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Improving academic performance in higher education through cooperative learning

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Abstract

Introduction. The European Higher Education Area (EHEA) proposes the improvement of the quality of teaching by promoting student protagonism through active learning. *Objective.* Enhancement of academic performance and the active learning of university students implementing cooperative learning strategies. *Methodology.* Convenience sampling, assessment of academic performance (e.g., qualifications) and teamwork skills, using the Cooperative Learning Questionnaire (CLQ). For descriptive indices, correlations, and reliability, SPSS 20.0 was used, and for confirmatory factor analysis (CFA), Mplus 8.4. *Results.* Academic performance was considerably improved compared to the previous academic year. The CFA shows that the social skills and group processing dimensions were highly correlated, resulting in a four-dimensional model, unlike the original validation, with five dimensions. *Conclusions.* The implementation of cooperative learning improves academic performance and teamwork skills, but it would be necessary to validate this questionnaire in other university settings to confirm the results.

Keywords

Cooperative learning; academic performance; competencies; higher education.

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Millorar el rendiment acadèmic en l'educació superior a través de l'aprenentatge cooperaMu

Resum

Introducció. L'Espai Europeu d'Educació Superior (EEES) proposa millorar la qualitat de la docència fomentant el protagonisme de l'alumnat mitjançant l'aprenentatge actiu. *Objectiu*. Millorar el rendiment acadèmic i l'aprenentatge actiu de l'alumnat universitari implementant estratègies d'aprenentatge cooperatiu. *Metodologia*. Mostreig per conveniència, avaluació del rendiment acadèmic (per exemple, notes) i de les habilitats de treball en equip, mitjançant el Qüestionari d'Aprenentatge Cooperatiu (CLQ). Per als índexs descriptius, correlacions i fiabilitat, es va utilitzar el programa SPSS 20.0, i per a l'anàlisi factorial confirmatori (CFA), el Mplus 8.4. *Resultats*. El rendiment acadèmic va millorar considerablement respecte al curs anterior. El CFA mostra que les dimensions d'habilitats socials i de processament grupal estaven fortament correlacionades, donant com a resultat un model de quatre dimensions, a diferència de la validació original, que tenia cinc dimensions. *Conclusions*. La implementació de l'aprenentatge cooperatiu millora el rendiment acadèmic i les habilitats de treball en equip, però seria necessari validar aquest qüestionari en altres entorns universitaris per confirmar els resultats.

Paraules clau

Aprenentatge cooperatiu; rendiment acadèmic; competències; educació superior.

Mejorar el rendimiento académico en la educación superior a través del aprendizaje cooperativo

Resumen

Introducción. El Espacio Europeo de Educación Superior (EEES) propone la mejora de la calidad de la docencia fomentando el protagonismo del alumnado a través del aprendizaje activo. *Objetivo.* Mejorar el rendimiento académico y del aprendizaje activo del alumnado universitario implementando estrategias de aprendizaje cooperativo. *Metodología.* Muestreo por conveniencia, evaluación del rendimiento académico (p. ej., notas) y de las habilidades de trabajo en equipo, mediante el Cuestionario de Aprendizaje Cooperativo (CLQ). Para los índices descriptivos, correlaciones y fiabilidad se utilizó el programa SPSS 20.0, y para el análisis factorial confirmatorio (CFA), el Mplus 8.4. *Resultados.* El rendimiento académico mejoró considerablemente respecto al curso anterior. El CFA muestra que las dimensiones de habilidades sociales y procesamiento grupal estaban fuertemente correlacionadas, dando como resultado un modelo de cuatro dimensiones, a diferencia de la validación original, con cinco dimensiones. *Conclusiones.* La implementación del aprendizaje cooperativo mejora el rendimiento académico y las habilidades de trabajo en equipo, pero sería necesario validar este cuestionario en otros entornos universitarios para confirmar los resultados.

Palabras clave

Aprendizaje cooperativo; rendimiento académico; competencias; educación superior.

INTRODUCTION

The European Higher Education Area (EHEA) proposes to improve the quality of teaching by promoting student protagonism through active learning. The new methodologies would aim at creating scenarios that allow students to self-regulate their learning and incorporate new strategies during the process. In this context, cooperative learning emerges as a pedagogical methodology that promotes active learning and student interaction (Attle & Baker, 2007; Guerra et al., 2019), as Vygotsky's socio-constructivist theory enacts.

Cooperative learning is an evidence-based teaching strategy based on the theories of cognitive development and behavioural learning, which has shown positive effects on students' social skills and their relationships with peers. This method empowers students to change their way of thinking and working by confronting dilemmas with other peers in the group, and activates cooperation through five essential elements, i.e., positive interdependence, promotive interaction, individual responsibility, social skills, and group processing (Johnson, 2003)

Positive interdependence occurs when the results of the work depend on all the components of the group, so that execution and production are collaborative, and the final qualification is the same for all members; promotive face-to-face interaction occurs when the group members verbally explain to each other how to solve a problem or a doubt; individual responsibility refers to the performance of the person that influences the results of the collaborators. This shared responsibility also contributes to achieving positive interdependence; social skills, leadership and conflict management, which may sometimes require support from the teacher, are other academic skills in the learning process; and group processing is reflected in the good functioning of the group, including self-reflection on what has been learned, in accordance with constructivist theories. Cooperative learning thus promotes communication between the members of the group and a degree of involvement in the tasks of the course, encourages autonomy and responsibility, and is therefore an appropriate method for improving learning and, consequently, academic

performance (Abramczyk & Jurkowski, 2020; Cañabate et al., 2020; Johnson & Johnson, 2014; Johnson, 2003).

It is therefore advisable for teachers to promote cooperative learning as an alternative teaching model to the exclusive use of lectures. In fact, it becomes especially relevant due to the current global and interconnected world, where cooperation plays a central role and the importance of interpersonal relationships and the need for creative thinkers is rapidly increasing (Johnson & Johnson, 2014; Loh & Ang, 2020). Because cooperative learning seems to be a valuable teaching strategy, and there is much evidence for group-level benefits from collaboration over the individual (Kyndt et al., 2013; Loh & Ang, 2020; Nokes-Malach et al., 2015), our aim was to improve the academic performance of university students using cooperative learning strategies. The specific objectives were to:

1. Validate the structure of the Cooperative Learning Assessment Questionnaire (CLQ) at higher education environment (Fernández-Rio et al., 2017).
2. Improve academic performance, both in-groups and individually.
3. Encourage students to attend the seminars to resolve questions.
4. Enhance positive interdependence and individual responsibility.

METHODOLOGY

Design, setting and participants

A post-test was carried out using a quasi-experimental design with a non-equivalent control group, placed in our university (removed for blind review). This study was part of an innovation project, which consisted of implementing the cooperative learning methodology in our course of Data Analysis. All students enrolled in our course, a total of n=411 participated in this innovation project, of which n=114 (27.8%) fulfilled the CLQ.

Study variables

Sociodemographic variables were registered (age, sex, course level). The independent variable was the intervention based on cooperative learning methodology and dependent variables were the different competences, such as promoting positive interdependence and individual responsibility, assessed with the CLQ, qualifications, attendance rate to seminars and student satisfaction.

Procedure

In order to implement the cooperative learning methodology, we designed two assessment tests consisting of the resolution of a research case by a randomly-formed working team of five members. The evaluation of this test was carried out through oral presentation of the results by one of the team members, randomly chosen by the teacher just before the presentation. The grade obtained was the same for all team members. It is noteworthy that the grade followed a rubric that was available to both teachers and teams. The rubric assessed different aspects of the oral presentation, such as the defence and formal aspects, which accounted for 75% of the total grade, as well as the written content, which accounted for the remaining 25%. Both the group presentation methodology and the equal allocation of the grade to all members would promote positive interdependence and cooperative skills. Some indicators enabled assessment of the impact of the implementation of the cooperative learning methodology, as follows.

Indicators

Indicator 1. With regard to the validation of the CLQ, it was expected that the original model would be confirmed in the university environment.

Indicator 2. With regard to the objective of improving academic performance, both in-group and individually, we established that the pass rate should be at least 75% and the overall average grade should be higher than in previous academic years.

Indicator 3. With regard to seminar attendance, we considered that the objective would be achieved if at least 85% of the students attended the seminars.

Indicator 4. Concerning the objective of promoting positive interdependence and individual responsibility, as well as the other competences related to cooperative learning, we considered that it would be successfully achieved if the CLQ scoring was ≥4.

Instrument

Cooperative Learning Assessment Questionnaire (CLQ)

Review of the available literature allowed us to identify different instruments designed and validated to assess cooperative learning: the Cooperative Learning Observational Schedule (Veenman et al., 2002), the Cooperative Learning Application Scale (CLAS) (Atxurra et al., 2015), the Higher Education Cooperation Analysis Questionnaire (García et al., 2012), the Group Interaction Self-Report (Ibarra & Rodríguez, 2007) for university contexts, and the Cooperative Learning Assessment Questionnaire (CLQ) (Fernández-Rio et al., 2017) for secondary and high school settings. Given that the Cooperative Learning Observation Schedule questionnaire was designed to assess cooperative learning by an external observer such as the teacher, that the CLAS does not assess individual responsibility competence, and that the Cooperation Analysis Questionnaire in Higher Education and the Group Interaction Self-Report instruments focus on group interaction, we decided to use the CLQ questionnaire to assess its structural validity in the university setting.

The Cooperative Learning Assessment Questionnaire (CLQ) (Fernández-Rio et al, 2017) was designed and validated for secondary education settings, with five dimensions: Social Skills (4 items, α=0.74), Group Processing (4 items, α=0.75), Positive Interdependence (4 items, α=0.72), Promoting Interaction (4 items, α=0.76), and Individual Responsibility (4 items, α=0.79), with a 5-point Likert scale response format (1 = Strongly disagree, 5 = Strongly agree). Both the first-order factor analysis in the original sample and the second-order analysis, called Cooperation Factor, presented adequate goodness-of-fit indices.

Ad hoc questionnaire

In the same form, we included five ad hoc questions to assess students' opinion of teamwork, with a 5-point Likert scale response format (1 = Strongly disagree, 5 = Strongly agree).

Data analysis

Statistical analysis was performed in two phases. SPSS version 20.0 (IBM, Chicago, IL) was used to calculate descriptive indices, inter-item and inter-scale correlations and reliability (internal consistency), and the Mplus 8.4 was used for confirmatory factor analysis (CFA). Normality distribution of the variables was assessed by Mardia's coefficient (Mardia, 1974), inter-item and inter-scale correlations of the CLQ were examined by the bivariate Pearson coefficient, and internal consistency was examined using Cronbach's alpha (α)

The multivariate kurtosis Mardia's coefficient showed a multivariate non-normal distribution of the CLQ items (Mardia's coefficient = 527.49, 2gl=1=247.9, p<0.001). We thus used the MLM (maximum likelihood with robust standard errors) estimation method, which is robust to violations of normality (Byrne, 2012). The fit indices were the Satorra-Bentler S-Bχ2 statistic (Satorra & Bentler, 1994), the CFI (Comparative Fit Index), the RMSEA (Root Mean Square Error Approximation) and the SRMR (Standardized Root Mean Square Residual). For the CFI, Bentler (1990) suggested that values of 0.95 or higher indicate a good fit, although other researchers have suggested a cut-off at 0.90 (e.g., Jöreskog et al., 2000). For the RMSEA, values below 0.05 indicate excellent fit, and values below 0.08 indicate only adequate fit. For the SRMR, Hu & Bentler (1999) suggest that values below 0.08 indicate a good fit. An invariance analysis was ruled out due to the small number of male participants.

Ethical Aspects

This study was approved by the Coordination of Teaching Innovation of the Institute of Educational Sciences. In accordance with Instruction 10/2020 on data protection in virtual assessment, the virtual sessions were recorded, having informed the students prior. Authorization to use the CLQ questionnaire was obtained from the main author. The CLQ was applied by using an online form, maintaining the anonymity of the participants and informing them of the purpose of the study, as well as the data protection regulations. All participants who completed this questionnaire signed the consent to participate in the study and to process the data.

RESULTS

Participants

The enrolment of the sample during this academic year involved a total of n=411 students, of whom n=342 (83%) were female, and n=69 (19%) were male, with a mean age of 21.8 years (SD=1.6 years). All students participated in the innovation project, but only n=114 (27.8%) fulfilled the CLQ.

Confirmatory Factor Analysis of the CLQ

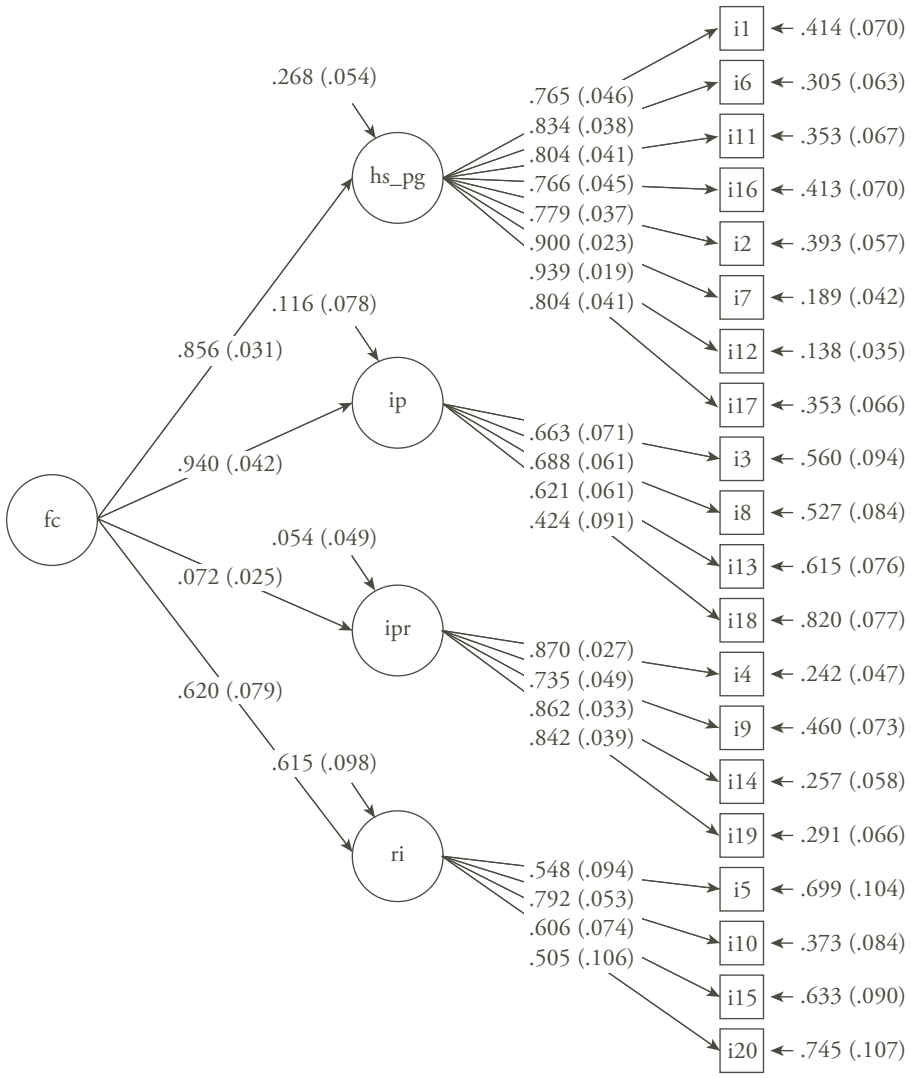
The original five-factor model was not estimable due to the appearance of a Heywood (1931) case, whereby the model estimates variances of negative correlations or correlations between latent variables greater than one, neither of which is possible. This phenomenon usually occurs when there is a high correlation – close to redundancy – between the observed variables. The study of the correlation matrix between scales, see table 1, indicates that this may be due to very high correlation between the social skills and group processing scales.

Figure 1 shows the four-factor model, with adequate fit indexes: Root Mean Square Error Approximation (RMSEA=0.065); Standardized Root Mean Square Residual (SRMR=0.065); Satorra-Bentler (Satorra and Bentler, 1994) S-Bχ2 (166) = 247.049, p < 0.001. The values obtained for the four factors were not so different to those reported by the original authors, i.e., RMSEA = 0.037; SRMR = 0.02; Santorra-Batler Bχ2 (160) = 2574.51, p< 0.001.

Impact of the cooperative learning methodology

The impact of the implementation of the cooperative learning methodology was evaluated according to different indicators, as mentioned above. With regard to the objective of improving academic performance, it was achieved since the results indicated that 99.8% passed the first evaluation test and 91.0% passed the second test, and a) performance was 72.0% in the previous year and 87.0% in this one (15 points absolute difference, 21.0% relative difference); b) the success rate was 75.0% in the previous year and 93.0% in this one (18 points absolute difference, 21. 0% relative difference); b) the success rate was 75.0% in the previous year and now it was 93.0% (18 points ab-

Figure 1: Factorial analysis. CLQ four factors.



Note: hs_pg = Social skills + group processing; ip = Positive Interdependence; ipr = Promotive Interaction; RI = Individual responsibility; fc = Cooperating Factor. Figure shows the unicity for the observed variables, and the standardized factor loadings for latent variables.

solute difference, 24.0% relative difference); c) the average grade was 5 in the previous year and 6.4 in the current academic year (1.4 points absolute difference, 27% relative difference). These data should be interpreted bearing in mind that the performance indicator reflects the percentage of passers among those enrolled and the success indicator reflects the percentage of passers among those presented. The average grade was calculated on a scale of 0–10. The percentage of no-shows remained constant at 3%.

With regard to attendance at seminars, the overall rate of around 50% was lower than expected, so this objective was not achieved. Regarding the objective of promoting positive interdependence and personal responsibility, as well as the other competences related to cooperative learning, we consider that it was successfully achieved. Our results showed adequate scores in almost all dimensions, even higher than the mean scores of the original sample. The inter-item and inter-scale correlations showed values between r=0.44 and r=0.91, and the internal consistency indices were $\alpha > 0.6$. table 1 shows the scores per dimension (mean and standard deviation), as well as the correlations between the scales and the internal consistency coefficients.

In addition, as part of the same objective, we included five ad hoc questions to gauge students' opinions about teamwork and seminars. Four of the questions were formulated with a 5-point Likert scale response format (1 = Strongly disagree, 5 = Strongly agree) and one question was formulated with an open response. Of the 114 participants, a total of n=25 (22.0%) answered the open-ended question, of which n=14 (12.3%) indicated disagreement with the randomised group method, as they expressed difficulties in working; n=8 (7.1%) indicated satisfaction with the teamwork, highlighting that they had a better understanding of the concepts; and n=2

Table 1: Scoring of each dimension of CLQ, correlations and internal consistency.

	M	SD	1.HS	2.PG	3.IP	4.IPR	α
1.HS	4.2	0.7					0.86
2.PG	4.3	0.9	0.91				0.91
3.IP	4.0	0.7	0.64	0.66			0.69
4.IPR	3.8	1.0	0.71	0.88	0.75		0.89
5.RI	4.3	0.6	0.44	0.44	0.54	0.50	0.67

Nota: Correlations by Pearson coefficient. HS= Social Skills; PG= Group Processing; IP= Positive Interdependence; IPR= Promotive Interaction; RI= Individual Responsibility; M= Mean; SD= Standard Deviation; α = Cronbach's alpha coefficient for internal consistency.

Table 2: Evaluation of team working and the seminars.

	M	SD
Working in a team has been a positive experience	3.9	1.2
Working in a team helps the learning of the subject matter	4.1	0.9
Seminar attendance facilitated the understanding of the subject matter	4.6	0.6
Delivering "practice dossiers" facilitated the understanding of the subject matter	4.0	1.0

Nota: M= Mean; SD= Standard deviation.

(1.8%) indicated difficulties in working in the team due to the exceptional situation. table 2 shows the results of the Likert scale questions, expressed as means and standard deviations.

DISCUSSION

The main aim of the study was to improve academic performance through the implementation of a cooperative learning methodology. The specific objectives were to validate the CLQ in the university setting; to improve academic performance both in the group and individually; to increase participation in practical seminars, and to promote positive interdependence and individual responsibility. Our results showed that most of the objectives were achieved.

Regarding the structural validity of the CLQ in a university setting, our results did not allow us to confirm the original model, as expected, due to the high correlation between the group processing and social skills dimensions. Thus, the final estimated model has four subscales, which we have called the original scale, except for the joint dimension hs_pg, social skills + group processing. The high correlation between these two scales may be due to several reasons. Firstly, because the sample is quite homogeneous in terms of age and common interests, as the students come from only one academic course. Secondly, it may also be due to a maturation factor, as the age differs considerably from the original validation sample. Finally, it may also be due to the difficulty of distinguishing between these two dimensions, since the group processing factor necessarily includes both inter-group and individual social skills (Cuéllar & Alonso, 2010). Similarly, Delgado-García et al. (2021) identified a distinct-factor model while analysing the CLQ with a sample of 500 students, encompassing both undergraduates and postgraduates. Their findings suggested a three-factor model. Discrepancies between these studies could be linked to differences in sample size and the educational level of the students.

Academic performance was improved at both group and individual levels compared to the previous academic year. However, with regard to the objective of increasing seminar attendance, the rate was lower than expected, probably due to the exceptional situation caused by the Covid 19 pandemic. Finally, regarding the objective of promoting positive interdependence, individual responsibility and, consequently, cooperative learning, our results showed satisfactory scores in most of the CLQ subscales. These results were relevant, especially if we take into account that some mechanisms can complicate the collaborative process, such as social loafing (diffusion of responsibility) and the fear of evaluation by group members (Nokes-Malach et al., 2015). Finally, the questions assessing student's opinion about both teamwork and the quality of the seminars showed satisfactory results. In the open-ended question, the most frequent disagree-

ments were related to the randomised group formation as well as the inadequate management of conflicts related to non-cooperative individuals in the project.

In the first case, it is worth mentioning that there are different ways of forming teams but allowing students to form their own group would be the last option considered here, as homogeneous teams tend to conform. Since the promotion of cooperative learning requires heterogeneous groups with different components, interests, perspectives and motivations that facilitate deeper thinking and greater exchange of opinions, random group formation would be best (Johnson et al., 1999). As the percentage of disagreement was minimal, and considering the advantages of random group formation, we suggest that the same methodology be used in future courses. In the second case, it is essential to provide teams with tools to deal with difficulties in order to successfully implement the cooperative learning methodology. This may be necessary when a participant is not very cooperative, when negative interdependence occurs, i.e., when there are students who discourage or hinder each other from achieving the common goal (Loh & Ang, 2020), or when other mechanisms complicate the collaboration, such as a fear of evaluation by group members (Nokes-Malach et al., 2015).

Evaluating processes is more difficult than evaluating a product or a competency and would probably require different indicators, as Cuéllar and Alonso (2010) proposed in their work related to the evaluation of cooperative learning, specifically, the group learning process. Some of their suggestions include assigning roles to the participants and assessing the working team environment, the portfolio, and registering the different tasks carried out for each component. These different techniques may be useful to better assess the process of cooperative learning together with validated scales.

Therefore, on the basis of our results, we consider that it would be advisable to continue using this method in future years and to evaluate the cooperative learning process both by applying the CLQ to a larger sample, thus confirming its structural validity in the university setting, and by using other techniques, such as the assignment of roles or the portfolio.

Limitations of our study include the lower participation of students in completing the CLQ questionnaire, probably due to low attendance at the seminars, resulting in a small, fairly homogeneous sample, probably motivated by teamwork and cooperation. The circumstances created by the pandemic made the implementation process more difficult. The context also made it difficult to conduct a randomised trial or a quasi-experimental design with an equivalent group, so that comparison of groups regarding the CLQ scoring was impossible, only qualifications and rate attendance. However, despite these limitations, we believe that the results are satisfactory enough to continue and improve this project in subsequent academic years.

CONCLUSIONS

The theoretical underpinnings of cooperative learning and its ability to foster active engagement, critical skills and intercultural understanding make it a compelling strategy in modern higher education. Its adaptability to different disciplines, coupled with the evolving technological landscape, positions cooperative learning as a key pedagogical tool for equipping students with the skills they need to excel academically and thrive in an interconnected world. However, we need better and more accurate indicators to evaluate group processes. It is worth noting that due to the complexity of successfully implementing the cooperative learning methodology and assessing group processes, a key indicator would be to improve teacher skills and provide sufficient time and resources to achieve this goal. In addition, research into optimal group sizes, roles and strategies for managing conflict within groups can provide valuable insights for refining cooperative learning practices.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used [CHAT Openai / GPT-3.5] in order to improve the Conclusions section. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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