Education Tech Research Dev
https://doi.org/10.1007/s11423-023-10289-y

Students' perceptions of their learning outcomes in a flipped classroom environment

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Accepted: 13 September 2023

Abstract

The flipped classroom model has positive effects on the educational process, and has recently become an alternative to the traditional model. However, additional research is necessary to identify the causes of those improvements and the contexts in which this methodology performs better. In this study, we analyze the perceptions of different students pursuing a bachelor's degree at the University of Jaén (Spain) regarding flipped learning dynamics and the relationship between those perceptions and perceptions of their learning outcomes. Specifically, we investigate whether students' acquired competences and attitude, as well as the use of formative assessment have positive effects on student perceptions on results. To accomplish this task, during the first semester of the 2020–2021 and 2021–2022 academic years, we collected the opinions of students via a questionnaire and tested those relationships using PLS. The results indicate that the three variables (acquired competences, attitude, and formative assessment) explain the perceptions of students with respect to achieving better grades, and are key elements of superior learning, that can improve students' performance. Accordingly, this study provides evidence regarding the positive effects of flipped classroom on the teaching–learning process in higher education and explains the reasons for the resulting improvement in learning outcomes.

Keywords Flipped classroom · Students' perceptions · Competences · Formative assessment · Attitude · Learning outcomes

Abbreviations

ICTs Information communication technology
PLS Partial least squares
CR Composite reliability
AVE Average variance extracted

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Published online: 09 October 2023

Introduction

The educational environment has undergone important changes in recent years, especially due to the COVID-19 pandemic. The use of learning platforms, virtual classrooms, and mobile learning resources are just a few examples of the process by which teachers and students adapt to new technologies.

However, despite constant technological innovation, higher education remains focused on traditional teaching methodologies (Galway et al., 2014), thus causing graduates to lack certain key competences related to their future professional skills. This situation represents a challenge for the educational system, whose main objective is to ensure an appropriate education for students, which includes providing them with knowledge and skills that can facilitate their entry into the labor market. This goal is achieved when students are able to solve complex problems and address real situations with a critical and analytical attitude and are responsible for their own learning process. In this context, the flipped classroom methodology provides a great opportunity to incorporate active learning into the educational process (O'Flaherty & Phillips, 2015; Prober & Heath, 2012; Yabro et al., 2014).

Flipped classroom is a pedagogical model according to which instructors share predetermined digital resources asynchronously with the students via an external platform (Bergmann & Sams, 2012). As such, prior to attending class, students are committed to working individually with materials related to the theoretical content of the course (videos, readings, study guidance, etc.), participating in more interactive activities during class (presentations, discussions, role-playing, debates, etc.), and addressing other issues such as just-in-time teaching or paired instruction (Abeysekera & Dawson, 2015; Berrett, 2012; O'Flaherty & Phillips, 2015; Sohrabi & Iraj, 2016). The main objective of this model is to develop higher-level competences based on the Bloom taxonomy (create, analyze, and evaluate), thus allowing students to play a more active role in their own learning process (Berenguer, 2016).

Interest in more efficient teaching methodologies is evidenced by the exponentially growing number of publications regarding flipped classroom in higher education over recent decades (Prieto et al., 2021), which have indicated the advantages or positive effects of flipped classroom (Bishop & Verleger, 2013; Lundin et al., 2018; O'Flaherty & Phillips, 2015). Flipped classroom facilitates better relationships with classmates and teachers (Bergmann & Sams, 2012; Chen et al., 2014; Roach, 2014), increases the interest of students in innovative and collaborative teaching methods (Strayer, 2012), and offers a better comprehension of the specific necessities associated with each student (Fulton, 2012; Roehl et al., 2013). Moreover, in the case of academic outcomes, flipped classroom leads to improved assessment results (Jensen et al., 2015), enhanced learning and better student academic results (Prieto et al., 2021; Strelan et al., 2020).

Despite the claimed advantages and positive effects of flipped classroom (Akçayir & Akçayir, 2018; Blair et al., 2016; González-Gómez et al., 2016; Love et al., 2014; Nouri, 2016), Goodwin and Miller (2013) highlight the scarcity of scientific research on the efficacy of this methodology in class. Moreover, Fadol et al. (2018) and Lopes and Soares (2018) claim that additional studies on different subjects and teaching contexts are necessary to improve our understanding of this new technique. Our study analyzes the reasons why flipped learning leads to better academic outcomes for students

by taking into account a series of explanatory factors. To accomplish this goal, we analyze the potential causal relation between the perceptions of students regarding different aspects of flipped learning (acquired competences, formative assessment and attitude) and their opinions concerning the extent to which they expect to certain learning outcomes.

The following section reviews the concept, characteristics, and outcomes associated with the flipped classroom methodology. The third section presents the context of the courses referenced in this study as well as its participants and some data on the research subjects. The fourth section presents the research methods used and is followed by the results section. Finally, we discuss the results and main conclusions of the study as well as its limitations and directions for future research.

Theoretical framework

The notion of flipped classroom has evolved since its creation in 2007 by Bergmann and Sams, and it has been supported by increasing amounts of academic and scientific evidence (Han & Røkenes, 2020; Prieto et al., 2021).

Flipped classroom implements a shift in the labor of teachers and students, both inside and outside the classroom (Bishop & Verleger, 2013). In the traditional model, students merely receive contents that are explained by the teachers and ultimately demonstrate their knowledge in an exam. Flipped classroom, in contrast, shifts the focus of the teaching–learning process from the teacher to the students, making them responsible for their own learning. Prior to class, the teacher provides students with information (in written or audiovisual form) to allow them to analyze, study, and understand the content autonomously and individually. This approach allows more time in the classroom to be spent solving questions, collaborating and working in teams, to reinforce the contents thus learned, using several ICTs (Martínez & Ruiz, 2020); this model allows for creative learning situations to characterize the interaction between teachers and students (Lundin et al., 2018).

Flipped classroom is based on more personalized form of learning that allows each student to learn at his or her own pace, thereby taking into account the various capacities of students in the class. Based on an inductive methodology, this approach is more efficient than the traditional deductive methodology. The most important requirement of this method is that learning outcomes should not focus on "explaining the lesson correctly" but rather on the task of ensuring that "students learn the lesson".

Flipped learning is aimed at the promotion of self-directed learning with the help of various technologies. When students work in a flipped learning environment, they become accustomed to working with ICTs to acquire knowledge and skills (Martín & Tourón, 2017). Students must search for information and analyze it, solve complex problems, present content, and interact with their classmates. They acquire transversal skills such as collaborative and cooperative working, communication, critical thinking, problem resolution and creativity and social conscience (Sanchez-Muñoz et al., 2020).

The acquisition of competences may be a key issue in higher education (Estriegana et al., 2019). Flipped classroom improves the acquisition of key competences (including specific and scientific-method-related knowledge, systemic competence, self-organization and social competence) (Schaeper, 2009). Some studies on the effect of flipped classroom

on competence acquisition have focused on analyzing competences pertaining to the management of online tasks and activities, as well as work groups and interactions among pairs (Foldnes, 2016; Zanuiddin & Perera, 2017). Other studies, such as Estriegana et al. (2019), have shown that the flipped classroom environment plays a key role in the acquisition and development of systemic, personal, and cooperative competences. The studies conducted by Van Vliet et al. (2015), Al-Zahrani (2015) and Chen et al. (2015) show that the flipped classroom environment improves critical thinking, promotes creativity, and helps students to acquire problem-solving skills. Furthermore, Murillo-Zamorano et al. (2019) provide empirical evidence regarding the causal relationships among the knowledge, skills, commitment, and satisfaction of students, thereby confirming the positive effects of flipped classroom on the commitment of students, eventually improving their knowledge and skills acquisition.

Another benefit of flipped classroom is that it helps teachers induce a change in the attitude of students toward the learning process. Although some studies have reported reticence and lack of satisfaction with the flipped methodology on the part of students (Burke & Fedorek, 2017; Missildine et al., 2013), the majority of studies have found a positive change in student's attitude. Students appreciate flipped classroom more than traditional classes (Danker, 2015; Saglam & Arslan, 2018), as indicated by several factors, such as students' greater commitment and implication (Danker, 2015; Murillo-Zamorano et al., 2019; Saglam & Arslan, 2018; White et al., 2017; Zainuddin & Attaran, 2016; Zheng et al., 2020), and the fact that students are more motivated in the class and enjoy it more (Danker, 2015; Davies et al., 2013; Saglam & Arslan, 2018; Turan & Göktas, 2015). This improvement is reflected in students' increasing class attendance and their growing participation and collaboration (Chao et al., 2015; Danker, 2015; Saglam & Arslan, 2018). Finally, this approach is perceived by students as a more flexible learning method (Turan & Göktas, 2015).

Another important element of the flipped classroom model is assessment (Flores et al., 2016). Otero-Saborido et al. (2018) indicate that in higher education, it is necessary to complement the summative assessment system with systems that are aimed at improving learning. Thus, formative assessment, which is understood as assessment that "aims to improve teaching–learning processes", contributes to student qualifications appropriately in the context of higher education (Zabalza, 2006). The objective of formative assessment is to help students track their progress and identify their strengths and weaknesses in specific areas so that they are able to improve and correct them (Hortigüela et al., 2019; Othman et al., 2022); such assessment thus promotes the understanding of content and focuses on educational aspects of assessment that range beyond mere qualification (Otero-Saborido et al., 2020).

Some studies have demonstrated a productive relationship between flipped classroom and formative assessment. For example, Lovvorn and Timmerman (2019) consider formative assessment to be the most appropriate method of assessment in a flipped classroom environment. Hew et al. (2021) affirm that flipped learning is more effective when this type of assessment is used. Similarly, the research of Cabiscol (2015) and Othman et al. (2022) lead us to conclude that flipped classroom environment allows teachers to practice continuous assessment while providing helpful feedback via formative assessment. The latter involves a feedback process in which all educational agents participate with the aim to improving both student learning and teaching practices (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) notes the positive impact of formative assessment

on learning outcomes due to self-assessment and feedback. Therefore, formative assessment can enhance learning and thereby contribute to students' future professional development (López & Sicilia, 2015).

The effects of flipped classroom with respect to all of the aforementioned elements of the learning process are reflected in improved and more significant learning as well as with greater understanding and retention of the learned contents (Prieto et al., 2021). The benefits of flipped classroom have been well documented and widely discussed in the literature (Baepler et al., 2014; Bishop & Verleger, 2013). Confidence in flipped learning and the development of autonomy, relationships, and competence, provide students with a greater motivation (Abeysekera & Dawson, 2015) and, when combined with other learning strategies, this approach contributes to the inculcation of deep knowledge and critical thinking skills in students (Fisher et al., 2018), as well as to the task of improving their attendance and studying effort (Chen et al., 2014).

Regarding learning outcomes, flipped classroom leads to an improvement in the results of assessment when combined with active learning (Jensen et al., 2015). The improved distribution of the activities throughout the class enables students to interact earlier and more robustly with the learning materials in a manner that is reinforced by the activities offered in class, eventually leading to better learning outcomes (Prieto et al., 2021; Strelan et al., 2020). Martín and Tourón (2017) highlight the fact that some factors that improve learning are the result of the interaction between the teacher and the students, the activities that are offered in class, debate, and reflection time.

However, our knowledge of why some students benefit from flipped classroom remains underdeveloped (Chen et al., 2014; Nouri, 2016). Moreover, although several studies have investigated the impact of student-focused pedagogies on learning outcomes using objective measures, the number of studies that have analyzed the perceptions of students regarding learning outcomes concerning subjects related to entrepreneurial management remains limited (Garnjost & Lawter, 2019). This topic refers to students' perceptions that participating in the flipped experience may help them become more efficient in terms of the learning process and may improve their learning outcomes.

Accordingly, the aim of this study is to offer empirical evidence regarding and clarify the possible causes of the positive effects of flipped classroom. Why do students' perceptions of their learning outcomes improve in a flipped classroom environment? Could factors such as the improvement observed in acquired competences, the application of formative assessment, or students' attitude toward the learning process influence these perceptions? To answer these questions, we propose the following research hypotheses:

H1 The positive attitude of students in a flipped classroom environment has a positive effect on the perceptions of students regarding their learning outcomes.

H2 The application of formative assessment in a flipped classroom environment has a positive effect on the perceptions of students regarding their learning outcomes.

H3 The competences acquired in a flipped classroom environment have a positive effect on the perceptions of students regarding their learning outcomes.

For a clearer understanding of the research questions summarized in the aforementioned hypotheses, we represent it graphically in a model in Fig. 1.

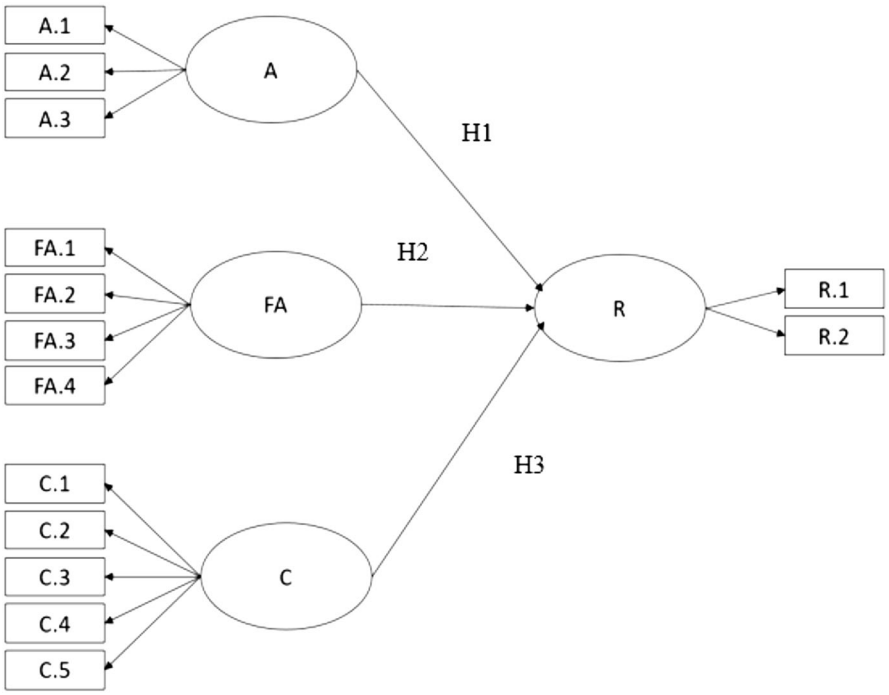

Fig. 1 Model representation. Latent variables: A: Attitude; FA: Formative Assessment; C: Competences; R: Results perception. Indicators: A.1: Motivation; A.2: Amusement; A.3: General Opinion; FA.1: Theoretical understanding; FA.2: Learning more and better; FA.3: Learning efficacy; FA.4: Working day by day; C.1: Comprehension; C.2: Critical thinking; C.3: Collaboration-cooperation; C.4: Communication (oral-written); C.5: Creativity; R.1: Learning self-evaluation; R.2: Marks

Methodology

Participants

The flipped classroom was used in classes pertaining to six subjects in the field of business management, associated with different bachelor's degrees at the University of Jaén (Spain) during the 2020–2021 and 2021–2022 academic years. The subjects included 60 h (4 weekly sessions over the course of 15 weeks). Due to the pandemic, during the 2020–2021 academic year, the classes employed a hybrid learning model (50% of the students participated in each class in person, and the two groups of students attended in person on alternate weeks), while during the 2021–2022 academic year, classes were again conducted face-to-face.

Table 1 shows the number of students who were enrolled in each of the subjects, distinguishing between the two academic courses.

Context: the flipped classes

At the beginning of each semester, the activities and resources to which students were given access both inside and outside the classroom were planned. Students were informed

Table 1 Bachelors and academic courses of the selected subjects, and number of students

Bachelor	Subject	No. students	
		2020–2021	2021–2022
Business Administration and Law	Strategic Management I	19	18
Finance and Accounting	Management Accounting II	48	21
	Human Resources Management	15	–
Industry Organization Engineering	Organization of Labor Force and Human Factor	27	35
Labor Relations and Human Resources	Business Organization and Administration	37	35
Statistics and Enterprise	Business Administration	26	35
		172	144

of the flipped classroom model. This fact is important because flipped classroom implies a change of roles for both teachers and students that must be clear from the outset.

The working dynamics associated with each class session can be summarized as follows. Prior to the class, the students reviewed the contents (videos, readings, infographics, etc.). During the class, teachers discussed with the students the work they had completed at home, addressed their doubts, verified the learned content, and worked through cases/exercises, debates, role-playing exercises, etc. These activities were conducted both individually and in teams and were evaluated by the teachers as part of the continuous, summative, and formative assessment process. After the class, the students had to interiorize the contents that they have learned in class.

Instruments for assessment

At the end of each semester, students completed a questionnaire to investigate their perceptions of different aspects of the flipped classroom experience. This questionnaire was designed and validated ad-hoc for this research, based on the work of Santiago and Bergmann (2018a). The Cronbach's alpha coefficient for the whole questionnaire was .83.

The questionnaire was completed by 218 students (107 in 2020–2021 and 111 in 2021–2022), accounting for 68.99% of the total number of students enrolled in the classes. The distribution of the sample is reflected in Table 2. The proportion of men (51.4%, 109 out of 212) and women (49.6%, 103 out of 212) were very similar.

Data analysis

Data analysis was conducted using the estimation technique of partial least squares (hereafter referred to as PLS). The selection of this technique was due to the facts that the variables to be analyzed were not directly observable and that there were multiple possible relationships among them. PLS has the advantage of incorporating not merely the econometric perspective (i.e., the magnitude of the effects and their statistical significance) but also the psychometric perspective (i.e., the modelization of the attitudinal behavior in the variables) (Chin, 1998; Fornell & Larcker, 1981) as measured through indicators. Moreover, this approach allows multiple relationships to be considered in a simultaneous, systematic, and comprehensive way, thereby allowing complex relationships to be modelled to

Table 2 Sample description

Subject	2020–2021	2021–2022	Total
Business Administration	10	24	34
Management Accounting II	32	27	59
Strategic Management I	4	13	17
Human Resources Management	12	–	12
Organization of Labor Force and Human Factor	26	26	52
Business Organization and Administration	23	21	44
	107	111	218

test entire theories (Nitzl, 2016; Ullman, 2006). Finally, PLS can be conducted not merely by reference to archival data but also by reference to primary data collected via surveys (Nitzl, 2016).

Variables and model design

Subsequently, the aspects that are associated with each variable (indicators) as well as the questions in the questionnaire that we used to measure those aspects (items) are summarized in Table 3. All questions were designed to use a Likert scale ranging from 1 (totally in disagreement) to 5 (totally in agreement).

Accordingly, in our model, graphically represented in Fig. 1, we include a dependent variable for results perception (R). This variable is measured by two items in the questionnaire related to the following indicators: Learning self-evaluation (R.1) and Marks (R.2). The first independent variable (A: Attitude) is measured by three items in the questionnaire related to the following three indicators: Motivation (A.1); Amusement (A.2); and General opinion (A.3). The second independent variable (FA: Formative Assessment), on the other hand, is measured by four items related to the following indicators: Theoretical understanding (FA.1); Learning more and better (FA.2); Learning efficacy—study materials (FA.3); and Working day by day (FA.4). Finally, the third independent variable (C: Competences) is measured by five items in the questionnaire related to the following educational competences: Comprehension (C.1); Critical thinking (C.2); Collaboration—cooperation (C.3); Communication—oral and written (C.4); and Creativity (C.5).

Results

One advantage of PLS is the reliability of its results, which is due to the fact that this approach first determines that the variables have been measured correctly and analyzes the relationships among the variables included in the model only after correct measurement has been ensured (Hair et al., 2011; Henseler et al., 2009; Nitzl, 2016). This approach allows for a more rigorous analysis of the predictive ability of the model and permits us to determine whether the empirical measures of the variables are actually correctly adjusted to the real data (Hair et al., 2016).

Following the two-step validation process, we subsequently present the results.

Table 3 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
A: Attitude	Independent	A.1: Motivation	This method motivated me more than a traditional class
		A.2: Amusement	I have enjoyed in the learning process
		A.3: General opinion	I like the flipped classroom methodology that was followed in the class
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

Table 4 Analysis of the measurement model

	Indicator loading	CR	AVE
A: Attitude		.923	.799
A.1 Motivation	.884		
A.2 Amusement	.878		
A.3 General opinion	.919		
FA: Perception on formative assessment		.941	.799
FA.1. Theoretical understanding	.91		
FA.2. Learning more and better	.939		
FA.3. Learning efficacy. Study materials	.905		
FA.4. Working day by day	.819		
C: Competences		.905	.657
C.1 Autonomy comprehension learning	.736		
C.2 Critical thinking	.779		
C.3 Collaboration-Cooperation	.794		
C.4 Communication (written and oral expression)	.87		
C.5 Creativity	.864		
R: Results perception		.916	.846
R.1. Learning self-evaluation	.915		
R.2. Marks	.924		

Reliability of the indicators and variables

Measurement model validity assessment

Following the procedure described by Hair et al. (2020), we start analyzing the individual-indicator reliability, in which context we check the magnitude of their loadings as well as the associated statistical significance using the p-value. Subsequently, at the construct level, for each variable, we analyze its reliability (using the composite reliability (CR) index) and its convergent (using the average variance extracted (AVE)) and discriminant validity (using the Fornell and Larcker (1981) criterion and an analysis of cross loadings). The results of these tests are shown in Table 4, with the exception of discriminant validity (untabulated, only commented).

The indicator loading indicates the individual ability of each item to correctly measure the theoretical variable with which it is linked, which is known as the individual indicator reliability (Fornell & Larcker, 1981; Hair et al., 2016). Loadings that are statistically significantly different from zero support the explanatory power of each indicator (Ullman, 2006). To ensure an appropriate level of reliability, it is recommended that all loadings be at least .7 (Carmines & Zeller, 1979) so that the shared variance between the variable and its indicators is higher than the variance of the measurement error (Roldán & Sánchez-Franco, 2012). As shown in Table 4, all indicator loadings exceed .7 and are thus an appropriate measure of the theoretical variables that they represent. Additionally, we employed a bootstrapping procedure featuring 5000 subsamples to verify that all indicators have a p-value of .000 and are thus statistically significant.

At an aggregate level for the variables, the composite reliability index (CR) developed by Fornell and Larcker (1981) measures the reliability of each variable aggregately

Table 5 Analysis of the structural model

Hypotheses	Explanatory variable	Coeff	SD	T	p value	Sig
H1	ATTITUDE	.203	.115	1.764	.078	*
H2	PERCEPTION FORMATIVE ASSESSMENT	.271	.111	2.435	.015	**
H3	COMPETENCES	.382	.103	3.696	.000	***

Magnitude and significance of the estimated coefficients

*Model significant at 10%, **model significant at 5%, ***model significant at 1%

measured with the items with the aim of ensuring that all those items reflect the same theoretical concept that they aim to explain with their shared variation (Ringle et al., 2014). It has been noted that values of CR above .7 are optimal. Table 3 shows that the four variables included in the model have CR values exceeding .7. Apart from this reliability, it is also advisable to verify that the indicators, which are alternative items used to measure the same theoretical concept, share a high proportion of variance, that is, that the indicators converge well between them and thus represent a unique and common reality (Henseler et al., 2009; Roldán & Sánchez-Franco, 2012). This measure is known as convergent validity and is measured using AVE. As a threshold value, an AVE greater than .5 is optimal (Hair et al., 2011; Henseler et al., 2009). All the variables included in our model, as shown in Table 4, have AVE > .5. In conclusion, considering both the convergent reliability and the validity, we can ensure not only that each item appropriately measures the variable but also that, at an aggregate level, the different items in aggregate explain the theoretical variable that they measure correctly, thus ensuring that the measurement is valid and reliable and the variables are correctly represented.

Finally, we investigate the extent to which each variable is actually different from the other variables. This difference is normally assessed using the Fornell and Larcker (1981) test, complementing the results with the analysis of cross loadings (Hair et al., 2020; Nitzl, 2016). We note that the results of both tests are untabulated. The former test indicates that the square root of the AVE for each variable must be lower than the correlations between this variable and the other variables. The results show that all variables meet these conditions. If we analyze the cross loadings, we can see that the indicator for each loading is higher for the variable that it measures than for the other variables included in the model. Thus, the variables measure different concepts that are perfectly distinguishable from one another, thereby confirming their discriminant validity.

Structural model validity assessment

Following the procedure described by Hair et al. (2020), we now analyze the relationships among the variables. First, we verify (untabulated) that the VIF values for all variables are approximately 3 (< 5), which is indicative of the absence of multicollinearity problems in the variables. Second, we analyze the magnitude and significance of the estimated coefficient for the explanatory variables, which is shown in Table 5.

Regarding the three variables, the coefficient is different from zero and statistically significant.

The variable with the highest effect in the perception of the results by students is the acquisition of competences, as shown by its high coefficient (beta = .382), which is statistically significant even at the 1% level (p-value = .000). The sign of this variable is positive; therefore, the flipped classroom methodology allows students to acquire competences during the learning process, and as long as these competences are achieved, the students have more positive perceptions of the results that they are able to obtain.

The second variable in terms of magnitude is the perception of formative assessment, which exhibits a positive relationship (beta = .271) and is statistically significant at the 5% level (p-value = .015). Therefore, it is confirmed that formative assessment in a flipped classroom environment is perceived favorably by students, and this fact is also reflected in a better perception of the learning outcomes that they expect to achieve.

Finally, the relationship between students' attitude and their perceptions of learning outcomes is positive and statistically significant, although only at the 10% level[1] (p-value = .078), indicating that better attitude on the part of students caused them to expect better results.

The next step is to analyze the in-sample predictive power of the model, as measured by the adjusted R^2 and the magnitude of the effect f^2. The adjusted R^2 of the model is .632, which is considered to indicate a highly predictive sample, because the 63.2% of the variation in student perceptions of their learning outcomes is explained by the variation in the attitude of the students, their perceptions of formative assessment, and their acquisition of competences. On the other hand, the effect size, as measured by the f^2 statistic, exhibits a sufficient, albeit small, predictive value, because it exceeds the threshold of .02 for all variables (.029 for attitude, .06 for formative assessment, and .119 for the acquisition of competences) but is lower than .15 (Hair et al., 2016).

The final step is to analyze the out-of-sample predictive power, as measured using the statistic Q^2 from a blindfolding procedure. The Q^2 is .523, which is clearly higher than zero, thus indicating the perceived relevance of the model for the dependent variable (perceptions of learning outcomes) (Hair et al., 2016). As a complementary analysis, we also employed PLS-Predict as a robustness test for the out-of-sample predictive model (Evermann & Tate, 2016; Hair et al., 2020). The value of the statistic Q^2_predict is .615, which is high. Furthermore, the RMSE of the prediction error of PLS is high for all indicators of the independent variable (.605 for the indicator of the qualifications, and .67 for the self-assessment), and lower than the errors of the referent naïve LM threshold (.653 and .711, respectively). These findings thus provide evidence of high predictive power even out-of-sample (Evermann & Tate, 2016).

In conclusion, the proposed model has an appropriate validity with respect to both variable measurement and structural model, indicating high in-sample and out-of-sample predictive power, thereby confirming the three hypotheses proposed in the theoretical framework.

[1] About the statistical significance, we set a threshold of 10% level, given that such threshold is admitted in Social Sciences, where, given the fact of having as the focus of study human behavior, the threshold needs to be adapted to this specific circumstance, increasing the traditional 5% level, whenever the results are able to stand up throughout time is admitted in specific fields of study (Gallo, 2016).

Discussion and conclusions

The flipped classroom is a promising model that can help students improve their learning process (Bishop & Verleger, 2013; Blair et al., 2016; González-Gómez et al., 2016; Lundin et al., 2018). Our study aims to provide evidence regarding the reasons for the positive effects of the flipped classroom on students' perceptions of achieving better academic outcomes. Specifically, the purpose of this study is to identify the perceptions of students regarding the use of flipped classroom in six subjects associated with several bachelor's degrees at the University of Jaén (Spain) over the past two academic courses. In this context, we focus on "key" variables (attitude, formative assessment and the acquisition of competences) that can be identified as explaining students' perceptions of the improvement of their learning outcomes.

Our hypotheses are confirmed and the results described above indicate that students' perceptions of obtaining better results in the final assessment for a subject are simultaneously positively correlated with their attitude toward the learning process, with their acquired competences and with the formative assessment employed throughout the course.

Regarding student attitude, results show that participating in the flipped classroom experience improves students' attitude regarding the learning process. In further detail, our students rate the different elements associated with this attitude highly: amusement, motivation and general opinion. Moreover, this improvement in attitude is positively related to students' perceptions of better academic results. These results are similar to the conclusions of a majority of relevant studies, in which support a shift toward a more positive attitude among students in the class when a flipped classroom is adopted (Chao et al., 2015; Danker, 2015; Flores et al., 2016; Murillo-Zamorano et al., 2019; Saglam & Arslan, 2018; Turan & Göktas, 2015; Zheng et al., 2020). In line with the conclusions of Zainuddin and Attaran (2016), the majority of university students have positive perceptions of the flipped classroom and are willing to use this model instead of other traditional teaching methods.

Regarding the assessment, our results reflect the fact that a learning experience using a flipped classroom approach and the associated formative assessment tools is perceived as positive by students who increase their theoretical understanding of the subject in question. In the same way, students positively value the fact that they have learned more material more effectively, have exhibited a higher learning efficiency when studying the material and have been able to work day-by-day, throughout the whole semester. All these aspects are positively correlated with students' perceptions of their learning outcomes. These results are consistent with those reported by Gikandi et al. (2011), who indicate that in higher education it is necessary to complement the summative assessment with other instruments to evaluate the whole teaching–learning process. The flipped classroom employs formative assessment to ensure an assessment that is linked to the learning process and can promote better questions and error-based learning (Martín & Tourón, 2017). As Salas and Vicente (2020) note, to achieve good results, tasks and activities should be distributed equitably so that students can work on a continuous basis and feel responsible for their own learning processes during the course. To ensure a more efficient assessment process, it is essential to understand the perceptions of students regarding the teaching–learning process (De la Fuente et al., 2011). Our students noted that their continuous work has allowed them to maintain a constant learning pace and that the feedback they received from the formative assessment helped them

better assimilate the course contents, thus improving their expectations regarding their final grades. Hence, consistent with the conclusion of López and Sicilia (2015), formative assessment can improve the learning process and contribute to the development of future professionals.

Finally, regarding competences, our results indicate that participating in this flipped classroom experience enhances students' perceptions with respect to their educational competences. In particular, students express high ratings of their achievement of competences related to understanding theory, critical thinking, cooperative and collaborative relationships, oral and written communication, and creativity. Improvement in these competences is positively related to students' perceptions of becoming more efficient with respect to the learning process and achieving better marks. These results are consistent with those reported by researchers who find that flipped classroom facilitates and improves the acquisition of competences. For example, Fadol et al. (2018) demonstrate that online access to materials improves students' understanding and critical thinking skills. In line with the results reported by Chen et al. (2014) and Galway et al. (2014), our students perceived that flipped learning has allowed them to interact better and more frequently with their classmates and the teacher. Similarly, as Santiago and Bergmann (2018b) also state, the reason for these perceptions may be the shift in roles between teacher and students that characterizes this model. Our results also show that the flipped classroom stimulates students' creativity. In line with the results reported by Al-Zahrani (2015), we observe that creativity is stimulated when students are required to analyze alternatives, find solutions to real situations, and solve problems. Students also positively acknowledge the work completed prior to the class, because it helps them better understand the contents of the subject at hand.

In conclusion, as we have demonstrated, students' perceptions of achieving better learning outcomes in the final evaluation depend positively on their acquired competences, their attitude toward learning, and the formative assessment that provides them with feedback during this process, thus helping students work better throughout the course. These results have several theoretical and practical implications that should be highlighted. Regarding the theoretical implications, our results reinforce the idea that the flipped classroom is an effective teaching–learning model. We provide additional evidence to support the positive effects of flipped classroom in the teaching–learning process of students in higher education and to identify elements that could be more effective in improving student perceptions of academic results. Accordingly, this research responds to Brewer and Movahedazarhouligh (2018), who note that additional research is necessary to identify the elements of the flipped learning model that can be implemented most effectively.

In relation to the implications for practice, first of all we should point out that the active work developed in the inverted classroom environment provides more opportunities for students to acquire basic competencies and become involved in their learning. Secondly, the change in attitude shown by our students in the classroom is undoubtedly a key element that facilitates the implementation of a flipped classroom model and its associated practices. Thirdly, our experience shows us that students assimilate the contents better and have a better perception of their results when we allow them flexibility in their study rhythms and times (working before, during and after class). Finally, we believe that this model is effective as long as it is well planned. The objectives, contents, tools and work dynamics must be well programmed in time and the students must know and understand them from the very beginning.

As a limitation of this study, although this research has focused on an appropriate number of subjects, we received few answers to the questionnaires. For that reason, this process should be replicated in the context of other degrees and courses. This limitation affects the

external validity of the results. Second, differences in students' perceptions may be due to differences in the content of the course, the type of exams or, even, the characteristics of the students, rather than to the implementation of the flipped classroom. Hence, there may be a potential influence of different course subjects on students' perceptions of flipped classroom (e.g. flipped classroom may be a better approach for accounting courses than for management courses).

As a result of these limitations, and with the aim of providing directions for future research, this study must be considered to represent a preliminary approach to this topic, and more data regarding and additional perceptions from students and teachers should be collected. In addition, future studies may focus on collecting in-depth descriptions of the experiences of the students and educators with flipped learning.

Acknowledgements Not applicable.

Author contributions Introduction: RM-J, MCR-J, AL-G. Theoretical framework: RM-J, MCR-J. Methodology: RM-J, MCR-J, AL-G. Results: AL-G. Discussion and conclusions: RM-J, CR-J, AL-G.

Funding Teaching Innovation Project "Aulas invertidas (Flipped Classroom): Una nueva forma de enseñar y aprender", granted by the University of Jaén (Spain) (PIMED-UJA 2019). Grant number: PIMED36_201921.

Data availability The datasets used and/or analyzed as part of the current study are available from the corresponding author up on reasonable request.

Declarations

Competing interests The authors have no competing interests that are relevant to the content of this article to declare, and the manuscript has not been submitted to any other journal.

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