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Collaborative learning in management subjects to university students: A multi-level research to identify group profile, engagement and academic performance

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ABSTRACT

Our research has consisted of a multilevel analysis of work groups within the framework of collaborative learning methodology through the Computer-Supported Collaborative Learning (CSCL) approach with respect to students who operate through a non-CSCL approach as a group of students control. The objective, in addition to examining to what extent the CSCL approach is more beneficial for academic performance, has been to identify the individual and group characteristics associated with work groups through the behavior of a set of variables. The research uses academic results obtained from a sample of 367 university students. The factors that most strongly contribute to reactive-positive behavior within the analyzed group profiles are the use of the CSCL approach, a higher average age of the group, a higher level of university experience, and a high level of qualification to access the degree required by the university.

1. Introduction

In 1999, the European Higher Education Area proposed collaborative learning as a useful tool for the development of skills and abilities among university students. Since then, the use of this methodology within the framework of educational innovation has become widespread due to the use of new information technologies. Numerous investigations have been carried out, and the use of collective learning through working groups has intensified during the COVID-19 pandemic. This was described in the fourth objective of the European Higher Education Area in 2020 -Bologna Process Implementation Report- (2020). There is also a need for educational transformation within the framework of quality education in the 2030 Agenda.[1] In this context and, as stated by Volet, Jones, and Vauras (2019), collaborative learning environments constitute a field of research that allows exploring important aspects such as learning participation and its active interaction degree, characteristics or profiles of the work group and group engagement degree.

The adequate planning and scheduling of activities through collaborative teamwork can enhance the motivation and efficiency of individual learning through the exchange of shared knowledge (Laux, Luse, & Mennecke, 2016; Malmberg, Järvelä, Järvenoja, &

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[1] -Naciones Unidas. Objetivos de Desarrollo sostenible: Objetivo 4.7 sobre Educacion global y Desarrollo sostenible. Available at: https://www.un.org/sustainabledevelopment/es/education/(Accessed 15 july 2020).

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Panadero, 2015). However, the acquisition of knowledge is not always guaranteed and does not always reflect the expected results, in most cases due to the lack of the necessary skills among the students in the group (Johnson & Johnson, 2004; Miller & Hadwin, 2015) or the lack of group identification and commitment due to the preference for the development of individual activities (Curşeu, Rusub, Maricuţoiu, Vîrgă, & Măgurean, 2020). According to Erkens and Bodemer (2019), requirements for the success of cooperative learning include the individual awareness regarding the previous knowledge that their group peers have and the aggregation of knowledge in the field of the work group through conscious integration of the members. However, individuals are sometimes unaware of the abilities of their groupmates, thereby increasing the emotional exposure of the student, which is typical in business education (Cope, 2003).

Personal learning environments, such as digital learning environments, have strongly contributed to the development of collaborative learning, as they are tools for information, communication, and cooperation (Castañeda & Adell, 2013; Gutiérrez-Porlán, Román-García, & Sánchez-Vera, 2018). More specifically, the application of computer-supported collaborative learning (CSCL) has had a significant impact on the development of group activities (Dillenbourg, 2003), although an adequate level of planning is required for group activities to ensure effectiveness, adequacy and social dimensions in the framework of collaborative learning (Hernández, González, & Muñoz, 2014). As several studies point out, CSCL allow for greater effectiveness of group learning through the participation and cooperation of students (Pattanpichet, 2011; Yazici, 2004), an organization of activities that is more flexible, versatile and with greater specific contribution (Durán & Amandi, 2011), as well as greater interactivity in the framework of the working group for the execution of the proposed activities (So & Brush, 2008) in a shared way and exploring information through personal interaction (Reychav, McHaney, & Burke, 2017) what supposes two forms of engagement; engagement with the task -study engagement- and engagement with the group -group study engagement- (Meslec & Curşeu, 2015; Volet, Vauras, Salo, & Khosa, 2017).

Collaborative learning must be an integral aspect of the creation of a group consciousness, as this approach will make use of the diversity of identities associated with each work group. The different types of motivation and personalities of each student combined with the group profile that arises when they interact intrinsically determines a particular collaborative learning approach that is difficult to control and parameterize (French & Kottke, 2013) since, new knowledge and ideas are generated that transcend the knowledge and understanding that the members of the group have individually (Meslec & Curşeu, 2015). Our research aims to investigate the diversity of identities that are detected in the work groups, the characteristics of the groups, and the essential traits that affect group interactions based on a set of factors that affect learning process, the group, or the individuals. We have categorized these factors into process factors and environmental factors (Andreu, 2011; Murillo, 2008; Pardo, Ruíz, & San Martín, 2007) that allows us to develop a multilevel analysis applied to the collaborative learning approach proposed in the university environment.

Our research is largely linked to what Curşeu et al. (2020) regarding the need to carry out more in-depth research regarding the individual differences of collaborative work groups, their contextual influences and their identification and profile in order to undertake positive adjustments to this learning tool. The research has two objectives. The first objective is to analyse and assess the performance trend in collaborative learning with respect to planned group activities throughout the academic year. The second objective is to analyse and assess how collective group learning contributes to students' individual performances, as assessed by exam grades. The results will be helpful in identifying the factors that significantly influence the dynamics of the work groups, the strengths and weaknesses of these groups show and the possible limitations of the applied collaborative learning approach.

This article is divided into four sections. In the second section, the theoretical framework and aspects related to the collaborative learning method under investigation are described. In the third section, the collaborative learning experience, the most relevant aspects of the sample and the methodology applied to the research are described. In the fourth section, the results are discussed. In the last section, our conclusions are presented.

2. Theoretical framework and methods of applied collaborative learning

The collaborative learning approach applied through the CSCL environment under investigation is based on the knowledge integration model proposed by Kintsch (1988; 2005). This learning process uses a set of previous knowledge to integrate, connect, and activate the learning autonomy of the working groups, wherein teachers monitor or guide the group (Erkens & Bodemer, 2019). This learning approach proposes two distinct but complementary and successive functions (Erkens & Bodemer, 2019). First the availability of previous thematic content that allows the activation of knowledge and individual training (Dochy, De Rijdt, & Dyck, 2002) contributes to improving the level of connection and homogeneity of group learning (Bodemer, Janssen, & Schnaubert, 2018). Second, collaborative learning uses group learning based on the previous knowledge mentioned above, texts, case studies, practical exercises and general preselected parts of the basic learning material or thematic modules (Dehler, Bodemer, Buder, & Hesse, 2011; Sangin, Molinari, Nüssli, & Dillenbourg, 2011).

2.1. The applied CSCL environment

Our collaborative learning approach integrates two tools: the Moodle platform, which is designed for the subject of group learning; and the One Drive platform, which is a tool that allows the exchange of the contents of group activities. In this way, Moodle serves as a basis for prior learning and is used to report the activities that are carried out in teams whose group work is evaluated. One Drive operates as an environment wherein collaborative work is developed. Both of these interrelated tools use the collaborative learning strategy as a framework for studying, analysing, understanding, reflecting upon and developing general and specific skills among students, which leads to adequate communication, the management of shared resources and the exchange of knowledge (Marín, Negre, & Pérez, 2014). Likewise, the use of technology facilitates communication between students, thereby minimizing possible personal communication problems and improving, a priori, the results derived from collaborative work in a team learning environment (Jones,

Connolly, Gear, & Read, 2006). Fig. 1 describes the CSCL environment and its execution phases: phase 1 involves independent and prior individual learning, phase 2 involves the development of group activities, phase 3 involves the process of reporting group activities, and phase 4 involves the process of evaluation and the qualification of group learning.

The process designed for collaborative learning activities using CSCL support is set out below.

- Phase 1: Corresponds to the individualized work by students of the thematic modules that make up each collaborative learning activity. Based on the given master class in the classroom, the following resources are made available to students through the "virtual classroom Moodle" tool: links to training resources open source in the University's virtual library, links to videos illustrative on matters and aspects of special relevance contained in these thematic modules, real and practical examples proposed by the teacher and, in some cases, press clippings related to the subject taught. This phase comprises approximately one week prior to the collaborative learning activity where the student, through the "Ms-office Teams" tool, can ask questions and doubts to the teacher (chat or videoconference in exceptional cases).
- Phase 2: Make available to students the contents of the group activity to be accomplished through collaborative learning in the classroom. The contents are distributed to each student through the "Ms Office One Drive" tool. The time length of the activity is 2 h.
- Phase 3. Resolution of the group activity and completion of the activity questionnaire through the "Moodle Platform" where, at the end of it, the activity is reported to the teacher and the student automatically visualizes the grade obtained. The student has deferred feedback once the activity is finished for those incorrect answers.
- Phase 4: Discussion on the group activity: Discussion in the classroom on the performance of the group activity and exhibition by students of possible group conflicts and existing incidents in the development of the same.

2.2. The dissemination of the collaborative learning approach and assignment of roles

The dynamics of collaborative work are explained in detail by teachers via an information session to create and enhance initial awareness (Buder, 2017). Teachers also describe the learning objectives, the required training, the context of group work and the necessary distribution of roles (Exley & Dennick, 2007; Guitert, 2011; Muehlenbrock, 2006). This is important because, as stated by Johnson and Johnson (2004), a lack of communication or poor communication of precise instructions decreases the effectiveness of group learning. On the other hand, detailed and clear communication of the competencies pursued by the work dynamics – general, transversal and specific competencies – (Rubia, 2010) leads to the integration and achievement of objectives required by the proposed collaborative learning methodology. After this information session, the members of each group meet one another with the objective of promoting group awareness, providing opinions and exchanging knowledge regarding their capacities and abilities, all of which are beneficial actions for defining roles and increasing the efficiency of group learning (Crommelinck & Anseel, 2013).

The definition of roles in the working groups has been adapted based on the eduScrum model (Delhij & Van Solingen, 2013; Noguera, Guerrero-Roldán, & Mas, 2018), which is described below in Table 1.

2.3. The contents of learning and its planning

The learning approach has been applied to the subject of production & operations management, a subject of both theoretical and practical nature in which group work significantly facilitates the development of competencies, skills and autonomous learning among students (Fitzpatrick & Ali, 2011; Oltra, García, Flor Peris, & Boronat, 2013; Yazici, 2004). The course comprises eight thematic units that are grouped into four modules of group activities. The group activities are selected according to the contents taught and include procedural aspects for the analysis and resolution of the problems, cases and programmed exercises (Escofet & Marimon, 2012). According to Haake and Pfister (2010) and Onrubia and Engel (2012), the design and planning of the activities and the process of communicating these activities to students includes the use of basic manuals and online resources that guide the development and execution of group activities.

3. Methodology

3.1. Description of the research experience and participants

The research has been applied to university students pursuing degrees in disciplines that teach collaborative learning, including business administration & management (BA&M), audiovisual communication and business administration & management (AC-BA & M), law and business administration & management (L-BA & M) and advertising and business administration & management (A-BA & M). All the degrees in relation to "business administration & management" present the same training itinerary and, specifically, the contents of the subject of "production & operations management" under study and its scheduled group activities, are homogeneous for all the degrees. The subject of "production & operations management" is taught according to what is described in section 2.3.

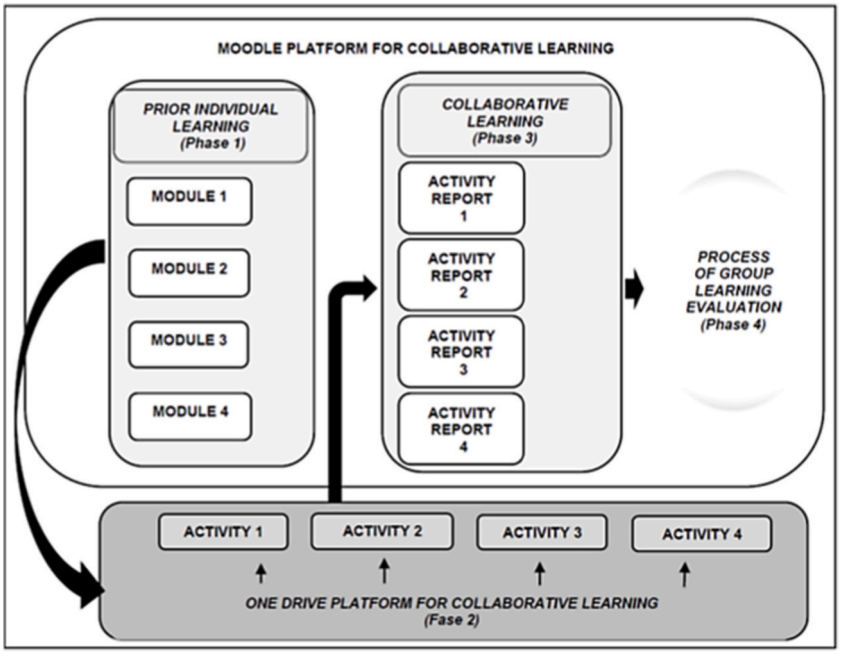


Fig. 1. Description of the applied CSCL and its execution phases. *Source*: Description of the applied computer-supported collaborative learning.

Table 1
Description of roles and their mission.

Roles	Mission
CSCL environment	• Instructions on learning objectives. • Instructions on group activity dynamics. • Learning performance assessment.
Work Teams	• Autonomy and Decision-making. • Assignment and distribution of activities. • Flexibility of action that guarantee learning productivity • Establishment of communication and information channels. • Responsibility for reporting group activities on time
Group Coordinator	• Leadership in the work group • Distribution of tasks according to abilities and skills. • Compliance with work rules and procedures. • Compliance with activities on time. • Collaborator and task facilitator. • Intermediation between group and instructor in conflict and incident resolution.
Teacher-monitor	• Establishment and communication of the collaborative learning plan. • Organization, monitoring and promotion of cooperative learning dynamics. • Task facilitator.

Source: Delhij & Van Solingen, 2013 and Noguera et al., 2018, adapted to the collaborative learning approach proposed in this research.

A first level segmentation was consider taking into account the student age, qualification of access to the degree, sex, degree and years of experience at the university. Therefore, all the analysis considers these factors as potential discriminant variables in the student performance evaluation tests.

The learning groups are composed of five students who were randomly allocated.[2] The research examines two typologies of group learning.

[2] The random grouping of students – given the homogeneity of previous knowledge they possess – allows the consolidation of the degree of commitment in the grouping (Guitert et al., 2003; Webber & Webber, 2012). In accordance with recommendations for sample selection techniques in design of experiments.

- Working groups under the CSCL methodology: groups work associated with a collaborative learning approach under a CSCL environment as a research "objective group", which operate according to the methodology described in section 2 -process described in Fig. 1-, whose roles and missions have been described in Table 1 and,
- Working groups under non-CSCL methodology: groups work associated with a collaborative learning approach that operate under a non-CSCL as a research "control group" whose work dynamics differ from CSCL groups in that they do not operate through a CSCL environment such as is described in Fig. 1 of section 2 nor are the roles and missions as described in Table 1 rigorously and explicitly assigned. Basically, working groups under non-CSCL methodology are commissioned to carry out the group activities at the end of each thematic block, which are sent with a weekly deadline by email to the professor-monitor who proceeds to their evaluation.

The weighting of the group activities in both learning approaches represents 20% of the final grade of the subject since collaborative work is more effective and more highly valued by the student if it is related to their grades (Machemer & Crawford, 2007).

3.2. The sample and the data

The sample consists of 367 students. The collaborative learning approach in the non-CSCL environment is applied to students pursuing BA&M and AC-BA & M degrees, while the collaborative learning approach in the CSCL environment is applied to students pursuing L-BA & M and A-BA & M degrees. The data that are necessary for analysis are defined in section 3.3 and were obtained through the records of the Rey Juan Carlos University website (https://www.urjc.es/intranet-urjc, 2019).[3]

The student's age ranged 18–30 years, with an average value 19.7 ± 1.17, 64.3% where females and had a university experience ranged between 2 and 5 years, being the 38.7% of the students on their second enrolled university year and the 53.1% of the students on their third enrolled university year. The average punctuation score to access to the university degree was 7.91 ± 1.08 over a total value of 14 in a range between 6.5 and 9.7 points.

3.3. The applied research methodology

The variables examined herein include the following. The learning tendency is used to assess the performance of the group activities among the work groups. The typology of learning tendencies used is described in Appendix 1. Exam grade is used to indicate the student's performance in the individual assessment (i.e., the exam), this allowing us to measure the impact of collaborative learning on the individual performance. The explanatory variables used are classified into two groups: process variables, such as the methodology of applied learning and average age of the work group; and environmental variables, such as student age, qualification of access to the degree, sex, degree and years of experience at the university.

A multilevel model was applied to examine the data, thus enabling three types of analysis: the effect of the learning tendency on group performance; the effect of exam grades on group performance; and a design of experiments to examine the tendency and exam grade variables.

4. Results and discussion

The results of the analysis for the learning tendency and exam grade variables are shown below. The exam grade variable does not present a normal pattern. However, if we consider the BA&M degree and the rest of the BA&M double degrees as a group, the Kolmogorov–Smirnov test indicates a normal distribution (p value = 0.114 and p value = 0.153, respectively).

4.1. Analysis 1: The trend of collaborative learning

The learning trend for the work groups is shown in Table 2. The analysis of the learning trend according to the applied learning methodology – CSCL environment and non-CSCL environment – and the variables of university degree, university experience and gender was carried out using a contingency table and the Fischer homogeneity test.

Table 3 shows a significant reactive trend for work groups associated with the CSCL learning methodology. The homogeneity contrast of the chi-square test rejects the hypothesis of independence (p value = 0), indicating significant differences in the trend of learning performance measured through the average grade of group activities between the CSCL and non-CSCL groups. Eighty percent of the work groups using the CSCL approach showed a positive reactive trend compared to 100% and 93.3% of the retroactive and random trends, respectively, observed in work groups using the non-CSCL approach. This last indicator represents the lack of motivation among work groups using the non-CSCL approach.

Table 4 shows the learning trends with respect to university degrees. The homogeneity contrast of the chi-square test rejects the hypothesis of independence (p value = 0), indicating that there are significant differences in the learning trend across university degrees. The learning trend the AC-BA & M and BA&M degrees was random (60.9%) and decreasing (36.7%), respectively, and

[3] Group grades and individual assessment grades have been obtained through the Virtual Classroom linked to the Production & Operations Management subject (https://www.aulavirtual.urjc.es/moodle/course/view.php?id=153298 accessed June 2019) and other publicly available student personal data (https://gestion.urjc.es/ServiciosApp/;PortalJSESSION=XihIWghPHOqucT3LTsTK7c2PY4jsYrU13MyJ3UnmQLtquWmprOK8!1103555798 (Accessed june, 2019).

Table 2
Collaborative learning trend.

Trend	Frequency	%	% accumulated
Increasing	0	0.0	0.0
Decreasing	105	28.6	28.6
Reactive	147	40.1	68.7
Retroactive	25	6.8	75.5
Random	90	24.5	100.0
Total	367	100.0	

Table 3
Learning groups trend according to learning methodology.

Trend	Learning Methodology			
	Non-collaborative Learning		Collaborative Learning	
	Cases	%	Cases	%
Increasing	0	0.0	0	0.0
Decreasing	69	65.7	36	34.3
Reactive	29	19.7	118	80.3
Retroactive	25	100.0	0	0.0
Random	84	93.3	6	6.7

Table 4
Learning groups trend according to university degree.

Trend	University Degree							
	AC-BA&M		BA&M		L-BA&M		A-BA&M	
	Cases	%	Cases	%	Cases	%	Cases	%
Increasing	0	0.0	0	0.0	0	0.0	0	0.0
Decreasing	4	17.4	22	36.7	41	28.3	38	27.3
Reactive	5	21.7	20	33.3	67	46.2	55	39.6
Retroactive	0	0.0	10	16.7	10	6.9	5	3.6
Random	14	60.9	8	13.3	27	18.6	41	29.5

students in these programmes were using the non-CSCL approach. Students in the L-BA & M and A-BA & M programmes, who were using the CSCL approach, show a trend of significant reactive performance (46.2% and 39.6%, respectively).

Regarding years of university experience,[4] the results in Table 5 show a tendency towards reactive learning among students with more university experience. The homogeneity test of the chi-square rejects the hypothesis of independence (p value = 0.001), indicating that there are significant differences in the learning trend with respect to the years of university experience. One hundred percent of students with at least four years of university experience show this reactive tendency (46.2% and 39.6%) compared to those students with less experience (43% and 37.4%). The group learning trend was not affected by gender since no significant gender differences were detected according to the chi-square homogeneity contrast test (p value = 0.73).

A series of unifactorial experiments was used to analyse the design of experiments on a factor, the age of the students and the qualification of access to the degree on the learning tendency. Table 6 shows a retroactive learning trend associated with lower average values of access to the degree, while there are no significant differences in the average age of the groups with a random, decreasing or reactive trend.[5] The nonnormal distribution of the qualification of access to the degree variable does not allow for classical hypothesis testing, but the high F statistic indicates that there is a difference in average values of qualifications of access to the degree between the CSCL and non-CSCL approaches. The univariate ANOVA indicates a significative effect of the group learning trend according to degree access qualification (F-value = 5046.51, p-value≈0). The findings indicate that the effect of qualification of access to the degree on the learning trend has an $R^2 = 0.982$. Fig. 2a and b shows the estimated marginal means of the qualifications of access to the degree with respect to the learning trend and show a box plot that illustrates the existence of a separate group with a retroactive tendency linked to lower qualifications of access to the degree.

An analysis of the work groups according to university degree grouping – i.e., the BA&M degree compared to the set of double degrees (AC-BA & M, L-BA & M and A-BA & M) – reveals that there are differences in student age and average age of the learning group. We must emphasize that, for both groups of degrees, the nonnormality of the average age variable does not allow for classical

[4] The subject "Production & Operations Management" is taught in the second, third or fourth year depending on the type of degree studied.
[5] The Levene test rejects the hypothesis of equality of variances in all the groups considered (p-value = 0.002), the variability being significantly higher in learning groups with a reactive tendency.

Table 5
Learning groups trend according to years of university experience.

Trend	Years of university experience							
	2 years		3 years		4 years		5 years or more	
	Cases	%	Cases	%	Cases	%	Cases	%
Increasing	0	0.0	0	0.0	0	0.0	0	0.0
Decreasing	42	29.6	60	30.8	3	10.3	38	27.3
Reactive	61	43.0	73	37.4	11	46.2	55	39.6
Retroactive	7	4.9	10	5.1	8	6.9	5	3.6
Random	32	22.5	52	26.7	6	18.6	41	29.5

Table 6
Learning trend regarding to degree access qualification.

Trend	Average	Standard Deviation	Cases
Decreasing	7.82009	1.097263	105
Reactive	8.08541	1.237726	147
Retroactive	7.21760	0.713997	25
Random	7.95354	0.771451	90
Total	7.91805	1.085911	367

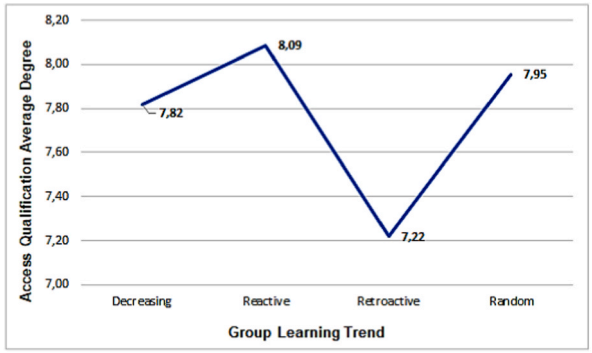


Fig. 2a. Group learning trend respect to degree access qualification.

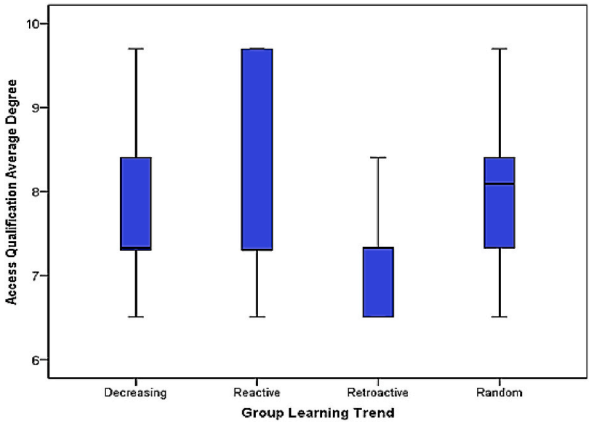


Fig. 2b. Group learning Trend.

hypothesis testing; however, the high F statistic indicates that there is a difference in average values in this variable.

Learning groups associated with the BA&M degree. Table 7 reveals a retroactive learning trend associated with the average ages of older students, with no significant differences in average ages between random, decreasing and reactive learning trends. The Levene test rejects the hypothesis of equality of variances in all the groups considered (p value = 0.002), indicating a significantly higher

Table 7
Average student age - Group learning trend.

Trend	Average	Standard error	Confidence interval 95%	
			Lower limit	Upper limit
Decreasing	18.455	0.124	18.206	18.703
Reactive	18.350	0.130	10.089	18.611
Retroactive	19.300	0.184	18.931	19.669
Random	18.125	0.206	17.713	18.537

Estimates: Student Average age respect to group learning trend.

variability with a retroactive trend. The results of the ANOVA applied to the average age of the student based on the learning trend indicates a significative effect of the group learning trend according to students age (F-value = 15180.56, p-value≈0), yielding an R^2 = 0.999. Fig. 3a and b shows the estimated marginal means of age with respect to the learning trend for this degree and illustrate the existence of a separate group with a retroactive trend based on the average ages of older students.

Collaborative learning groups associated with degrees (AC-BA&M, L-BA&M y A-BA&M). Table 8 reveals that the tendency of reactive learning is associated with older students, while there are no significant associations between average student ages and a random, decreasing or retroactive tendency. The Levene test rejects the hypothesis of equality of variances in all the groups considered (p value = 0.002), indicating that the variability of a reactive tendency is significantly higher. The results of the ANOVA applied to the average age of the student based on the learning trend indicates a significative effect of the group learning trend according to students age (F-value = 26,276.67, p-value≈0), yielding an R^2 = 0.997. Fig. 4a and b shows the estimated marginal means of age with respect to the learning trend for this group of degrees and illustrate the existence of a separate group with a reactive trend in the case of higher average age values.

4.2. Analysis 2: Effect of the learning approach on the exam score

There is a strong linear relationship between the exam grade with respect to the qualification of access to the degree and the average age of the group. We performed a stepwise regression analysis to examine the relationship between exam grade and the explanatory variables, i.e., qualification of access to the degree, age of the student, average age of the learning group and years of experience in the degree. This regression model did not have a constant variable, which indicates that the selected variables would be the qualification of access to the degree and the average age of the group. The regression equation is shown in Eq. (1), where R^2 = 0.95. The Kolmogorov–Smirnov normality test for the model residuals indicates a normal distribution (p value = 0.123), thereby validating the regression model.

$$\textit{Exam score} = 0.97\ \textit{Qualification access score} - 0.137\ \textit{Average age group} \tag{1}$$

We carried out experiments to analyse the effects of the applied methodology, sex, degree and years of university experience on the exam score. Table 9 shows that the Kolmogorov–Smirnov contrast test on the test score variable rejects the null hypothesis for the set of degrees studied. If we consider the BA&M degree and the rest of the double BA&M degrees separately, we can assume normality, which validates our analysis.

Learning methodology regarding exam grading. The learning methodology applied to the BA&M degree is non-collaborative, and the sex and university experience variables are not significantly associated with exam scores.

For the set of double BA&M degrees, the Levene test[6] rejects the null hypothesis of homogeneity of variance, as the source of variation was the methodology applied with respect to exam grade. The results of the ANOVA applied to the exam scoring and the applied learning methodology and years of university experience indicates significant differences in the exam score with respect to the type of methodology used and the years of experience in the degree (F-value = 3,605, p-value = 0.059 and F-value = 9.725 and p-value≈0). The average grade is higher when the learning is collaborative and when the student has at least three years of experience, as shown in Table 10. The parameters of the bifactorial model of main effects are shown in Table 11. Finally, it should be noted that gender was not significantly associated with exam scores.[7]

5. The tendency of the learning group and the learning methodology applied: effects on exam grades

To examine the tendency of the learning group and the learning methodology applied and the effects on exam grades, an analysis was carried out through two groups: learning groups associated with the BA&M degree and learning groups associated with doubles degrees, where the assumption of normality is assumed in the exam grades variable.

The tendency of the learning groups and the methodology applied: Effects on the exam scores in the BA&M degree. Table 12 shows a

[6] The Levene test applied to the variables of learning methodology and university experience offers an F statistic of 5,424, a value of 6 and 300 for one and two degrees of freedom and a significance of 0.000.

[7] The Kolmogorov–Smirnov normality test for the model residuals assumes the hypothesis (p-value = 0.262) which validates the bifactorial main effects model.

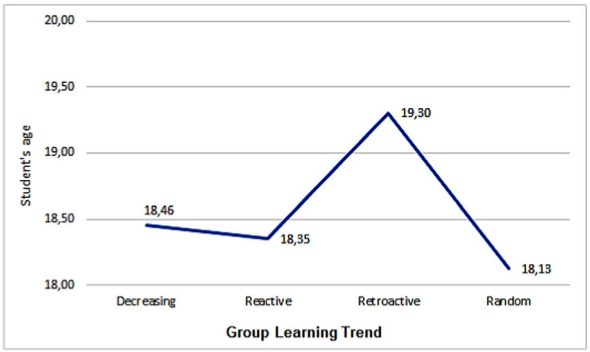


Fig. 3a. Group learning trend respect to Student average age.

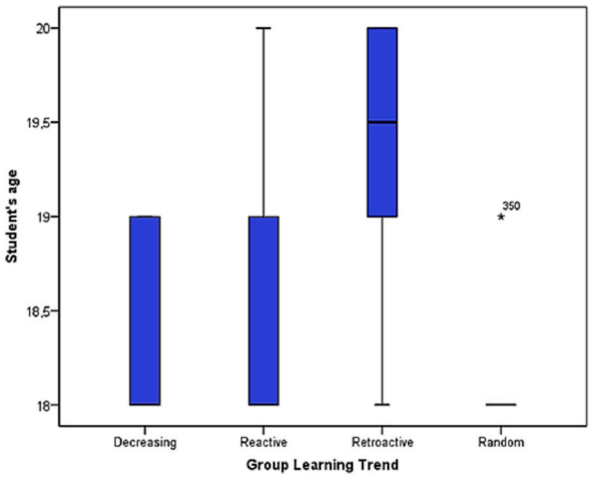


Fig. 3b. Group learning trend.

Table 8
Average student age - Group learning trend.

			Confidence interval 95%	
Trend	Average	Standard error	Lower limit	Upper limit
Decreasing	19.855	0.118	19.623	20.088
Reactive	20.244	0.096	20.056	20.432
Retroactive	19.333	0.278	18.786	19.881
Random	19.646	0.119	19.412	19.880

Estimates: Student Average age respect to group learning trend.

decreasing trend of the learning groups associated with higher exam scores, with no significant differences in the average exam score of the work groups between reactive or retroactive trends. The random trend is associated with learning groups that have a lower average exam score.[8] Fig. 5 shows the average exam scores with respect to the trend factor of work groups in the BA&M degree. The univariate ANOVA reveals that there are no significant differences in exam scores between the learning trends.

The tendency of the learning groups and the methodology applied: Effect on the exam score in the double degrees of BA&M. Table 13 shows that the learning approach is not significantly associated with exam scores among students pursuing double degrees. Table 14 shows that there is a decreasing trend among students with higher average scores, while there are no significant differences in the average test

[8] Levene's test assumes the hypothesis of equality of variances for all learning groups, which are associated with the non-cooperative learning approach (p-value = 0.347).

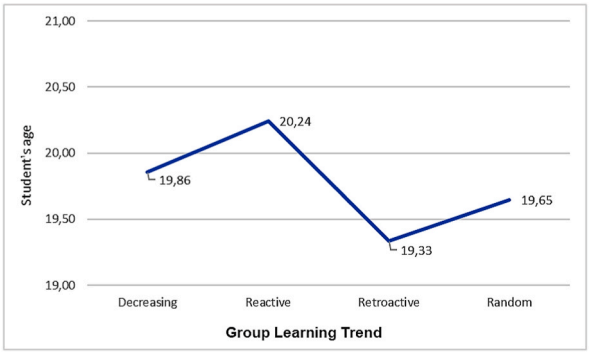


Fig. 4a. Group learning trend respect to Student average age.

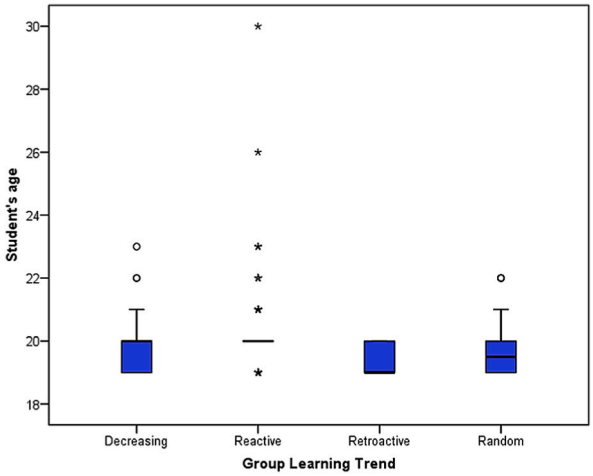


Fig. 4b. Group learning trend.

Table 9
Kolmogorov-smirnov contrast on exam scores.

		Total Degrees	BA&M degree	AC-BA&M, L-BA&M and A-BA&M degrees
Cases		367	60	307
Normal parameters[a,b]	Average	5.0208	3.5767	5.3030
	Standard Deviation	1.97371	1.54496	1.92622
More extreme differences	Absolute	0.074	0.154	0.065
	Positive	0.074	0.154	0.059
	Negative	−0,069	−0.110	−0.065
Z of Kolmogorov-Smirnov		1.408	1.196	1.134
asymptotic significance (bilateral)		0.038	0.114	0.153

[a] The contrast distribution is a Normal distribution.
[b] The normal parameters have been calculated from the data.

score between groups with a reactive, random or retroactive trend.[9] Fig. 6 shows the average exam scores with respect to the learning trends of work groups in the double BA&M degrees. The univariate ANOVA reveals that there are no significant differences in exam scores between learning trends.

[9] The Levene test rejects the hypothesis of equality of variances in all the groups considered (p-value = 0.002), being higher in the group with a random trend.

Table 10
Descriptive statistics: Exam Scoring - Applied Learning Methodology and years of university experience.

Trend	University Experience	Average	Standard Deviation	Cases
Non-collaborative learning	2 years	4.6250	2.07736	44
	3 years	5.4402	2.08730	97
	4 years	5.2000	1.51261	6
	Total	5.1864	2.08611	147
Collaborative learning	2 years	4.6543	1.36863	63
	3 years	6.1269	1.71022	80
	4 years	5.0447	1.84683	15
	5 years	3.2950	3.62746	2
	Total	5.4102	1.76647	160
Total	2 years	4.6422	1.68713	107
	3 years	5.7506	1.95109	177
	4 years	5.0890	1.72184	21
	5 years	3.2950	3.62746	2
	Total	5.3030	1.92622	307

Table 11
Exam Scoring - Applied Learning Methodology and years of university experience.

					Confidence interval 95%	
Dependent variables	B	Standard error	t	Sig.	Lower limit	Upper limit
Learning Methodology						
Non-collaborative learning	2.887	1.325	2.180	0.030	0.281	5.494
Collaborative learning	3.295	1.307	2.521	0.012	0.723	5.867
University experience	1.515	1.322	1.146	0.253	−1.087	4.117
2 years	2.679	1.320	2.030	0.043	0.082	5.276
3 years	1.911	1.369	1.395	0.164	−0.784	4.605
4 years	0[a]					
5 years						

[a] Zero value parameter for being redundant.

Table 12
Average Exam Score - Learning group trend.

Trend	Average	Standard deviation	Cases
Decreasing	3.8545	1.90306	22
Reactive	3.4750	1.35797	20
Retroactive	3.4700	1.34499	10
Random	3.2000	1.21302	8
Total	3.5767	1.54496	60

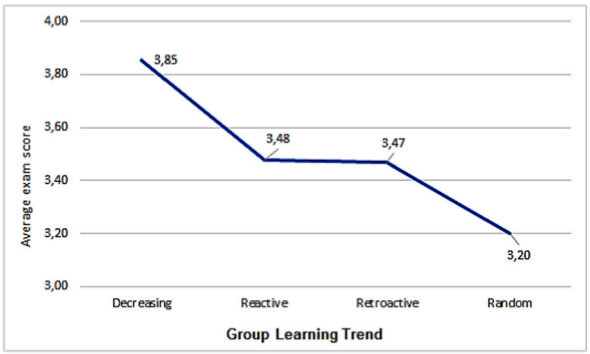


Fig. 5. Average exam score - Learning group tren

Table 13
Average exam score - Applied learning methodology.

Learning methodology	Average	Standard Deviation	Cases
Non-collaborative learning	5.1864	2.08611	147
Collaborative learning	5.4102	1.76647	160
Total	5.3030	1.92622	307

Table 14
Average exam score - Learning group trend.

Trend	Average	Standard Deviation	Cases
Decreasing	5.6240	1.97376	83
Reactive	5.2009	1.75117	127
Retroactive	5.0200	1.62446	15
Random	5.1882	2.16714	82
Total	5.3030	1.92622	307

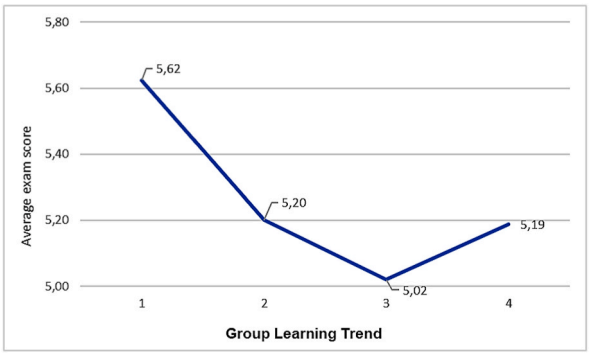


Fig. 6. Average exam score - Learning group trend.

6. Conclusions

Research on different approaches to collaborative learning under the proposed CSCL environment shows that a reactive-positive group learning dynamic is beneficial and leads to increasing performance. This dynamic of reactive-positive learning should be understood as a positive indicator of the proposed learning approach and assumes the awareness and progressive capacity of the work group to improve their collective learning results at a certain moment during the execution of the study. The learning process examined herein can be used to improve motivation and the framework of the learning dynamics. Insurmountable aspects, such as a lack of group integration at the beginning of the learning process or lack of experience and discipline in this dynamic, may have a significant impact such that the proposed learning approach does not lead to improved performance.

A significant fact to highlight is that the CSCL environment is significantly more intensive and enhances group learning than the non-CSCL environment. In the latter approach, the trend of learning performance is retroactive-negative, random and even decreasing, which denotes a low level of motivation towards group learning and indicates that aspects such as adequate and accurate planning, communication about the learning dynamics, and the definition of roles are important to the success of a learning approach.

In addition to using a CSCL approach, the factors that most strongly contribute to a reactive-positive trend and define the profile of the work groups are a high qualification of access to the degrees investigated, a high average age of the work group and a high level of university experience. Factors that do not positively influence collaborative learning methodologies include a non-CSCL environment, in which group learning is discouraged in favour of a greater tendency towards individual student learning. Thus, we can conclude a non-CSCL approach clearly and significantly discourages the student regarding collaborative learning. However, certain factors that shape the profile of the members of the work group, such as saving face, avoiding embarrassment, potential intimidation in the group work environment or conformity and inability to manage conflicts, are factors that are always difficult to measure when examining student participation in collaborative tasks (Micari & Drane, 2011; Robinson, Harris, & Baurton, 2015; Vuopala, Hyvönen, & Järvelä, 2016).

Finally, it should be noted that the impact of collaborative learning on individual performance, which was measured by exam grades, is not significant. It was commonly observed that in the face of decreasing learning trends, students have better individual performances, which suggests a lack of connection between group learning and individual student learning. In this sense, we agree with the research carried out by Chan, Wan, and Ko (2019) and Tan and Vicente (2019) who point out that the need to design activities under a collaborative learning environment with a higher level of motivation and entertainment, as well as those that allow greater

creativity in the development of activities can significantly promote greater interactivity. and learning performance.

Future research should investigate why the fundamentally positive learning approach only works among individuals with a more years of university experience. Such findings suggests that learning approaches should be adapted based on the year in which the subject is taught or what competencies from the student's perspective need to be enhanced and improved in the collaborative learning approach. Research on students' degrees and the use of a collaborative learning approach should be further examined in this field.

Author statement

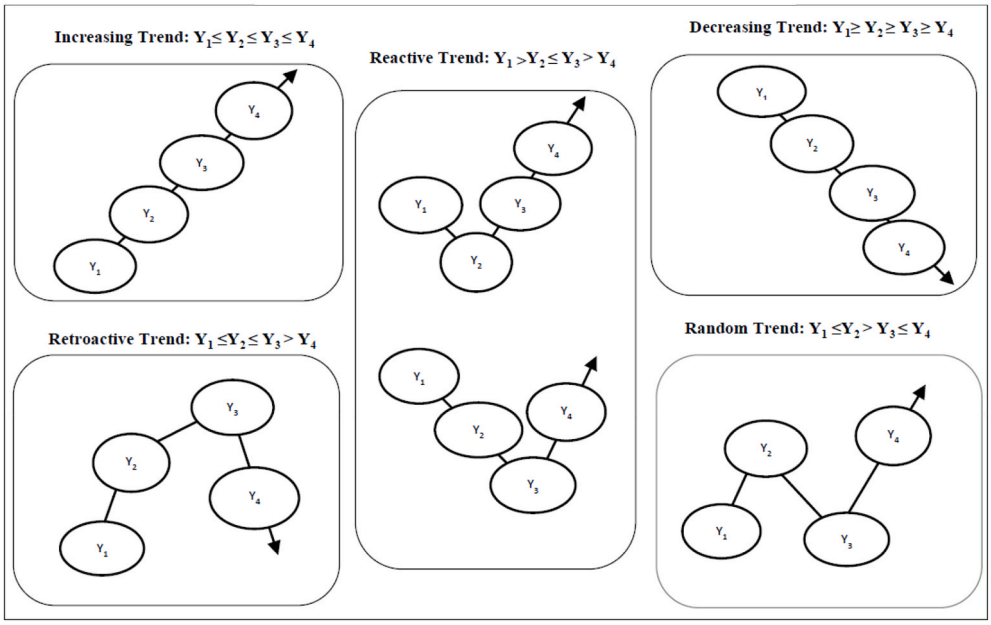
Juan Pedro Muñoz Miguel: Conceptualization, formal analysis, Methodology, investigation, resources, data curation, Writing - Original Draft and supervision. **Clara Simón de Blas**: Formal analysis, software, investigation, data curation and supervision. **Francisca Anguita Rodríguez**: Methodology, investigation, data curation and Writing - Review & Editing. **Ana Elizabeth García Sipols**: Investigation, resources and data curation.

Data availability

No data was used for the research described in the article.

APPENDIX 1. Typology of trend in collaborative learning of work groups

Appendix 1 shows the possible trends of the variable T for the learning groups, where X_i is the score achieved by the working groups and Y_i is the accumulated trend over time[10] for the ith group activities (i = 1, 2, 3, 4).



where, *Increasing Trend* assumes a learning trend and development of group skills increasing over time, *Decreasing Trend* assumes a learning trend and development of group skills decreasing over time, *Reactive Trend* assumes a trend towards learning and development of growing group skills At a given moment in time, given the awareness of previous negative learning performance, *Retroactive Trend* assumes a tendency towards initially growing group learning and skills development, growing but less than proportionally over time and, finally, decreasing over time. Decrease or even disappearance of learning or development of group skills and, finally, *Random Trend* supposes, trend of learning and development of group skills uneven over time. Evidence of lack of group organization and coordination over time.

[10] The different values that the variable Y takes show the following sequence: $Y_1 = X_1$; $Y_2 = \sum_{i=1}^{2} Xi$; $Y_3 = \sum_{i=1}^{3} Xi$; $Y_4 = \sum_{i=1}^{4} Xi$

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