergmann & Sams, 2012). Thus, prior to attending class, students individually engage with content materials, often via prerecorded lectures, prescribed readings, study guides, interactive videos, simulations and cases, and in-class pedagogies such as interactive engagement, just-in-time teaching, and peer instruction (Berrett, 2012). They then build on the prepared learning to construct knowledge using, for example,

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presentations, discussions, role-plays, and debates (Abeysekera & Dawson, 2015; O'Flaherty & Phillips, 2015; Sohrabi & Iraj, 2016). The model's main objective is to work on the higher-level skills of Bloom's taxonomy (i.e., create, analyze, and evaluate) by making the student take a much more active role in their learning process (Berenguer, 2016). The interest in applying more effective and efficient methodologies in the classroom is reflected in the exponential growth in the number of publications on flipped classrooms in universities over the last decade. Proof of this is the number of citations in Google Scholar on "flipped classroom", which increased from 187 in 2009 to 11,000 in 2019 (Prieto et al., 2021). Studies such as those published by Bishop and Verleger (2013), O'Flaherty et al. (2015), and Lundin et al. (2018) show the advantages or positive effects of the flipped classroom from the point of view of both students and teachers. Therefore, the flipped classroom allows for better relationships with peers and teachers (Bergmann & Sams, 2012; Chen et al., 2014; Roach, 2014; The Flipped Classroom, 2019), makes students more amenable to innovative and collaborative teaching methods (Strayer, 2012), and involves a better understanding of the specific needs of individual students (Fulton, 2012; Roehl et al., 2013).

Although the flipped classroom has many advantages and positive effects (Akçayir & Akçayir, 2018; Blair et al., 2016; González-Gómez et al., 2016; Love et al., 2014; Nouri, 2016; Roach, 2014) Goodwin and Miller (2013) point out that the evidence on the inverted model is still to come, recognizing that there is currently no large scientific research indicating exactly how effective classrooms that follow this model are. Also, Fadol et al. (2018) and Lopes and Soares (2018) consider that further studies on different subjects and instructional contexts are needed to gain a better understanding of this new flipped classroom technique. Thus, with this work, we want to analyze this cause-effect relationship, i.e., why inverted classroom dynamics produce better results and what the reasons or causes are. Therefore, we analyze this causal relationship through the students' perception of different aspects of the classroom dynamics, their attitude, and their assessment of the degree of acquisition of content and 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 about the effects of this methodology. At the end of this section, we formulate our research hypothesis. The third section, the flipped experience, presents the course context, participants, and some information about the inverted experience development. The fourth section presents the research methods used and is followed by the results section. Finally, we engage in a discussion of the results. In the conclusion section, future research directions and limitations of the study are presented.

2. Theoretical framework

The teachers Jon Bergmann and Aaron Sams, of Denver High School in Colorado can trace the origins of the flipped classroom model back to 2007. Initially based on replacing a classroom lecture with a video, especially for those students who could not attend class, the concept has evolved into a broader and continuously developing methodology that is being nourished by increasingly more extensive academic and scientific evidence.

The flipped classroom changes the context and way of working for both the teacher and the students, inside and outside the classroom (Bishop & Verleger, 2013). In the traditional model, students just "sit and receive content"; they expect the teacher to explain what to learn, how to learn it, when to learn it, and how to demonstrate afterward that they have learned it. The flipped classroom, however, displaces the teacher from the center of the educational process and places the responsibility for learning on the students. Thus, prior to the class session, the teacher provides the students with information (audiovisual or written) for them to analyze, study, and understand the content independently. Students study individually and prepare for the lesson. This frees up time in the classroom that can be devoted to resolving doubts, to collaborative teamwork and discussion, or to applying and reinforcing what has been learnt, with the potential use of different digital tools (Martínez & Ruiz, 2020). Creative and meaningful learning situations are thus created within the classroom through interaction between the students themselves and with the teachers (Lundin et al., 2018).

The flipped classroom is based on personalized learning, as it allows each student to learn at his/her own pace, thus catering to the diversity of abilities found in the classroom. It is based on an inductive methodology, which is more effective than the traditional deductive methodology. Most important of all, the outcome of the whole process should no longer be that "the subject is explained very well" but that "the student learns the subject".

An extensive amount of literature focuses on the effects of the flipped classroom on multiple elements of the educational process. 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 expands the working space and allows for a different distribution of classroom dynamics before, during, and after class, offering students the opportunity to interact earlier and more robustly with the learning materials and, thus, leading to better reading reinforced by classroom activities, as well as to better academic outcomes (Prieto et al., 2021; Strelan et al., 2020).

Most of these studies have investigated the impact of learner-centered pedagogies on learning outcomes using objective measures. However, the number of surveys analyzing students' perception of learning outcomes is low (e.g. Forbes et al., 2001; Garnjost & Brown, 2018; Pérez-Pérez et al., 2020) and, in business-related courses, is limited (Garnjost & Lawter, 2019). It could be interesting to measure students' perception of learning outcomes using self-reported outcomes, even more if we take into account the results of Duque (2014), who found that these perceptions have a strong relationship with students' overall satisfaction with a course.

Moreover, one aspect on which there is greater agreement is that, with the application of active teaching-learning strategies, the teaching staff have achieved a change in students' attitude towards teaching. Although some studies report resistance and lack of satisfaction with the flipped classroom methodology (Burke & Fedorek, 2017; Herreid & Schiller, 2013; Missildine et al., 2013), most of the works find a shift towards a positive attitude.

For example, Danker (2015) and Saglam and Arslan (2018) show that students who followed the flipped classroom model had a better attitude than did those students who followed traditional instruction.

This change in attitude can be seen in aspects such as class attendance, participation, commitment, involvement, and motivation. Turan and Göktas (2015) find that students have a very positive perception of the flipped classroom, as they consider it a method that they enjoy while allowing them to make their learning process more flexible. Along the same lines are the works of Davies et al. (2013) and Chao et al. (2015). In Davies et al. (2013), the results show how classroom sessions are more effective and motivating. The study by Chao et al. (2015) shows a positive attitude towards the teaching-learning process on the part of students. It refers to a shift towards a more participatory attitude so that students ask questions and become more involved in lessons, leading to greater cooperation. Zainuddin and Attaran (2016), White et al. (2017), Murillo et al. (2019), and Zheng et al. (2020) also report changes in attitude and improved student engagement and involvement among their results.

Another important element on which the flipped classroom model pivots, as indicated by Flores et al. (2016), is assessment. Methodologies based on a student's ability to control and decide on his/her work time have allowed for a greater educational impact (Delgado et al., 2018). The learner's organizational capacity has already demonstrated improved learning outcomes (Salas & Vicente, 2020; Turan & Göktas, 2015) and, to this end, process-related assessment is key (Meusen-Beekman et al., 2015). Gikandi et al. (2011) and Otero-Saborido, Sánchez-Oliver, Grimaldi-Puyana, and Álvarez-García (2018) indicate that in higher education, it is necessary to complement the summative assessment system with systems aimed at improving learning. For this reason, formative assessment, understood as that which "aims to improve teaching-learning processes", contributes to a qualification that is more in line with the competency model presupposed in university education (Zabalza, 2006). In this sense, formative assessment favors the understanding of content and focuses on educational aspects of assessment beyond the mere qualification aspects (Otero-Saborido et al., 2020).

Some studies evidence a fruitful relationship between the flipped classroom and formative assessment. This way, Lovvorn and Timmerman (2019) demonstrate that in a flipped classroom environment, traditional evaluation systems are not appropriate, suggesting that formative assessment is the most appropriate system for approaching this new teaching paradigm. Cabiscol (2015) highlights that the flipped model allows for integrating self-assessment procedures, such as formative assessment, resulting in several aspects such as the greater chance to receive feedback about the extent of acquired knowledge by students, the learning process, and the improvement of students' autonomy and implication.

The flipped classroom is ideal for the assessment of student learning outcomes because it is possible to work with continuous assessment while providing better feedback through formative assessment. The latter involves a feedback process between all educational agents, without being associated with a grade, and with the aim of improving both student learning and teaching practice itself (Hortigüela et al., 2019). Thus, formative assessment allows students to be more aware of what they learn and allows them to self-regulate their learning. Also, combined with the use of active and participatory methodologies that allow each student to assess both their work and that of others, the use of different feedback channels is favored: oral, written, video, individual, group … Students are in favor of replacing memorization-based assessment with an assessment based on practical application. As the literature shows, formative assessment can enhance learning and thus contribute to students' future professional development (López & Sicilia, 2015).

The effects of the flipped classroom on all the elements of the educational process indicated in the previous paragraphs translate into better, more meaningful learning, with better understanding and retention of what is learned (Prieto et al., 2021). Based on these positive effects, the aim of this paper is to provide more scientific evidence and analyze the possible causes of this positive effect. We try to answer the following research questions: Why do academic results improve in a flipped classroom? Do students perceive that they can achieve better learning outcomes with this new methodology? Could aspects such as the improvement observed in students' attitudes or the application of formative assessment influence these outcomes? To answer these questions and uncover the factors that could explain an improvement in the perception of students' academic results in a flipped classroom environment, the following research hypotheses are proposed:

H1. The better attitude of students in flipped classroom learning has a positive effect on the students' perception of their academic outcomes.

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

3. The flipped experience

During the first semester of the 2020–2021 year, this experience of the flipped classroom was used in six different courses and degrees at the University of Jaén (Spain) (shown in Table 1). All the subjects had a teaching load of 60 h (four weekly class sessions for 15 weeks). Due to the pandemic situation, the first semester started with a hybrid teaching system. This means that half of the students

Table 1
Courses and degrees.

Degree	Subjects	Course	Number of students
Business administration and management and law	Strategic management I	4th	19
Finance and accounting	Management accounting II	3rd	48
	Human resources management	2nd	15
Industrial organization engineering	Work organization and human factor	3rd	27
Labor relations and human resources	Business organization and administration	1st	37
Statistics and business	Business administration	1st	26

attended the courses in person on alternating weeks, maintaining the recommended safety procedures and social distance. The other half followed the lessons electronically, online.

The relatively low number of students enrolled in the courses has made the application of this new methodology very easy. Specifically, as we can see in Table 1, 172 students were enrolled in these six courses.

Any methodological change involves time, for both planning and scheduling of the process. In this way, teachers met at the beginning of the semester to organize it (class dynamics and the selection of in-class and homework resources and activities). It has been even more important in this course because, due to the COVID-19 situation, many of the methodological procedures had been modified. However, we believe that the flipped classroom helped us make these changes more bearable, as one of the advantages of this methodology is the possibility of working in technological environments, both with students in the classroom and with online students.

At the beginning of the semester, the students were briefed about the methodological change that would be made in the lectures. The "game rules" for both individual and group spaces were explained. This is an important topic because the flipped classroom involves a change of roles (for both the teacher and the students), and this fact should be clear from the beginning. Unlike the traditional model, in which direct instruction is on the teacher side and the student performs an activity to improve his/her knowledge (the teacher has an active role as an information provider and evaluator, while the student has a passive role and needs homework to consolidate what has been learnt), in the flipped classroom, students assume new roles and develop new skills. For each session, the dynamic was as follows:

1. Homework before class. The flipped classroom was settled as a different course organization, in which instructional content (prerecorded video lectures, readings, research, online presentations, or sample applications) was assigned as homework, to be done before class. For each of the subjects, we prepared a video as an introduction to each unit's main theoretical concepts. Previously, we had explained to the students how to prepare or work on each video at home. Students could also find an online presentation about each unit's content. Finally, in some units, we added two or three micro-readings. In general, the average amount of previous work employed for each class was about 15–30 min.
2. In-class time (four sessions per week). The first 10–15 min were dedicated to presenting the objectives and structure of each specific session and reviewing the related theoretical concept. Then, we worked on problems, went deeper into the different concepts, and engaged in collaborative learning such as role-play, 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 carried out during each class session throughout the semester. In addition, and most importantly, students were evaluated using different pre-established criteria or rubrics, considering competencies and learning results. Therefore, we used a continuous summative/formative assessment in which students periodically received feedback on their progress. A complementary final theoretical exam was also implemented, with a 50% weight on the final mark.

At the end of the semester, students were invited to participate in a quantitative survey that tested students' perception of different aspects related to the flipped learning experience, as we explain in the next section.

4. Methodology

4.1. Data collection

As stated in the Theoretical Framework section, this study sought to analyze the effect that students' attitudes and formative assessment have on the perception of the learning outcomes of those students. Henceforth, we base our analysis on primary data, collecting the opinion of those students who participated in the flipped experience. In detail, the study uses a voluntary and anonymous survey to seek different students' perception of their motivation, satisfaction, understanding, autonomy, and learning effectiveness stemming from their participation in the flipped system of these subjects.

The survey was carried out using an ad-hoc questionnaire, validated by experts on the matter and based on those of Santiago and Bergmann (2018) and Aguilera et al. (2017). The Cronbach's alpha of this instrument was 0.83. The survey was voluntary and anonymous and was completed only by flipped experience students on the course's last day. It took 15 min, more or less, to complete the whole questionnaire.

As we previously mentioned, 172 students were enrolled in the six courses, although not all of them participated in the flipped experience (because they could not attend classes regularly). Among them, 107 students (62.21%) completed the questionnaire used in the present research, corresponding: 10 to business administration; 32 to management accounting II; 4 to strategic management I; 12 to human resources management; 26 to work organization and human factor; and 23 to business organization and administration.

The age of the respondents was between 18 and 31 (average age: 22.8). In addition, in terms of sex, 53 were men and 54 were women.

4.2. Model design. Estimation technique and variables

The selection of the appropriate technique for conducting the statistical analysis depends on the object of study. The present study aims to analyze behavioral aspects, for we are focusing on attitudes, perceptions, the effectiveness of the systems of evaluation, etc. These types of variables, which are very common in Social Sciences, have the particularity of being not directly observable. Second-

generation statistical techniques, as in the case of Partial Least Squares (PLS), allow for this type of analysis, given that the relationships among the variables are not restricted to the observed ones (econometric analysis), but also include the non-directly observable, behavioral ones (psychometric analysis) (Fornell, 1982; Fornell & Larcker, 1981; Nitzl, 2016). Considering this, we believe that this model perfectly fits with our variables. Furthermore, PLS allows for the modelization of multiple relationships that are considered simultaneously, presenting final effect results as a whole (Gefen et al., 2000). This is particularly interesting in our research, for we seek the whole effect of attitude and formative assessment on the results, with simultaneous effects of both variables. That reinforces our option for the PLS technique.

In the PLS technique, as stated before, we can analyze the relationships between non-directly observable, theoretical concepts. These concepts, named "latent variables", are formed with a conjunct of several directly observable items, named "indicators", which are indicative of those theoretical concepts (Chin, 1998). In our model, the indicators are obtained from the students' responses to the different items of the questionnaire (this is directly observable). Their responses are a reflection of their opinion about those attitudinal, behavioral concepts that we aim to analyze (non-directly observable, latent variables). In other words, a change in those behavioral concepts would change their opinions. This type of relationship is called a reflective one.

To represent the model graphically, we use the classical PLS model scheme, in which the theoretical concepts to analyze (attitude, formative assessment perception, and perception of the results) are represented with circles, while the indicators for these latent variables (responses to the different items in the questionnaire) are represented in rectangles. The reflective relationship previously described is represented with arrows that go from the latent variable to the indicators.

Next, we present, in Fig. 1, the representation of the model design, with the variables. We also detail the description of each variable.

The description of the variables in Fig. 1 is as follows:

- R: RESULTS PERCEPTION. This is our dependent variable. This variable is represented by items that reflect students' opinions about how they think their participation in the flipped experience may help increase their learning efficiency, in terms of getting better marks (learning outcomes). In particular, they were asked to value, on a Likert scale, the extent to which they agreed (from 1: Strongly disagree, to 5: Strongly agree) that flipped learning allowed them to conduct self-evaluation in their learning process (R.1 = "Learning self-evaluation") and whether this methodology helped them improve their marks (R.2 = "Marks").
- A: ATTITUDE. This is an independent variable represented by items showing students' opinions about how they perceived that the learning experience led to a change in their attitude towards learning the different subjects. In particular, following the same Likert scale, they were asked whether the flipped experience had motivated them in their studies more than a traditional lesson (A.1 = "Motivation") and whether they'd had fun in their learning process (A.2 = "Amusement"). Additionally, they were asked to give their opinion about a general impression about this methodology (A.3 = "General opinion").
- FA: FORMATIVE ASSESSMENT PERCEPTION. This is an independent variable represented by items that indicate the extent to which students found helpful, for their studies, the fact of following a formative assessment valuation, in which they worked day by day, getting continuous feedback on their work. In particular, following the same Likert scale, we asked them about their agreement with four different aspects: i) whether flipped learning helped them better understand the theoretical concepts of the lessons (FA.1 = "Theoretical understanding"); ii) whether, thanks to the flipped experience, they had learnt more and better (FA.2 = "Learning more and better"); iii) whether the activities carried out during the flipped experience allowed students to learn the study materials more efficiently (FA.3 = "Learning efficacy. Study materials"); and iv) whether this method helped the students work day by day, on a continuous basis, rather than studying just a couple of days before the exam (FA.4 = "Working day by day").

Following the model in Fig. 1, we analyzed the relationship between the attitude and the learning outcomes (results) perception (A » R) to test hypothesis H1 and, simultaneously, using the PLS technique, the relationship between the perception about a formative assessment evaluation system and the learning outcomes (results) perception (FA » R) to test hypothesis H2.

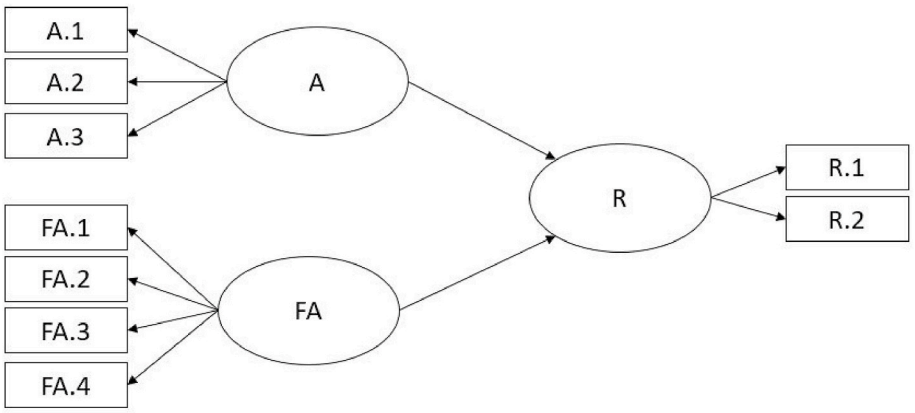

Fig. 1. Model design.

In the next section, we present the results from the PLS estimation.

5. Results

As a first step, we formed three constructs to identify the aspects that are indicative, jointly, of the variables that are the object of study. Following the process of model valuation of the PLS technique, we first assess whether each construct is appropriately measured with its indicators (measurement model valuation). Once the validity of each construct is verified, in a second phase we will analyze whether the expected relationships between the variables are met (structural model valuation) (Chin, 1998, 2010; Hair et al., 2016).

5.1. Measurement model valuation

To assess the validity of each construct, several aspects should be considered. The first aspect to analyze is whether each of the items that compose the construct appropriately represents the theoretical concept of the variable it explains. This is the individual indicator reliability (Chin, 1998, 2010), for which each of the items individually considered should have an indicator loading of at least 0.7. Given that we are joining several aspects as indicative of the concept, we must also check, as a second aspect, whether these indicators together represent the same theoretical concept. To do this, we analyze whether all of the items, aggregately, represent a high proportion of the behavior of the concept that they measure, with two indices: Cronbach's (1951) alpha and the Composite Reliability (CR) index. If those indices exceed 0.7, it means that, jointly, the indicators can explain the concept, being representative of it, to a high extent (Chin, 2010; Hair et al., 2016; Roldán & Sánchez-Franco, 2012). Additionally, we observe whether the variance of the theoretical concept is sufficiently explained by the average variance of its indicators, looking at the Average Variance Extracted (AVE) index, being the minimum threshold for this value of 0.5 (Chin, 2010; Hair et al., 2016; Roldán & Sánchez-Franco, 2012). Table 2 presents the results for measurement model valuation.

As we can observe in Table 2, all of the indicators have loadings above 0.7. Henceforth, we can conclude that, at the individual level, each indicator is appropriately measuring the concept that it represents. At the construct level, for the three variables, the indicators jointly represent the concept correctly, as shown by the values for both Cronbach's alpha and CR exceeding 0.7 widely (actually, all of them are about 0.9 except the Results Perception, which, in any event, exceeds the minimum). We want to highlight that the convergent reliability of the construct is sufficiently assessed because the measure of CR is strict in guaranteeing reliability (Hair et al., 2016). Finally, the statistics for the AVE in Table 2 are very high, for the variance of the constructs is represented, in all cases, for about 80% of the variance of their indicators. In conclusion, the theoretical concepts that we want to analyze in the model are appropriately represented as constructs with the observable indicators that are indicative of it, correctly measuring their extent.

As a final step, prior to structural model valuation, it is advisable to assess the correct discriminant validity of the constructs, that is, whether each concept is distinguishable from each other and whether their indicators are actually measuring that concept and no others. To assess the discriminant validity, there are several tests, with the most common one being the Fornell and Larcker (1981) criterion (Nitzl, 2016). According to this criterion, to meet the required threshold, the correlations of each pair of variables should be lower than the square root of their AVE. In Table 3, we represent a matrix where the elements in the diagonal represent the square root of the AVE of the different constructs, while the rest of the values represent the pairs of correlations between the variables.

The results in Table 3 lead us to conclude that the three variables are, actually, different from each other, for the values of the diagonal are, in any case, higher than the values of the pairs of correlations. Apart from these results, we have checked (untabulated results) that other, more recent tests for discriminant validity, such as the Heterotrait-Monotrait (HTMT) criterion, which have been proven to be more accurate and strict (Hair et al., 2016; Henseler et al., 2015; Nitzl, 2016), are perfectly met. This can be observed with untabulated values for HTMT that are lower than 0.9 for all pairs of combinations, as suggested in prior literature (Henseler et al., 2015). Furthermore, we run the cross-loading test (also untabulated) and check that the loading of each indicator is higher in its own construct as compared to the other two constructs.

Table 2
Results from the measurement model valuation.

	Indicator loadings	Cronbach's alpha	CR	AVE
A: ATTITUDE.		*0.877*	*0.924*	*0.802*
A.1. Motivation.	0.886			
A.2. Amusement.	0.874			
A.3. General opinion.	0.926			
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			

Table 3
Fornell and Larcker matrix for discriminant validity assessment.

	A	FA	R
A	0.896		
FA	0.794	0.885	
R	0.677	0.659	0.903

5.2. Structural model valuation

Only after determining that our variables are measured appropriately can we analyze if the expected relationships between them, theoretically justified and expressed as hypotheses H1 and H2, are statistically significant, as are their sign and magnitude.

The structural model valuation implies analyzing both the magnitude and the sign of the estimated coefficient, as well as the R^2 and adjusted R^2 of the model. Table 4 presents the estimates of the hypothesized relationships. To make it more easily understandable, we have also summarized, in the table, the structural relationship between the variables that was stated in each of the hypotheses (the letter on the left is the independent variable and the letter on the right is the dependent variable), as well as the predicted sign for each one, which was theoretically justified in the Theoretical Framework section.

Our results indicate, as we can see in Table 4, that both hypotheses are met. In particular, the variable with a higher incidence in the perception of the learning outcomes (results) is attitude. As predicted, such a relationship is positive, for the better the student's attitude, the better the student's perception of his/her potential result. Hence, aggregately, students' general perception of their participation in this learning experience and, in particular, the ability of the flipped learning to motivate and make students enjoy, positively affects their results, being the coefficient of the estimate of high magnitude (Coefficient = 0.414), and statistically significant even at the 1% level (p-value 0.006). Thus, we can conclude that hypothesis H1 is supported.

About the relationship between the fact of having a formative assessment system of evaluation that determines the perception of the learning outcomes (results), stated in hypothesis H2, although with a slightly lower magnitude (Coefficient = 0.330), our results also confirm that this relationship is positive, as predicted, and statistically significant, in this case only at the 5% level (p-value = 0.038). Hence, hypothesis H2 is also supported.

Additionally, to prove the robustness of our model, we have included, as control variables, the students' age and gender (dummy variable). However, neither of these variables has a statistically significant relationship with the dependent variable.

Finally, apart from analyzing whether each of the independent variables actually has a statistically significant effect on the perception of the results, we show, in Table 4, the values of the statistics R^2 and adjusted R^2. The fact that both values are about 0.5 leads us to conclude that the model has a medium-high estimation power because at least 50% of the variation in the perception of the results is explained by the variation in the attitude and the benefits of the formative assessment system of evaluation.

Even more, the model improved both its adjusted R^2 and p-values by including both independent variables simultaneously. This shows that the conjunction of the two variables really explains students' perception of outcomes.

6. Discussion

In 2012, the Horizon Report (Johnson et al., 2012) described the flipped classroom as a promising model that may lead to new approaches in education. Since then, the implementation of the flipped classroom has been a subject of frequent research. Many of the published works have highlighted its advantages and demonstrated that this methodology can help students in their learning process (e.g., Bishop & Verleger, 2013; Blair et al., 2016; González-Gómez et al., 2016; Love et al., 2014; Lundin et al., 2018).

This work has focused on analysing some "key" variables (attitude and formative assessment perception) that can be identified as explaining students' perception of the improvement of their academic results. The results, described above, show that the students' perception of obtaining better results in the final assessment of the subject depend positively both on the attitude with which the students approach their learning through these active methodologies and on the formative assessment that feeds back into this process and helps them work better day by day throughout the course.

More specifically, in relation to attitude, some studies report student resistance to the uptake of flipped learning (Burke & Fedorek, 2017; Herreid & Schiller, 2013) and lack of satisfaction with the pedagogy (Missildine et al., 2013), despite evidence of reduced cognitive load and higher achievement levels for students taught using the flipped classroom model (Turan & Göktas, 2015). However, most of the works (e.g., Chao et al., 2015; Murillo-Zamorano et al., 2019; Saglam & Arslan, 2018; Turan & Göktas, 2015; Zheng et al., 2020) agree that students shift towards a more positive attitude in the classroom when a flipped classroom model is applied. Our results are consistent with the latter group. More specifically, we found that, with the application of the flipped classroom model, our

Table 4
Results from the structural model valuation.

Hypothesis	Structural relationship	Predicted sign	Estimate coefficient	p-value	Result	R^2 *(R^2 Adj)*
H1	A> > R	+	0.414	0.006 ***	Supported	0.498 *(0.488)*
H2	FA> > R	+	0.330	0.038 **	Supported	

Note: *** Significant at 1% level; ** Significant at 5% level.

students felt very motivated, had a lot of fun, and enjoyed the experience very much. Agreeing with Zainuddin and Attaran (2016), the majority of university students have positive perceptions of flipped classrooms and want to continue using this model instead of conventional teaching methods. This allows us to affirm that when students are given a more active role in the learning process, they feel more involved, engaged, and motivated.

These results are also supported by the fact that the flipped classroom allows students to work in technological environments with which they identify. As Prieto et al. (2021) state, the effect of the flipped classroom on learning is based on its capacity to stimulate students to do things in order to learn and become more involved in their own learning. Therefore, our results are consistent with those of Danker (2015) and Flores et al. (2016), as they also show that methodologies such as the flipped classroom make students show a positive attitude towards the subjects they are studying.

Regarding the assessment process, our 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 (focused on a test at the end of the process) with tools aimed at assessing the whole teaching-learning process. Flipped teaching is committed to continuous assessment throughout the course to achieve an assessment intertwined with the learning process and promoting the generation of better questions and learning from mistakes (Martín & Tourón, 2017). As Salas and Vicente (2020) point out, to achieve good results, we must distribute tasks and activities equally so that students work continuously and take responsibility for their own learning throughout the course.

De la Fuente et al. (2011) state that, to achieve a more efficient evaluation process, it is of vital importance to know students' perception of the teaching-learning process. Our students have reported that the continuous work has enabled them to maintain a steady pace of learning. Thanks to this, and to the possibility of receiving feedback through formative assessment, they have been able to assimilate the contents better and learn more. Similarly, they have reported better perspectives on the results of the final assessment of the subjects.

Our results agree with those of López and Sicilia (2015) in the sense that formative assessment can enhance learning and thus contribute to the development of future professionals. The effort that the students make in preparing before the classes, the continuous work, and the feedback they receive are important elements that they value and that translate into better assimilation of content, which also influences a better perception of their results.

7. Conclusion

The flipped classroom is a methodological model that reduces time spent in the classroom on the simplest cognitive processes (listening, reading, remembering …) to prioritize, through face-to-face teacher-student interaction, more complex cognitive processes based on activities such as debate, creation, or reciprocal teaching among students (Santiago & Bergmann, 2018). The inverted classroom model allows us experiment with other teaching and learning systems different from the traditional model.

Taking this into account, the aim of this study was to find out how students perceived the application of flipped classroom teaching in six subjects of different degrees at the University of Jaén, during the first semester of the 2020-21 academic year. Although a range of issues is related to the effects of the flipped classroom on the teaching-learning process, in this case, we have focused on the following aspects: knowing the attitude of students in their class routine; knowing their assessment of continuous work and formative assessment; and knowing their perception of the expected results.

To achieve our objective, we conducted a survey of our students in which we sought to determine their perception of various items, including, more specifically, the following three variables: attitude, formative assessment, and perception of results. In this sense, one of the first steps that we took was to check the reliability of the items used as indicators of each of the variables. This was done using statistical analysis with PLS, verifying their validity and reliability in all cases.

By way of a final conclusion, we can say that, as our model has shown, students' perception of obtaining better results in the final assessment of the subject depends positively on both the attitude with which the student approaches his/her learning through these active methodologies and the formative assessment that feeds back into this process, helping the student work better throughout the course. In this way, the results of this study provide further evidence for the literature on the positive effects of the flipped classroom on the teaching-learning process of students at the university level. Then, we respond to what Brewer and Movahedazarhouligh (2018) established, considering that more research is needed on identifying the contexts in which the flipped learning model works best and how to most effectively implement the elements of the flipped model.

As a limitation of this work, we know that though this experience has been implemented in a relatively good number of courses, we collected a low number of questionnaires. This makes it hard to infer the results. For this reason, the process should be repeated in other degrees and courses. Another limitation is that there was no control group. Both limitations condition the external validity of the results. We should also mention that differences in students' perception may be due to differences in the course content and/or type of exams or, even, in the students' characteristics, rather than the implementation of the flipped classroom.

Even more, the special situation of the 2020–2021 academic year, with the pandemic and the hybrid scenario in our university, could condition the obtained results.

Because of these limitations, and as future lines of research, we recognize that this study must be considered an initial approach and must include more course data (for example, in a completely face-to-face environment) and more students' and professors' perceptions. Furthermore, future studies might focus on in-depth descriptions of students' and educators' lived experiences of flipped learning.

Author statement

M. Carmen Ruiz Jiménez: Conceptualization and design of study, project administration, acquisition of data, writing-original draft, writing-review & editing.

Rocío Martínez Jiménez: Conceptualization and design of study, supervisión, acquisition of data, methodology and writing-review & editing.

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Declaration of competing interest

None.

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