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Factors influencing students' perceived impact of learning and satisfaction in Computer Supported Collaborative Learning

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A R T I C L E I N F O

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A B S T R A C T

The analysis of the processes and elements articulating effective Computer Supported Collaborative Learning (CSCL) constitutes a focal research stream in education. Following these streams, satisfaction and perceived impact on learning have already been stablished as determining aspects of any type of learning and, particularly, of CSCL. The goal of this study was to identify factors affecting students' satisfaction and perception of impact on learning in CSCL. The Partial Least Squares technique was used, applying a questionnaire to 701 students in a virtual university. The proposed model exhibited high predictive performance, confirming the 13 hypotheses established. The variables confirmation, perceived usefulness, and perceived enjoyment positively and significantly influenced students' satisfaction with CSCL. Perceived ease of use and perceived usefulness positively and significantly influenced attitude, and attitude, together with perceived enjoyment, were determining factors in perceived impact on learning. These are factors that should be considered when designing CSCL to be implemented both at the institutional and class level, and teachers and students should be aware of these interdependencies for CSCL to be successful.

1. Introduction

There is no doubt, now more than ever as a consequence of the changes in education caused by COVID-19, that technology mediated education has been roundly established on a global scale in higher education (Darling-Hammond & Hyler, 2020; García-Peñalvo, Corell, Rivero-Ortega, et al., 2021; García-Peñalvo, Corell, Abella-García, & Grande-de-Prado, 2021; Hadar et al., 2020). Research on *Convergence Culture* (Jenkins, 2010) and *Learning Ecologies* (González-Sanmamed et al., 2019; González-Sanmamed et al., 2020) support the integrated use of digital media, following a humanistic approach examining the interrelations of social, cultural and technological systems. In academic contexts, ICT media and platforms are considered fundamental for their potential in the joint creation of knowledge (Al-Emran et al., 2019, 2021; Lyons et al., 2020; Tarun, 2019). Collaboration is a distinctive and necessary approach for learning in any modality, and, in particular, for learning processes in virtual environments (Garrison, 2006). Situated,

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shared or distributed cognition, social constructivism, activity theory, and the sociocultural approach have already clearly indicated the benefits of a non-individualistic concept of learning, linked to cognitive and socio-emotional levels.

These considerations have led to Computer Supported Collaborative Learning (CSCL), a line of research in online education. CSCL facilitates the creation of learning communities aligned with the education paradigm emerging from today's social and technological environment, in which participants can alternate between the roles of student, designer, and active contributor (Fischer et al., 2007; Stahl et al., 2006; Al-Emran et al., 2018). CSCL involves creatively solving problems from a multidisciplinary perspective during a period of intense cooperation in which students need to find a commonly created solution, design a project, create a prototype, or produce a product. The cooperation process leads to multiple opportunities for the construction of shared meaning, which entails both cognitive or knowledge convergence and divergence (Puntambekar, 2006; Weinberger et al., 2007). Convergence and divergence occur in an intense negotiation process to move towards a common vision and output, rejecting prior individual constructs and therefore encouraging the restructuring of previous knowledge (Borge et al., 2018).

The purpose of this study was to analyse both direct and indirect effects of factors that significantly influence the level of satisfaction and the perceived impact on learning in university students who used CSCL as a learning method. In order to do this, we used three theoretical frameworks, based on widely consolidated theories, as the basis for identifying the constructs making up the research model (see Fig. 1); the Expectation-Confirmation Model (ECM) (Bhattacherjee, 2001), the Technology Acceptance Model (TAM) (Davis, 1989) and Flow Theory (Csikszentmihalyi, 1997).

2. Theoretical frameworks

Research has shown CSCL to be a successful method for enhancing students' learning and therefore individual performance (Tang et al., 2014). Students themselves perceive the cooperation process to be useful both for academic purposes and for acquiring social skills for future cooperative processes (Kim et al., 2013; Kwon et al., 2014). However, it is important to note that learning only occurs as an integration of the technological, pedagogical and social elements making up a virtual learning environment (Lu et al., 2010; Näykki et al., 2017). Below, we consider the most significant aspects that affect the learning process in CSCL, looking at pedagogical, technological, and social elements.

2.1. *Learning in CSCL: design, implementation, and evaluation*

The learning processes through CSCL need detailed planning which clearly defines all of the pedagogical, curricular, social, and technological aspects to be borne in mind (Dillenbourg & Hong, 2008; Haake & Pfister, 2010; Sobreira & Tchounikine, 2012; Hernández-Sellés et al., 2014). Engagement in seeking a common goal is a key element through which the activities to be done and the structure of the collaboration are shaped (Näykki et al., 2017).

In the implementation phase, interaction is particularly important and is a challenge at the organizational, social, and cognitive levels (Borge et al., 2018; King, 2007). Through the planned exchanges, and others that may arise, each student must restructure their prior knowledge and be ready to learn with others. Motivation, task engagement, intra-group support, and a sense of belonging to the community are key, both for the learners' success, and for their perceived satisfaction (Capdeferro & Romero, 2012; Garrison et al., 2010; Vuopala et al., 2016). Teacher feedback is also fundamental for guiding and adjusting the processes of knowledge convergence

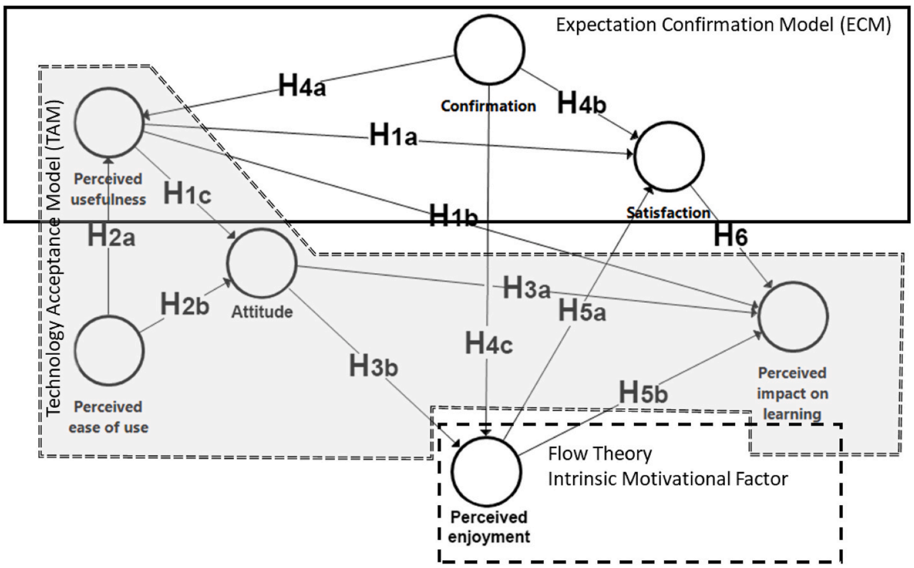

Fig. 1. Research model.

and divergence that occur (King, 2007; Vuopala et al., 2016; Borge et al., 2018; Yilmaz & Yilmaz, 2019).

Evaluation of CSCL processes should consider not only the product or the achievement of goals, but also the dynamics of the interactions that occurred as well as cognitive and social elements (Gikandi et al., 2011; Evans, 2013; Balderaset al, 2018). In this regard, co-evaluation is a very suitable system for the analysis of individual and group achievement, whether by summative or formative evaluation processes (Gikandi et al., 2011; Evans, 2013; Hernández-Sellés et al., 2018).

2.2. The social component as an axis of learning and satisfaction in CSCL

Co-operation and negotiation are essential for learning in CSCL, as both aspects influence the satisfaction levels of both students and teachers who participate in the experience (King, 2007; Kwon et al., 2014). The collaboration should therefore be carefully defined during the CSCL design phase so that the implementation includes consideration of social relationship aspects and to ensure the articulation of cognitive aspects related to task completion and the intended construction of knowledge (Borge et al., 2018; Borge & Mercier, 2019; Puntambekar, 2006; Weinberger et al., 2007). Intra-group emotional support is particularly important in this regard (Garrison et al., 2010).

The group can only function well if the social interaction is rich, enthusiastic, respectful, and above all when there is a positive, socially accepting atmosphere. It is worth remembering that research has warned that the social interaction needed to achieve the satisfaction of all of the group members and learners does not happen spontaneously, instead it must be planned in the design phase and monitored so that it happens properly during implementation in order to avoid poor learning experiences and individual or group failures (Kwon et al., 2014; Reyes et al., 2012).

2.3. Technology as an enabler of learning and satisfaction in CSCL

The technological tools used in CSCL have a positive, significant influence on the learning processes and the dynamics of collaboration underlying them (Bowman & y Akcaoglu, 2014; Hamid et al., 2015; Molinillo et al., 2018). Technological resources must be selected according to the learning goals that are being pursued, and must be consistent with the planned pedagogical, cognitive, and social activity (Luet al, 2010, Tarun, 2019; Lyons et al., 2020). In this regard, the technology that mediates collaborative learning must be able to structure complex tasks and facilitate group analysis and the negotiation that will lead to resolving them (Strijbos et al., 2004).

3. Research model and hypotheses

Based on the theoretical frameworks above, the constructs and causal relationships shaping our research hypothesis are shown in Fig. 1. Below, we introduce each of the theories that support the research model, analyzing the characteristics that cover the research hypotheses.

The Expectation–Confirmation Model (ECM) is a consolidated theoretical framework which has been widely used as an Information Systems (IS) research model. Its focus is on examining users' satisfaction and intentions to continue in IS (Bhattacherjee, 2001). Studies have been done on the basis of the ECM model and its extensions (Tiyar & Khoshsima, 2015; Zhou, 2017) in which constructs such as *confirmation, perceived usefulness,* and *satisfaction* were key factors for explaining users' intentions to return to collaborative learning processes and for predicting whether initial expectations about CSCL were confirmed after experiencing learning using this method.

The technology acceptance model (TAM), formulated by Davis (1989), posits that user acceptance of a technology is directly determined by the user's behavioural intention (BI) to use the technology. For Davis, BI refers to the desire or willingness of an individual to use a technology and it is considered a significant influence in system use. TAM and its extended versions (Al-Emran, Al-Maroof, et al., 2021; Arpaci et al., 2020) have been used in various studies to predict users' acceptance of collaborative technologies (Cheung & Vogel, 2013; Lin & Lin, 2019; Shiue & Hsu, 2017; Yueh et al., 2015). The core variables of TAM are perceived usefulness and perceived ease of use, which both have a positive influence on attitude, which in turn has a positive influence on BI, or the willingness to use IT, and therefore on IT use (Dwivedi et al., 2012; Ifinedo, 2017a; Bölem, 2020).

Flow theory, from Csikszentmihalyi (1997), focuses on understanding factors influencing intrinsic motivation during a process besides the final outcome of the activity. Flow is defined as the holistic experience of people acting with total involvement, where involvement is a synonym of engagement. Typical flow experiences occur when people concentrate only on the ongoing activity and lose their self-consciousness (Csikszentmihalyi, 1997; Nakamura, & Csikszentmihalyi, 2009, 2012, pp. 195–206). In Flow theory, flow is measured by perceived enjoyment, among other variables (Ifinedo, 2017a; Nakamura & Csikszentmihalyi, 2009, 2012, pp. 195–206).

3.1. Perceived usefulness as a reference in satisfaction, attitudes, and learning

As the TAM model and the ECM theory both indicate, perceived usefulness is one of the key constructs in various reference models for the analysis of technology-mediated learning processes (Cabero-Almenara & Pérez, 2018; Doleck et al., 2017; Ifinedo, 2017a). Perceived usefulness in CSCL refers to the extent that a student believes that collaboration through technology will enhance their individual learning (Alenazy et al., 2019; Guo & Stevens, 2011; Ifinedo, 2017a). Previous studies have found evidence that perceived usefulness has a positive significant effect on satisfaction and on the perceived impact on learning (International Journal of Computer-Supported Collaborative Learning, ; Bölem, 2020). Likewise, various studies about the use of technology in learning have shown a positive association between perceived usefulness and attitude (Stone & Baker-Eveleth, 2013). Therefore, we propose the following hypotheses:

H1a. Perceived usefulness will have a significant positive influence on CSCL satisfaction.

H1b. Perceived usefulness will have a significant positive effect on perceived impact on learning in CSCL.

H1c. Perceived usefulness will have a significant positive effect on students' attitudes towards CSCL.

3.2. The influence of perceived ease of use on attitudes and perceived usefulness

Perceived ease of use in CSCL refers to how effortless students believe collaboration through technology will be (Bölen, 2020). Studies such as Abdullah, Ward, and Ahmed (2016), Ashtari and Eydgahi (2017), Al-Emran, Arpaci, and Salloum (2020) and Al-Emran, Mezhuyev, and Kamaludin (2021). Show perceived ease of use and perceived usefulness to be positively related, and to have a positive influence on behavioural intention (BI) to use the technology. Students with favourable beliefs towards technology often develop positive attitudes towards the use of such tools for learning purposes and are therefore willing to use them (González-Sanmamed et al, 2017). We therefore postulate that:

H2a. Perceived ease of use in CSCL will positively influence perceived usefulness.

H2b. Perceived ease of use will have a significant positive effect on attitudes towards CSCL.

3.3. The effect of attitudes on learning and enjoyment

Studies such as Lin and Li (2019) and Muñoz-Carril et al. (2020) confirmed that a positive attitude towards the use of technology-based learning methodologies, such as CSCL, increases students' perceived enjoyment when using various tools for learning purposes. Attitude and perceived enjoyment imply intrinsic motivation and increase the relative likelihood of students having a positive perception of the impact on learning. Taking this into account, we have formulated the following hypotheses:

H3a. Students' attitudes towards Collaborative Online Work (CSCL) will have a significant positive effect on the perceived impact on learning.

H3b. Students' attitudes towards Collaborative Online Work (CSCL) will have a significant positive effect on perceived enjoyment.

3.4. The impact of confirmation on usefulness, satisfaction, and enjoyment

Confirmation in CSCL refers to how much a student's expectations of the collaborative learning experience match how they perceive performance, or their experience of it. In other words, the extent to which student expectations are met (Dwivedi et al., 2012). Confirmation has been shown to be a key element of students' satisfaction with technology-mediated learning systems (Chen et al., 2015; Lee, 2010; Limayem & Cheung, 2008) as well as in their perceptions of usefulness (Joo et al., 2017). Similarly, various studies have confirmed that positive confirmation influences perceived enjoyment (Park, 2020). Based on this, we propose the following hypotheses:

H4a. Confirmation will have a significant positive influence on the perceived usefulness of the CSCL

H4b. Confirmation will have a significant positive influence on the level of satisfaction of students who perform tasks using CSCL

H4c. Confirmation will have a significant positive effect on perceived enjoyment of CSCL.

3.5. The effect of perceived enjoyment on satisfaction and learning

In the context of this study, perceived enjoyment refers to how enjoyable students find the process of learning in technologically-mediated collaboration, regardless of the result of the collaboration process itself. As previously indicated, perceived enjoyment is a significant variable in the Flow Theory framework, and studies have shown a positive effect on satisfaction (specifically with the use of technology) (Ifinedo, 2017a). Satisfaction with CSCL refers to how satisfied students are with the experience of technology-mediated collaborative learning (Ifinedo, 2018a, 2018b; Balderas, Palomo-Duarte, Dodero et al., 2018). Those studies found that satisfaction with learning was positively correlated with student motivation. More specifically, proper planning and implementation of CSCL (Hernández-Sellés et al., 2014; (Hernández-Sellés et al., 2020)) fosters high levels of satisfaction in students, and this has an impact on emotional aspects which are also linked to the learning experience and its effects (Hernández-Sellés et al, 2019; Molinillo et al., 2018).

H5a. Perceived enjoyment during CSCL will significantly positively influence students' satisfaction with CSCL.

H5b. Perceived enjoyment in CSCL will have a significant positive effect on students' perceived impact on learning.

3.6. The influence of satisfaction on learning

Some authors (Chow & Shi, 2014; Ifinedo, 2017a; Mansouria & Piki, 2016) have established satisfaction as a relevant factor with a positive effect on the perceived impact of technology-mediated learning. We have included the following hypothesis in our proposed model.

H6. Students' satisfaction during CSCL will significantly positively influence the perceived impact on learning.

4. Method

4.1. Procedure and participants

A total of 701 master's students, who were doing four-month courses worth 6 ECTS credits, voluntarily took part in the study. Just over half (54.2%) were women, 45.8% were men. The mean age of the participants was 25.4 years old. The courses included online collaborative working processes using project and case-study based methodologies. Table 1 includes a description of the collaborative learning experience with its phases, objectives and student's and teacher's tasks.

Once the courses were finished, the researchers contacted the students to inform them about the aim of the study, assuring them of the confidentiality of their responses. Data were collected via an online questionnaire.

4.2. Instrument

We used an ex post facto design based on survey methodology (McMillan & Schumacher, 2010), using an anonymized questionnaire sent to the students to complete voluntarily. The questionnaire used a seven-point Likert-type scale ranging from "completely disagree (1)" to "completely agree (7)". Table 2 gives the means and standard deviations for the 27 items used, spread over 7 constructs. Scales which had already been validated in previous studies were used to construct the questionnaire. The items in the constructs "perceived ease of use" and "attitude" were adapted from the scales from Davis (1989) and Ifinedo (2018a). The basis for the items measuring "perceived usefulness", "satisfaction", and "confirmation" were the scales from Bhattacherjee (2001) and Ifinedo (2017a). The "perceived enjoyment" construct was based on the study by Martin and Rimm-Kaufman (2015). Lastly, the items measuring "perceived impact on learning", were adapted from the scales proposed by Hernández-Sellés et al. (2015) and Ifinedo (2017a).

Before the scale was applied, it was reviewed by a panel of 5 international experts who analysed aspects including uniqueness, relevance, and importance for each item. We also performed a pre-test to validate the questionnaire with 30 students chosen at random from the courses involved in the study. Following feedback from those two sources, we made minor grammatical changes. This process enhanced the content validity of the questionnaire.

5. Analysis and results

We used multivariate analysis via structural equation modelling (SEM) with the partial least squares (PLS) technique. This technique has various characteristics that make it ideal for evaluating the proposed research model and for testing our hypotheses. As indicated by Esposito Vinzi, Trinchera, & Amato, 2010, PLS does not demand multivariate normality from the observations. It is a

Table 1
Description of the collaborative learning experience.

Phase	Objective	Student's Tasks	Teacher's Tasks
1. Before forming study groups.	Identifying classmates' characteristics, strengths, weaknesses, and availability during the course.	a) Presentation via the virtual campus forum b) Video recording to be on the class blog c)Online debate on the course contents.	a) Creating and managing the virtual spaces prior to the group formation. b) Introducing activities and their deadlines to the students. c) Planning, facilitating, and participating in the debate activity.
2. Group creation process	Create groups with 4 or 5 members.	Groups are formed by students themselves, using the virtual classroom forums and Google Sheets.	Creating the virtual spaces prior to the group formation and the Google Sheet.
3. Intra-group management and establishment of agreements	To agree on group's internal rules and management.	As a group, to discuss and agree on key aspects, such as member's roles and functions, communication tools and their purpose, attitudes to be maintained during the course, and defining how to act when a group member is not committed to the task.	Revision of group agreements and feedback on them to groups.
4. Development of learning activities	Development of the learning proposal based on collaborative projects and case studies.	Interaction to carry out the tasks and activities required by each course.	Supervision and feedback.
5. Assessment	Online self-assessment and peer-assessment of process and results.	Development of a self-reflection of the learning process itself for the enhancement of meaningful learning.	Analyzing student's self and co-evaluations, reviewing the final project-task products, assessing groups' collaborative work processes.

Table 2
Questionnaire items and descriptive statistics.

Construct	Item number	Description	Mean	Standard deviation
Perceived ease of use	PEOU_1	Working collaboratively in a virtual environment was easy for me.	5.43	1.55
	PEOU_2	I found it easy to use a methodology based on collaborative online work to learn within the framework of the course.	5.68	1.35
	PEOU_3	As I progressed through the course, I found it easier to work in a collaborative virtual environment.	6.01	1.34
	PEOU_4	In general, I think it was easy to work collaboratively and remotely with members of my group.	5.38	1.55
Perceived usefulness	PUSS_1	Collaborative work processes have improved my academic performance in the subject.	5.74	1.28
	PUSS_2	Working collaboratively with my group has improved the efficacy of my learning about issues covered in this course.	5.68	1.32
	PUSS_3	Working collaboratively has helped me to learn the course content better.	5.63	1.41
	PUSS_4	The collaborative work we did in my group was useful for me to achieve the course competencies.	5.76	1.35
	PUSS_5	The collaborative work we did in my group helped me to effectively complete the various tasks and activities required by the course.	5.82	1.35
Attitude	ATTI_1	I enjoy learning collaboratively.	5.82	1.42
	ATTI_2	Collaborative work is a good method of learning.	5.99	1.29
	ATTI_3	For me it is rewarding to do academic tasks collaboratively.	5.94	1.27
	ATTI_4	I like the idea of working collaboratively to learn.	5.87	1.37
Confirmation	CONF_1	My experience of working collaboratively in a virtual environment was better than I expected.	5.55	1.60
	CONF_2	Having used a method of working collaboratively as a learning system during this course, it was better than I thought it would be.	5.56	1.52
	CONF_3	Generally, most of my expectations were met about the online collaborative working methods used in the course.	5.61	1.42
Perceived enjoyment	PENJ_1	Working collaboratively in the virtual environment was enjoyable.	5.13	1.62
	PENJ_2	I enjoyed working collaboratively with the members of my group.	5.37	1.57
	PENJ_3	I enjoyed the sensation of working collaboratively in a virtual environment.	5.52	1.58
Satisfaction	SATI_1	After having done the course, I feel satisfied to have used online collaborative working processes as a method to learn.	5.87	1.36
	SATI_2	I am satisfied with the online collaborative working methodology used in the course.	5.83	1.36
	SATI_3	I loved the experience of working collaboratively in a virtual environment during the course.	5.54	1.58
	SATI_4	I am satisfied with the level of skills acquired during the course thanks to online collaborative working.	5.80	1.32
Perceived impact on learning	PIML_1	Having used a method based on online collaborative working during the course, it has made a positive impact on learning the subject.	5.68	1.49
	PIML_2	Being part of a virtual collaborative working team was a significant, valuable help to me in improving my learning processes.	5.65	1.47
	PIML_3	I gained better understanding of some concepts and practices in the course thanks to the online collaborative work with the members of my group.	5.63	1.52
	PIML_4	Online collaborative working helped me to perform academically.	5.61	1.48

technique that is suitable for predicting and evaluating the relationships between latent variables (non-observable constructs) from the indicators in complex models (Chin et al., 2003). In addition, PLS is becoming more commonly used in the educational arena (Marcoulides & Chin, 2013; Al-Emran, Arpaci, & Salloum, 2020) and can be used as a strategy for the development of exploratory models, as in the present study.

Using PLS required two phases (Henseler & Chin, 2010). In the first, we analysed and evaluated the measurement model (Baghaei & Tabatabaee Yazdi, 2016), while in the second phase we produced the structural model to test the research hypotheses from the coefficients thus obtained (Tenenhaus et al., 2005). For the analyses in both phases, we used SmartPLS (version 3.2.7) statistical software.

5.1. Measurement model

As Table 3 shows, we obtained suitable values for both reliability and convergent validity. The Cronbach alpha coefficients were high, in all cases above 0.70 (O'Dwyer & Bernauer, 2014) and composite reliability indices were over 0.5 (Bagozzi & Yi, 1989). These values confirmed the internal reliability of each construct. In terms of convergent validity, the average variance extracted (AVE) was well over the minimum value of 0.5 recommended by Hair et al. (2011). For acceptance levels of loadings, we followed the criteria from Falk and Miller (1992) who stated that loadings should be 0.505 or higher. As Table 3 shows, the values in this study were well above this limit.

To verify that the measurement model was adequate, we examined discriminant validity using two complementary methods. The first was to determine whether the loadings for each indicator in their respective constructs were higher than the cross loadings of the other constructs (Hair et al., 2014), which was the case. We also used the criteria from Fornell and Larcker (1981) to verify that the square root of the AVE for each construct was greater than the correlation between that construct and the others (Table 4).

In addition, the heterotrait-monotrait ratio (HTMT) was checked to determine whether the correlation between two constructs was

Table 3
Reliability and convergent validity.

	Cronbach's alpha	Composite reliability	Average variance extracted (AVE)	Loadings
Perceived ease of use	0.891	0.924	0.751	
PEOU_1				0.858
PEOU_2				0.872
PEOU_3				0.849
PEOU_4				0.888
Perceived usefulness	0.946	0.958	0.822	
PUSS_1				0.889
PUSS_2				0.926
PUSS_3				0.909
PUSS_4				0.926
PUSS_5				0.882
Attitude	0.959	0.970	0.889	
ATTI_1				0.938
ATTI_2				0.939
ATTI_3				0.952
ATTI_4				0.942
Confirmation	0.932	0.957	0.880	
CONF_1				0.952
CONF_2				0.952
CONF_3				0.910
Perceived enjoyment	0.944	0.964	0.899	
PENJ_1				0.943
PENJ_2				0.953
PENJ_3				0.950
Satisfaction	0.957	0.969	0.885	
SATI_1				0.951
SATI_2				0.951
SATI_3				0.934
SATI_4				0.926
Perceived impact on learning	0.959	0.970	0.890	
PIML_1				0.946
PIML_2				0.949
PIML_3				0.941
PIML_4				0.938

less than 0.9 (Henseler et al., 2015) or significantly smaller than 1 (Franke & Sarstedt, 2019; Voorhees et al., 2016).

Additionally, to test the measurement model a confirmatory factor analysis (CFA) was conducted. Different fit indices were used and the results obtained were as follows: $\chi 2/\mathrm{df} = 4.38$; GFI = 0.876; CFI = 0.958; TLI = 0.952; IFI = 0.958; RMSEA = 0.069; 90% CI [0.066 - 0.073]. Once the psychometric requirements for reliability and validity were shown to be met, we evaluated the structural model in order to test our hypotheses.

5.2. Structural model

Evaluation of the structural model involves the analysis of the level of significance of the relationships between the constructs, along with an assessment of their predictive quality. To analyse the robustness of the indicator loadings and whether the relationships between variables were significant, we used a bootstrapping procedure with 5000 subsamples (Hair et al., 2011). Fig. 2 gives a representation of the structural model which includes the latent variables we considered. As R^2 indicates, 84% of the variance of the construct "perceived impact on learning" was explained by the latent variables "satisfaction", "perceived usefulness", "attitude", and "perceived enjoyment" which make up part of the model. Thus, with reference to Chin (1998), who indicated R^2 above 0.67 as substantial and above 0.33 as moderate, the predictive value of the model overall was adequate.

In addition, to evaluate the predictive relevance for each of the endogenous variables in the model we used the Stone-Geisser or Q^2

Table 4
Discriminant validity using the criteria from Fornell and Larcker.

	1	2	3	4	5	6	7
1. Perceived ease of use	**0.867**						
2. Perceived usefulness	0.715	**0.906**					
3. Attitude	0.612	0.644	**0.943**				
4. Confirmation	0.716	0.784	0.639	**0.938**			
5. Perceived enjoyment	0.727	0.776	0.690	0.846	**0.948**		
6. Satisfaction	0.738	0.817	0.726	0.897	0.871	**0.941**	
7. Perceived impact on learning	0.692	0.817	0.749	0.859	0.841	0.890	**0.943**

NOTE: The square root of the AVE for the construct is in bold.

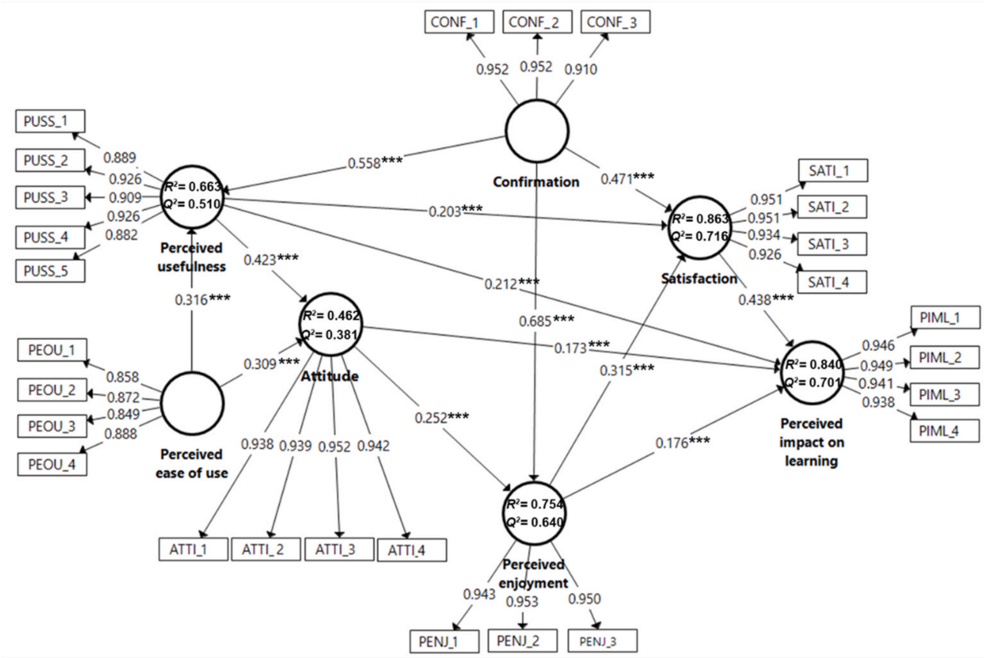

Fig. 2. Evaluation of the structural model via PLS Note: *** = significant at $p < 0.001$.

test. According to Doleck et al. (2017), values above 0 indicate that the model has an acceptable level of predictive relevance, which was the case here, as Fig. 2 shows.

The results show that the thirteen hypotheses we formulated (Table 4) were all supported by the proposed model. In addition to the standardized regression coefficients (β), Table 4 shows the associated T statistics and the significance levels (p-value) which allowed us to establish whether the hypotheses were supported by the proposed model.

We also calculated the f^2 coefficients to examine the effect size between the variables (Chin, Marcolin & Newted, 1996). Cohen (1988) established values of 0.35 (large), 0.15 (moderate), and 0.02 (small) for interpreting f^2. As the Table 5 below shows, there were notable values for f^2 of 0.452 and 0.394 for the relationships between the variables "confirmation" and "perceived usefulness", and between "confirmation" and "satisfaction" respectively. There was also a considerable effect size (0.211) between the constructs "satisfaction" and "perceived impact on learning".

Finally, to evaluate the goodness of fit for the structural model, we used the SRMR (*Standardized Root Mean Square Residual*) proposed by Henseler et al. (2016), which indicates good fit with values below 0.08 (Hu & Bentler, 1999). The result was 0.05.

6. Discussion

The few studies about CSCL that have used structural equation models shared a limited view by not systematically addressing the inherent complexities of collaborative learning in virtual environments. In order to overcome this weakness, in our study we examined various factors that influence university students' satisfaction and perceived learning after using CSCL. In order to do that, we

Table 5
Summary of results and hypothesis testing.

Hypothesized path	β	T Statistic	f^2	Result
H1a. Perceived usefulness → Satisfaction	0.203	t (700) = 6.088, p = 0.000	0.103	Supported
H1b. Perceived usefulness → Perceived impact on learning	0.212	t (700) = 6.088, p = 0.000	0.088	Supported
H1c. Perceived usefulness → Attitude	0.423	t (700) = 7.681, p = 0.000	0.163	Supported
H2a. Perceived ease of use → Perceived usefulness	0.316	t (700) = 7.134, p = 0.000	0.144	Supported
H2b. Perceived ease of use → Attitude	0.309	t (700) = 5.928, p = 0.000	0.087	Supported
H3a. Attitude → Perceived impact on learning	0.173	t (700) = 5.725, p = 0.000	0.086	Supported
H3b. Attitude → Perceived enjoyment	0.252	t (700) = 7.361, p = 0.000	0.152	Supported
H4a. Confirmation → Perceived usefulness	0.558	t (700) = 12.306, p = 0.000	0.452	Supported
H4b. Confirmation → Satisfaction	0.563	t (700) = 11.937, p = 0.000	0.394	Supported
H4c. Confirmation → Perceived enjoyment	0.685	t (700) = 21.335, p = 0.000	1.129	Supported
H5a. Perceived enjoyment → Satisfaction	0.395	t (700) = 8.011, p = 0.000	0.181	Supported
H5b. Perceived enjoyment → Perceived impact on learning	0.176	t (700) = 4.285, p = 0.000	0.043	Supported
H6. Satisfaction → Perceived impact on learning	0.438	t (700) = 8.734, p = 0.000	0.211	Supported

developed a research model with good predictive power (Fig. 2) in which we included latent variables from the three theories of the proposed model (Fig. 1). This gave us an overall picture which is novel in the field of CSCL.

In line with previous studies, such as Cheung and Vogel (2013), we were able to confirm that *perceived usefulness* had a significant positive effect on *satisfaction* (H1a; $\beta = 0.203$; $p < 0.001$; $f^2 = 0.103$), *perceived impact on learning* (H1b; $\beta = 0.212$; $p < 0.001$; $f^2 = 0.088$), and *attitude* (H1c; $\beta = 0.423$; $p < 0.001$; $f^2 = 0.163$). This confirms that students who received education via CSCL thought that this system of learning was valuable.

We also confirmed that *perceived ease of use* was a robust predictor, positively and significantly influencing both students' *attitudes* towards CSCL (H2a; $\beta = 0.316$; $p < 0.001$; $f^2 = 0.144$) and their *perceptions of usefulness* (H2b; $\beta = 0.309$; $p < 0.001$; $f^2 = 0.087$). These findings are consistent with previous studies into CSCL such as Shiue and Hsu (2017). It is important to bear in mind that the participants in this study received guidance from teachers, and obviously the work of teachers is key for students to learn effectively with the members of their groups, as well as to deploy cognitive, organizational, and social interaction processes through various online tools (Hernández- Sellés et al., 2019).

Our data also showed that those students who had favourable *attitudes* towards the use of SCSL perceived a *positive impact on their level of learning* (H3a; $\beta = 0.173$; $p < 0.001$; $f^2 = 0.086$), as well as on their *ability to enjoy* these types of virtual collaborative learning contexts (H3b; $\beta = 0.252$; $p < 0.001$; $f^2 = 0.152$). These results are analogous to other studies into the use of technology such as Muñoz-Carril et al. (2020), Ifinedo (2017b), and Hung et al. (2016). As in those studies, positive attitudes contributed to a more pleasant environment and increased perceived levels of learning.

Confirmation was also shown to be a fundamental variable in the framework of ECM theory. In fact, our results showed that this construct had a significant positive influence, with a large effect size, on *perceived usefulness* (H4a; $\beta = 0.558$; $p < 0.001$; $f^2 = 0.452$), *satisfaction* (H4b; $\beta = 0.563$; $p < 0.001$; $f^2 = 0.394$) and on *perceived enjoyment* (H4c; $\beta = 0.685$; $p < 0.001$; $f^2 = 1.129$). Other research into online collaborative learning, such as Zhou (2017), has confirmed this. That author noted that "when users feel that their actual performance overcomes their prior expectation, their confirmation will be positive. This positive confirmation will thus result in higher-level satisfaction" (p.126).

Perceived enjoyment was also shown to have a significant positive influence on *satisfaction* (H5a; $\beta = 0.395$; $p < 0.001$; $f^2 = 0.181$) and on *perceived impact on learning* (H5b; $\beta = 0.176$; $p < 0.001$; $f^2 = 0.043$) in students who learned in a CSCL environment. In the words of Venkatesh and Dillenbourg and Hong (2008), *perceived enjoyment* refers to "the extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use" (p. 351). The literature confirms that students who experienced sensations of enjoyment in online environments were more satisfied with the learning process and perceived an effective impact on their academic development (Serrano-Cámara et al., 2014).

In terms of the relationship between *satisfaction* and *perceived impact on learning*, in line with recent studies (Ifinedo, 2017a), we confirmed the hypothesis that students' satisfaction during CSCL positively and significantly influenced the perceived impact on learning (H6; $\beta = 0.438$; $p < 0.001$; $f^2 = 0.211$).

7. Conclusions

The confirmation of the 13 hypotheses in our proposed model allows us to identify the factors that contribute to the level of satisfaction ($R^2 = 0.863$) and the perceived impact on learning ($R^2 = 0.840$) in university students who learn using CSCL. More specifically, our results showed that *perceived enjoyment, confirmation,* and *perceived usefulness* have a direct effect, positively and significantly influencing students' *satisfaction* in CSCL environments. In addition, *attitude*, together with *perceived usefulness* and *perceived enjoyment* also directly, positively and significantly influence the *perceived impact of learning* in online collaborative work situations.

The results of this study point towards the need for thorough consideration of various theoretical and practical implications related to CSCL.

7.1. Theoretical contributions

Theoretical implications of this study extend the field of understanding of CSCL and, more specifically, give us a better understanding of the factors that affect learning success and improve levels of satisfaction. It is also worth noting the value of using the three theories, TAM, ECM, and Flow to identify and assess the influence of constructs such as attitude, usefulness, ease of use, and enjoyment in the CSCL learning process.

From the students' perspective, our study allowed the participants to do some self-reflection about the implications of their experience with CSCL. This level of introspection allowed us to discover their concerns, and highlighted the positive impact of working collaboratively in virtual environments. Paraphrasing Lai et al. (2012), we can say that if students feel that CSCL (and the underlying technologies) is compatible with their learning styles, expectations, and beliefs, they will be more inclined to continue adopting online collaborative working methodologies to improve their learning.

7.2. Practical implications

The practical implications can be approached from, at least, three perspectives; the macro, meso, and micro levels. At the macro-level, few studies have explored CSCL via the creation of a model incorporating seven constructs analysed together rather than separately, based on three theories—TAM, ECM, and Flow Theory. The results of this combined analysis using PLS may serve as the basis for extending the scientific literature along this research line and open the door to future studies in the university environment, as well as in other stages of education. Similarly, the research model we proposed may be replicated to validate it in other contexts.

At the meso-level, the study may be useful in prompting academic institutions to think about the need to modify their curriculum policies in order to encourage the use of methodologies such as CSCL, applying it to various knowledge areas in order to promote authentic, active, significant learning by the students (Ornellas & Muñoz Carril, 2014; Hernández-Sellés et al., 2020). This would require university authorities to commit to the design of educational models that address the peculiarities of online collaborative work, along with the provision of suitable technological, organizational, and pedagogical conditions. CSCL is going to become more prominent, not only in universities offering distance or semi-remote programs, but also in traditional in-person institutions which are having to develop virtual education environments thanks to the COVID-19 situation (Abu Elnasr, Hasanein, & Abu Elnasr, 2020; Dhawan, 2020; García-Peñalvo, Corell, Rivero-Ortega, et al., 2021). For these higher education institutions, the transition to online learning systems has involved profound changes for both teachers and students, which is why the results of this study may help education authorities identify the key factors that can affect the effective implementation of methodologies such as CSCL.

At the micro-level, our study may be of particular interest to teachers and students. Teachers should make efforts to guide students about the potential of CSCL (Jeong & Hmelo-Silver, 2016) and provide satisfying collaborative working environments from pedagogical, cognitive, and emotional perspectives. As various studies have confirmed ((Hernández-Sellés et al., 2019; Hamid et al., 2015), teachers play a significant role, guiding students in the use of collaborative communication tools that permit flowing, effective interaction within work groups and acting as mediators in any internal conflicts that may arise.

7.3. Limitations and future lines of research

The present study contributes to the understanding of the key factors that influence satisfaction and perceived impact of learning by university students in the framework of CSCL, and authors wish to point to some limitations that should be taken into consideration and might help in future research in this field. In the first place, since the research has been carried out in a single University, it would be advisable to test the research model based on a greater number of institutions, both nationally and internationally. In addition, and in connection to the generalization of results, it would be appropriate to use a larger and more heterogeneous sample of students from different fields of knowledge and educational levels, such as undergraduate, graduate, and postgraduate students.

Another aspect to be considered is the possibility to adopt a mixed methodology in future research, which would allow a qualitative deepening and understanding of some of the emerging results, in particular, of the underlying context in which the CSCL studies have been carried out.

On the other hand, it should be noted that the present study focuses only on student's perception in a CSCL context. It would be interesting to add the teachers' perception, since they have a fundamental role in the process, connected to the planning, implementation, and evaluation of CSCL.

Author statement

All authors contributed to the research design and development, discussed the results and contributed to the final manuscript.

Declaration of interest

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Authors' contributions

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