# Students' achievement through peer to peer and student to Physical Education teacher interdependences

*El logro de los estudiantes a través de las interdependencias entre pares y entre estudiantes y maestros de Educación Física*


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## Abstract

Introduction: Sustainable development in education requires not only a variety of teaching strategies but also more demands on the education of students. This study conducted quantitative research based on the combination of the three peer-to peer principles of cooperative learning in positive interdependence, promotive interaction and individual accountability, with the physical education teacher to student interdependences in teacher providing structure and promoting students' autonomy and involvement.
Methodology: A survey of 124 pre-service physical education teachers was conducted to determine the relationship between need support teaching, cooperative learning and achievement.
Results: The results of the study showed that need supportive teaching had a significant positive impact on students' autonomy support and structure, which set the stage for the application of cooperative learning principles. Cooperative learning also had a strong positive impact on student achievement, particularly in terms of promoting a sense of personal responsibility.
Discussion: The effects were not significant in the areas of promotive interaction and positive interdependence, suggesting that more targeted interventions may be needed in this area of physical education. In addition, need supportive teaching could more effectively impact student academic outcomes through cooperative learning. Innovative physical education challenges can make a significant contribution to the development of cooperative learning skills.
Conclusions: This study highlights the importance of designing physical education programs that not only focus on physical skills, but also intentionally develop social and collaborative skills



## Keywords

Achievement: cooperative learning; motivation; need supporting teaching; teaching strategies;



## Resumen

Introducción: El desarrollo sostenible en educación requiere no sólo una variedad de estrategias de enseñanza, sino también mayores exigencias en la educación de los estudiantes. Este estudio realizó una investigación cuantitativa basada en la combinación de los tres principios de aprendizaje cooperativo entre pares en interdependencia positiva, interacción promotora y responsabilidad individual, con interdependencias entre el profesor de educación física y el alumno. El profesor proporciona estructura y promueve la autonomía y la participación de los estudiantes.
Metodología: Se realizó una encuesta a 124 futuros profesores de educación física para determinar la relación entre la necesidad de apoyo al estudiante, el aprendizaje cooperativo y el rendimiento. Resultados: Los resultados del estudio mostraron que la necesidad de apoyo al estudiante tuvo un impacto positivo significativo en la autonomía y la estructura de enseñanza, lo que preparó el terreno para la aplicación de los principios del aprendizaje cooperativo. El aprendizaje cooperativo también tuvo un fuerte impacto positivo en el rendimiento de los estudiantes, particularmente en términos de promover un sentido de responsabilidad personal.
Discusión: Los efectos no fueron significativos en las áreas de interacción promotora e interdependencia positiva, lo que sugiere que pueden ser necesarias intervenciones más específicas en esta área de la educación física. Además, la necesidad de apoyo a la enseñanza podría tener un impacto más efectivo en los resultados académicos de los estudiantes a través del aprendizaje cooperativo. Los desafíos innovadores de educación física pueden contribuir significativamente al desarrollo de habilidades de aprendizaje cooperativo.
Conclusiones: Este estudio destaca la importancia de diseñar programas de educación física que no solo se centren en las habilidades físicas, sino que también desarrollen intencionalmente habilidades sociales y colaborativas.



## Palabras clave

Aprendizaje cooperativo; estrategias de aprendizaje; motivación; rendimiento

## Introduction

In the context of global educational development, higher education is facing unprecedented challenges and opportunities. With the rapid changes in society, it is becoming increasingly important to develop students' collaborative skills for sustainable development (Johnson et al. 2007, Lozano et al. 2013, 2017). Within this framework, research has shifted its focus to the development of teaching models and the effects of learning environments on student achievement. Teachers' strategies for enhancing achievement by students have a substantial impact on students' learning outcomes, and establishing a supportive teaching climate is especially critical in this process. (Ayllón et al., 2019; Leenknecht et al., 2017).

In recent years, need supportive teaching (NST) has emerged as an effective approach to enhance student engagement and foster peer-teacher interdependence. This approach focuses on three key aspects: autonomy, structure, and involvement. Autonomy involves providing students with meaningful choices and acknowledging their perspectives (Guay, 2022). In physical education, this might include allowing students to choose warm-up exercises or modify game rules. Structure refers to setting clear guidelines, expectations, and consistent consequences (Vermote et al., 2020). For instance, providing step-by-step breakdowns of complex movements and establishing clear assessment criteria for physical skills. Involvement entails active engagement with students' learning processes and showing genuine interest in their progress. This could manifest as participating in activities alongside students or discussing individual goals (Ahn et al., 2021).

Cooperative and collaborative learning, as comprehensive pedagogical models rather than mere teaching strategies, play a fundamental role in educational development (Roselli, 2016). These models encompass not only instructional methods but also theoretical foundations, learning principles, and broader educational goals. Reeve et al. (2020) notes that need-supporting teaching increases student engagement in learning at the individual level. At the collective scale, it promotes positive interactions among students (Aelterman et al. 2013, Deci and Ryan, 2008, Reeve et al., 2004). Physical education, as an integral part of comprehensive quality education, offers a unique platform for implementing these strategies. It not only pays attention to students' physical development, but also focuses on cultivating their social skills and teamwork spirit (Kao, 2019). Cooperative and collaborative learning, as an effective teaching strategy, has been widely applied and studied in physical education (Bores-García et al. 2021; Cañabate et al. 2021; Alfonzo Marín et al. 2025¸ Añazco Martínez et al. 2024). This approach can enhance both interpersonal relations (Baena-Morales, 2020, Wattanawongwan et al. 2021, Zhou and Colomer, 2024). However, the specific mechanisms by which need-supportive teaching strategies based on cooperative learning principles improve student achievement in physical education remain under-researched. More investigation is needed into how these approaches align with principles of sustainability in education (Vansteenkiste et al 2012).

Need supportive teaching is an approach that aims to foster a learning environment where both students and teachers mutually support each other's basic psychological needs, particularly focusing on autonomy support, structure, and involvement (Klassen et al., 2012). This approach is crucial in developing student-teacher interdependence, where the quality of relationships between students and teachers plays a vital role in the learning process (Reeve, 2006).

Autonomy support is a key component of need supportive teaching that promotes student-teacher interdependence (Vansteenkiste et al., 2012). In this context, teachers provide meaningful choices in learning activities and acknowledge students' perspectives. In a physical education class, a teacher might allow students to choose from a variety of warm-up exercises or let them decide on the rules for a modified game (Gil-Arias et al., 2020). This approach encourages students to take initiative in their learning and fosters a sense of ownership over their physical activities. By respecting students' input, teachers create an environment where students feel valued and are more likely to engage actively with both their peers and the teacher.

Structure in need-supportive teaching refers to the provision of clear guidelines, expectations, and consistent consequences (Domen et al., 2020). In physical education, this might involve setting clear objectives for each lesson, explaining the criteria for skill assessment, and establishing rules for safe participation in activities (Lieberman et al., 2024). A teacher might provide a step-by-step breakdown

of a complex movement, set benchmarks for improvement, and clearly communicate how teamwork will be evaluated in group activities (O'Brien et al., 2022). This structured approach helps students understand what is expected of them and how they can succeed, which in turn promotes a sense of competence and encourages them to seek help from both peers and teachers when needed.

Teacher involvement is the third crucial aspect of need-supportive teaching that fosters peer-teacher interdependence (Adams, 2023). This involves teachers actively engaging with students' learning processes and showing genuine interest in their progress and well-being. In a physical education setting, this could manifest as a teacher participating in activities alongside students, providing individualized feedback, or taking time to discuss a student's personal fitness goals (Fernandez-Rio et al., 2020). By modeling active involvement, teachers encourage students to engage more deeply with the learning process and with each other. This approach also helps create a supportive classroom climate where students feel comfortable seeking guidance from their teacher and collaborating with their peers (Ferreira et al., 2020).

By implementing these strategies of autonomy support, structure, and involvement, teachers can create an environment that promotes student-teacher interdependence. This leads to enhanced student engagement and motivation, improved skill development, and stronger relationships within the classroom.

Cooperative learning, as a pedagogical model, is built upon solid theoretical foundations that go beyond merely instructional techniques (Davidson & Major, 2014). When exploring cooperative learning in physical education, it is critical to understand its core principles (Dyson & Casey, 2012). These principles can be categorized into three main categories: positive interdependence, individual responsibility, and peer interaction. The principle of positive interdependence emphasizes students' ability to understand others' perspectives, plan roles regardless of gender, and co-create challenges (Cañabate et al., 2021). The principle of personal responsibility, on the other hand, focuses on students' ability to recognize their own and their peers' perspectives, generate empathy across differences, and actively motivate their peers (Lee & Hannafin, 2016). The principle of peer interaction includes the ability to regulate relational feedback in peer dialog, communicate effectively, and embrace multiple perspectives (De Backer et al., 2012).

Supportive teacher instruction plays a key role in implementing these principles. By creating supportive learning environments, teachers can promote positive interactions and mutual support among students. For example, teachers can first design tasks that require teamwork and encourage students to rely on and support each other (positive interdependence). Second, assign clear roles and responsibilities to each student to foster a sense of personal accountability (personal responsibility). Third, guide students to engage in effective peer feedback and communication to improve their communication skills (peer interaction). Four, help students learn to respect and appreciate different points of view through modeling and coaching (cultural sensitivity). And five, create a safe environment that encourages students to express ideas and take risks (psychological safety). These principles represent more than just guidelines for classroom instruction; they form an interconnected system that shapes the entire educational environment (Halpern, 2000). As a pedagogical model, cooperative learning creates a framework that influences curriculum design, assessment methods, teacher-student relationships, and learning outcomes. This comprehensive approach transforms the traditional teaching paradigm by establishing new roles for both teachers and students, and by creating learning environments that promote deep understanding and sustainable skill development.

At the same time, mutual support among students is key to the success of cooperative learning. Students can support each other in the following ways: encouraging and motivating each other in team sports (emotional support), sharing knowledge and skills to help their peers improve (learning support), working together to find solutions when faced with challenges (problem solving support), and developing empathy, understanding and accepting the different needs of peers (social-emotional support). However, how to improve students' achievement through teachers' supportive teaching strategies based on cooperative learning and other educational methods is still an issue that needs to be thoroughly researched. More research is needed to explore how successful students are when teachers' educational approaches are based on the principles of sustainability (Henriksen et al., 2024).

In addition, this study explores how innovative physical education challenges affect the application and development of collaborative learning principles. Through the design and implementation of targeted physical activities, we expect to observe students' progress on these principles. For example, we will examine how students understand and adapt to each other's perspectives in team sports (Principle 1), how they assign roles regardless of gender (Principle 2), and how they co-create and solve challenges in the face of cultural differences (Principles 3 and 4). At the same time, we will also assess how students take personal responsibility, motivate their peers, and manage conflict (Principles 5 and 6).

## Method

### *Participants*

Participants were 124 pre-service physical education teachers, of whom 46 (37.1%) were female and 78 (62.9%) were male, with 13 (10.5%) in the preschool education bachelor, 66 (53.2%) in the primary education bachelor and both included dual bachelor (preschool education and primary education) with 45 (36.3%) participants. Before collecting information, the consent of each student participating in the research was obtained which included a previous explanation of the main purpose of the study. Students who had chosen to participate independently filled out an informed consent form. The Research Ethics Committee of the University of Girona approved the procedures and protocols for the study under code PE24/RECPro0224.

### *Procedure*

The pre-service students were involved in a full semester 48 hour in total in cooperative learning. During classes the main instructional approach was the development of cooperative physical education challenges. One method built upon the principles of cooperative learning is cooperative physical challenges. The teacher gives the students the challenge in one of two formats: structured, or unstructured. To accomplish a shared physical challenge, the students must cooperatively plan, organize the task, and suggest an action pathway that will set up a dynamic group exercise of shared accountability for each other learning. The fundamental components of cooperative physical challenges include peer-to-peer discussion, mutual respect and assistance, task-oriented cooperation, and action-oriented thinking. Usually, the instructional methodology starts with the identification of symbolic elements that enable the pre-service teachers' symbolic imagination to be awoken through a challenge. The teacher poses questions to frame the challenge and provides the students with a space for group development, inquiry, and discovery. Students propose a solution to create a challenge, and they must be overcome as a group using the motor activity. A preferred empathic environment is generated for the co-constructed symbolic context, which supports both the teacher-student and student-to-student connection. The participants' contributions and reactions, along with the teacher's proactive feedback are what make the whole supportive partnership work. It also depends on each member of the group accepting accountability for the cooperative physical challenges and actively engaging in the group's resolution. At the end of the whole activity, each student was involved in solving ten cooperative physical challenges.

A questionnaire gathering the information on both the categories of need-supportive teaching and cooperative learning was administered to the students at the very end of the process. Before completing the questionnaire, students were briefed about the idea of this study and assured that their answers would be kept confidential. They were told that there was no right or wrong answer and that the answers should reflect their own views. Students were also told that they could refuse to answer the questionnaire at any time. No students refused to participate. It took approximately 15 minutes to complete the questionnaire, and the researchers collected the completed filled questionnaires.

#### *Instrument*

For 3 of the measures, students completed a questionnaire in which they responded, on a 5-point scale ranging from (1) totally disagree to (5) totally agree to statements related to each measure. We used the Teacher as Social Context Questionnaire (TASCQ; Belmont, Skinner, Wellborn, & Connell, 1992) to measure student perceptions of teacher need-supportive practices. The 24-item short form comprises three scales, each with eight items: Autonomy Support (e.g., My teachers give me a lot of freedom in how

I organize the activities; My teachers listen to my ideas; My teachers listen to my opinion), Structure (e.g., My teachers make clear what they expect of me in class; If I can't solve a problem, my teachers show me the different strategies to try; Every time I do something wrong, my teachers respond differently), and Involvement (e.g., My teachers know me well; My teachers just don't understand me; I can't count on my teachers when I need them). The final scale comprised 24 items (8 Autonomy Support, 8 Structure, and 8 Involvement) and had good internal consistency (Autonomy Support α = .766; Structure α = .818; Involvement α =.893; Need satisfaction teaching α = .812).

The original version of this instrument had been designed and validated for Spanish contexts (Fernandez-Rio et al., 2017). Following Muñiz et al. (2013), the International Test Commission Guidelines for test translation and adaptation were followed. To assess the concurrent validity of 4 out of the 5 sub-scales of our questionnaire, the following dimensions of the CL were used: positive interdependence (5 items: Understanding the perspectives of others; Planning student roles independent of gender; Ability to co-create challenges with internal and external contexts; Ability to create challenges considering ethical, cultural and social differences; Accepting diversity of opinions, experiences and perspectives), individual accountability (5 items: Ability to identify one's own and peers' perspectives; Generation of empathy with others across differences; Taking responsibility for motivating peers; Taking responsibility when coping with personal conflicts, contradictions, and setbacks; Ability to consider ethics, justice, and ecological integrity) and promotive interaction (4 items: Ability to regulate relational feedback between peers' dialogs; Ability to communicate effectively in contextualized contexts; Accepting ideas independent of ethnicity, culture, or social strata; Ability to create community actions in contextualized contexts). They answered in a 5-point Likert scale from (5) totally agree to (1) totally disagree. The different subscales showed adequate internal consistency (positive interdependence α =.934, individual accountability α =.832, promotive interaction α = .948, Cooperation learning α =.736).

To test the academic achievement of the students, an internal assessment questionnaire was used (Cañabate et al. 2021) and refined and modified to suit the purpose of this study. It was divided into five main items (1st item: design of challenges, 2nd item: self-assessment of challenge objectives, 3rd item: assessment by peers of the challenge objectives, 4th item: self-reflection on cooperative dimensions, and 5th item self-reflection on collaborative skills) and had good internal consistency (Achievement α = .745).

### *Data analysis*

Partial least squares structural equation modeling (PLS-SEM) techniques are used in our study to examine the collected data with SmartPLS 4. PLS-SEM is widely used in the field of management and information technology (IT), where it is said to yield reliable outcomes (Sarstedt et al., 2021). PLS-SEM is a non-parametric technique exploiting the explained variance in latent dimensions, that are not able to be observed in any direct way. Unlike the covariance-based SEM (COV–SEM), smart PLS-SEM requires less information about residual distributions, measurement scales, and sample sizes (Hair et al., 2021). Smart PLS-SEM is deemed suitable for analyzing the complex research models that are proposed as an estimation framework incorporating related theories and empirical data. Following Leguina's (2015) suggestion, a two-step approach was adopted, in which, the proposed theoretical model first tested the outer model for convergent and discriminant validity, then second the inner model was evaluated for hypotheses testing.

## Results

### *Evaluation of the outer measurement model*

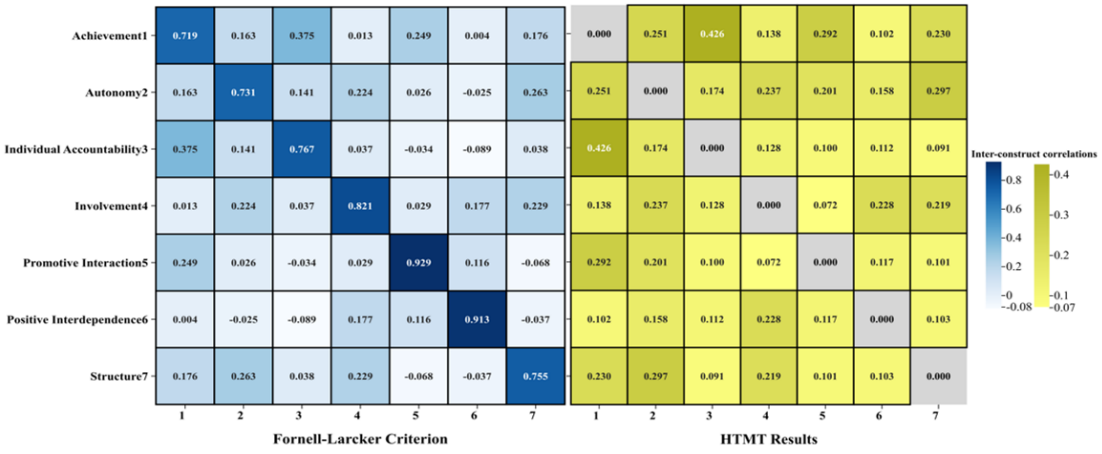
Several statistics were employed to calculate the reliability and validity of the study outer model as suggested (Hair et al. 2019). These statistics include "composite reliability" (CR); "internal consistency reliability" (Cronbach's alpha); "convergent validity"; and "discriminant validity". First, according to Table 1, Cronbach's alpha (α) values ranged from .766 to .948 and composite reliability (CR) values ranged from .845 to .963, indicating that the scale has acceptable internal reliability (Rex, 2015).

Second, each of the factors had values of "Standardized Factor Loading" (SFL) that were greater than .60, which provided further evidence that the study dimensions have a satisfactory level of reliability. Third, convergent validity was ensured by evaluating whether AVE values were higher than 0.5 (Hair et al., 2021). This value is the minimum level of acceptability that is adequate convergent validity.

Table 1. Factors Cross-loading.

| Items | Achievement | Autonomy | Individual Accountability | Involvement | Promotive Interaction | Positive Interdependence | Structure |
|---|---|---|---|---|---|---|---|
| A1 | .062 | .661 | .091 | .161 | .083 | -.087 | .298 |
| A2 | .184 | .861 | .088 | .168 | -.023 | .111 | .131 |
| A5 | .13 | .545 | .104 | .256 | .337 | .049 | .25 |
| A6 | .171 | .863 | .116 | .135 | -.071 | .041 | .173 |
| A8 | .046 | .675 | .115 | .136 | -.101 | -.189 | .164 |
| AC1 | .713 | .288 | .356 | .02 | .015 | -.085 | .227 |
| AC2 | .727 | .212 | .158 | .002 | .21 | .026 | .2 |
| AC3 | .727 | .002 | .174 | .046 | .275 | .125 | .098 |
| AC4 | .702 | .014 | .343 | .032 | .199 | -.012 | .009 |
| AC5 | .723 | .083 | .313 | -.062 | .193 | -.048 | .111 |
| I1 | .024 | .197 | .11 | .877 | .07 | .09 | .201 |
| I2 | .042 | .211 | .056 | .86 | -.017 | .192 | .197 |
| I4 | .023 | .147 | .034 | .765 | -.021 | .224 | .136 |
| I6 | -.041 | .183 | -.09 | .891 | .029 | .158 | .214 |
| I7 | -.042 | -.002 | -.036 | .692 | -.048 | .191 | .033 |
| IA1 | .259 | .183 | .775 | .01 | -.083 | -.063 | -.016 |
| IA2 | .195 | .088 | .746 | .052 | -.082 | -.017 | -.027 |
| IA3 | .175 | .018 | .71 | -.017 | -.105 | .01 | .006 |
| IA4 | .314 | .152 | .846 | .094 | -.003 | -.049 | .101 |
| IA5 | .385 | .081 | .751 | .004 | .057 | -.149 | .042 |
| PI1 | .247 | -.012 | -.056 | .104 | .919 | .151 | -.04 |
| PI2 | .212 | .043 | -.008 | -.026 | .928 | .108 | -.05 |
| PI3 | .221 | -.013 | -.037 | -.002 | .949 | .071 | -.148 |
| PI5 | .236 | .086 | -.015 | .001 | .921 | .086 | -.028 |
| POI2 | .026 | -.03 | .005 | .162 | .146 | .929 | -.055 |
| POI3 | .001 | .002 | -.133 | .122 | .056 | .912 | -.082 |
| POI4 | -.064 | -.093 | -.151 | .145 | .069 | .891 | -.039 |
| POI5 | .02 | -.003 | -.074 | .224 | .147 | .918 | .058 |
| S1 | .217 | .316 | .047 | .166 | -.008 | -.068 | .854 |
| S2 | .073 | .117 | -.005 | .144 | -.043 | -.031 | .842 |
| S3 | -.039 | .121 | .027 | .22 | -.083 | .071 | .483 |
| S4 | .098 | .042 | -.035 | .122 | -.082 | -.077 | .772 |
| S5 | .203 | .147 | .035 | .151 | -.085 | -.042 | .765 |

Figure 1. Inter-construct correlations, the square root of AVE, and HTMT results. Diagonal plus black font is the square root value of AVE.



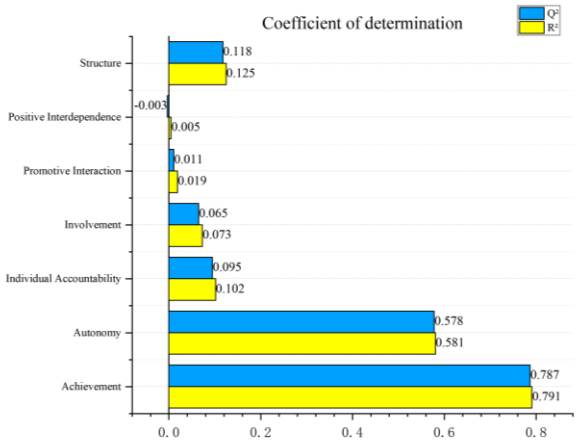

Additionally, three main criteria were employed to encore the scale has an adequate discriminant validity as suggested by Leguina (2015). These criteria included the "cross-loading matrix", the "Fornell-Larcker criterion method", and the "heterotrait-monotrait method" ratio (HTMT). To start, as shown in Table 1, the outer-loading (bolded) of each latent unobserved variable needs to be higher than the cross-loading (with other measurements) to guarantee discriminant validity.

In addition, as presented in Figure 1, the bolded diagonal AVE values are greater than the inter-variable correlation coefficient, which is indicative of high discriminant validity (Hair et al. 2019) and the square root of the AVEs for the results of this study ranged from .719-.929. Finally, as stated by Leguina (2015), HTMT values should be under .90. Study HTMT levels were significantly lower than the reference value (Figure 1). Taken together, the previous results confirm and support the scale reliability, discriminant, and convergent validity as approved in the study measurement outer model.

### *Assessment of the structural inner model*

A structural equation investigation was employed to test the study proposed hypotheses. Specifically, the main aim is to examine the model's aptitude to explain and predict the variation in the endogenous variables caused by the exogenous variable (Hair et al., 2021). Furthermore, Chin (1998), suggested $R^2$ value of at least 0.10 to ensure a satisfactory model fit. Accordingly, the endogenous variables "Achievement" has an $R^2$ value of .791, $R^2$ values exceeded the recommended threshold score and designating that the study model sufficiently represents the collected data (Figure 2). Likewise, The Stone-Geisser Q2 calculation displayed a value of (.787), with values that were higher than zero (Figure 2), indicating a satisfactory predictive power of the structure model (Henseler et al., 2009).

Figure 2. Coefficient of determination ($R^2$, $Q^2$)




The structure of the model we constructed in Figure 3 shows that the impact of needs supportive teaching on academics is reduced under the influence of the mediating role of cooperative learning, confirming that cooperative learning interventions have a favorable effect (β=.267, t=4.075***).

In the end, a bootstrapping method was implemented in smart PLS4 to determine the path coefficient and its associated t-value for both the direct and mediating relationships in Table 2. The smart PLS results showed that Cooperation learning -> Achievement (β=.866, t=42.807***), Cooperation learning -> Individual Accountability (β=.32, t=5.929***), Cooperation learning -> Promotive Interaction (β=.138, t=1.254), Cooperation learning -> Positive Interdependence (β=.072, t=.577), Need support teaching -> Achievement (β=.067, t=1.575), Need support teaching -> Autonomy (β=.762, t=17.069***), Need support teaching -> Cooperation learning (β=.309, t=4.128***), Need support teaching -> Involvement (β=.354, t=2.684**), Need support teaching -> Structure (β=.354, t=5.398***), Need support teaching -> Cooperation learning -> Achievement (β=.267, t=4.075***), Need support teaching -> Cooperation learning -> Individual Accountability (β=.099, t=3.108**), Need support teaching -> Cooperation learning -> Promotive Interaction (β=.043, t=1.163), Need support teaching -> Cooperation learning -> Positive Interdependence (β=.022, t=.558).

Figure 3. Inner & Outer Model with the categories for Cooperation learning, need supporting teaching and achievement

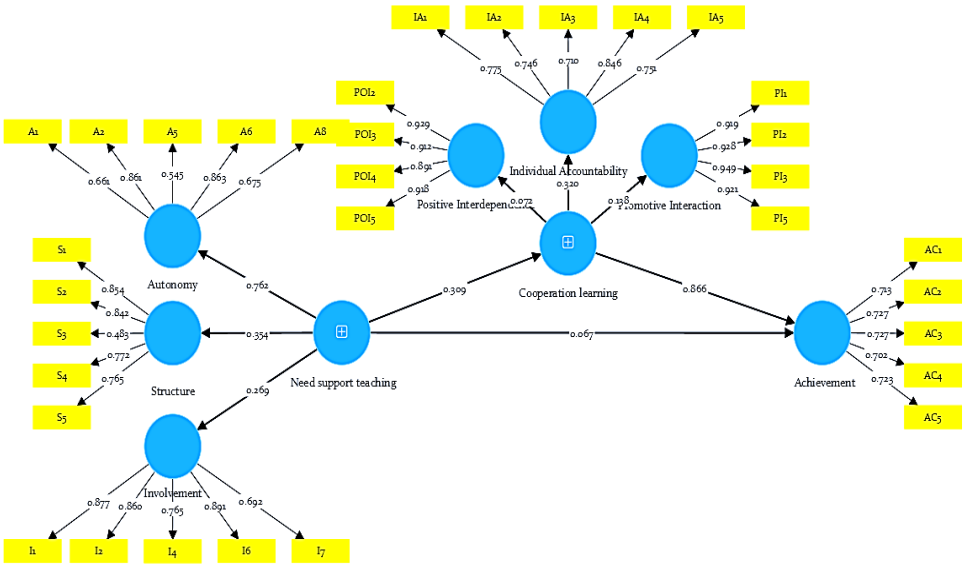



Table 2. Path coefficient.

| Path coefficient | β | SE | t | P |
|---|---|---|---|---|
| Cooperation learning -> Achievement | .866 | .02 | 42.807 | 0 |
| Cooperation learning -> Individual Accountability | .32 | .054 | 5.929 | 0 |
| Cooperation learning -> Promotive Interaction | .138 | .11 | 1.254 | .21 |
| Cooperation learning -> Positive Interdependence | .072 | .126 | .577 | .564 |
| Need support teaching -> Achievement | .067 | .043 | 1.575 | .115 |
| Need support teaching -> Autonomy | .762 | .045 | 17.069 | 0 |
| Need support teaching -> Cooperation learning | .309 | .075 | 4.128 | 0 |
| Need support teaching -> Involvement | .269 | .1 | 2.684 | .007 |
| Need support teaching -> Structure | .354 | .066 | 5.398 | 0 |
| Need support teaching -> Cooperation learning -> Achievement | .267 | .066 | 4.075 | 0 |
| Need support teaching -> Cooperation learning -> Individual Accountability | .099 | .032 | 3.108 | .002 |
| Need support teaching -> Cooperation learning -> Promotive Interaction | .043 | .037 | 1.163 | .245 |
| Need support teaching -> Cooperation learning -> Positive Interdependence | .022 | .04 | .558 | .577 |

*$P<.05$, **$P<.01$, ***$P<.001$

## Discussion

The results show that cooperative learning has a significant direct positive effect on student achievement (β=. 866, p<. 001), but also has a significant positive effect on personal responsibility (β=. 32, p<. 001). However, the direct impact of cooperative learning on promotive interaction and positive interdependence is not significant. Need to support teaching on autonomy (β=. 762, p<. 001) and involvement (β=. 354, p<. 01) and structure (β=. 354, p<. 001) have significant positive effects and indirectly affect student achievement through cooperative learning (β=. 267, p<. 001) and individual accountability (β=. 099, p<. 01). The need to support teaching also directly affects cooperative learning (β=. 309, p<.01. However, neither the direct impact of the need for supportive teaching on student achievement nor the indirect impact of cooperative learning on facilitating promotive interaction and positive interdependence are significant. These findings highlight the importance of cooperative learning in enhancing student achievement, as well as the need to support the critical role of teaching in promoting cooperative learning and fostering student autonomy and involvemtent and on a structured teaching as well.

### *Impact of need-supportive instruction on the principles of cooperative learning*

The results of the study indicated that need supportive teaching had a significant direct impact on teacher providing autonomy support and structure. This is consistent with the core principles of Self Determination Theory (SDT), which emphasizes the important role of teachers in meeting students' basic psychological needs (Ryan & Deci, 2000). This finding suggests that teachers create a favorable

environment for the application of cooperative learning principles by meeting students' basic psychological needs (Brown & Campione, 2013). By supporting students' autonomy, teachers may have facilitated students' better understanding and adaptation to each other's perspectives in team sports (Principle 1), which is consistent with the findings of Cheon et al. (2014). Similarly, providing a clear structure may have facilitated students' role allocation regardless of gender (Principle 2), as it provided a framework for all students to participate equally (Theobald et al., 2017).

Interestingly, this study found that needs-supportive teaching had a significant indirect effect on student achievement through cooperative learning. This finding highlights the importance of cooperative learning as a mediating mechanism between needs-supportive teaching and student achievement. It suggests that when teachers adopt a needs-supportive teaching approach, they can create an environment that is more conducive to cooperative learning, which in turn promotes student learning outcomes.

### *The central role of cooperative learning in innovative physical activity*

This study revealed that cooperative learning significantly influences individual accountability, while its effects on promotive interaction and positive interdependence were not significant. These findings provide a nuanced view of the internal dynamics of cooperative learning, partly aligning with and partly diverging from established theories.

The significant impact on individual accountability aligns with Slavin et al.'s (2003) emphasis on the importance of individual responsibility in group settings. This suggests that well-structured cooperative learning environments successfully foster a sense of personal responsibility among students, potentially motivating them to contribute more effectively to group tasks. However, the non-significant effects on promotive interaction and positive interdependence are somewhat surprising, given their theoretical importance in cooperative learning models (Johnson & Johnson, 2019).

These results might indicate that while cooperative learning structures provide opportunities for interaction and interdependence, these elements may not automatically manifest strongly in all contexts. Factors such as group composition, task design, or cultural background could moderate these effects. Alternatively, these findings might suggest a need for more explicit strategies to enhance promotive interaction and positive interdependence within cooperative learning settings. Future research could explore interventions specifically designed to strengthen these aspects and examine their subsequent impact on learning outcomes.

### *The role of cultural differences and conflict management in physical education*

Although our statistical results did not directly measure cultural differences and conflict management (Principles 3, 4, and 6), the significant relationship between needs-supportive teaching and student involvementt provides some interesting insights. This relationship may indicate that students are more likely to be actively involved in intercultural cooperation and conflict resolution activities when teachers create a supportive environment. These results are highly consistent with the core insights of SDT (Ryan & Deci, 2017). SDT emphasizes that the satisfaction of basic psychological needs (autonomy, structure, and involvement) is essential for promoting intrinsic motivation and active engagement, and our study provides empirical support for this theory.

Of note is the fact that needs-supported instruction had the most significant impact on autonomy. This may reflect the trend in contemporary educational environments to empower students with more choice and decision-making power. As noted by Reeve (2016) and Ventaja-Cruz et al. (2025), supporting students' autonomy enhances their intrinsic motivation, which in turn improves learning engagement and outcomes. Our findings reinforce this view and emphasize the importance of creating autonomy-supportive environments in teaching practice.

However, the direct impact of demand-supportive teaching on student achievement was not significant. This finding may seem paradoxical, but there may be differences in students' perceptions of demand-supportive teaching in the classroom, which is consistent with the findings of Ahn et al. (2021). It also provides strong evidence for our study that demand-supportive teaching may indirectly affect learning outcomes by enhancing students' psychological need satisfaction, which in turn affects other factors such as motivation and ultimately engagement. This result calls for the need for a more comprehensive understanding of the pathways through which instructional practices influence student achievement.

### *Gender equality in the distribution of team roles*

The application of need supportive teaching significantly affects cooperative learning, a result that reveals a potential synergy between the two teaching methods. This relationship may stem from the fact that need support teaching creates a favorable psychological environment for effective cooperative learning (Johnson et al., 2007; Uz Bilgin & Gul, 2020; García-Taibo, 2024). When students feel their autonomy, competence, and relational needs are met, they may be more willing and able to engage in cooperative learning activities (Han, 2021; García-Taibo, 2024). This may also suggest how a supportive learning environment may promote more equitable role distribution.

Further, the study showed that need supportive teaching had an indirect effect on student achievement and personal responsibility through cooperative learning. This finding echoes the results of the Reeve et al. (2004) study, who found that teacher autonomy support promotes student engagement in the classroom. Our study further extends this idea by showing that demand-supportive teaching not only enhances engagement but may also improve learning outcomes by optimizing the collaborative learning process. This indirect effect highlights the importance of integrating different instructional strategies in educational practice. It implies that simply implementing cooperative learning may not be sufficient to maximise learning outcomes; rather, creating a supportive environment that meets students' basic psychological needs may be the key to realizing the full potential of cooperative learning. This finding may provide educators with valuable insights into the necessity of designing comprehensive, multilevel instructional strategies.

## Conclusions

This study examined the impact of need supportive teaching and cooperative learning on student achievement, that is, student achievement through peer-to-peer and student-to-teacher interdependence. The findings not only enhance our understanding of these educational strategies, but also provide important insights into educational practice.

First, the study strongly confirms the significant positive impact of cooperative learning on student achievement. This finding re-emphasizes the importance of promoting and optimizing cooperative learning strategies in educational settings. Educators should be proactive in creating opportunities that enable students to learn in an interactive and collaborative manner, thereby enhancing learning outcomes.

Second, the study revealed the important role of need supportive teaching in meeting students' basic psychological needs, particularly in enhancing students' autonomy, involvement, and providing structure. Although the direct impact of need supportive teaching on student achievement was not significant, it indirectly contributed to student learning outcomes by influencing cooperative learning. This finding highlights the importance of creating supportive learning environments that not only meet the psychological needs of students, but also lay the foundation for effective cooperative learning.

Furthermore, the findings suggest that there is a synergistic effect between need supportive teaching and cooperative learning. This finding provides a theoretical basis for integrating different instructional strategies and implies the need to design a comprehensive, multilevel approach to instruction. Educators should consider how to incorporate elements of demand support into cooperative learning activities to maximise learning outcomes. However, the study also found that cooperative learning did not have a significant impact on facilitative interactions and positive interdependence, which reminds us that we need to pay more attention to how to foster these important elements in cooperative learning. Future research and practice should explore more effective ways to enhance interaction and interdependence among students.

Overall, the findings of this study emphasize the importance of adopting a holistic approach in educational practice. By combining need supportive teaching and cooperative learning, educators can create a learning environment that both meets students' basic psychological needs and promotes effective collaboration. This holistic approach is not only expected to improve students' achievement but may also have a positive impact on their social skills, autonomy, and motivation to learn. Although this study provided valuable insights, further research is needed to gain insight into the long-term

effects of these educational strategies and their applicability in different cultural and educational contexts. Future studies should consider longitudinal designs and mixed methods to gain a more comprehensive understanding. Finally, the findings of this study provide an important reference for educational policy makers and practitioners. It highlights the potential benefits of integrating the principles of need supportive teaching and cooperative learning in the education system and provides new ideas for improving educational quality and student achievement. Through continuous research and innovative practices, teaching and learning strategies can be continuously optimized to create an educational environment more conducive to student learning and development.

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