

Jigsaw Puzzle technique vs. traditional group work: academic performance and satisfaction of the university students

Técnica del Rompecabeza vs. al trabajo en grupo tradicional: rendimiento académico y satisfacción de los estudiantes universitarios

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Abstract

Alternative learning methods such as the Jigsaw Puzzle (JP) technique have gained prominence over traditional teaching to promote the acquisition of skills in Higher Education. The aim of this research was to compare the academic performance and satisfaction of students depending on whether the JP technique or traditional group work was used. This is a cross-sectional study that involved 61 students in their 2nd year of the Degree in Physical Activity and Sport Sciences (20.11 ± 0.43 years). In one class group, the JP technique was applied ($n = 29$), while the traditional technique was used in the other group ($n = 32$). After the end of the workshop, the grade and the degree of satisfaction obtained with the techniques used were evaluated. The JP group obtained a grade ($X = 8.52$; $SD = 0.5$) and a degree of satisfaction ($X = 7.28$; $SD = 1.5$) which were significantly higher than the traditional group (rating: $X = 5.58$; $SD = 0.6$; satisfaction: $X = 6.34$; $SD = 1.6$) ($p < .001$ and $p = .023$, respectively). A correlation was found between grade and satisfaction ($ICC = .360$; $p = .004$). In conclusion, conducting a one-off session based on the JP technique versus using a traditional technique yields better grades and greater satisfaction with the teaching-learning process.

Keywords: Higher education, cooperative methodologies, teaching methodology, traditional methodology, innovation methodology.

Resumen

Los métodos de aprendizaje alternativos como la técnica del Jigsaw Puzzle (JP) han cobrado relevancia frente a la enseñanza tradicional para promover la adquisición de las competencias en la Educación Superior. El objetivo de la presente investigación fue comparar el rendimiento académico y el grado de satisfacción de los alumnos en función de si se utilizaba la técnica JP o el trabajo en grupo tradicional. Se trata de una investigación trasversal. En el estudio participaron 61 alumnos de 2^o curso del Grado en Ciencias de la Actividad Física y del Deporte (20.11 ± 0,43 años). En un grupo de clase se aplicó la técnica JP ($n = 29$) y en el otro grupo una metodología tradicional ($n = 32$). Tras la aplicación del taller se evaluó la calificación obtenida en el taller y el grado de satisfacción con la técnica utilizada. El grupo JP obtuvo una calificación ($X = 8.52$; $DS = 0.5$) y un grado de satisfacción ($X = 7.28$; $DS = 1.5$) con la técnica empleada superior al grupo de trabajo tradicional (calificación: $X = 5.58$; $SD = 0.6$; satisfacción: $X = 6.34$; $SD = 1.6$) de manera significativa ($p < .001$ and $p = .023$, respectivamente). Se encontró una correlación entre la calificación y la satisfacción ($CC = .360$; $p = .004$). En conclusión, la realización de una sesión puntual basada en la técnica JP frente al uso de una técnica tradicional reporta mejores calificaciones y mayor satisfacción con el proceso de enseñanza-aprendizaje.

Palabras clave: Enseñanza superior, metodologías cooperativas, metodología de la enseñanza, metodología tradicional, metodología de la innovación.



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Introduction

In modern society, considered as “the learning society”, in which “lifelong learning” is an important aspect, training and education have become essential factors (European Commission, 1997). For this, in higher education, as in lower levels, it is important to introduce active methodologies that favor students becoming the protagonist of their own learning, which allows this learning to be effective and lasting (Foig-Vila, 2018). In Spain, the European Higher Education Area and the Spanish Royal Decree 1393/2007 have brought about a radical change in university education, towards focusing on the development of competencies (Ministerio de Educación y Ciencia, 2007), an aspect that has been maintained in the current Spanish Royal Decree 822/2021 (Gobierno de España, 2021). Competencies are understood as the set of knowledge, skills and attitudes that are acquired or developed through coordinated training experiences, to attain functional knowledge that efficiently responds to a task or problem of daily and professional life that requires a teaching and learning process (González-Gálvez et al., 2018). Based on this, there is a need to provide the student not only with knowledge, but also with the ability to use that knowledge (Agencia Nacional de evaluación de la calidad y acreditación (ANECA), 2013).

University education has been adapting and incorporating changes in its teaching methodology to respond to changing educational needs (Foig-Vila, 2018). In this sense, these efforts have been centered on the premise that the training/education of a person should not be limited to a single and specific period, given the needs of the current social context, which implies the need for the development of basic skills that allow students to develop and learn autonomously throughout life. For the development of the teaching-learning process, it is necessary to know that learning is structured into a series of skills, in ascending order: Knowledge, Understanding, Applying, Analysis, Synthesis, Evaluation and Creation, with creation being considered higher-order thinking. This order is referred to as Bloom's revised Taxonomy of Learning Domains (Anderson & Krathwohl, 2001; Parra, 2017).

Given the above, a trend has been observed towards a change in learning methods to achieve the acquisition of competencies in higher education, such as instrumental, interpersonal and systematic competencies (Ministerio de Educación y Ciencia, 2007). Developing a competency implies a practical application, with the application of theory and practice being a fundamental feature. Theoretical knowledge is only meaningful with practice, so that theoretical knowledge must be approached with a focus on concrete work situations (González-Gálvez et al., 2018). Therefore, lectures, characterized by a predominantly passive approach to learning theory, have proven to be ineffective in the acquisition of competencies (Ahadiyan, 2007). On the contrary, active learning has been shown to favor knowledge retention and a deeper understanding of the subject matter as opposed to passive learning (Littlewood

et al., 2013; Subramanian et al., 2012). In addition, it fosters student engagement and self-directed learning (Kimonen & Nevalainen, 2005), and it can also be an effective methodology for conflict resolution and for fostering teamwork (García García et al., 2011; Summers & Svinicki, 2007). In this line, it has been found that cooperative learning has clear advantages over individualistic or competitive learning (Hänze & Berger, 2007; Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Springer et al., 1999; Suárez-Cunqueiro et al., 2017).

Among the educational methodologies based on group work, we find cooperative learning. Cooperative learning promotes the formation of groups, generally small and heterogeneous, and seeks the participation of all group participants to work with their peers with the objective of performing a series of group tasks from a cooperative approach that enhances the individual and collective improvement of the students (Gillies, 2004; Sharan, 2010). However, in group work, cooperation between group members is not always the case. To achieve this cooperation, it is necessary to meet certain premises for group work to guarantee the benefits of cooperative work. Thus, to ensure that cooperative learning is truly cooperative, there is a need for positive interdependence among group members, the promotion of interaction, personal and individual responsibility, the development of interpersonal and social skills; and group processing, periodic evaluation, or self-evaluation (Torrego & Negro, 2012). On the other hand, there are certain generalized problems in group work, such as the stowaway effect, excessive leadership, dispersion of responsibility and social idleness, premature resignation or abandonment, and destructive conflict, which must be avoided if there is to be truly cooperative work (Latané et al., 1979; Sharan, 2010).

Among the cooperative techniques that meet these premises we find the Jigsaw Puzzle (JP) technique. The JP technique starts from the presence of socio-cognitive conflict, which is the engine of learning, and seeks meaningful learning, for which it proposes an interactive learning environment, in which the student is considered the center and protagonist of the teaching-learning process. Not surprisingly, although the JP technique respects the individuality of the students, it uses a collaborative learning approach that diminishes the differences between students with varied learning (Jafariyan et al., 2017; Wolff et al., 2015). Among the objectives pursued with this technique, we find the following: (a) to improve cooperative learning; (b) to make profitable the use of individual and group tutoring; (c) to foster a positive attitude among group members; (d) to increase academic performance; (e) to favor meaningful and self-directed learning; (f) to encourage the continued study of a subject, so that students do not memorize, but rather mature knowledge; (g) to develop solidarity and civic commitment among students; (h) to develop social skills to relate to the group and assertively express one's own point of view; (i) to foster autonomy in learning; and (j) to tend to

the diversity of interests, values, motivations and abilities of the student body (Doymus, 2008; Göçer, 2010; Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017).

This technique is mainly used in secondary education and university studies, as it is necessary to have certain social skills and abilities for its successful development (Traver & García, 2004). The JP technique presents a series of steps to follow (Figure 1). First, students are divided into groups of three to six students with heterogeneous characteristics, called home groups. During the development of this first phase, the topic to be worked on is divided into as many sub-sections as the number of group members. After this, each member of the group chooses the sub-section they want to work on. Once the distribution has been carried out, each member must seek information on the chosen subsection, read it, and understand it individually.

Once this activity has been carried out individually, the expert group phase begins. To this end, students who have chosen the same sub-section in the different home groups meet and each member explains what he/she has understood, completing his/her knowledge with the help of the others. Once this phase is over, the students return to their home group and explain their sub-section to all their colleagues. Finally, the degree of knowledge of the group as a whole, and of everyone individually, is checked. Thus, the student works individually and with two different groups during the entire process. With this technique, each student is responsible for his or her part of the work, but there is also positive interdependence and cooperation between the partners that is necessary for the correct functioning of the group (Doymus, 2008; Göçer, 2010; Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017).

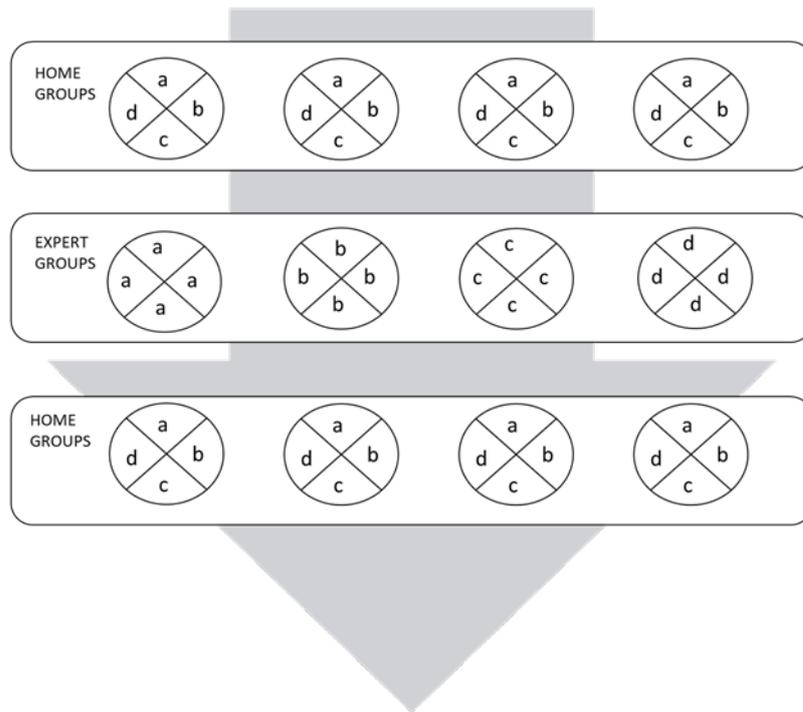


Figure 1. Jigsaw Puzzle technique representation

Previous research has compared the JP technique with lectures in a university context, finding that students in the JP group obtained higher grades, a greater satisfaction with the teaching process, and a higher self-esteem, which could be due to several aspects, including the novelty of being faced with other stimuli in the teaching-learning process, or feeling more involved in the teaching-learning process (Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017). However, lectures and the JP technique differ in their essence, as one involves this innovative technique of group work, and the other a traditional technique of individual work (Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suá-

rez-Cunqueiro et al., 2017). There is therefore a gap in the previous literature, as it is not possible to know whether the differences between the techniques used in previous studies could be due to students working in groups, which could increase their involvement in the teaching-learning process (Gillies, 2004; Sharan, 2010), or to the fact that JP is an innovative technique that allows for a more autonomous management of learning (Torrego & Negro, 2012). In this sense, traditional group work differs from JP. In the former, the students are asked to work in groups without paying attention to group functions (Jacobs, 1997), whereas in the JP technique, there are specific working premises, which are carefully prearranged, planned and supervised

(Doymus, 2008; Göçer, 2010; Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017). However, no studies have compared the JP technique with the traditional group work technique, as students are distributed into groups, which are autonomously managed to achieve the marked result. Despite the restructuring that has been attempted in education, traditional teaching is still the most widely used at the university level (Mulryan-Kyne, 2010). Thus, there is a current gap on the subject matter that needs to be addressed. Therefore, the objective of the present research study was to compare the ratings obtained and the degree of satisfaction depending on whether the Jigsaw Puzzle or traditional group work was used as a technique with university students.

Method

Design

This is cross-sectional study. The independent variable of the present study was the educational innovation program based on the jigsaw technique. The dependent variables were the academic performance and students' satisfaction. These dependent variables were chosen based on previous studies (Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017). Measurements of these variables were taken (post-test). The covariates were rating on the virtual poster, role in the group, and perception of previous transversal competences.

The research was carried out following the STROBE guidelines. Before the start of the study, approval was obtained from the Institutional Ethics Committee [code: CE052011]. All participants in the research study signed an informed consent form prior to data collection, where they were informed of the objectives of the study, as well as the treatment of the data obtained, and its confidentiality.

Participants

The sample size was calculated using Rstudio software (version 3.15.0, Rstudio Inc., Boston, MA, USA). The significance level was set at $\alpha = .05$. The standard deviation (*SD*) was set based on a previous study ($SD = 0.92$) (Kaplan & Maehr, 1999) with an error (*d*) of 0.18. The estimated sample needed was 52 subjects.

The selection of participants was carried out by consecutive non-probabilistic sampling, with the selection of all possible suitable subjects, who wished to participate voluntarily in this study, and who met the following inclusion criteria: 1) be enrolled in the Degree in Physical Activity and Sport Sciences; 2) be enrolled in the second year of the Degree; 3) attend the theoretical sessions in person; and 4) not have previous experience on the use of the JP technique or the traditional cooperative work technique.

Sixty-one students enrolled in the Degree in Physical Activity and Sport Sciences (mean age: 20.11 ± 0.43 years) were involved in the study. A total of two classroom groups

participated in the study. In one group, the Jigsaw technique was applied ($n = 29$), while in the other group a traditional technique ($n = 32$) was used.

Procedures

Within the subject of individual gymnastic sports, there is a block of content dedicated to new fitness trends, including the Pilates method. A workshop was carried out on this content, through the application of the JP technique (Jigsaw puzzle group (JPG)), and a traditional methodology (Traditional methodology group (TMG)). Both workshop sessions were conducted by the same professor and lasted 60 minutes. The objectives and evaluation criteria proposed for the students in the development of the workshop, regardless of the technique used for its delivery, were based on: a) developing the capacity for analysis and synthesis; b) favoring the capacity for organization and planning; c) improving the capacity for written communication; d) learning the origin, definition and basic principles of the Pilates Method; e) identifying breathing and the apparatus used in the Pilates Method; and f) initiation in the correct writing of bibliographic references according to APA guidelines. The following contents were worked on: a) Capacity for analysis, synthesis, organization and planning as a means to solve problems; b) Formal and adequate written communication; c) Origin, definition and basic principles of the Pilates Method; d) Costal breathing in the Pilates Method; e) The apparatus used in the Pilates Method: Reformer, Cadillac, Chair and Barrel; and f) Bibliographical references: APA guidelines. In turn, the specific contents to be worked on: 1) origin of the Pilates method (PM); 2) definition of the PM; 3) principles of the PM; 4) breathing of the PM, and 5) apparatuses of the PM; were the same in both groups. For the workshops, each group was randomly divided into subgroups of five or six students, depending on the number of participants in each group. In the groups with 6 students, content one was worked on by two students. They were provided with a code to allow for the blind evaluation of the workshops by the principal investigator.

In the JPG, the session started with an explanation about the workshop. During this phase, the following were described: the content of the workshop (Pilates Method), the location of the documentation to be consulted (available on the Virtual Campus), and the necessary resources (computer per student). The different phases of the Aronson Puzzle technique were also explained. In addition, the importance of individual responsibility and responsibility for/with the group was emphasized, as well as the relevance of interaction of all group members, and assertive communication. Then the home groups were formed, with 5 students per group selected at random. The time for this phase was 8 minutes. In the following phase, once the groups had been formed, the students in each group divided up the contents to be worked on. Each student had to be an expert and was responsible for a topic within the workshop. Each student individually read the documents

shared on the Virtual Campus and extracted and synthesized the relevant information to complete their part. They also had to compile the bibliographical references used, to include them in the corresponding section (10 min). Next, the expert groups were formed (6 min). All the experts who conducted research on the same part met and explained to the rest of the experts what they had understood, and the information they considered most relevant. For this, each student made a 1-minute intervention. This allowed other students to complete the information they had extracted, as well as to share the information with the rest of the group of experts. Afterwards, the students returned to the home group, so that each of them could explain his or her part to his or her peers with a 1-minute intervention per student. In this way, the aim was for everyone to understand all the parts from their peers (6 min). Finally, all members of the group produced a report including all the parts created by all members of the group. They were also informed that at the end of the creation of the final report, the professor could randomly choose which student would present each part. In this way, all the students had to know all parts of the work (10 min). Finally, a presentation of the sections was made at random. For this, the teacher randomly selected which member of each group was to present each of the sections in a summarized form to the whole class. This final phase lasted 20 minutes. Student satisfaction was assessed by means of an *ad-hoc* questionnaire of 10 questions based on the Leyva-Moral questionnaire (Leyva-Moral & Riu Camps, 2016) and considering the learning objectives, competences, and skills. The participants had to indicate the degree of agreement or disagreement with each item using a Likert scale with scores ranging from 1 to 10, where 1 was the most negative response and 10 the most positive. The resulting mean satisfaction of the students was categorized into the following values: 1 - 4.9 = not at all satisfied; 5 - 6.9 = moderately satisfied; 7 - 8.9 = satisfied; 9 - 10 = very satisfied. At the end of the workshop, with each group, the professor corrected the work submitted by the students anonymously. The students handed in their work with a code and the teacher corrected it without knowing which students or which technique each code referred to. To evaluate the work, the same correction rubric was used with both groups. An ordinal rating scale was created for this evaluation, considering the learning objectives, competences, and skills. A correction rubric composed of the following items was used to evaluate the work created by both groups: a) The content incorporated into the work is a synthesis of the proposed sections, as a result of the analysis and reflection on the most relevant information; b) The writing of the document is adequate, formal, and does not contain grammatical and/or spelling mistakes; c) It summarizes the origin, definition and principles of PM, d) It describes the breathing of the PM including all relevant aspects; e) It names the different apparatuses used in PM and explains them briefly, and f) The wording of the bibliographical references is adequate and does not contain major errors.

Each item on the rubric could be graded on a scale of 1 to 10; 1 being completely wrong with the expected result and/or incomplete, 5 presenting some errors, although mostly correct, and 10 completely correct and complete. The final grade of the document was the average grade of the different items of the rubric. In addition, the variable grade was categorized in the following values: 1 - 4.9 = fail; 5 - 6.9 = pass; 7 - 8.9 = notable; 9 - 10 = outstanding.

Statistical Analysis

The statistical analysis was performed with the SPSS 21.0 for Windows statistical package. An error of $p \leq .05$ was established. The normality of the variables was analyzed with the Kolmogorov-Smirnov test, with a descriptive analysis performed for quantitative variables (count, mean, maximum, minimum, and standard deviation) and qualitative variables (academic performance and satisfaction categorization) (frequency). To determine differences between the two groups in the quantitative variables, the Student's t-test for independent samples was used. To determine differences between the two groups in the qualitative variables, a chi-square test was used. To find the relationship between the variables, Pearson's r correlation was used, with the establishment of the ranges $r < .5$ for low correlation; $.5 - .7$ for moderate correlation; and $> .7$ for high correlation. Stepwise multiple linear regression models were used to explore the associations between the dependent variables and each independent variable. To analyze whether nonlinear multiple regression models provided the best explanation of the variance, a curvilinear estimation analysis was used to explore the best model association between the dependent and independent variables. A multiple nonlinear regression analysis was performed to analyze the association between the dependent variable with the independent variables.

Results

Table 1 presents the descriptive analysis according to the technique used (JPG vs TMG), showing the number (N), mean (\bar{X}), maximum (Max), minimum (Min) and standard deviation (SD) for the grade obtained in the final work and for the degree of satisfaction with the activity. The average grade for the JPG was 8.52, while for TMG, it was 5.58. In relation to student satisfaction, the JPG obtained a mean value of 7.28 points, while the TMG showed a value of 6.34. Significant differences were found in the workshop grade when comparing the grades obtained in the JPG and TMG, with higher scores for the JPG ($p < .001$). Likewise, a significant difference was found in student satisfaction with respect to the technique used, finding a higher level of satisfaction for the JPG ($p = .023$) (Table 1). In addition, the maximum and minimum grades in the workshop and the maximum and minimum scores with respect to satisfaction with the workshop of the members of the JPG, were higher than those shown by the TMG students.

Table 1. Descriptive data on the results of the work and the degree of satisfaction with the activity

	JPG (n=29)				TMG (n=32)				Mean±SD TOTAL (n=61)	Dif. JPG- TMG	CI 95% (Diff. JPG- TMG)	p
	Mean	DS	Max	Min	Mean	DS	Max	Min				
Academic performance	8.52	0.5	9.50	8.00	5.58	0.6	7.00	5.00	6.98±1.6	2.94	2.66;3.21	<.001
Satisfaction	7.28	1.5	10.00	4.00	6.34	1.6	9.00	3.00	6.79±1.6	0.94	0.13;1.74	.023

JPG= Jigsaw Puzzle Group; TMG= traditional methodology group.

When categorizing the grades, with the variables failing grade, pass, notable, and outstanding, significant differences were observed between the JPG and TMG ($p < .001$), with the JPG showing higher percentages in the grades

found in the higher strata than the TMG. In turn, the JPG showed higher percentages tending to significance in the upper strata than the TMG ($p = .052$) (Table 2).

Table 2. Descriptive data of the work rating and degree of satisfaction according to categorization for JPG and TMG

		JPG (n=29) %(n)	TMG (n=32) %(n)	p
Academic performance	Fail	0(0)	0(0)	< .001
	Pass	0(0)	90.63(29)	
	Merit	75.86(22)	9.38(3)	
	Outstanding	24.14(7)	0(0)	
Satisfaction	Not at all satisfied	3.45(1)	15.63(5)	.052
	Moderately satisfied	24.14(7)	25(8)	
	Satisfied	55.17(16)	56.25(18)	
	Very satisfied	17.24(5)	3.13(1)	

JPG= Jigsaw Puzzle group; TMG= traditional methodologic group.

A correlation was found between the grade obtained in the workshop and the degree of satisfaction shown by the student ($r = .360$; $p = .004$). A stepwise multiple regression analysis is shown in table 3. This analysis shows that the

academic performance was mainly influenced by the membership in the intervention group (JPG), and that the satisfaction shown by the student with the technique used was also influential ($R^2 = .892$; $p < .001$).

Table 3. Stepwise multiple linear regression analysis of the relationship of Academic performance with categorization for JPG and TMT and group satisfaction

Difference OFE-Standing	Analysis	R ²	p Value	Included independent variables	Standardized Coefficient (β)	DS	t	p
Academic Performance	Model 1	.884	<.001	Group	-2.939	0.223	-21.173	<.001
	Model 2	.892	<.001	Group	-2.85	0.141	-20.23	<.001
				Satisfaction	0.092	0.04	0.10	.040

Discussion

The aim of the present investigation was to compare the scores obtained depending on whether the JP or a traditional technique was used as a teaching technique in university students. Academic performance has been one of the most studied variables in studies conducted on the effects of different teaching techniques (Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017). In the present study, the results indicated

that students who participated in the workshop as part of the JPG obtained higher scores than those in the TMG ($p < .001$), also showing higher scores when analyzing the maximum and minimum scores. In fact, when qualitatively analyzing the grade received in the workshop, the JPG students obtained grades between notable and outstanding, while the TMG students were graded between pass and notable. In addition, the present study also evaluated the difference between the two teaching techniques in terms of student satisfaction ($p = .023$) with the technique used.

This variable is vital for the teaching-learning process to be effective, as student motivation has an influence on the degree of involvement in the task to be performed (Kimonen & Nevalainen, 2005; Littlewood et al., 2013; Subramanian et al., 2012). In fact, this variable has been included previously to analyze the effect of different teaching techniques on it (Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017). It was found that the JPG students provided a satisfaction score that was almost one-point higher than the TMG, with this difference being statistically significant. The maximum and minimum scores for the JPG were also higher than for the TMG. These results coincide with those obtained in previous studies that applied methodologies with the Jigsaw technique or cooperative learning in university students with similar characteristics to those of the present research, both in relation to the sample and the intervention carried out. (Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017). Thus, the results found could be due to students becoming more involved in the teaching-learning process (Aronson & Pantone, 2010), having a leading role in decision-making in the classroom (Aronson & Pantone, 2010; González-Gálvez et al., 2018), being more encouraged towards cooperative work (Aronson & Pantone, 2010; Johnson et al., 2008), having greater individual and group responsibilities (Cecchini et al., 2021), where interpersonal competence has no place (Manzone et al., 2014), and where there is interdependence between group members (Chai et al., 2019), with all of these increasing their self-perception as learners (Shaaban, 2006; Vaquero-Cristóbal et al., 2021). Moreover, such innovative methodologies foster better peer interactions and promote autonomy among students, also influencing their intrinsic motivation (Zainuddin & Perera, 2017). Furthermore, one of the most widely used theories to explain academic success in students is the achievement goal theory, which focuses on analyzing how students adopt different types of goals: mastery motivational or performance motivational (Elliot, 2005). In this sense, the motivational climate generated by the professor in the classroom (mastery motivational climate or performance motivational climate) is a precursor of students' goal orientations, which have a powerful influence on motivation, basic psychological needs, and performance (Brisimis et al., 2022). Therefore, a positive effect of innovative methodologies on this aspect has been reported (Vaquero-Cristóbal et al., 2021). In addition, novelty is another factor to be considered, although it may disappear over time. In this sense, novelty has been considered as a basic psychological need that may subsequently affect motivation (González-Cutre et al., 2016, 2020), which could partly explain the results found in the JP technique group.

The JP technique has been previously used, and has yielded positive results in different areas and stages of education (Jafariyan et al., 2017; Kalra et al., 2015; Kodama & Koyama, 2016; Suárez-Cunqueiro et al., 2017). In this line, previous studies have pointed out that undergraduate and

postgraduate students understand that the JP technique helps to improve the teaching-learning process from a multifactorial perspective, promoting active learning and improving teaching skills (Kalra et al., 2015); and increasing student self-efficacy and promoting active learning (Kodama & Koyama, 2016).

However, few studies have compared the results obtained after implementing this technique with another. A previous study compared the grades obtained between the JP technique and a group of university dental students who worked individually on the resolution of practical cases for three months in Spain. The researchers found the JPG obtained better final grades on the subject, although not significantly, than the other group (Suárez-Cunqueiro et al., 2017). In the same vein, another study compared the JP technique with a master class given to Iranian medical students, and found that students in the JPG obtained higher grades than students in the master class group (Jafariyan et al., 2017). In another study with pharmacy students, the JP technique was compared with individual learning. The results showed that 88% considered this technique to be more useful than individual learning, 90% indicated that this technique helped them to learn more, and 74% indicated that it helped them to develop their co-communicative skills. The authors also indicated that the students showed a greater motivation with this technique than with the individual work technique (Phillips & Fusco, 2015). The results from these studies coincide with those of the present study. In a similar vein, Calderón et al. (Calderón et al., 2019) reported on the positive relationship between active learning environments supported by digital pedagogy and intrinsic motivation, and learning climate and academic performance of university students in initial teacher training. Also, Meroño et al. (2021) showed how the characteristics of cooperative learning enhanced the benefits of digital pedagogy on the academic performance results of university students. This could be due to the greater active participation of students during the teaching and learning process, which could trigger higher academic performance scores.

Another important finding of the present research was that a significant correlation was found between the grade and the degree of student satisfaction with the technique used, as well as an influence of the use of the JP technique versus a more traditional technique, and student satisfaction with academic performance. Different authors have pointed out that co-operative learning techniques increase students' autonomy, their level of competence, and their social relations (Hänze & Berger, 2007), thereby favoring the retention of knowledge and a deeper understanding of the subject matter learned (Littlewood et al., 2013; Subramanian et al., 2012), fostering student engagement and self-directed learning (Kimonen & Nevalainen, 2005), which could result in better performance. However, these results should be contrasted in future research. In addition, previous research has shown that when innovative techniques are used in combination with new technologies in higher

education, students show high levels of satisfaction. Therefore, the presence of the face-to-face educator remained a fundamental element of the process, according to the participants' opinions (Prieto et al., 2016; Vera et al., 2016).

An interesting result from the present research was that younger students, i.e., those enrolled in the subject in the correct academic year, as they had not failed any courses, obtained higher grades on the final paper than older students, i.e., those who had repeated at least one academic year or had previously failed this subject and were repeating it. Previous studies have found that repeating academic years or subjects may even be counterproductive, negatively affecting academic results (Fertig, 2004; Morrison & leong On No, 2007; Snead et al., 2022), which could explain the results found in the present research. This has led to previous studies pointing to the need to pay more attention to repeaters to maximize their chances of successful inclusion in the education system (Snead et al., 2022).

Among the strengths of the present research, we find that it is the first study to compare the effects of two techniques that promote cooperative student work, one based on a traditional system, and another based on a novel methodology. This allows us to discern whether the effects found are due to working in a group, without the need for traditional, of lecturer-based classes (Gillies, 2004; Sharan, 2010), or due to the autonomy experienced by students, provided by innovative techniques that allow them to oversee and manage their own teaching-learning process (Torrego & Negro, 2012).

However, this study is not without limitations. Firstly, the present research analyzed the effects of the JP technique used in a one-off manner. Previous studies have suggested that the use of innovative teaching techniques in a one-off manner could have an immediate effect on the motivation and involvement of learners, arousing their interest, although this effect could return to baseline levels when the novelty wears off (Ahmadi et al., 2022; González-Cutre et al., 2016, 2020). Therefore, future lines of research could investigate the effects of innovative techniques such as the JP technique, in a longitudinal manner.

Not surprisingly, educational theorists have indicated that it is not the surface features that make teaching successful - but rather the deep structure, i.e., the structure of the learning environment, the learning climate, the link to previous knowledge, etc. (Beattie et al., 1997; Lizzio et al., 2002), which could explain the limited results of these learning techniques used on an *ad hoc* basis.

Secondly, in the present research, the control group used a traditional group work technique, rather than, for example, cooperative learning methods. This was due to the fact that traditional teaching is still the most widely used at the university level (Mulryan-Kyne, 2010). However, future studies could compare this technique with cooperative learning methods to compare their results.

In addition, this study compared the use of an innovative group work technique (JP method) with a traditional group work technique. This resulted in the lack of a group that did not use a cooperative technique, which could be a constraint, as it is not possible to treat students individually (Torrego & Negro, 2012). Future studies could include other teaching techniques such as a traditional individual work technique or an innovative individual work technique to discern the effects the effect of group work or separate autonomy on the learning process, and to be able to adapt to the individual needs of each academic year.

Another limitation is that the groups that participated in the study were not randomly selected, so the personality traits of the participants could be another contributing factor to the positive outcomes. It would be useful to carry out this research on other groups of students from different academic years to analyze the replicability of the data.

The last limitation was that the sample size was somewhat small. It would be interesting in future studies to replicate this research in larger groups to analyze the influence of covariates such as gender or grade point average, among others, on the results found.

Conclusions

In conclusion, the implementation of a one-off session based on the JP technique as opposed to the one-off teaching of the same subject with a traditional group work technique has certain advantages, such as better grades obtained by the students and greater satisfaction with the teaching-learning process.

Thus, the JP technique could be an interesting tool to implement in the educational environment, even on an *ad hoc* basis, to bring novelty and a change in the teaching-learning process, as it elicited good responses from students. However, further studies are needed to analyze its long-term effect once the novelty has worn off.

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