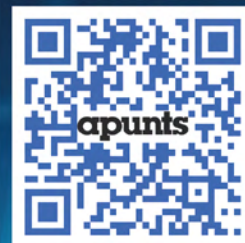


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The Development of Body Expression in Spain: Mercè Mateu, an Inspiring Teacher

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.
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Abstract

The development of Body Expression in Spain has been closely linked to the educational sphere, especially to the training of Physical Education teachers. In this context, Mercè Mateu's teaching and research career has had a significant influence on the consolidation of Body Expression as a field of knowledge and as a specific content area within physical education, as well as on pedagogical practice aimed at teacher education.

This article is part of a historiographical narrative review with a hermeneutic-interpretive approach and aimed to analyze and contextualize Mercè Mateu's main contributions to the development of Body Expression in the academic and educational fields. To this end, a systematized review of her published scientific output was carried out, both as lead author and as co-author.

From a qualitative perspective, the analysis made it possible to identify a trajectory structured around several fundamental axes: the performing arts (dance and circus), motor praxeology as an integrating theoretical framework, emotional education, the gender perspective, and teacher education.

The results show that the doctoral dissertation defended in 2010 constituted a turning point by establishing a bridge between the analysis of the internal logic of artistic motor practices and their stage and pedagogical application. Taken together, Mercè Mateu's work highlights the potential of Body Expression as an interdisciplinary field for emotional education, teaching innovation, and comprehensive education in contemporary Physical Education.

Keywords: body expression, circus, dance, emotional education, gender perspective, motor praxeology, physical education

Introduction

The development of Body Expression in Spain has undergone a slow but continuous evolution that becomes most prominent in the educational context. The didactics of Body Expression within the framework of Physical Education represents a firm commitment to educating all generations in the knowledge of their own bodies and the expressive resources that movement offers us (Coterón & Sánchez, 2010). Sánchez (2022) notes that:

Bodily expressiveness is a natural and everyday human behavior that reveals the emotional states of the person expressing themselves. The body activates its expressive resources and, whether with the help of words or without them, brings into play a series of facial gestures, postures, and movements of the hands and arms, among others, that testify to the emotions each individual expresses. This expressiveness forms a genuine part of a person's identity markers, resulting in a unique body language that distinguishes them from others. Just as verbal language is the result of learning, experience, and relationships with others (pp. 104–105).

From a phenomenological perspective, the expressive dimension of movement can be understood as embodied experience, where the body does not act solely as a functional instrument but as a subject of meaning (Husserl, 1970). This conception is consistent with the subsequent development of the discipline within the university context. The expressive dimension of movement encompasses all motor manifestations that involve the intention to express one's inner world and share it with others through original creative processes with a significant aesthetic component. The fundamental elements of the expressive dimension of movement are expressiveness, communication, creativity, and aesthetics (Sánchez et al., 2008a, 2008b; Sánchez, 2010).

Within this evolutionary context of teaching Body Expression in Spain, the figure of Professor Mercè Mateu stands out, who has now completed more than forty-three years dedicated to teaching at the National Institute of Physical Education of Catalonia (INEFC), both at the Barcelona and Lleida campuses, as well as at the Institut del Teatre de Barcelona (see Figure 1). Her career and contributions have had a significant impact both on the

Figure 1

Images of Professor Mercè Mateu during her last Body Expression class at INEFC Barcelona (2025)



Note. Photographs provided by INEFC.

university training in Physical Education and Dance of graduates from the aforementioned institutions and on various fields of research, all related to the discipline of Body Expression.

This article falls within the genre of historiographic narrative review with an interpretive approach and aimed to analyze and contextualize the main contributions of Mercè Mateu to the development of Body Expression in both academic and educational contexts. To this end, an exhaustive review of her published scientific production was carried out, both as a principal author and as a co-author. From the National Association of Teachers of Physical Activity and Body Expression (AFYEC), it was considered relevant to collect these contributions in recognition and gratitude toward someone who has traced a fruitful path focused on the initial training of teachers. Using a qualitative and hermeneutic research approach, an in-depth analysis of her texts was conducted based on the interpretation of the experiences lived and narrated in them. The ultimate aim was to contribute to a better understanding of her academic and pedagogical legacy, as well as to highlight her impact on consolidating Body Expression as a field of knowledge.

Methodology

The study was conducted through a historiographic narrative review with a hermeneutic-interpretive approach. This dual methodological framework allowed, on the one hand, the systematic reconstruction of Mercè Mateu's academic and scientific trajectory (historiographic dimension) and, on the other, the interpretation of the meaning and conceptual evolution of her contributions within the socio-educational context of Body Expression (hermeneutic dimension).

Historiographic Dimension

An exhaustive compilation of the author's published academic production between 1990 and 2024 was carried out, including articles in indexed journals, books, book chapters, conference proceedings, and her doctoral dissertation. The documents were selected according to criteria of thematic relevance (body expression, performing arts, motor praxeology, emotional education, and gender perspective) and academic relevance.

The historiographic analysis made it possible to identify key milestones in her research trajectory, especially the publication of reference works (Mateu, 1990; 2003; Mateu et al. 1992), the defense of her doctoral dissertation (Mateu, 2010), and the development of consolidated research lines in emotional education and gender (Gelpi et al., 2014; Romero et al., 2017; Mateu et al., 2021).

Hermeneutic Dimension

From a hermeneutic perspective inspired by the tradition of Husserl (1970) and Gadamer (1998), an interpretive reading was conducted aimed at understanding the evolution of the meaning attributed to Body Expression in the author's work. Particular attention was paid to the relationship between lived experience, teaching practice, and theoretical construction.

The interpretive analysis followed an iterative procedure characteristic of the hermeneutic circle (Gadamer, 1998), alternating the understanding of individual texts with the reconstruction of the overall academic trajectory. This process made it possible to avoid a fragmented reading and to promote a contextualized and relational interpretation of the identified contributions.

The interpretation focused on identifying:

1. Conceptual continuities.
2. Transformations in the pedagogical approach.
3. Structural contributions to the disciplinary consolidation of Body Expression as a content area within Physical Education.

This procedure made it possible to integrate documentary analysis with a contextualized understanding of the academic and pedagogical impact of her trajectory.

To reinforce the consistency of the analysis, an internal triangulation was applied between primary sources (the author's publications) and secondary sources (co-authored works and related studies), ensuring interpretive coherence and avoiding biases derived from isolated readings.

Results

Historiographic Construction and Conceptual Evolution

The documentary analysis made it possible to reconstruct Mercè Mateu's academic trajectory by identifying an evolution articulated around four major axes:

1. the construction of an expressive perspective linked to the performing arts;
2. the incorporation of motor praxeology as a theoretical framework;
3. the development of a research line in emotional education and gender perspective;
4. the consolidation of a specific training model in the initial education of Physical Education teachers.

The presentation of the results combines a chronological criterion with a thematic analysis, allowing observation of both the continuity and the transformations in her pedagogical and scientific thinking.

The Construction of the Expressive Perspective

Mateu's interest in the expressive, communicative, and artistic dimension dates back to her youth as a gymnast and coach, as well as to her fondness for cultural performances. One of these proved especially significant and decisive for her. It was the staging of Jonathan Livingston Seagull by the American mime Stewy, presented at the well-known Sala Cadarso in Madrid in 1981. She explains her impressions very clearly in Mateu (2008):

I was captivated by what that body conveyed through motor evolutions that appeared gymnastic and acrobatic, placed at the service of a story about freedom. Until then, I had experienced those motor actions from the mechanistic perspective of sport, and in fact it was from that aesthetic experience as a spectator that I discovered and began to take an interest in the expressive and communicative dimension of motor behavior (p. 71).

It was precisely that same year when she completed her studies in psychology and opened herself to an immense world. This admiration for the potential of the body in motion led her to an interest in bodily expressiveness in all its dimensions, which was further strengthened by her training at the Institut del Teatre. These experiences led her to ask herself many questions that required answers and demanded determination in intellectual and academic study. With this background, she ventured to deepen her analysis through artistic manifestations and performing arts, whether dance-based, circus-based, or acrobatic.

Mercè Mateu gradually built an intellectual and motor universe to which she would devote more exclusive attention after joining the faculty of INEFC Lleida in 1982, coinciding with the creation of the center. A perfect laboratory for composing, experimenting, and reflecting through courses such as Women's Artistic Gymnastics and Dynamic Expression, which would later be renamed Body Expression.

From all the experiences accumulated during ten years of university teaching practice emerged the publication of the book *1300 Exercises and Games Applied to Gymnastic Activities* (Mateu, 1990), a work of a markedly practical nature that achieved notable dissemination, especially among Physical Education teachers.

The consolidation of her research trajectory can be understood as a process of progressive expansion from artistic experience toward theoretical grounding and applied research.

A Chronology of her Research Interests

Along this line of progressively constructing an expressive and pedagogical perspective, her research trajectory began to be structured around several thematic axes that would shape her scientific development.

The Performing Arts, the Circus

I began to train in the language of Body Expression, dance, mime, and gesture theater. My passion for the physical body and its possibilities for acrobatic expression led me to the language of the circus, the mastery of ylinx (risk, vertigo, inversion), and the relationship with objects and apparatuses, all in the service of an idea, a theme, a narrative. (Fragment written by Mateu in Garcías et al., 2023, p. 53).

Her interest in acrobatics would grow and, from 1987 onward, would be directed toward increasingly structured proposals, such as monographic courses and summer courses with professional teachers and artists. In the 1990s, the National Gymnasts' Gatherings (*Gimnastradas Nacionales*) would emerge, which, with an internal logic halfway between sport and art, would become excellent showcases for presenting the collective works of INEFC.

In 2003, within the framework of the 1st International Congress on Body Expression and Education, held in Zamora and organized by AFYEC and the University of Salamanca, she presented her paper entitled *The Circus, Body Expression, and Physical Education*, in which she explicitly raised the educational value of the circus:

Circus artistic performances constitute centers of historical-cultural knowledge (like creations in dance, gesture theater, or mime...) from which we can extract and sequence content that can be transmitted and learned in educational institutions (Mateu, 2003, p. 136).

The Motor Praxeology of Pierre Parlebas

The creative energy with which INEFC Lleida began its activity required a permanent effort to build stable structures in both teaching and research. Proof of this was the creation in 1991 of the Praxeological Study Group at INEFC Lleida, directed by Professor Francisco Lagardera, with the participation of Gerard Lasierra, Pere Lavega, Conchita Durán, Mario Lloret, and Mercè Mateu, among others.

The seed had arrived in 1986, brought by Domingo Blázquez, a professor at INEFC Barcelona, when Pierre Parlebas presented his work *Éléments de sociologie du sport* (Parlebas, 1986), a foundational text of motor praxeology that decisively influenced the subsequent development of the praxeological study group at INEFC Lleida.

That meeting sparked in Professor Lagardera an immediate interest in the science of motor action and initiated a line of work that culminated, in a first stage, in 1995 with the defense of the first doctoral dissertation on praxeological themes by Professor Pere Lavega and continued with the investiture of Professor Pierre Parlebas as doctor honoris causa by the University of Lleida in 2002.

The insatiable need for knowledge and her personal boldness in searching for the meaning of artistic motor behavior led Mateu to complete a doctoral dissertation of enormous erudition. A voluminous, profound thesis with numerous intersections, in which all the author's concerns converge. A work of great theoretical density and analytical depth that articulates multiple conceptual frameworks and went beyond the demands of the Academy.

And thus, in 2010, she defended the dissertation *Observación y Análisis de la expresión motriz escénica. Estudio de la lógica interna de los espectáculos artísticos profesionales: Cirque du Soleil (1986-2005)*. In it we find all the paths she has traveled in creating her own intellectual universe: motor praxeology, the performing arts, the circus, Body Expression, and the essential value of emotions in artistic creation. Directed by Maria Teresa Anguera and Marta Castañer, it is a document of more than 700 pages in which a work of great maturity is presented, the tangible result of a solid and recognized professional trajectory, woven over time with care and dedication.

The present work develops around a theme—motor expression—that represents an association between personal life, professional trajectory, and an interest in research in the field of motor behavior, and specifically

its fascinating possibilities to impress, express, and communicate. At the same time, my attraction to this theme arises from my enthusiasm for the motor manifestations of the body, as a physical, psychological, and relational entity and, above all, as something capable of perceptual and emotional resonance. (Mateu, 2010, p. 1).

Mateu studied ten productions of Cirque du Soleil, identifying the specific characteristics of stage motor-expression situations, as well as the motor, communicative, and symbolic interactions that characterize them.

Her in-depth study of the analysis of the internal logic of expressive activities constitutes a major contribution to the field of human motor behavior by combining a theoretical framework based on motor praxeology with a rigorous and exhaustive observational methodology. This combination establishes a bridge between the analysis of circus motor practice and its application in the educational context (Mateu, 2020; Mateu & Bortoleto, 2011).

The Didactics of Body Expression

Parallel to her praxeological and performing arts studies, Mateu developed a line of research focused on the didactics of Body Expression, especially on the emotional dimension of motor practices. In the field of Body Expression didactics, she made many contributions. In recent years, she has focused particularly on the study of emotions, where some of her most important conclusions are the following:

- Body Expression practices appear to promote emotional well-being, although at the beginning unfamiliarity may manifest as an initial and common embarrassment among most students.

- Positive emotions can enhance creativity and the state of flow, which is key in learning dance and Body Expression. Neuroscience also supports the idea that learning is more firmly established when it is associated with positive emotions.

- The type of task influences the emotional experience: more introspective tasks generate calm and surprise; communicative tasks generate affective bonds; group tasks generate enjoyment. It is the teacher's responsibility to select the type of task according to the objective to be achieved.

- Physical contact and gaze can generate both well-being and discomfort, depending on the context and previous experience.

With all this, Mateu suggests that emotional education focuses especially on fostering sensations and emotions most conducive to creation, closely linked to sensing the present moment and bodily awareness. She also proposes that teachers create a safe and creative climate in classroom tasks in order to activate emotional impact, showing themselves very receptive to what happens in the classroom (Torrents et al., 2011).

Her continuous need for exploration, as well as for objectifying knowledge through scientific responses to intuitions verified in teaching practice, led her to analyze Body Expression from a gender perspective.

Her findings in this field reaffirm the pedagogical power of expressive motor practices as a bridge between body and emotion, capable of awakening pleasant and intense experiences that go beyond mere motor execution. The absence of significant gender differences questions deeply rooted stereotypes and opens the path toward a more egalitarian and conscious Physical Education. This implies that educating from the expressive dimension of movement is also opening the door to a deep understanding of emotion, and in that dance between gesture and feeling a pedagogy is forged that humanizes, balances, and transforms (Gelpi et al., 2014).

Convinced that there is a link between the positive results of practice and the level of students' attention, Mateu collaborates in research on the factor of mindfulness, where what she transmits daily in her teaching is scientifically validated through her powerful ability to create spaces where students can express themselves freely and safely. This reaffirms what she had already defended: the educational and human value of expressive practices and the importance of dignifying bodily awareness in the academic sphere. The empirical evidence obtained in these studies consistently supports the pedagogical hypotheses previously formulated from teaching practice, which has left such a profound mark on the training of so many generations (Rovira et al., 2014).

The results of these studies require greater integration as a whole, and she continues with research focused on the emotional states generated by the practice of Body Expression (Mateu et al., 2021; Romero et al., 2017). The potential of these studies, with large samples, lies in showing how these practices produce effects on students' well-being. Likewise, they reveal the close relationship between the emotional dimension and the positive influence on mental health, an issue that currently constitutes a matter of social concern.

On the other hand, she turns to the study of the connections between gender and sports background, highlighting the emotional importance of including expressive and cooperative practices in the degree in Physical Activity and Sport Sciences (CAFYD), since reinforcing these types of activities could promote both emotional well-being and the development of socio-affective competencies. The results suggest that emotional responses do not depend on gender, which may help dismantle stereotypes (Romero et al., 2018).

Finally, it is worth highlighting her interest in analyzing social contexts with intense stimuli of coexistence. Thus, she participates in a study that makes a valuable contribution to knowledge about the effects and usefulness of Body Expression, highlighting the importance of the interuniversity Body Expression and dance meetings organized annually by AFYEC, based on the experience of their participants. These meetings function as authentic pedagogical laboratories, where coexistence becomes an emotional element that promotes learning outside the classroom. The climate generated shows that when the environment is carefully cultivated, motor expression becomes a fertile space for personal and social growth. In this context, Body Expression and educational dance cease to be merely a form of expression based on technique and instead become a means of self-knowledge and openness toward others.

The intensity of shared emotions and the importance given to interpersonal bonds suggest that Body Expression becomes a catalyst for cohesion, belonging, and mutual recognition. Likewise, it reinforces the purpose of a more humane and sensitive education (Garcías et al., 2022).

Educational Dance

Interest in dance as an artistic and pedagogical practice constitutes another relevant line in Mercè Mateu's trajectory, expanding the understanding of Body Expression toward its sociocultural and historical dimension. Her natural curiosity leads her to raise questions about dance and its pedagogical application, which fosters its recognition as a comprehensive educational tool for physical, mental, and emotional well-being, as well as a vehicle for expression, creativity, and social transformation.

Her contribution stands out for its innovative and reflective approach and for incorporating the figures of the spectator and the creator as educational agents. The practical application of the examples proposed by Mateu is particularly valuable, as it shows how dance can be

meaningfully integrated into diverse school and social contexts (Mateu et al., 2013).

She has also addressed the perspective of the social, cultural, and historical analysis of dance. The struggle of power over the control of the body and the struggle of the body to confront power have historically been present in dance, but they require a scientific approach. Her review, characterized by a critical perspective that highlights the historical invisibility of women in dance, their struggle to occupy a deserved position, the objectification of the female body in dance, stereotypes, etc., constitutes a key element of the discourse necessary to understand, in a well-founded manner, the historical evolution of dance in terms of gender (Serrano et al., 2021).

In other collaborative works, Mateu has mapped the geography of research on dance in Catalonia, highlighting the limited production of doctoral dissertations, the importance of providing predoctoral funding, and the need to articulate dance with other fields of knowledge and art (Cañabate et al., 2022).

The Training of Physical Education Teachers

The formative dimension of Mateu's trajectory represents one of the most consistent contributions to the development of Body Expression as a university subject within the Degree in Physical Activity and Sport Sciences. Beyond her theoretical and empirical contributions, the most visible impact of her trajectory lies in the initial training of Physical Education teachers, an area in which she consolidated her own pedagogical model.

The well-known maxim of Étienne Decroux (1963), "Head of an actor, body of an athlete, and heart of a poet," synthesizes the pedagogical approach that has guided her university teaching.

... words that I try to keep present when conducting and sharing a working session: the head of an actor in the sense of play, the body of an athlete in the sense of working with the instrument-body, and the heart of a poet in the sense of attending to emotion, feeling, and the story inscribed in bodies. Working with *actors, athletes, and poets* is also the memory I keep from the meeting in Madrid with the AFYEC group, carried out through the endearing Ana Pelegrín (Mateu, 2008, p. 74).

Throughout her long trajectory, Professor Mateu has reflected extensively on the methodology of teaching Body Expression and on the outcomes manifested in her classes. It can be affirmed that at INEFC she has consolidated a unique training model based on the hybridization between sports practices and performing arts, a combination that has generated innovative pedagogical experiences, performances of great impact, and spaces of creativity capable of transforming students' professional trajectories. The interaction between dance, gesture theater, circus, acrobatics, mime, and physical-sport activities not only broadens expressive competencies but also shapes a more integrative and sensitive educational approach to the artistic development of movement. She invites us to consider Body Expression and artistic practices as a strategic field for future research and as an emerging domain with the potential to redefine the academic and professional identity of the field. In light of this evolution, Mateu argues for recognizing the performing arts as a possible fifth training line within the degree in Physical Activity and Sport Sciences (CAFYD), given their growing educational, professionalizing, and social importance (Garcías et al., 2023). Autobiographical narratives show how this hybridization has been possible thanks to the collaborative work of faculty members, with a particularly prominent role played by Mercè Mateu, and to the active involvement of students and the INEF Lleida club in the creation of long-term artistic projects.

Regarding her research on the curricula of CAFYD, such an uneven distribution of credits highlights a broader structural problem: the persistence of a deeply masculinized body imaginary. The hegemony of competitive sports reveals a historical model that has privileged performance, competitiveness, and the logic of federated sport as the legitimate core of physical-sport knowledge. As a consequence, training in CAFYD continues to rely on traditional logics that do not respond to contemporary challenges, especially the need to construct bodily spaces that are inclusive, diverse, and sensitive to gender identities and experiences.

This predominance not only marginalizes artistic and expressive practices but also reduces the understanding of the body to a functional and achievement-oriented vision. Activities culturally associated with femininity continue to occupy a marginal position, reinforcing the dichotomy between practices considered "serious" and those relegated to the status of "accessory." In this context, the topic raises

a broader question: should the incorporation of a gender perspective go beyond simply balancing credits and lead us to rethink which bodily practices are considered valuable, which bodies are legitimized, and which models of movement are reproduced in higher education?

However, comparative data show a progressive trend toward greater incorporation of expressive practices in more recent curricula, especially in more recently established faculties, where a slight increase in credits allocated to artistic-expressive content can be observed (Serrano et al., 2024). This progress, although still insufficient, indicates a gradual opening toward more inclusive and diversified training models.

Discussion

The historiographic analysis conducted allows us to affirm that Mercè Mateu's contribution to the development of Body Expression in Spain is articulated at three complementary levels.

First, at the epistemological level, her systematic incorporation of motor praxeology (Parlebas, 1986) made it possible to provide scientific grounding for practices traditionally considered peripheral within Physical Education. The application of the concept of internal logic to stage motor-expression situations (Mateu & Bortoleto, 2011) opened a path toward the academic legitimization of circus arts and dance as curricular content.

Second, at the pedagogical level, her research on emotions in expressive motor practices (Gelpi et al., 2014; Romero et al., 2017; Mateu et al., 2021) contributed to strengthening the link between Body Expression, well-being, and holistic education. This approach expands the traditional conception of the body in Physical Education by incorporating affective and relational dimensions consistent with contemporary demands related to mental health and emotional education.

Third, at the structural and training level, her influence on the configuration of curricula and on the hybridization between sports practices and performing arts has generated a distinctive training model within the Spanish university context (Garcías et al., 2023). This model challenges the hegemony of the competitive-sport paradigm and opens space for inclusive bodily practices that are sensitive to the gender perspective (Serrano et al., 2024).

Overall, her trajectory not only represents a significant individual contribution but also exemplifies the process of disciplinary consolidation of Body Expression as a legitimate

field within university Physical Education. In hermeneutic terms, this trajectory can be interpreted as a process of progressive resignification of the body in Physical Education, shifting it from an exclusively biomechanical logic toward a symbolic and relational understanding.

Conclusion

The review of Mercè Mateu's academic and research trajectory allows us to identify a coherent and sustained contribution to the development of Body Expression in the educational sphere and in the performing arts. Her scientific production consistently articulates motor practice, pedagogical reflection, and theoretical construction, integrating the performing arts—especially dance and circus—motor praxeology, and the study of emotional experience.

The analysis of her work, both as a principal author and as a coauthor, shows a progressive evolution of her research interests, in which the doctoral dissertation defended in 2010 occupies a central place by establishing a bridge between the analysis of the internal logic of artistic motor practices and their artistic and pedagogical application. From this framework, her subsequent research has contributed to consolidating Body Expression as a relevant space for emotional education, well-being, and the holistic development of students, as well as for the incorporation of the gender perspective in the training of Physical Education teachers.

Overall, her trajectory highlights the potential of Body Expression as an interdisciplinary field of knowledge and as a domain of teaching and research innovation in contemporary Physical Education.

The review carried out highlights the coherence and depth of a trajectory that has significantly contributed to the academic consolidation of Body Expression in Spain. Beyond personal recognition, her work constitutes a reference for understanding the evolution of this field in contemporary Physical Education and provides insights for future lines of research and teaching innovation.

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Profiles of Social Learning Preferences and Differences in Prosocial Behaviors Among Physical Education Students

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Abstract

Physical Education (PE) lessons have long been recognized not only for promoting the development of students' motor skills and behaviors, but also as a valuable context for fostering social and emotional learning. Despite this, limited research has explored students' social learning preferences in PE and their associations with prosocial behaviors. This study aimed to identify distinct student profiles based on four social learning preferences in PE (i.e., competitive, cooperative, affiliative, and individualistic) and to examine how these profiles differ in prosocial behaviors, including empathy, respect, relatedness, and leadership. Validated questionnaires were administered to 299 Spanish adolescents (50% boys; $M_{age} = 13.76$). A two-step cluster analysis (Ward's method + K-means) revealed four distinct profiles: (1) highly competitive-cooperative-affiliative preference, (2) moderately cooperative preference, (3) moderately competitive-individualistic preference, and (4) individualistic preference. A MANCOVA (with gender as a covariate) showed that profiles emphasizing cooperation and affiliation exhibited the highest levels of empathy, relatedness, and leadership, even when competitiveness was also present. In contrast, the individualistic profile scored the lowest across all prosocial dimensions. These findings highlight the potential of cooperative and affiliative activities in PE to promote adolescents' prosocial development. PE teachers are encouraged to design tasks that enhance peer collaboration and belonging, while minimizing excessively individualistic approaches.

Keywords: empathy, leadership, relatedness, respect, social interactions

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.
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Introduction

Physical Education (PE) lessons are essential not only for the development of students' motor skills and behaviors, but also for promoting social, emotional, and cognitive learning (Casey & Goodyear, 2015). Within this context, social interaction plays a pivotal role in fostering social competence and reinforcing prosocial dispositions in young people (González et al., 2019). According to González et al. (2014), social interaction in the PE classroom encompasses the communicative dynamics that emerge between teachers and students, as well as among peers. Several studies have highlighted that the nature of social interactions in PE can lead to both adaptive and maladaptive outcomes, such as the development of communication skills, teamwork, or academic performance (Dyson, 2002; González et al., 2014; Inglés et al., 2009; Ruiz et al., 2010). Nonetheless, research exploring how combinations of these interactions relate to prosocial behaviors in PE remains limited. Therefore, this study addresses this gap by identifying students' social learning preferences profiles in PE and examining how these combinations foster or hinder prosocial behaviors, namely empathy, respect, relatedness, and leadership. Ultimately, this work seeks to contribute to the creation of more inclusive and supportive learning environments in PE.

Social Learning Preferences

Social learning preferences refer to students' tendencies to engage in particular types of social interaction during learning activities (Ruiz et al., 2010). These preferences directly influence both academic performance and the development of social skills (Navarro-Patón et al., 2019; Ruiz et al., 2010). Four primary types of social interaction have been identified in PE contexts (Johnson et al., 1994; Ruiz et al., 2010): (1) competitive, where students individually strive to outperform others; (2) cooperative, where students collaborate to achieve shared goals; (3) affiliative, which emphasizes belonging and social acceptance within a group (Weiss & Chaumeton, 1992); and (4) individualistic, where students work toward goals independently of others' performance.

Research indicates that cooperative and affiliative environments tend to enhance communication skills and academic outcomes, whereas competitive and individualistic settings may generate less favorable effects, depending on their pedagogical implementation (Navarro-Patón et al., 2019; Oortwijn et al., 2008; Velázquez, 2015). In PE, competitive dynamics are often inherent to the content itself (e.g., sport-based activities), but the effects of competition

largely depend on how teachers shape the motivational climate of the class. According to achievement goal theory (Di Battista et al., 2019; García-González et al., 2019), when the focus is placed on personal improvement and effort (task-involving climate), competition can enhance enjoyment, engagement, and prosocial outcomes. In contrast, when the emphasis is on outperforming others (ego-involving climate), students may experience increased anxiety, disaffection, or social comparison (García-González et al., 2019; Lochbaum et al., 2019). Competitive preferences can therefore elicit both positive and negative outcomes, contingent on how teachers structure and frame activities (Prat & Soler, 2003). Conversely, individualistic preferences, often conceptualized as the opposite of cooperative ones, tend to be associated with less prosocial engagement (Ruiz et al., 2010).

While these preferences are often studied separately, they are not mutually exclusive. Students may exhibit combinations of preferences, for instance, aligning high cooperative with affiliative tendencies, or competitive with individualistic orientations. Competitiveness, in particular, is considered an ambivalent dimension (Prat & Soler, 2003), as it may coexist with either socially constructive preferences (e.g., cooperation or affiliation) or with more individualistic ones, depending on how teachers design and manage the learning environment (task or ego climate) (García-González et al., 2019). Despite this potential for coexistence, there is a scarcity of research examining the multiple social learning preferences—especially in relation to prosocial outcomes in PE. To our knowledge, only a few studies have explored students' social interaction in the PE context (Ruiz et al., 2010; Luengo et al., 2013), and none have directly linked them to prosocial behaviors. For example, Ruiz et al. (2010) charted adolescents' cooperative, competitive, affiliative, and individualistic dispositions in PE classes, finding that cooperative learning was generally the most preferred style, while individualistic approaches were the least favored. However, that variable-centered study did not examine how these preferences cluster within participant or how a mix of preferences might influence social outcomes. Similarly, Luengo et al. (2013) acknowledged that competitive orientations can co-occur with either cooperative or individualistic tendencies, yet empirical evidence connecting specific preference profiles to prosocial behavior is lacking. This gap underscores the need to better understand the interplay of these preferences and their implications for youths' social development in PE settings.

Prosocial Behaviors

Prosocial behaviors are voluntary actions intended to benefit others and are essential for effective group functioning and social well-being (Abdullahi & Kumar, 2016; Eisenberg et al., 2006). According to Martorell et al. (2011), key dimensions of prosocial behavior include empathy, respect, relatedness, and leadership. Empathy refers to an affective response triggered by understanding another's emotional state (Eisenberg et al., 2006). In PE, this may be demonstrated when a student helps a peer who is struggling to achieve a goal. Respect is a value associated with personal and social integrity (Anderson, 2019); for example, a student may show respect by listening to others' opinions or showing patience when a teammate makes a mistake. Relatedness involves warm, trusting interpersonal connections (Mayseless et al., 1998; Ryan & Deci, 2017) and in PE is reflected in inclusive participation and group cohesion. This behavior is particularly relevant in adolescence, as peer relationships often become more salient than family connections (Mayseless et al., 1998; Ryan & Deci, 2017). Lastly, leadership refers to the ability to influence and guide others (Lacunza et al., 2013), such as when a student organizes a group activity or facilitates collective goal achievement.

While prosocial behaviors emerge throughout development (Martorell et al., 2011), adolescence is a critical period for their consolidation, as youths refine their identities and expand their social competencies (Inglés et al., 2009; Luengo et al., 2013). Although most research on prosociality in PE has focused on younger children (Contreras & Reyes, 2009), it is during adolescence that fostering these behaviors becomes particularly relevant for long-term social development (Luengo et al., 2013). Given that social learning preferences influence how students interact with peers in PE contexts, exploring how different combinations of these preferences relate to prosocial behaviors during this life stage may offer valuable insights for educational practice.

The Present Study

To address the above-mentioned gaps, the present study pursued two main objectives: (1) To identify student profiles based on combinations of four social learning preferences in PE (i.e., cooperative, affiliative, competitive, and individualistic). Given the exploratory nature of this

analysis, no specific hypotheses were formulated regarding the coexistence of these preferences. (2) To examine how these different combinations of social interaction preferences are more or less adaptive in terms of prosocial behaviors by comparing students' scores on empathy, respect, relatedness, and leadership. It was expected that profiles characterized by higher cooperative and affiliative preferences would exhibit more adaptive prosocial patterns, whereas those with higher individualistic tendencies would score lower on prosocial dimensions (Dyson & Strachan, 2002; Navarro-Patón et al., 2019; Oortwijn et al., 2008; Velázquez, 2015). Expectations regarding competitive preferences were more tentative, given the mixed findings in the literature about its effects in achievement settings (Prat & Soler, 2003).

Design, Participants, and Procedure

A cross-sectional design with purposive sampling was employed. A total of 311 Spanish students from a semi-private school in northeastern Spain agreed to participate. Two students were excluded due to incomplete responses, and an additional nine were removed because of extreme univariate and/or multivariate outliers (see the Statistical Analysis section for details). The final sample comprised 299 students (47.83% girls), aged between 12 and 17 years ($M_{age} = 13.76$, $SD = 1.28$), divided into 12 classes ($M = 24.92$). In terms of school year distribution: 79 students were in Year 8 (1st year of Spanish Secondary Education; 26.5%), 75 students in Year 9 (2nd year; 25%), 72 students in Year 10 (3rd year; 24%), and 73 students in Year 11 (4th year; 24.5%).

The main researcher contacted the school administration and PE teachers to request collaboration. Both students and their parents were informed of the study's objectives, and written informed consent was obtained from both parties. Before completing the online questionnaire, students were assured that participation was voluntary and anonymous. Data were collected in a quiet classroom without the PE teacher present. The main researcher remained available to answer any questions. Completing the questionnaires required approximately 25–30 minutes.

This study adhered to the ethical principles of the Declaration of Helsinki and was approved by the Research Ethics Committee of the University of Zaragoza (CEIN_2025_3).

Instruments

Social Preferences for Learning in PE

The Graupera/Ruiz Social Participation in Physical Education Scale (GR-SIPPEL; Ruiz et al., 2010) was used to assess students' preferences for social interaction. The scale begins with the stem "In PE class activities..." and includes 28 items across four subscales (i.e., seven items per subscale): competitive (e.g., "I like to do things better than others"), cooperative (e.g., "I like to say and do things that help others"), affiliative (e.g., "I work in groups so they want to be with me"), and individualistic (e.g., "I like to do things my way, without worrying about what others are doing"). Students responded on a 5-point Likert scale ranging from 1 (strongly agree) to 5 (strongly disagree). Confirmatory factor analysis (CFA) supported the four-factor structure: $\chi^2 (df = 344) = 595.375, p < .001; \chi^2/df = 1.73; CFI = .93, TLI = .92, RMSEA = .05, SRMR = .05$. McDonald's omega (ω) coefficients indicated good internal consistency, being .84 for competitive, .74 for cooperative, .63 for affiliative, and .79 for individualistic preferences.

Prosocial Behaviors in PE

The Prosocial Behavior Questionnaire (Martorell et al., 2011) was used to assess prosocial behaviors. The instrument includes 54 items across four subscales: empathy (19 items; e.g., "When someone has problems, I worry"), respect (16 items; e.g., "When I offend or bother someone, I apologize"), relatedness (11 items; e.g., "I like to talk to my friends and colleagues"), and leadership (8 items; e.g., "I like to lead work groups"). Students responded using a 4-point Likert scale ranging from 1 (never) to 4 (always). CFA confirmed the four-factor structure: $\chi^2 (df = 1371) = 1891.56, p < .001; \chi^2/df = 1.38; CFI = .97, TLI = .97, RMSEA = .04, SRMR = .04$. McDonald's omega (ω) coefficients indicated good internal consistency, being .91 for empathy, .82 for respect, .72 for relatedness, and .78 for leadership.

Data Analyses

Descriptive statistics, Pearson's correlations, and McDonald's omega (ω) reliability coefficients were computed for all study variables. While a reliability threshold of .70 is widely accepted, some researchers advocate for interpreting

reliability along a continuum: .90–.95 (excellent), $\geq .80$ (good), $\geq .70$ (acceptable), $\geq .60$ (reasonable), $\geq .50$ (fair), and $< .50$ (unacceptable) (George & Mallery, 2003; Hernaez, 2015). A two-step cluster analysis was used to identify student profiles based on social learning preferences, combining hierarchical (Ward's method) and non-hierarchical (K-means) approaches (Garson, 2014). Prior to clustering, Z-scores were computed for the four preferences. Students with univariate scores ± 3 SD or extreme Mahalanobis distances were excluded to minimize the influence of outliers (Steinley & Brusco, 2011). In Step 1, hierarchical clustering using Ward's method with squared Euclidean distances was conducted. Three- to five-cluster solutions were evaluated based on explained variance and theoretical coherence (Aguinis et al., 2013). In Step 2, a K-means cluster analysis was performed using the centroids from Step 1. The final cluster solution was validated using double-split cross-validation with Cohen's Kappa, where values above .50 were considered acceptable. Because gender may influence social participation styles in PE (Navarro-Patón et al., 2019; Ortega et al., 2019), its inclusion as a covariate was tested via chi-square analysis. Finally, a Multivariate Analysis of Covariance (MANCOVA) with Bonferroni-adjusted post hoc comparisons was used to examine differences between clusters on students' prosocial behaviors. Partial eta squared (η_p^2) was used to interpret effect sizes: small ($> .01$), medium ($> .06$), and large ($> .14$) (Cohen, 1988). All statistical analyses were conducted using IBM SPSS 29.0.

Results

Descriptive Statistics, Reliability Coefficients, and Correlations Among Variables

Table 1 presents the descriptive statistics (i.e., M and SD), reliability coefficients (McDonald's omega, ω), and Pearson's correlations for all study variables. Among the social learning preferences, competitive preference was significantly and positively correlated with both affiliative and individualistic preferences. Cooperative preference showed a significant positive correlation with affiliative preference and a significant negative correlation with individualistic preference. All four prosocial behaviors, empathy, respect, relatedness, and leadership, were significantly and positively

correlated with each other. Regarding the links between social learning preferences and prosocial behaviors, competitive preference was significantly and positively related to relatedness and leadership. Both cooperative and affiliative preferences showed significant positive correlations with all prosocial behaviors, except for respect, which was not significantly related to affiliative preference. Finally, individualistic preference was significantly and negatively correlated with relatedness.

Identification and Interpretation of Students' Profiles Based on Social Learning Preferences in PE

Four distinct student groups were identified, explaining an average variance of 62% across the four social learning preferences in PE (i.e., competitive, cooperative, affiliative, and individualistic). The three-cluster solution was discarded due to its low explained variance (40%), while the five-cluster solution was rejected due to challenges in interpretability

(Ellison et al., 2005; Ruiz et al., 2010). For the four-cluster solution, the double-split cross-validation procedure yielded a mean Kappa value of .85, indicating excellent cluster stability.

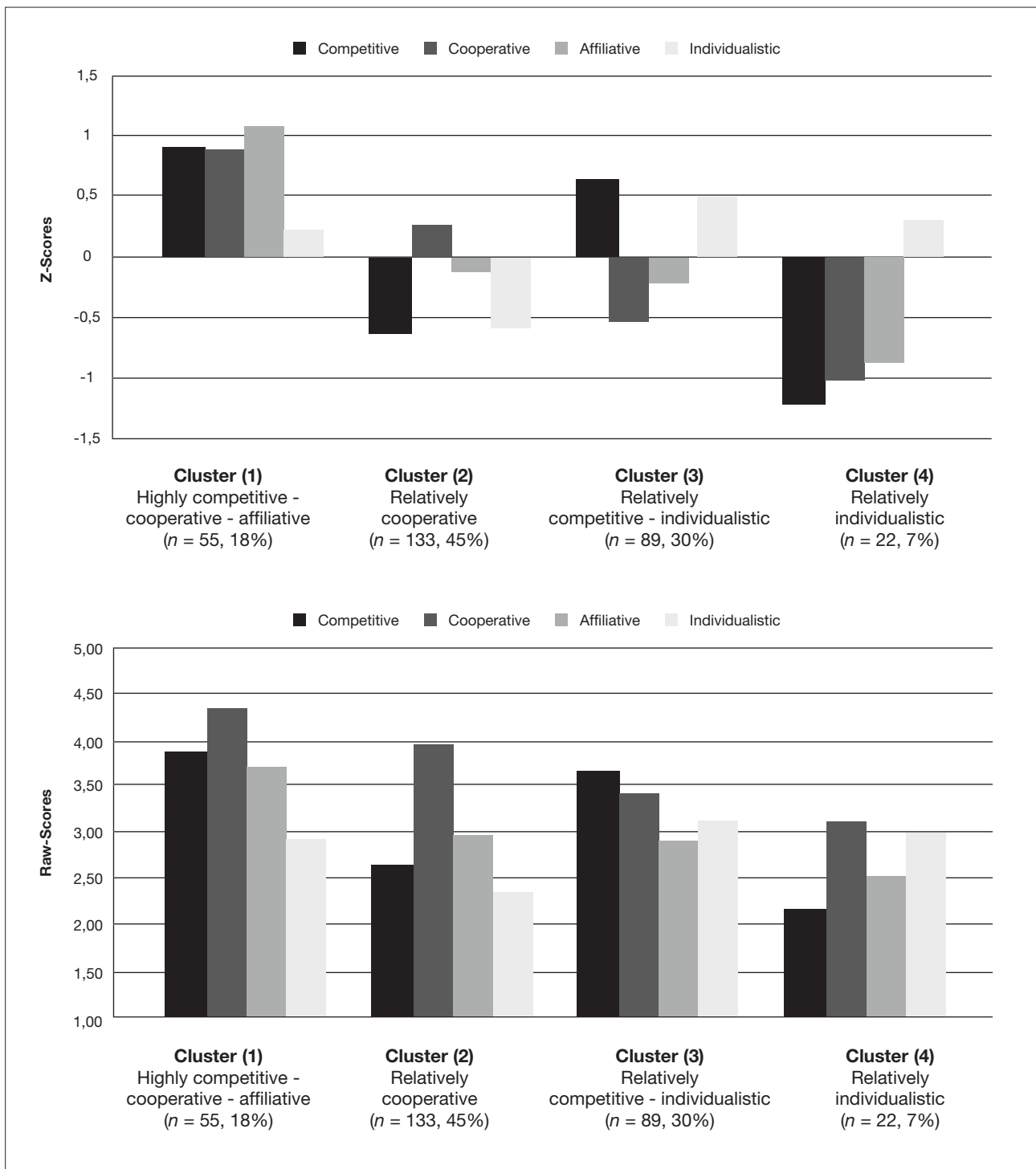
Figure 1 displays the Z-score profiles of the four identified clusters based on students' social learning preferences in PE. The first cluster, labeled "highly competitive-cooperative-affiliative" ($n = 55$; 18%), included students who reported high levels of competitive, cooperative, and affiliative preferences, alongside relatively low levels of individualistic preference. The second cluster, "relatively cooperative" ($n = 133$; 45%), was characterized by moderate cooperative tendencies and low scores across the other dimensions. The third cluster, "relatively competitive-individualistic" ($n = 89$; 30%), reflected a pattern of highly competitive and individualistic preferences, combined with lower levels of cooperation and affiliation. Finally, the fourth cluster, "relatively individualistic" ($n = 22$; 7%), showed moderate endorsement of individualistic preference and the lowest scores across all other social learning dimensions.

Table 1
Descriptive statistics, reliability coefficients, and Pearson's correlations among study variables

Variable (range)	M(SD)	1	2	3	4	5	6	7	8
Social learning preferences									
1. Competitive (1–5)	3.11(.78)	-	.10	.30**	.35**	.03	-.09	.13*	.22**
2. Cooperative (1–5)	3.78(.58)		-	.41**	.28**	.44**	.33**	.41**	.34**
3. Affiliative (1–5)	3.03(.54)			-	.06	.15**	.08	.17**	.17**
4. Individualistic (1–5)	2.72(.66)				-	-.10	-.07	.14**	.03
Prosocial behaviors									
5. Empathy (1–4)	2.88(.46)					-	.57**	.48**	.48**
6. Respect (1–4)	3.13(.39)						-	.32**	.36**
7. Relatedness (1–4)	3.11(.37)							-	.51**
8. Leadership (1–4)	2.56(.52)								-

Note. * $p < .05$; ** $p < .01$; *** $p < .001$.

Figure 1
Four-cluster solution based on Z- and Raw-Scores for social learning preferences in PE



Gender distribution across the four identified profiles was then examined. A chi-square test revealed a significant association between gender and cluster membership ($\chi^2 [3, N = 299] = 32.837, p < .001$), justifying the inclusion of gender as a covariate in subsequent analyses. In the “highly competitive-cooperative-affiliative” group (cluster 1), boys represented 66% ($n = 36$) and girls 34% ($n = 19$). The

“relatively cooperative” group (cluster 2) showed the opposite pattern, with 66% girls ($n = 88$) and 34% boys ($n = 45$). The “relatively competitive-individualistic” group (cluster 3) comprised 62% boys ($n = 60$) and 38% girls ($n = 29$), while the “relatively individualistic” group (cluster 4) had the highest proportion of boys (68%, $n = 15$) compared to girls (32%, $n = 7$)

Table 2Clusters' mean scores, *F*-values, and effect sizes for social learning preferences and prosocial behaviors

Variables	Cluster 1: Highly competitive- cooperative- affiliative	Cluster 2: Relatively cooperative	Cluster 3: Relatively competitive- individualistic	Cluster 4: Relatively individualistic	<i>F</i> (3, 294)	η_p^2
	<i>n</i> = 55 (18 %)	<i>n</i> = 133 (45 %)	<i>n</i> = 89 (30 %)	<i>n</i> = 22 (7 %)		
Cluster dimensions – social preferences for learning						
Competitive preference						
Z-Scores	0.91 (0.58) ^a	-0.62 (0.63) ^b	0.64 (0.65) ^a	-1.21 (0.70) ^c	115.82**	.54
Raw. scores (1–5)	3.84 (0.46) ^a	2.62 (0.50) ^b	3.63 (0.52) ^a	2.15 (0.56) ^c		
Cooperative preference						
Z-Scores	0.88 (0.66) ^a	0.27 (0.61) ^b	-0.51 (0.75) ^c	-0.99 (0.75) ^d	70.70**	.42
Raw. scores (1–5)	4.32 (0.43) ^a	3.92 (0.40) ^b	3.40 (0.49) ^c	3.09 (0.49) ^d		
Affiliative preference						
Z-Scores	1.08 (0.59) ^a	-0.11 (0.79) ^b	-0.20 (0.57) ^b	-0.86 (0.79) ^c	55.50**	.36
Raw. scores (1–5)	3.68 (0.37) ^a	2.95 (0.49) ^b	2.89 (0.35) ^b	2.49 (0.49) ^c		
Individualistic preference						
Z-Scores	0.23 (1.07) ^a	-0.58 (0.68) ^b	0.50 (0.68) ^a	0.32 (0.98) ^a	33.28**	.25
Raw. scores (1–5)	2.91 (0.76) ^a	2.34 (0.48) ^b	3.11 (0.48) ^a	2.98 (0.10) ^a		
Outcomes – prosocial behaviors						
Empathy						
Z-Scores	0.31 (0.92) ^a	0.14 (0.87) ^{ab}	-0.28 (1.02) ^{bc}	-0.53 (1.36) ^c	7.90**	.08
Raw. scores (1–5)	3.02 (0.42) ^a	2.94 (0.39) ^{ab}	2.75 (0.46) ^{bc}	2.64 (0.62) ^c		
Respect						
Z-Scores	0.07 (1.07) ^a	0.20 (0.91) ^a	-0.24 (0.93) ^a	-0.37 (1.32) ^b	3.61*	.04
Raw. scores (1–5)	3.16 (0.42) ^a	3.21 (0.35) ^a	3.04 (0.36) ^a	2.99 (0.51) ^b		
Relatedness						
Z-Scores	0.34 (0.95) ^a	0.13 (0.84) ^{ab}	-0.14 (1.00) ^b	-1.09 (1.20) ^c	14.10**	.13
Raw. scores (1–5)	3.23 (0.35) ^a	3.16 (0.31) ^{ab}	3.06 (0.37) ^b	2.70 (0.44) ^c		
Leadership						
Z-Scores	0.30 (0.94) ^a	-0.05 (0.94) ^b	0.14 (0.92) ^{ab}	-1.02 (1.14) ^c	14.00**	.13
Raw. scores (1–5)	2.71 (0.49) ^a	2.53 (0.49) ^b	2.63 (0.48) ^{ab}	2.03 (0.59) ^c		

Note. Standard errors are reported in brackets. The different letters in super-indices indicate significant differences between groups. The coefficients for each group were extracted, allowing for pairwise comparisons. Z-Score = Standardized scores. Raw. = Absolute. * = $p < .05$; ** = $p < .001$

Analysis of Differences According to Groups of Social Preference for Learning

Using the four-cluster solution of social learning preferences as the independent variable and gender as a covariate, MANCOVA revealed a significant multivariate effect with a large effect size ($F(24, 832.98) = 28.16, p < .001, \eta_p^2 = .43$). Bonferroni-adjusted pairwise comparisons, as well as *F*-values and univariate effect sizes (η_p^2) for prosocial behaviors (empathy, respect, relatedness, and leadership), are reported in Table 2.

The “highly competitive-cooperative-affiliative” group (cluster 1) exhibited the highest levels of empathy, relatedness, and leadership. However, despite showing the highest means, it did not differ significantly from the “relatively cooperative” group (cluster 2) in empathy, respect, and relatedness, nor from the “relatively competitive-individualistic” group (cluster 3) in respect and leadership. Moreover, no significant differences were found between the “relatively cooperative” (cluster 2) and the “relatively competitive-individualistic” (cluster 3) groups on any of

the prosocial behavior dimensions, suggesting comparable prosocial patterns. In contrast, the “relatively individualistic” group (cluster 4) displayed the least favorable prosocial profile, with significantly lower scores across all variables, except for empathy, where it did not differ from the “relatively competitive-individualistic” group (cluster 3).

Discussion

The present study aimed to examine how students combine different social learning preferences in PE lessons and how these combinations (i.e., clusters) differ in terms of their empathy, respect, relatedness, and leadership. The main findings revealed that: 1) PE students exhibit diverse combination of competitive, cooperative, affiliative, and individualistic preferences; 2) Students in the “highly competitive-cooperative-affiliative” group reported the highest levels of prosocial behaviors, whereas those in the “relatively individualistic” group reported the lowest levels on these variables; and 3) no significant differences in prosocial behaviors were found between students in the “relatively cooperative” group and the “relatively competitive-individualistic” group.

Identification and Interpretation of Students' Profiles Based on Social Learning Preferences in PE

Regarding the first aim, students reported moderate-to-high levels of cooperative preference ($M = 3.78/5$), moderate levels of competitive ($M = 3.11/5$) and affiliative ($M = 3.03/5$) preferences, and moderate-to-low individualistic preference ($M = 2.72/5$). Interestingly, even among students in the “relatively individualistic” group, cooperative preference remained moderate ($M = 3.09/5$), suggesting that cooperation is generally valued across the sample. These findings are in line with previous research (Navarro-Patón et al., 2019; Ortega et al., 2019; Ruiz et al., 2004; Ruiz et al., 2010), which indicates that adolescents in PE tend to prioritize cooperation, followed by competition, affiliation, and lastly individualism. This order of preference, also supported by Ruiz-Maestre et al. (2024), challenges the widespread assumption that competition and individualism prevail in educational settings, and reinforces the importance of promoting cooperative attitudes in PE contexts.

In terms of combinations, the results revealed four significantly distinct clusters, two of which (clusters 2

and 4) reflected contrasting tendencies in participation, cooperation vs. individualism (Ruiz et al., 2010). The “relatively cooperative” group (cluster 2) included nearly half the sample (45%), while the “relatively individualistic” group (cluster 4) comprised just 7%. These results reinforce the idea that most adolescents are predisposed to participate in PE through cooperation (Velázquez, 2015) and are less inclined to engage in individualistic modes of interaction (Ruiz et al., 2010). Similarly, given that cooperative and individualistic dimensions appear to be conceptually opposed (Ortega et al., 2019; Ruiz et al., 2010), the emergence of these two distinct groups suggests that students who strongly favor cooperation are less inclined to engage in individualistic forms of interaction in PE, and vice versa.

In line with the conceptual framework of social participation dimensions (Johnson et al., 1994; Ruiz et al., 2010), two additional groups (clusters 1 and 3) were identified, in which certain preferences clearly predominated over others, revealing more complex interaction profiles. Consistent with studies linking cooperation and affiliation (Ruiz et al., 2004), the “highly competitive-cooperative-affiliative” group (cluster 1) emerged, comprising 18% of the students. This group stood out for its high levels of both cooperative and affiliative preferences, suggesting that students may simultaneously prioritize collaborative and group-oriented goals in PE. Notably, this group also showed the highest competitive scores, indicating that some adolescents pursue personal achievement without disregarding social connection. This pattern may reflect a task-involving orientation, in which competition is framed positively and aligned with effort, improvement, and shared success (Di Battista et al., 2019; García-González et al., 2019). In contrast, the “relatively competitive-individualistic” group (cluster 3), which comprised nearly one-third of the sample, was characterized by moderate-to-high levels of both competitiveness and individualism. This profile suggests a preference for self-oriented success and outperforming others, with less emphasis on group collaboration. Such a profile is conceptually aligned with an ego-involving climate, which prioritizes social comparison (Lochbaum et al., 2019).

Additionally, gender distribution across profiles aligns with previous findings, where girls were more frequently found in the purely cooperative group (cluster 2), and boys were more represented in profiles with stronger competitive or individualistic components (clusters 1, 3, and 4) (Navarro-Patón et al., 2019; Royo et al., 2025; Ruiz et al., 2010). This supports earlier claims that boys tend to seek social

comparison and victory, whereas girls are more motivated by the social and participatory aspects of PE. These patterns may also reflect the persistence of hegemonic masculinity in PE settings, where competitive success and dominance are often emphasized and socially reinforced among boys (Beltrán-Carrillo et al., 2012; Beltrán-Carrillo & Devís-Devís, 2019).

Analysis of Differences According to Groups of Social Preference for Learning

While identifying distinct groups of adolescents based on their combinations of social learning preferences in PE represents an important theoretical contribution, its practical relevance lies in understanding how these combinations influence prosocial behavior. In this regard, previous research has shown that cooperative and affiliative learning preferences support adolescents' holistic development, while individualistic preferences tend to be associated with less adaptive outcomes (Navarro-Patón et al., 2019; Ortega et al., 2019). The role of competitive preferences, however, appears more nuanced, with both positive and negative effects depending on the context and outcomes assessed (Prat & Soler, 2003). Similarly, previous studies have shown that competitive preference can be either positive or negative depending on the consequences explored (Prat & Soler, 2003). Consistent with these findings and with expectations, the “highly competitive-cooperative-affiliative” group (cluster 1) showed the highest levels in empathy, relatedness, and leadership, whereas the “relatively individualistic” group (cluster 4) was characterized by the lowest scores across all four prosocial dimensions.

On the other hand, literature suggests that purely cooperative preferences should be the most adaptive for achieving prosocial behavior (Dyson, 2002; Navarro-Patón et al., 2019; Oortwijn et al., 2008). In this sense, an especially relevant comparison for educational practice is that between the “relatively cooperative” group (cluster 2) and the combined group (cluster 1), which showed high levels of cooperation, affiliation, and competitiveness. According to the results, both groups demonstrated similar levels of prosocial behavior, except for leadership, which was significantly higher in cluster 1. However, these results should be interpreted with caution. Although cluster 1 displayed higher levels of competitiveness, it also reported higher levels of cooperation and affiliation than cluster 2, which may offset or equalize the prosocial impact of a

group based solely on cooperation but with lower absolute levels of this preference. This could explain the minimal differences observed between both clusters. Moreover, the higher leadership scores observed in cluster 1, the group with stronger competitive preference, may be attributed to another complementary explanation. A recent study found a strong relationship between competitive preference and perceived motor competence in PE (Royo et al., 2025). This may indicate that students with a greater preference for competition also possess higher levels of motor competence, which in turn may position them as natural leaders in group activities and tasks.

Although the “highly competitive-cooperative-affiliative” group (cluster 1) was largely similar to the “relatively cooperative” group (cluster 2), the differences became more pronounced when compared to the “relatively competitive-individualistic” group (cluster 3), especially in empathy and relatedness. These findings suggest that competitive preference may be beneficial for prosocial behavior when paired with high levels of adaptive social preferences (i.e., cooperation and affiliation), but less so when aligned with individualistic tendencies. This interpretation is consistent with previous research indicating that even minimal levels of individualism can have negative developmental consequences in adolescence (Navarro-Patón et al., 2019).

Finally, the results confirm that a purely individualistic profile (cluster 4) constitutes the least adaptive pattern in terms of prosocial behaviors. This was evident even when compared to cluster 3, whose members also exhibited high levels of individualistic preference but combined it with greater endorsement of competitive, cooperative, and affiliative preferences. Students in cluster 3 scored higher in respect, relatedness, and leadership, suggesting that the positive influence of these additional social learning preferences (Navarro-Patón et al., 2019) may help buffer the negative effects of elevated individualism, at least within the scope of prosocial outcomes.

Practical Implications

The findings of this study offer meaningful guidance for PE teachers aiming to foster students' social and emotional development through everyday instructional practices. First, the positive association between cooperative and affiliative learning preferences and prosocial behaviors suggests that teachers should design activities that promote collaboration,

mutual support, and group belonging. Structuring tasks that value group participation and shared achievements can reinforce empathy, respect, and relatedness among students. Second, the ambivalent role of competitiveness identified in this study highlights the importance of how competitive elements are framed. Rather than eliminating competition, teachers are encouraged to implement it within a framework that values effort, improvement, and shared experience, avoiding formats that reward only individual superiority. By doing so, students can still experience the motivational benefits of competition without fostering isolation or social comparison. Lastly, the consistently negative outcomes associated with individualistic learning preferences point to the importance of avoiding tasks that promote excessive independence or detachment from peers. PE lessons should aim to cultivate inclusive environments where students feel connected and engaged with others. By balancing cooperative and competitive elements thoughtfully, PE teachers can contribute to more adaptive social climates that support both student participation and social development.

Limitations and Future Directions

This study presents several limitations that should be acknowledged. First, the findings are based on a cross-sectional design, which limits the ability to determine whether the identified profiles of social learning preferences remain stable over time or how their evolution may influence the development of prosocial behaviors in PE. Future research should adopt longitudinal or experimental designs to explore how changes in social learning preferences affect various student outcomes. Second, all variables were measured through self-report questionnaires, which, despite the anonymity provided, may be subject to response biases such as belief distortion, subjective self-perception, or social desirability. To address this limitation, future studies could complement self-report data with observational methods to enhance validity. Third, the sample was purposive and composed exclusively of Spanish adolescents from a single secondary school, which limits the generalizability of the results. Therefore, findings should be interpreted with caution. Further studies should include larger and more diverse samples, incorporating participants from multiple schools, cultural contexts, and educational stages. Fourth, it is important to emphasize that student learning outcomes

are not solely determined by their social preferences for learning. The teaching style and interactions of PE teachers also play a crucial role (Abós et al., 2018). As such, future studies should include measures of teachers' (de)motivating teaching styles to better contextualize the influence of students' preferences. Finally, the present study focused exclusively on positive outcomes, specifically prosocial behaviors. Future research should extend this line of inquiry by exploring how social learning preferences relate to negative outcomes, such as conflict, disengagement, or disruptive behavior.

Conclusions

This study identified four distinct profiles of social learning preferences among adolescents in PE, reflecting different combinations of cooperative, competitive, affiliative, and individualistic tendencies. The results showed that students who combine high levels of cooperation and affiliation, sometimes alongside moderate competitiveness, tend to display more favorable prosocial behaviors, such as empathy, respect, relatedness, and leadership. In contrast, students with predominantly individualistic preferences, especially when paired with competitiveness, exhibited less adaptive prosocial patterns. These findings suggest that social interaction styles in PE are not fixed or mutually exclusive but can coexist in ways that influence students' social functioning. From an educational perspective, promoting cooperative and affiliative dynamics in PE lessons appears essential for fostering a socially enriching environment. While competitive elements can be beneficial, their integration should be carefully managed to ensure they support, rather than hinder, group cohesion and prosocial development. Overall, this study underscores the importance of designing PE activities that cultivate meaningful peer interactions and encourage students to participate in ways that contribute positively to the group climate.

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Pedagogical Models and Psychological-Motivational Development in Physical Education. A Systematic Review and Meta-Analysis

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.
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Abstract

The application of pedagogical models in the field of Physical Education provides numerous benefits for students. Noteworthy is the increase in intrinsic and extrinsic motivation together with a decrease in amotivation towards this subject. This study aimed to: (a) identify different intervention programmes that apply pedagogical models to the motivational domain and basic psychological needs; and (b) examine the effect of pedagogical model-based intervention programmes on the motivational domain and basic psychological needs. To address these two objectives, a systematic review was conducted following the PRISMA criteria. The search for research was carried out in ERIC, Web of Science, PubMed, PsycINFO and Scopus. The search was limited to the following areas of knowledge: "Education Educational Research", "Psychology", "Psychology Applied", "Psychology Educational", "Sport Sciences" and "Social Sciences". A positive effect of the application of pedagogical models was found on autonomy satisfaction ($g = 0.2942$; [0.0856; 0.5027]; $p < .05$), competence ($g = 0.351$; [0.137; 0.566]; $p < .05$) and relatedness ($g = 0.478$; [0.177; 0.779]; $p < .05$). A positive effect on the development of intrinsic motivation was also observed ($g = 0.307$; [0.013; 0.600]), along with a negative effect size for extrinsic motivation ($g = -0.066$; [-0.190; 0.058]) and amotivation ($g = -0.263$; [-0.475; 0.010]). It was concluded that pedagogical models have a positive impact on the motivational and psychological domain of primary school students.

Keywords: extrinsic motivation, intrinsic motivation, primary education, psychological needs, teaching styles

Introduction

Continuous educational changes have shaped the history of the educational system since its beginnings, with the aim of improving teaching strategies and learning processes (Fernández-Río et al., 2020). In research, this issue has been one of the main concerns within the field of Physical Education (Manzano-Sánchez & Gómez-López, 2023). In this area, there is an increasing focus on making students the protagonists of their own learning, moving away from traditional approaches (Gaspar et al., 2021).

Pedagogical models have emerged to address this issue, seeking to establish an active methodology that provides learners with various benefits within the current educational context, such as: (1) enhancing students' cultural literacy; (2) promoting cooperation among peers; (3) fostering students' creativity; (4) achieving meaningful learning; (5) establishing a progressive learning program; (6) conducting continuous and formative assessment of students; and (7) responding to the main challenges of the twenty-first century (Fernández-Río et al., 2020; Pérez-Pueyo et al., 2021). The concept of a pedagogical model is defined as a methodology that responds to the main pillars of teaching (teacher, student, content, and context) and adapts the teaching-learning process to students' characteristics, with the aim of achieving the established objectives through the content to be taught (Hortigüela-Alcalá et al., 2019).

There are multiple pedagogical models. Among them, two groups can be distinguished (Pérez-Pueyo et al., 2021): basic pedagogical models and emerging models. The most widely used from an educational perspective and those that have evolved the most over time are the basic pedagogical models (Pérez-Pueyo et al., 2021). Within the subject of Physical Education, these models have played the most prominent role since its beginnings. Gil-Arias et al. (2021) highlight that there is no ideal model for an educational context, but rather that their combination (model hybridization) allows adaptation to the characteristics and needs of participants and maximizes their development. The different studies analyzed show that the hybridization of models in the teaching-learning process makes it possible to achieve meaningful learning and promote adherence to physical activity and sport (Rodríguez-Martínez et al., 2021).

The hybridization of pedagogical models is understood as the combination of the different significant elements of each model (Pizarro et al., 2024). The aim of model hybridization is to incorporate the most relevant characteristics of each model or to establish a new model based on these characteristics within a learning situation (Rodríguez-Martínez et al., 2021). In addition to the previously mentioned benefits, pedagogical models aim to promote students' adherence to physical

activity. This will contribute positively to the development of psychosocial factors (Fernández-Bustos et al., 2024).

One of the variables that most strongly influences psychosocial factors is motivation, which is supported by self-determination theory (Deci & Ryan, 2004; Ryan & Deci, 2017). This theory is based on a hierarchical organization of motivational processes (Deci & Ryan, 2004; Ryan & Deci, 2017). It explicitly establishes that the satisfaction of basic psychological needs constitutes a fundamental antecedent of different motivational states (Deci & Ryan, 2004; Ryan & Deci, 2017). These needs are innate and universal, and their degree of satisfaction determines the quality of the motivation that emerges, ranging from more controlled forms to fully self-determined states (Ryan & Deci, 2017; Ryan & Deci, 2020). It has been shown that when social contexts promote the satisfaction of basic psychological needs, students experience an increase in autonomous motivation, which in turn positively affects well-being and persistence toward activity (Ryan & Deci, 2017; Ryan & Deci, 2020).

In contrast, the frustration of basic psychological needs generates less adaptive motivational dynamics, characterized by external regulation, introjection, or even amotivation (Deci & Ryan, 2004; Ryan & Deci, 2017). Based on this, motivation does not constitute the cause of the satisfaction of basic psychological needs, but rather derives directly from the extent to which the social context limits or facilitates these fundamental needs (Deci & Ryan, 2004; Ryan & Deci, 2017). In physical educational contexts, the perceived degree of autonomy, competence, or relatedness predicts the level of intrinsic motivation and persistence toward academic tasks (Gaspar et al., 2021; Navarro-Patón et al., 2018).

The satisfaction of basic psychological needs is not only the trigger of motivation, but also acts as a filter through which students adapt to the level of novelty of the pedagogical proposals established by the teacher (Manzano-Sánchez & Gómez-López, 2023; Manzano-Sánchez & Valero-Valenzuela, 2019). When educational experiences promote the satisfaction of autonomy, competence, and relatedness, students generate better conditions to interpret novelty as a stimulating challenge (Fierro-Suero et al., 2024; Železnik-Mežan et al., 2023). When these needs are satisfied, the level of pedagogical novelty increases autonomous motivation and generates a favorable climate for active engagement, creativity, and meaningful learning (Fierro-Suero et al., 2024). On the contrary, if novelty is introduced in an environment where basic psychological needs are not addressed, it may lead to frustration or external pressure, resulting in controlled motivation or amotivation (Fierro-Suero et al., 2024).

Based on all the above, the following research hypotheses were established:

H.1. The application of pedagogical models will exert a positive effect on intrinsic motivation, extrinsic motivation, and the satisfaction of basic psychological needs of Primary Education students.

H.2. The application of pedagogical models will exert a negative effect on the development of amotivation in Physical Education classes.

Derived from the research hypotheses, the proposed research objectives were:

O.1. To identify different intervention programs that apply pedagogical models to the motivational domain or the satisfaction of basic psychological needs in Primary Education.

O.2. To examine the effect of pedagogical model-based intervention programs on the motivational domain and the satisfaction of basic psychological needs in Primary Education students.

Methodology

For the execution of the systematic review with meta-analysis, the criteria established in the PRISMA statement were taken as a reference (Page et al., 2021). Previously, the study was registered on the PROSPERO platform with the following code: CRD42025644236.

Sources of Information and Search Strategies

The search was carried out from October 2024 to December of the same year. A topic-based search was conducted in Web of Science, PubMed, ERIC, Scopus, and PsycINFO. The resulting search query was as follows: “Hybrid Model” OR “Pedagogical Model” AND “Elementary Education” AND “Physical Education” AND “Student”. The following areas were examined “Education Educational Research”, “Psychology”, “Psychology Applied”, “Psychology Educational”, “Sport Science”, and “Social Sciences”.

For the search, a temporal range of studies published between 2000 and 2024 was established in order to analyze the evolution of scientific production. Only scientific articles published in Spanish, English, and Portuguese were considered. This temporal range was selected because most of the studies were published during those years.

Eligibility Criteria

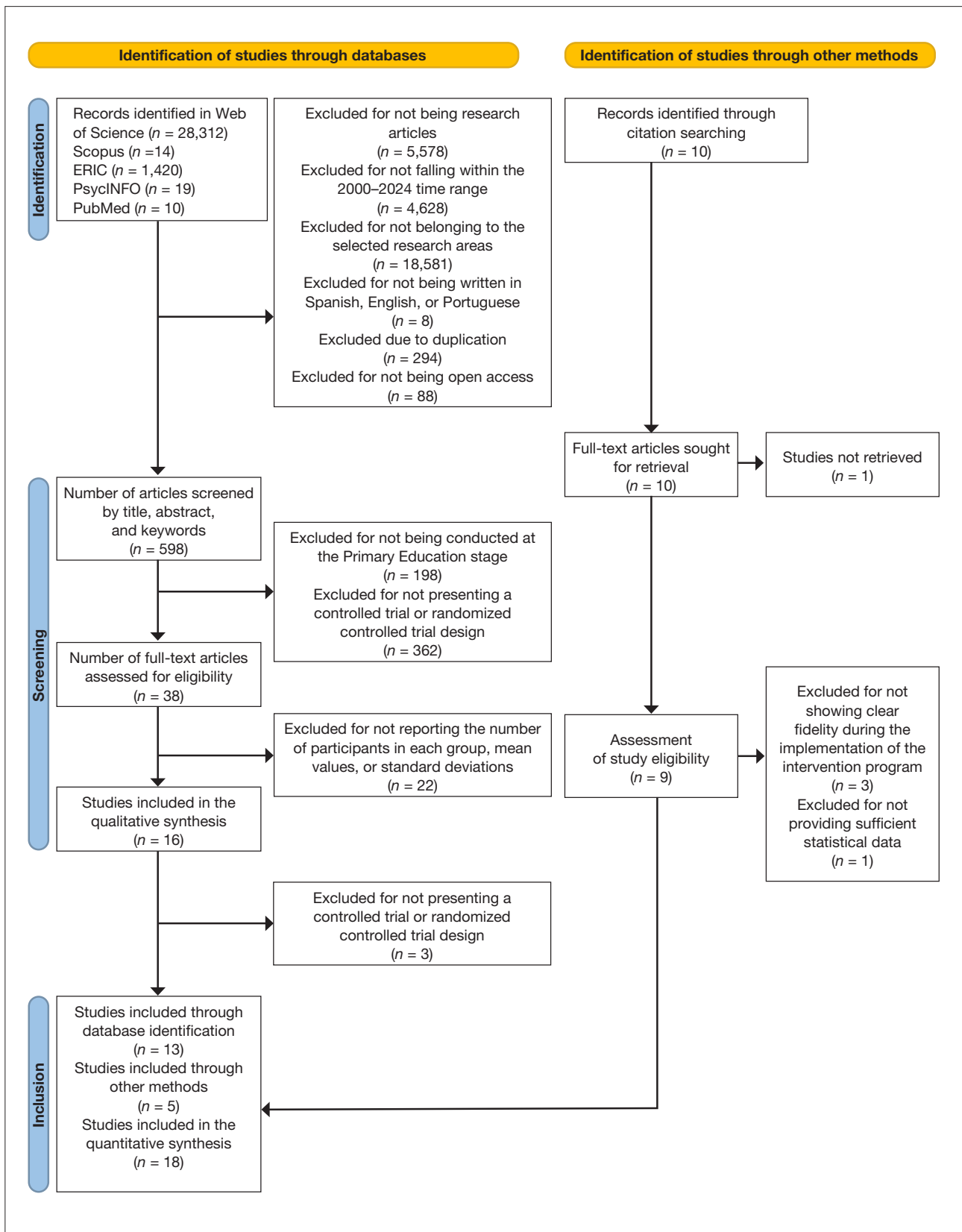
The PICOT criteria were followed to present the eligibility criteria (Villca-Villegas & Moreno-Choque, 2020). Table 1 presents each of the criteria together with a brief description of each of them.

Table 1
Description of the inclusion and exclusion criteria

	<i>Inclusion criteria</i>	<i>Exclusion criteria</i>
Population	Primary Education students	Early Childhood Education, Secondary Education, Upper Secondary Education, and university students
Intervention	Interventions that employ model hybridization and pedagogical models targeting psychosocial factors and executive functions	Interventions that do not use pedagogical models or model hybridization
Comparison	Interventions in which the control group used traditional teaching models Interventions with pretest and posttest Studies with a control group design and randomized control group	Non-scientific articles or those that do not use the aforementioned designs
Outcome	Analysis of the variables intrinsic motivation, extrinsic motivation, amotivation, relatedness, autonomy, and competence	Studies that do not analyze the variables defined above
Time	Articles published between 2000 and 2024	Articles not published between 2000 and 2024
Setting	Research conducted in the subject of Physical Education	Another sports discipline
Language	Articles written in Spanish, English, or Portuguese	Articles written in a language other than those mentioned
Study characteristics	Open Access articles Research subject to a peer-review process Articles using validated instruments Articles that provide mean values, standard deviations, and number of participants in both the control and experimental groups	Articles that do not meet any of the above requirements

Source: Own elaboration.

Figure 1
Flow diagram of the systematic review



Source: Own elaboration. Adapted from Page et al. (2021).

Study Selection

Figure 1 presents the flow diagram followed to obtain the scientific articles that make up the research sample. In the identification phase, a total of 29,798 records were initially collected through searches in Web of Science, Scopus, ERIC, PsycINFO, and PubMed. Additionally, 10 records were identified through manual citation searching. A large number of studies were excluded for the following reasons: not being research articles ($n = 5,578$), not belonging to the established time range ($n = 4,628$), not falling within the selected research areas ($n = 18,511$), and not being written in Spanish, English, or Portuguese ($n = 8$). Studies that were duplicated ($n = 294$) and those that were not available in open access ($n = 88$) were also excluded. A total of 598 scientific articles passed this initial screening phase.

In the screening phase, of the 598 scientific articles reviewed by title, abstract, and keywords, only 38 full-text studies were evaluated in detail to determine their eligibility. Exclusion at this stage was mainly due to interventions not being conducted at the Primary Education stage ($n = 198$) or not presenting a controlled trial or randomized controlled trial design ($n = 362$). Subsequently, other articles were excluded for not providing sufficient statistical information ($n = 22$) or for not demonstrating fidelity in the implementation of the pedagogical model in Physical Education classes ($n = 3$). In parallel, 10 scientific articles were identified through manual citation searching, of which 9 were retrieved in full text. Studies that did not present a controlled trial or randomized controlled trial design ($n = 2$) or did not provide sufficient statistical data ($n = 1$) were excluded.

Finally, the quantitative synthesis of the research consisted of 18 scientific articles. Specifically, 13 studies were extracted from the process of identifying studies through databases and 5 through the identification of studies by other methods.

Data Analysis and Calculation of Effect Size

The analysis was established using the standardized mean difference as the outcome measure. A random-effects model was applied. The amount of heterogeneity (τ^2) was calculated using the restricted maximum likelihood estimator (Viechtbauer, 2005). In addition to the estimation of τ^2 (τ^2), the values of the Q test for

the degree of heterogeneity (Viechtbauer, 2005) were examined together with the I^2 statistical test. For any level of heterogeneity ($\tau^2 > 0$, regardless of the results of the Q test), a prediction interval for the true effects was provided. Studentized residuals and Cook's distances were used to explore whether studies presented outlying or influential values within the context of the model. Studies whose Cook's distance exceeded the median plus six times the interquartile range of Cook's distances were considered influential (Viechtbauer, 2005). The rank correlation test and regression test, using the standard error of the observed effects as a predictor, were employed to justify funnel plot asymmetry (Viechtbauer, 2005).

To estimate effect size, Hedges' g was used. This measure includes a correction for sample bias, making it more appropriate, especially when sample sizes are small (Hedges, 1981). It is calculated by dividing the difference between group means by the pooled standard deviation and then applying a correction factor to reduce bias in the estimation of effect size (Hedges, 1981). This measure allowed interpretation of the magnitude of differences on a standardized scale, considering values of 0.2, 0.5, and 0.8 as small, medium, and large effect sizes, respectively (Cumming, 2012). The Comprehensive Meta-Analysis program (CMA, version 3; ©2014, Biostat, Inc., Englewood, NJ) was used.

Coding of the Selected Studies

The following information was extracted (Table 2): (1) authors (year); (2) country; (3) study sample; (4) educational stage; (5) session duration (number of sessions); (6) pedagogical model applied; (7) variables; (8) instruments used; (9) effect size.

Results

Characteristics of the Research Forming the Quantitative Synthesis

The quantitative synthesis included 18 research articles. Likewise, the sample consisted of 3,098 students. Practically all of the studies were conducted in Primary Education.

Table 2
Characteristics of the final study sample

Authors (Year)	Country	Sample	Educational stage	Number of sessions	Pedagogical models	Approach	Variables	Instruments	Effect size
Harvey et al. (2017)	United States	94 Primary Education students 39 girls 55 boys 79 Secondary Education students 45 girls 34 boys	Primary and Secondary Education	65 sessions	Teaching Games for Understanding (TGFU)	Quantitative	Intrinsic motivation	CS	-0.17 [-0.46; 0.11]
							Extrinsic motivation		0.00 [-0.28; 0.28]
							Amotivation		-0.02 [-0.30; 0.27]
							Autonomy	NSMQ	0.10 [-0.18; 0.38]
							Competence		0.02 [-0.25; 0.31]
							Relatedness		0.03 [-0.25; 0.31]
Navarro-Patón et al. (2017)	Spain	104 students 45 girls 59 boys	Primary Education	10 sessions	Cooperative Learning	Quantitative	Competence	EMMDCR	0.74 [0.35; 1.14]
							Amotivation		SMM
							Intrinsic motivation		0.03 [-0.35; 0.42]
							Extrinsic motivation		0.30 [-0.08; 0.69]
Navarro-Patón et al. (2018)	Spain	98 students 45 girls 53 boys	Primary Education	6 sessions	Cooperative Learning	Quantitative	Autonomy	EMMDCR	0.02 [-0.37; 0.41]
							Competence		0.07 [-0.31; 0.46]
							Amotivation	SMM	-0.17 [-0.57; 0.23]
							Intrinsic motivation		-0.14 [-0.54; 0.25]
							Extrinsic motivation		0.13 [-0.26; 0.53]
Puente-Maxera et al. (2018)	Spain	38 students 19 girls 19 boys	Primary Education	10 sessions	Sport Education	Mixed	Intrinsic motivation	CMI EMMD	-0.91 [-1.60; -0.22]
							Autonomy		Interviews
							Competence		0.14 [-0.50; 0.78]
							Relatedness		0.36 [-0.28; 1.01]

Source: Own elaboration.

Table 2 (Continued)
Characteristics of the final study sample

Authors (Year)	Country	Sample	Educational stage	Number of sessions	Pedagogical models	Approach	Variables	Instruments	Effect size
Hortigüela-Alcalá et al. (2019)	Spain	96 Primary Education students 52 girls 44 boys 83 Secondary Education students 45 girls 38 boys	Primary and Secondary Education	27 sessions	Cooperative Learning	Mixed	Intrinsic motivation	PeerMCYSQ	1.74 [1.41; 2.07]
Manzano & Valero-Valenzuela (2019)	Spain	25 students 11 girls 14 boys	Primary Education	(-)	Personal and Social Responsibility Model	Mixed	Autonomy	PNSE	0.98 [0.17, 1.79]
							Intrinsic motivation		0.51 [-0.29; 1.31]
							Extrinsic motivation	EME	-0.32 [-1.11; 0.48]
							Amotivation		0.64 [-0.17; 1.45]
Manzano-Sánchez & Valero-Valenzuela (2019)	Spain	206 Primary Education students 114 girls 92 boys 65 Secondary Education students 25 girls 40 boys 29 teachers	Primary and Secondary Education	(-) 7 months in duration	Personal and Social Responsibility Model	Mixed	Autonomy	PNSE	0.10 [-0.21; 0.42]
							Competence		-0.003 [-0.32; 0.31]
							Motivación	0.51 [0.19; 0.83]	
							Extrinsic motivation	EME	-0.15 [-0.47; -0.17]
							Amotivation		0.03 [-0.29; 0.35]
Engels & Freund (2020)	Germany	285 students 138 girls 147 boys	Primary and Secondary Education	18 sessions 6 weeks	Cooperative Learning	Quantitative	Autonomy	FEFS-J	0.20 [-0.02; 0.43]
							Competence		0.24 [0.01; 0.48]
							Relatedness		0.46 [0.22; 0.70]

Source: Own elaboration.

Table 2 (Continued)
Characteristics of the final study sample

Authors (Year)	Country	Sample	Educational stage	Number of sessions	Pedagogical models	Approach	Variables	Instruments	Effect size
Fernández-Río et al. (2020)	Spain	290 students 138 girls 152 boys	Primary and Secondary Education	30 sessions	Gamification	Mixed	Intrinsic motivation	PLCS	0.35 [-0.03; 0.73]
Merino-Barrero et al. (2020)	Spain	72 students 34 girls 38 boys 4 teachers	Primary and Secondary Education	29 sessions 5 months in duration	Personal and Social Responsibility Model	Quantitative	Autonomy	BPNES	0.54 [0.07; 1.01]
							Competence		0.28 [0.13; 0.79]
							Relatedness		0.46 [-0.006; 0.93]
							Intrinsic motivation	Physical Education Motivation Questionnaire	0.69 [0.21; 1.16]
							Amotivation		-0.74 [-1.21; -0.21]
Quintas et al. (2020)	Spain	417 students 222 girls 195 boys	Primary Education	12 sessions	Gamification	Quantitative	Intrinsic motivation	PLCS	-0.18 [-0.40; 0.05]
							Extrinsic motivation		0.12 [-0.10; 0.35]
							Amotivation		-0.07 [-0.30; 0.15]
							Autonomy	BPNES	-0.003 [-0.32; 0.31]
							Competence		-0.04 [-0.27; 0.17]
							Relatedness		-0.007 [-0.21; 0.23]
Gaspar et al. (2021)	Spain	111 students	Primary Education	16 sessions	Teaching Games for Understanding (TGFU)	Quantitative	Autonomy	BPNES	1.20 [0.80; 1.61]
							Competence		1.25 [0.85; 1.65]
							Relatedness		1.15 [0.75; 1.55]
							Intrinsic motivation	CMEF-EP	0.55 [0.17; 0.92]
							Amotivation		-0.49 [-0.87; -0.12]

Source: Own elaboration.

Table 2 (Continued)
Characteristics of the final study sample

Authors (Year)	Country	Sample	Educational stage	Number of sessions	Pedagogical models	Approach	Variables	Instruments	Effect size
Gil-Arias et al. (2021)	Spain	292 students 140 girls 152 boys 6 teachers 2 women 4 men	Primary Education	16 sessions	Model hybridization (Sport Education and TGFU)	Quantitative	Autonomy	BPNs	0.86 [0.62; 1.10]
							Competence		0.78 [0.54; 1.02]
							Relatedness		0.90 [0.66; 1.14]
							Intrinsic motivation	PLCQ	0.72 [0.49; 0.96]
Rodríguez-Martínez et al. (2021)	Spain	32 students 14 girls 18 boys	Primary Education	8 sessions	Model hybridization (Cooperative Learning and self-construction of materials)	Quantitative	Autonomy	BPNES	0.25 [-0.23; 0.73]
							Competence		0.16 [-0.32; 0.64]
							Relatedness		1.10 [0.58; 1.62]
							Intrinsic motivation	PLOC	-0.75 [-1.25; -0.24]
Amotivation		-0.56 [-1.06; -0.06]							
Železnik-Mežan et al. (2023)	Slovenia	157 students 71 girls 86 boys	Primary Education	30 sessions	Cooperative Learning	Quantitative	Relatedness	MC	0.25 [-0.06; 0.57]
Manzano-Sánchez & Gómez-López (2023)	Spain	192 Primary Education students 222 Secondary Education students	Primary and Secondary Education	(-) 5 months	Personal and Social Responsibility Model	Quantitative	Intrinsic motivation	EME	0.76 [0.56; 0.96]
							Amotivation		-0.72 [-0.92; -0.52]
							Autonomy	PNSE	0.26 [0.07; 0.46]
							Competence		0.39 [0.20; 0.59]
Relatedness		0.37 [-0.007; 0.76]							
Fernández-Bustos et al. (2024)	Spain	121 students	Primary Education	12 sessions	Health-based Physical Education	Quantitative	Amotivation	CMEFEP	-0.18 [-0.53; 0.16]
							Intrinsic motivation		0.44 [0.09; 0.79]
							Extrinsic motivation		0.11 [-0.24; 0.45]
Pizarro et al. (2024)	Spain	11 students 3 girls 8 boys	Primary Education	14 sessions	Model hybridization (Ludotechnical Model and TGFU)	Quantitative	Intrinsic motivation	EMD	1.49 [0.55; 2.44]
							Amotivation		-0.96 [-1.84; -0.08]

Source: Own elaboration.

Figure 2
Distribution of bias



Source: Own elaboration.

Risk of Bias Study

Figure 2 presents the distribution of bias across the different dimensions. A total of 18 scientific articles were analyzed. The lowest risk of bias was observed in allocation concealment ($n = 15$; 84.22%) and in the blinding of participants and personnel ($n = 14$; 78.96%). The dimensions with the highest presence of moderate bias were blinding of outcome assessment ($n = 5$; 26.26%) and other biases ($n = 4$; 21.04%).

Effectiveness of the Application of Pedagogical Models on Basic Psychological Needs for Primary Education Students

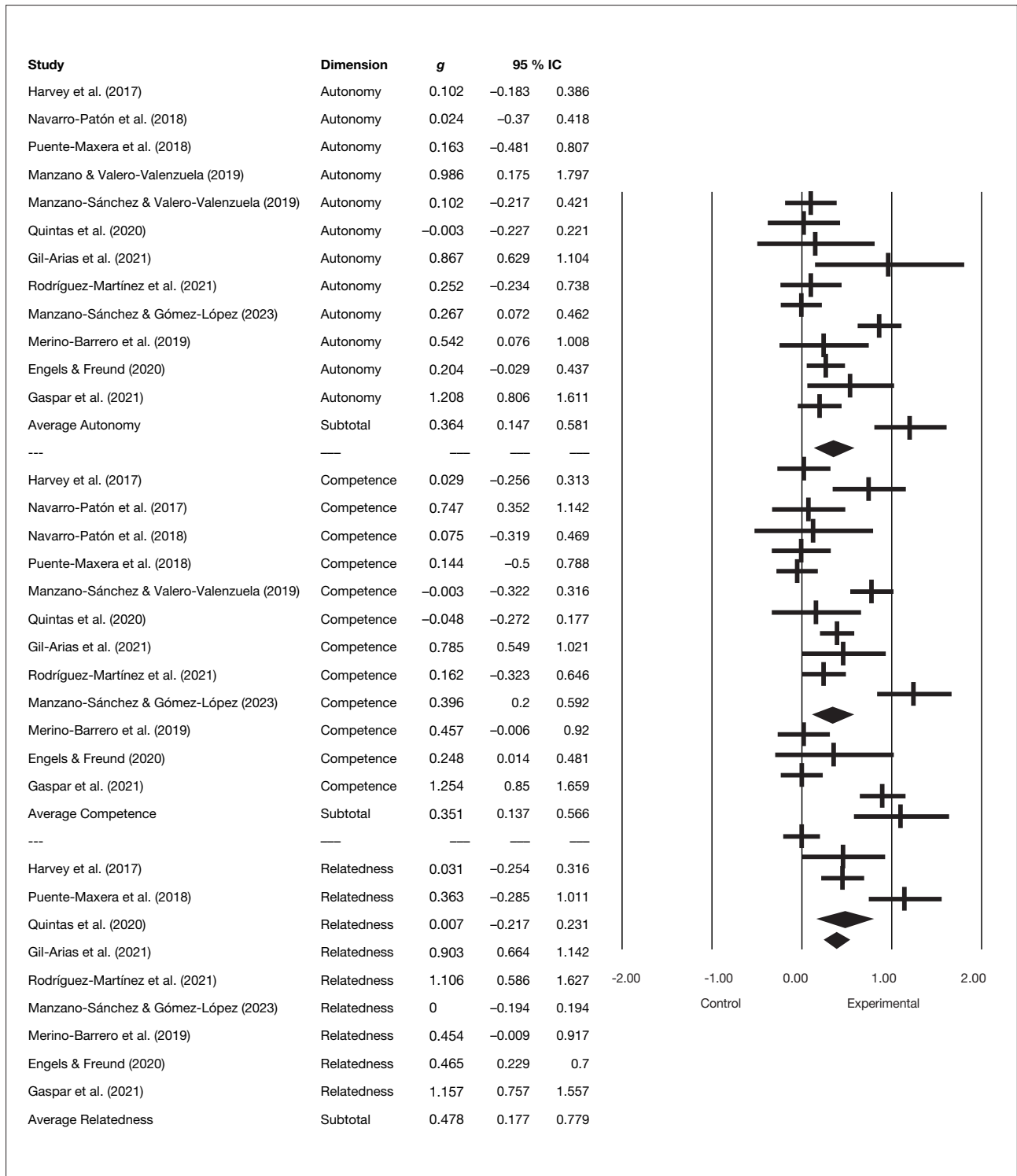
Figure 3 presents the results obtained from the application of pedagogical models on basic psychological needs.

Regarding autonomy, 12 studies were included in the analysis. No presence of possible asymmetries was observed, as neither the rank correlation test nor the regression test detected significant levels of asymmetry ($p = .445$ and $p = .439$). A significant and moderate level of heterogeneity among the studies was also observed ($Q = 57.637$; $p < .001$; $\tau^2 = .118$; $I^2 = 71.823\%$). It was observed that the application of pedagogical models exerts a small average effect size ($g = 0.364$ [95% CI: 0.147; 0.581]), which indicates that the mean result differs significantly from zero ($Z = 3.170$; $p = .002$). These results highlight the positive application of pedagogical models on the development of autonomy in Physical Education classes.

Continuing with the results obtained for competence, 12 scientific articles were included. No asymmetries were found in the results for this variable, as neither the rank correlation test nor the regression test showed significant values ($p = .387$ and $p = .826$). Likewise, a significant and high heterogeneity value was obtained in the studies ($Q = 61.062$; $p < .001$; $\tau^2 = .123$; $I^2 = 73.521\%$). It was observed that the application of pedagogical models exerts a small average effect size on the development of competence ($g = 0.351$ [95% CI: 0.137; 0.566]), which indicates that the mean result differs significantly from zero ($Z = 2.926$; $p = .003$). These results highlight the positive effect of the application of pedagogical models on the development of competence in Physical Education classes at the Primary Education stage.

With regard to the results related to relatedness, a total of 8 scientific studies were included. No asymmetries were found in the overall results, as neither the rank correlation test nor the regression test showed significant values ($p = .178$ and $p = .076$). A significant and high heterogeneity value was obtained in the studies ($Q = 46.837$; $p = .0003$; $\tau^2 = .183$; $I^2 = 81.447\%$). It was observed that the application of pedagogical models exerts a small average effect size on the development of competence ($g = 0.478$ [95% CI: 0.177; 0.779]), and that the mean result differed significantly ($Z = 2.137$; $p = .032$). These results suggest that the impact of pedagogical models on the satisfaction of relatedness is more variable and less consistent compared to the satisfaction of autonomy and competence.

Figure 3
Forest plot of the application of pedagogical models on basic psychological needs



Source: Own elaboration.

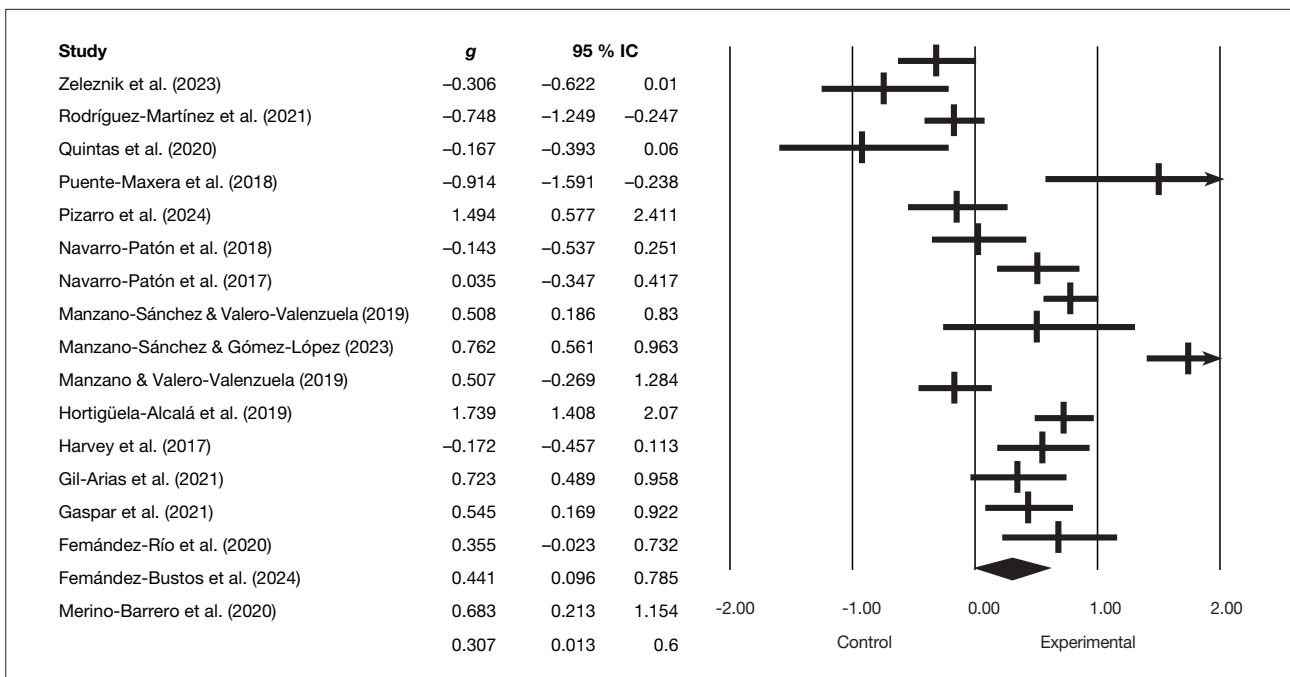
Effectiveness of Pedagogical Models on Intrinsic Motivation

Figure 4 presents the results obtained from the application of pedagogical models on the development of intrinsic motivation. The sample of scientific articles consisted of 16 studies. The results did not show asymmetries, as neither the rank correlation test nor the regression test showed significant values ($p = .776$ and $p = .934$). Regarding the level of heterogeneity, a significant and high value was obtained in the studies ($Q = 190.511$; $p < .0001$; $\tau^2 = .392$; $I^2 = 92.863\%$). A small effect size of the application of pedagogical models on the development of intrinsic motivation was found ($g = 0.307$ [95% CI: 0.013; 0.600]), and the mean result did not differ significantly from zero ($Z = 1.903$; $p = .057$).

Effectiveness of Pedagogical Models on Extrinsic Motivation

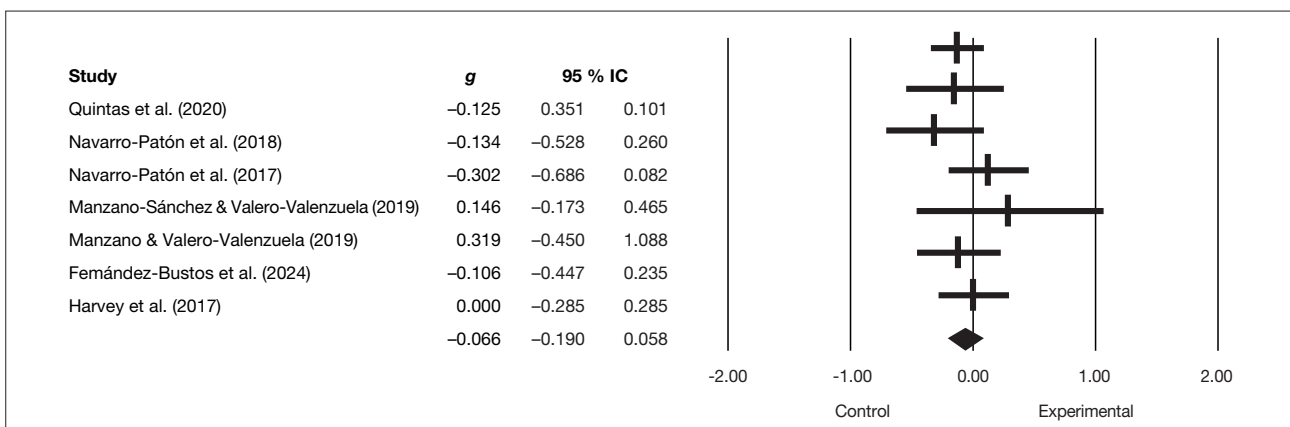
Figure 5 presents the results obtained from the application of pedagogical models on the development of extrinsic motivation. A total of five scientific studies were included. The results did not show asymmetries, as neither the rank correlation test nor the regression test showed significant values ($p = .985$ and $p = .524$). A non-significant and low heterogeneity value was obtained for this variable ($Q = 4.399$; $p = .493$; $\tau^2 = .0000$; $I^2 = 0.00\%$). A small and negative effect size of the application of pedagogical models on the development of extrinsic motivation was found ($g = -0.066$ [95% CI: -0.190 ; 0.058]), and the mean result did not differ significantly from zero ($Z = -1.159$; $p = .246$).

Figure 4
Forest plot of the application of pedagogical models on intrinsic motivation



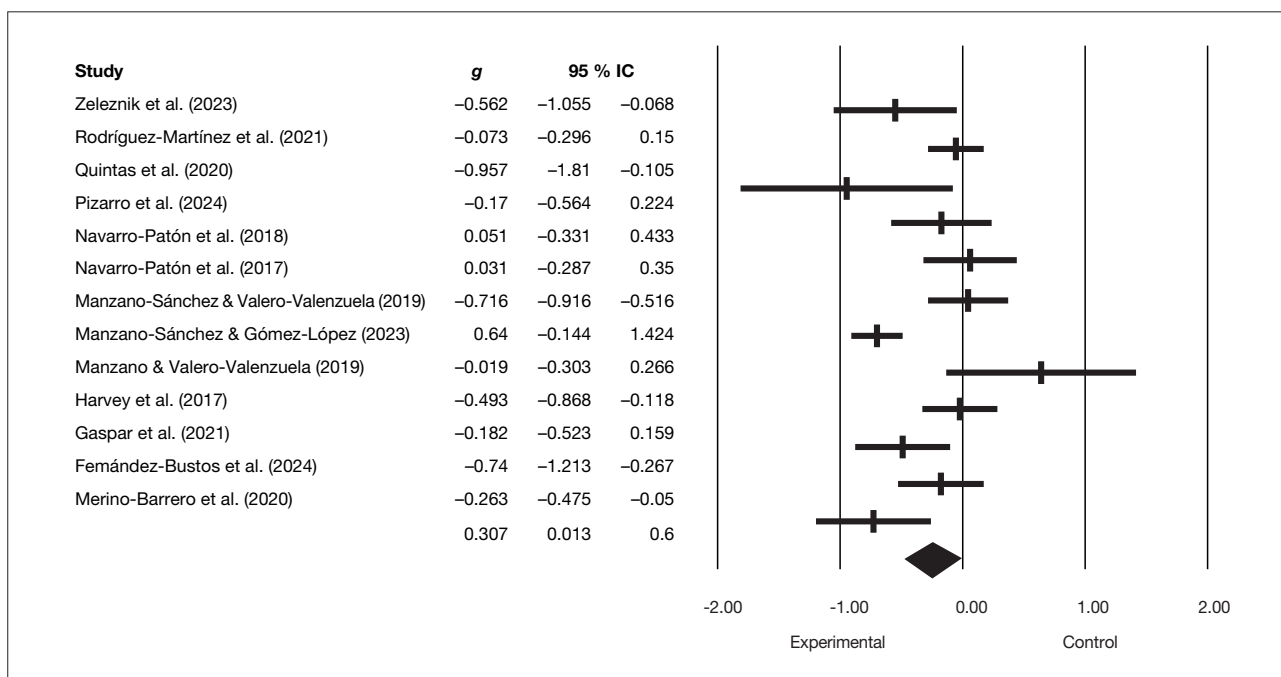
Source: Own elaboration.

Figure 5
Forest plot of the application of pedagogical models on extrinsic motivation



Source: Own elaboration.

Figure 6
Forest plot of the application of pedagogical models on amotivation



Source: Own elaboration.

Effectiveness of pedagogical models on amotivation

Figure 6 presents the results obtained from the application of pedagogical models on amotivation. In this case the analysis consisted of twelve scientific articles. Neither the rank correlation test nor the regression test showed significant results ($p = .459$ and $p = .958$), therefore no possible asymmetries were observed. A significant and moderate heterogeneity value was obtained ($Q = 44.940$; $p < .0001$; $\tau^2 = .082$; $I^2 = 72.67\%$). A small and negative effect size of the application of pedagogical models on the development of extrinsic motivation was found ($g = -0.263$ [95% CI: -0.475 ; -0.050]), and the mean result differed significantly from zero ($Z = -2.560$; $p = .010$).

Discussion

The objectives of the present study were to analyze the proposals established by the different intervention programmes that use pedagogical models to influence basic psychological needs and motivation (intrinsic, extrinsic and amotivation). The main findings show that pedagogical models at the Primary Education stage have become a tool for addressing basic psychological needs and the development of students' intrinsic motivation.

The results obtained in relation to autonomy show that the pedagogical models applied in Physical Education classes generate a positive and statistically significant effect, although of small magnitude. This finding is consistent with the central premise of self-determination theory (Ryan & Deci, 2017), which identifies autonomy as a basic psychological need whose satisfaction promotes intrinsic motivation and greater learning (Ryan & Deci, 2020). In the context of Primary Education, pedagogical models offer opportunities for students to make decisions, assume responsibilities in task development and actively participate in the organization of the class (Guijarro et al., 2020; Harvey et al., 2017; Navarro-Patón et al., 2018). These methodological characteristics allow students to exhibit a greater degree of control over their learning process (Engels & Freund, 2020; Gaspar et al., 2021). Likewise, at this educational stage, it is relevant to consider that the autonomy perceived by students is not only linked to freedom of choice, but also to the assurance that their decisions are valued and respected by the teacher and the rest of the group (Navarro-Patón et al., 2017). In addition, these models explicitly incorporate this component by encouraging students to set personal goals and participate in collective decision-making, which contributes to making the experience of autonomy meaningful (Manzano-Sánchez & Valero-Valenzuela, 2019; Merino-Barrero et al., 2020).

The small magnitude of the effect may be related to the complexity of fostering autonomy at early ages. Although pedagogical models provide structured frameworks that favor decision-making, autonomy does not emerge automatically, but depends to a large extent on the way in which the teacher implements them (Manzano-Sánchez & Gómez-López, 2023; Navarro-Patón et al., 2018). Offering real choices or proposing open-ended tasks with different solution pathways will allow students to assume roles within group dynamics (Gil-Arias et al., 2021; Navarro-Patón et al., 2017).

With regard to competence satisfaction, the results show that the application of pedagogical models in the Physical Education subject has a positive but small effect. Pedagogical models allow students to assume graded challenges, receive formative feedback and observe personal progress in their performance (Gil-Arias et al., 2021; Engels & Freund, 2020; Iglesias et al., 2023; Puente-Maxera et al., 2018). These models, by focusing on active participation, teamwork and process-based assessment, facilitate the experience of success that nurtures the feeling of competence (Engels & Freund, 2020; Puente-Maxera et al., 2018). However, the reduced effect suggests that the mere application of pedagogical models does not guarantee a substantial change; rather, it is the way in which the teacher adapts activities, organizes resources and accompanies learning that determines whether students truly feel competent (Manzano-Sánchez & Valero-Valenzuela, 2019). In this sense, their application should consider not only the methodological structure, but also the pedagogical intentionality of teachers in order to personalize challenges and make them achievable according to the characteristics of each group (Quintas et al., 2020).

Continuing with the satisfaction of relatedness, the results show a positive effect somewhat greater than in the case of autonomy. These findings suggest that the application of pedagogical models appears to be effective in strengthening social bonds and the sense of belonging in Physical Education classes (Puente-Maxera et al., 2018; Rodríguez-Martínez et al., 2021; Quintas et al., 2020; Železnik-Mežan et al., 2023). This basic psychological need is particularly relevant in the Primary Education stage, where experiences of acceptance, inclusion and collaboration decisively influence the construction of students' socio-emotional well-being (Harvey et al., 2017). Specifically, Cooperative Learning and the Personal and Social Responsibility Model have been shown to foster group cohesion and empathy, contributing to the creation of an environment of trust and respect in

Physical Education classes (Manzano-Sánchez & Gómez-López, 2023). If cooperative dynamics are not structured appropriately or if the teacher does not act as an active mediator of interactions, there is a risk that inequalities or exclusions may arise within the group (Quintas et al., 2020). Therefore, rather than relying solely on methodology, it is necessary for the teacher to adopt a proactive role in managing the social climate of the class, designing activities that guarantee equitable participation and providing spaces for reflection on respect and coexistence (Rodríguez-Martínez et al., 2021; Železnik-Mežan et al., 2023). In this way, the impact of pedagogical models on the satisfaction of the need for relatedness could be amplified, generating not only improvements in academic and physical performance, but also in students' holistic development (Quintas et al., 2020).

With regard to intrinsic motivation, the results show a small and positive effect of the application of pedagogical models. This trend is understandable, as intrinsic motivation largely depends on the satisfaction of basic psychological needs (Ryan & Deci, 2017). Pedagogical models offer favorable conditions for this; however, the short duration of some interventions or fidelity in the degree of implementation may have limited their capacity to generate significant changes (Hortigüela-Alcalá et al., 2019; Puente-Maxera et al., 2018). At the Primary Education stage, students are still in a process of discovering physical activity, so fostering stable intrinsic motivation requires time, varied experiences and a classroom climate that values both the process and enjoyment of the activity (Manzano-Sánchez & Valero-Valenzuela, 2019; Pizarro et al., 2024; Quintas et al., 2020).

With regard to extrinsic motivation, the results show a small and negative effect size. This finding may be due to the logic of pedagogical models, which prioritize students' active engagement over external incentives (Fernández-Bustos et al., 2024; Harvey et al., 2017). In Primary Education, it is common for students to feel motivated by rewards or comparisons; however, pedagogical models seek to promote a transition towards more autonomous forms of motivation (Navarro-Patón et al., 2018; Quintas et al., 2020). A small and negative effect size is also observed for amotivation. This evidence suggests that pedagogical models not only contribute to fostering more adaptive forms of motivation, but also play a protective role by reducing lack of interest or disengagement towards Physical Education (Manzano-Sánchez & Valero-Valenzuela, 2019; Merino-Barrero et al., 2020). This is particularly relevant in the Primary Education

stage, as early amotivation towards physical activity may translate into negative attitudes and abandonment of physical practice in later educational stages (Fernández-Bustos et al., 2024; Pizarro et al., 2024). The participatory structure of pedagogical models may explain why students feel less amotivated when participating in classes where they perceive a more active role and a more supportive climate (Harvey et al., 2017; Navarro-Patón et al., 2018; Quintas et al., 2020).

Limitations

Despite the findings obtained, this research presents several limitations that should be considered. First, the heterogeneity of the studies included, both in the use of pedagogical models and in their duration, limits the generalization of the results and makes it difficult to precisely establish the true effect size. Likewise, some interventions were of short duration and fidelity in methodological implementation was not always reported, which may have reduced the observed impact on motivational and psychological variables. In addition, some studies presented risk of bias in random sequence generation, blinding and selective reporting. Limitations related to the search process were also identified, as only certain subject areas from the different databases were selected. Furthermore, the study focused on a specific time range, which may have left out research that met the inclusion criteria.

The results of this review show that the application of pedagogical models in Physical Education constitutes an effective strategy to improve the experience of Primary Education students, as it enhances motivation and satisfaction of their basic psychological needs. With regard to intrinsic motivation, the results suggest that teachers should orient their classes towards fostering student protagonism, allowing them to choose tasks and creating spaces oriented towards reflection on their own learning. Regarding satisfaction of basic psychological needs, teachers should provide options and assign responsibilities within the classroom to promote autonomy, adapt tasks to students' levels and encourage feedback that enhances competence. In addition, it is important to promote situations that foster cooperative work and mutual respect, thereby strengthening relationships among students. Likewise, teachers should reduce reliance on rewards or punishments, promote more internal forms of learning, maintain student engagement and avoid negative attitudes towards physical activity practice.

Conclusions

It is concluded that the application of pedagogical models in Physical Education at the Primary Education stage constitutes an effective strategy to promote both motivation and satisfaction of students' basic psychological needs. In particular, it has been observed that pedagogical models have a positive effect, although small in magnitude, on the satisfaction of autonomy and competence, while in the dimension of social relatedness the impact is somewhat greater, reinforcing group cohesion and the sense of belonging.

An increase in intrinsic motivation is also evident, reflecting greater enjoyment and commitment to the activity, accompanied by a significant reduction in amotivation. This confirms the protective role of these methodologies against disinterest in the subject. In contrast, extrinsic motivation shows a slight decrease, suggesting that the application of pedagogical models promotes transitions towards more autonomous forms of motivation.

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Teacher Feedback as a Predictor of the Type of Motivational Orientation of Physical Education Students

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.

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Abstract

The aim of the present study was to analyze the relationship between the feedback provided by teachers and the type of motivation developed by physical education (PE) students in elementary education. To this end, an associative and predictive research design was employed. A total of 416 schoolchildren aged between 10 and 12 years participated in the study ($M = 10.78$; $SD = .67$). All participants attended schools in Málaga (Spain) with similar school curricula and sociodemographic characteristics. Data were collected using the Revised Teacher Feedback Perceptions Questionnaire (PTF-R) and the Physical Education Motivation Questionnaire (CMEF-EP). The correlation and linear regression analyses revealed that most self-determined forms of motivational regulation, such as identified motivation and intrinsic motivation, were associated with positive feedback, both verbal and nonverbal, as well as with performance-related feedback. Conversely, positive and performance-related feedback showed an inverse relationship with amotivation and extrinsic motivation, while a positive relationship was observed with negative feedback. Overall, the findings of this study suggest a significant differential relationship between the type of feedback provided by physical education teachers and students' motivational regulation, highlighting the importance of interaction styles in physical education classes and the need for teachers to analyze and structure their instructional practices in order to enhance students' experiences and their adherence to PE classes.

Keywords: enjoyment, feedback, lifestyle, motivation

Introduction

Physical education (PE) during elementary education is fundamental to children's overall development, as it significantly improves motor skills as well as social, cognitive, and emotional abilities (Andermo et al., 2020; Li et al., 2023; Teraoka et al., 2021). Physical education is also an excellent setting for developing active lifestyles and teaching healthy habits, which positively impact student learning and overall well-being (Carse et al., 2018; Zueck et al., 2020). In this day and age, in which passive leisure activities contribute to the development of increasingly sedentary lifestyles, the mandatory nature of this subject represents an opportunity to promote access and adherence to physical activity habits (García-Ceberino et al., 2023; Silva et al., 2018).

Student motivation in PE classes is a decisive factor for their level of adherence, effort, and enjoyment during class (Moreno-Murcia et al., 2018; Muñoz et al., 2018; Leyton-Román et al., 2020). This aspect not only specifically impacts the educational setting, but it also plays a crucial role in the formation of healthy lifestyle habits and the adoption of a long-term active lifestyle (Esqueda-Valerio et al., 2024; López-Alonzo et al., 2021). Understanding the factors that influence student motivation in PE classes is key to determining how teachers should approach their instruction and what strategies can be used to achieve these goals (Fernández-Espínola et al., 2022).

Motivation is a complex and multifaceted construct that encompasses beliefs, perceptions, values, interests, and actions that guide behavior (Deci & Ryan, 1985), and requires analysis based on a strong theoretical framework. Self-determination theory (SDT; Ryan & Deci, 2000, 2017) is one of the main contemporary theories of motivation for understanding human behavior and has been widely used in the context of physical activity and sports, and in PE specifically (Sun et al., 2017). According to SDT, human motivation exists along a continuum ranging from intrinsic or self-determined motivation to amotivation, passing through different degrees of extrinsic motivation (Deci & Ryan, 1985). Self-determined motivation is associated with greater interest, enjoyment, and satisfaction in PE classes, thus increasing the likelihood of adherence (Lonsdale et al., 2019; Vasconcellos et al., 2020). Conversely, extrinsic motivation or amotivation diminishes commitment to PE classes, increasing boredom and reducing the intention to engage in physical activity (Vasconcellos et al., 2020; White et al., 2021).

In the context of SDT, and in relation to these forms of motivation, organismic integration theory (OIT) explains how people internalize reasons for their actions and behaviors, creating different types of regulatory styles that range from more controlled or external to more autonomous (Ryan & Deci, 2000). With external regulation, actions are motivated by external rewards or punishments, and individuals act to meet expectations or avoid penalties. With introjected regulation, individuals experience internal pressure to perform a task, such as feelings of guilt or shame, or a desire to feel useful or competent. In identified regulation, individuals place value on an activity and consider it important to engage in it to achieve a goal, using it as a tool. With integrated regulation, another type, an activity must be aligned with personal values, and individuals consider it a part of their identity and way of life. Finally, with intrinsic regulation, individuals engage in an activity because they enjoy it, it creates satisfaction, and they find it interesting (Ryan & Deci, 2000).

Thus, according to SDT, if students have an intrinsic regulatory style and exhibit more self-determined motivation during PE, they are more likely to enjoy the subject and physical activity in general (White et al., 2021). In this context, in addition to other factors, teacher interactions influence student motivation in PE classes, meaning that the strategies teachers use are important during the instructional process (Cheon et al., 2014; Fin et al., 2019; Leo et al., 2022; Vasconcellos et al., 2020).

Among other factors, teaching styles that support student autonomy are those that provide meaningful learning, foster autonomy, show interest in students' progress, personalize learning, and encourage the regulation of intrinsic motivation (Chang et al., 2016; Leo et al., 2020). By contrast, styles that do not individually support student progression are those that do not provide useful information to enhance learning and those based on an approval or disapproval system regarding the final learning outcome, thus promoting the regulation of more extrinsic motivation (Leo et al., 2022; White et al., 2021).

Therefore, educational strategies that support intrinsic motivational regulation promote student adherence and effort (Boulley-Escriva et al., 2018; Polet et al., 2019). The type of interaction between teachers and students is decisive in fostering a motivational and supporting learning environment (Burgueño et al., 2024; Diloy-Peña et al., 2021; Leo et al., 2020).

In this context, feedback provided during the learning process is one of the most common interactions in PE and is a key component of students' learning (Huéscar & Moreno-Murcia, 2012; Koka & Hein, 2003, 2005). In education, Koka and Hein (2005) define feedback as information that teachers give their students regarding their performance and behavior during physical activities. It has been suggested that appropriate feedback that positively reinforces student performance can foster a greater sense of autonomy and may contribute to higher motivation and adherence to physical activity.

This feedback may be verbal or nonverbal and plays a crucial role in regulating student behavior, in students' perceptions of their own abilities, and in their motivation to participate in physical activity (Simpson et al., 2024). Verbal feedback uses language and technical terms to communicate information, while nonverbal feedback includes gestures, facial expressions, and body posture to communicate with students (Rojo-Ramos et al., 2025). The combination of the two types of feedback defines the learning context for the student and creates expectations for it, thereby increasing or decreasing motivation and effort when participating in PE classes (Zhou et al., 2021).

Positive feedback can increase intrinsic motivation in PE students (Mouratidis et al., 2008). Koka and Hagger (2010) noted that positive general feedback has an impact on students' intrinsic motivation, basing this relationship on the satisfaction of basic needs that this type of feedback provides. They also analyzed other types of feedback, including nonverbal feedback, and observed that one type of negative nonverbal information, such as disapproving gestures and expressions of disagreement, led to a decrease in students' self-determined motivation. Meanwhile, Zhou et al. (2021) pointed to the importance of performance-focused feedback, particularly aimed at consolidating motor skills. Leo et al. (2022) highlighted the importance of giving students positive feedback when they perform tasks well, rather than only providing negative feedback when they perform poorly.

This phenomenon can be explained by the hierarchical model from Vallerand (1997), which analyzes motivation holistically and presents a series of social factors that can influence different levels of motivation. According to Vallerand, the social environment is essential for effective learning, as motivation in an achievement-centered context is influenced by the interactions that occur in the classroom. Therefore, feedback provided by teachers may impact

some of the dimensions that Epstein (1988) identified as fundamental and that influence the type of motivation that students develop, such as task, authority, recognition, grouping, and time evaluation.

Furthermore, as Cecchini et al. (2019) reported, in line with their circular model, teacher feedback can influence the triangle encompassing intrinsic motivation, effort, and motor skills. Therefore, providing students with adequate feedback should reinforce learning and skills perception, while also fostering more self-determined motivation to engage in physical activity, thereby promoting commitment to such activity.

Feedback is likely the most common type of interaction in PE classes and has a lasting effect on students' perceptions of their participation, influencing how they evaluate their skill level and enjoyment. Based on these premises, it is likely that the type of feedback given also affects the type of motivation that students develop. Accordingly, this study aimed to analyze the relationship between feedback provided by teachers in PE classes and the type of motivation that elementary school students developed. To this end, we used the Revised Teacher Feedback Perceptions Questionnaire (PTF-R), which evaluates students' perceptions of the feedback they received, focusing on feedback quality, quantity, and impact, as well as how it influences motivation and performance in PE settings (Huéscar & Moreno-Murcia, 2012; Koka & Hein, 2003, 2005). The results of the study are expected to contribute to a better understanding of how pedagogical practices in PE, and teacher feedback specifically, influence student motivation. The findings could provide PE teachers with practical guidance on how to structure and deliver feedback to foster intrinsic motivation in students or, at minimum, more self-determined motivation.

Method

Participants

A total of 416 students aged 10 to 12 years participated in this study ($M = 10.78$; $SD = 0.67$). All of them attended four schools in Málaga (Spain), with similar school curricula and sociodemographic characteristics. All were public schools with similar educational approaches. The students were in the 5th and 6th years of compulsory elementary education

and had three hours of physical education classes per week. Of the total, 49.76% ($n = 207$) were male and 50.24% ($n = 209$) were female. G*Power software (v.3.1.9.7; Heinrich-Heine, Universität Düsseldorf, Düsseldorf, Germany) was used to calculate whether the sample size was adequate. For the tests used in this study, with a 5% probability of error, a 95% confidence level, and statistical power of .95, the required minimum sample size was 158 participants. The inclusion criteria were as follows: (a) not having repeated a grade; (b) being aged between 10 and 12 years; (c) having regularly participated in physical education classes (>90%) since the beginning of the school year; and (d) not having presented any injuries in the two weeks prior to starting the research.

Instruments

Revised Teacher Feedback Perceptions Questionnaire (PTF-R) (Huéscar & Moreno-Murcia, 2012; Koka & Hein, 2003, 2005). This scale evaluates students' perceptions of the feedback received from teachers within the context of physical education classes. It includes 14 items and four factors: (a) perceived positive general feedback (e.g., "My work is frequently encouraged by the teacher."); (b) perceived knowledge of performance (e.g., "The teacher often instructs me when performing in class."); (c) perceived negative nonverbal feedback (e.g., "The teacher shakes their head when I perform incorrectly."); and (d) perceived positive nonverbal feedback (e.g., "The teacher praises me even though I don't deserve it."). The questionnaire uses a Likert scale ranging from 1 (false) to 5 (true). For this study, we evaluated the internal consistency of the questionnaire and obtained the following values (Cronbach's alpha): perceived positive general feedback, $\alpha = .72$; perceived knowledge of performance, $\alpha = .70$; perceived negative nonverbal feedback, $\alpha = .76$; and perceived positive nonverbal feedback, $\alpha = .77$.

Motivation in Physical Education Questionnaire (CMEF-EP, by its Spanish acronym) (Leo et al., 2016). This scale evaluates students' types of motivation in the context of physical education classes. It includes 18 items and five factors: (a) intrinsic motivation (e.g., "Because physical education is fun."); (b) identified regulation (e.g., "Because this subject provides knowledge and skills that I think are important."); (c) introjected regulation (e.g., "Because I think it is necessary for me to feel good about myself."); (d) external regulation (e.g., "To show the teacher

and my classmates that I'm interested in the subject."); and (e) amotivation (e.g., "I actually feel like this subject is a waste of my time."). The questionnaire is answered using a Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). For this study, we evaluated the internal consistency of the questionnaire and obtained the following values (Cronbach's alpha): intrinsic motivation, $\alpha = .71$; identified regulation, $\alpha = .78$; introjected regulation, $\alpha = .73$; external regulation, $\alpha = .70$; amotivation $\alpha = .74$.

Procedure

The sample was selected from multiple educational centers in Málaga, Spain. The study used convenience sampling, a type of nonprobability sampling. The schools were similar in terms of their physical education curricula, number of weekly class hours, material resources, and socioeconomic characteristics. The first step involved requesting authorization to participate in the research from the school principal. Second, we explained in depth the aim of the study to the students, their families, and the PE teachers. Written informed consent was obtained from the participants and their parents or legal guardians. We stated that student participation was voluntary and anonymous, and that the data would be used only for this study.

The questionnaires were self-administered, and any questions that arose were answered. A classroom was provided in which groups of 10-25 students could complete the questionnaires. It took approximately 30 minutes to answer the questions, and the process was completed without incident. The entire research process was conducted in accordance with the ethical principles of the Declaration of Helsinki. The University of Málaga Research Ethics Committee (CEUMA: 67-2025-H) also granted approval to conduct the study.

Data Analysis

Descriptive and inferential analyses were conducted. We estimated means, standard deviations, skewness, and kurtosis. Data normality was assessed using the Kolmogorov-Smirnov test. Correlation analyses were then conducted using Pearson's bivariate correlation coefficient ($\pm .01$ to $\pm .19$ = very low correlation; $\pm .20$ to $\pm .39$ = low correlation; $\pm .40$ to $\pm .59$ = moderate correlation; $\pm .60$ to $\pm .79$ = high correlation; Evans, 1996). Multiple linear regression analyses were also

conducted to assess the predictive capacity of the teachers' feedback on students' motivational styles. We estimated Durbin-Watson values, coefficients of determination (R^2), β values, student's t -test, tolerance index (T), and the variance inflation factor (VIF). The data were processed using SPSS software package version 25.

Results

Table 1 presents values for the means, standard deviations, skewness, and kurtosis for the study variables, as well as their correlations. The Kolmogorov-Smirnov test was also applied, and in all cases adequate values were obtained ($p > .05$). As shown in Table 1, positive general feedback and performance-related feedback were positively associated with intrinsic and identified motivation and negatively associated with external motivation and amotivation. Positive nonverbal feedback was positively associated with intrinsic, identified, and introjected motivation. Lastly, negative nonverbal feedback was positively associated with introjected and external motivation and amotivation.

Table 2 presents the analyses of the multiple linear regression models generated. The independent variables were the feedback dimensions provided by the teachers, and the

dependent variables were the motivation dimensions studied. The data met the assumptions of linearity in the relationship between the dependent and independent variables, as well as homoscedasticity and normality of the residuals, whose mean value was 0 and the standard deviation approximately 1 (.99). In addition, the Durbin-Watson values were satisfactory, ranging from 1.59 to 1.91 (Pardo & Ruiz, 2005).

As shown, the model predicting intrinsic motivation explained 20% of the variance ($R = .46$; $R^2_{adj} = .21$; $F = 27.37$; $p < .001$), and the model predicting identified motivation explained 19% ($R = .44$; $R^2_{adj} = .19$; $F = 24.55$; $p < .001$). In both cases, positive general feedback and positive verbal feedback were statistically significant independent variables, with the former having a greater weight in the model. The model for introjected motivation explained 4% of the variance ($R = .22$; $R^2_{adj} = .04$; $F = 5.28$; $p < .001$), with two nonverbal feedback dimensions emerging as significant independent variables. For extrinsic motivation, the model explained 6% of the variance ($R = .27$; $R^2_{adj} = .06$; $F = 8.06$; $p < .001$), with negative nonverbal feedback and performance-related feedback having the greatest negative weights. Lastly, positive general feedback, (negative weight) and negative nonverbal feedback predicted 12% of amotivation ($R = .35$; $R^2_{adj} = .12$; $F = 14.75$; $p < .001$).

Table 1
Descriptive statistics and correlation measures

	<i>M</i>	<i>SD</i>	<i>S</i>	<i>K</i>	2	3	4	5	6	7	8	9
1. Positive general FB	3.36	0.97	-0.13	-0.66	.55**	.54**	-.07	.44**	.43**	.08	-.10*	-.25**
2. Execution FB	3.67	0.88	-0.47	-0.34	-	.43**	-.08	.31**	.26**	-.02	-.14**	-.14**
3. Positive NV-FB	2.72	0.85	0.19	-0.46		-	.07	.32**	.31**	.14**	.03	-.07
4. Negative NV-FB	1.92	0.90	1.04	0.49			-	-.05	-.06	.16**	.22**	.27**
5. Intrinsic motivation	4.12	0.85	-1.18	1.01				-	.45**	-.01	-.04	-.42**
6. Identified motivation	3.92	0.85	-0.70	0.04					-	.17**	.13**	-.28**
7. Introjected motivation	2.78	1.15	0.15	-0.74						-	.35**	.21**
8. External motivation	2.98	0.96	-0.03	-0.59							-	.20**
9. Amotivation	1.71	0.90	1.37	1.23								-

Note. *M* = Mean; *DT* = Standard Deviation; *S* = Skewness; *K* = Kurtosis; FB = Feedback; NV = Nonverbal. * $p < .05$, ** $p < .01$.

Table 2
Multiple linear regression models

Criterion	<i>R</i>	<i>R</i> ² _{adj}	D-W	Predictors	<i>Beta</i>	<i>t</i>	<i>T</i>	VIF
Intrinsic motivation	.46	.21	2.01	(Constant)		13.37***		
				Positive general FB	.34	5.98***	.58	1.73
				Execution FB	.07	1.29	.67	1.49
				Positive NV-FB	.11	2.04*	.67	1.49
				Negative NV-FB	-.02	-.54	.97	1.03
Identified motivation	.44	.19	1.91	(Constant)		13.10***		
				Positive general FB	.35	5.94***	.58	1.73
				Execution FB	.02	.31	.67	1.49
				Positive NV-FB	.12	2.28*	.67	1.49
				Negative NV-FB	-.05	-1.05	.97	1.03
Introjected motivation	.22	.04	1.70	(Constant)		7.39***		
				Positive general FB	.08	1.23	.57	1.73
				Execution FB	-.10	-1.75	.67	1.49
				Positive NV-FB	.13	2.21*	.67	1.49
				Negative NV-FB	.15	2.97**	.97	1.03
Extrinsic motivation	.27	.06	1.56	(Constant)		12.61***		
				Positive general FB	-.08	-1.25	.57	1.73
				Execution FB	-.12	-2.16*	.67	1.49
				Positive NV-FB	.11	1.87	.67	1.49
				Negative NV-FB	.20	4.12***	.97	1.03
Amotivation	.35	.12	1.81	(Constant)		8.77***		
				Positive general FB	-.26	-4.30***	.57	1.73
				Execution FB	-.01	-.06	.67	1.49
				Positive NV-FB	.06	1.02	.67	1.49
				Negative NV-FB	.24	5.16***	.97	1.03

Note. D-W = Durbin-Watson; *T* = Tolerance; VIF = Variance Inflation Factor; FB = Feedback; NV = Nonverbal.

p* < .05, *p* < .01, ****p* < .001

Discussion

The aim of this study was to analyze the relationship between feedback provided by physical education teachers and the types of motivation developed by a group of elementary school students. The results showed statistically significant relationships between the studied constructs. They indicated that the most self-determined forms of motivational regulation were positively associated with positive feedback, both general and nonverbal, while the most extrinsic forms of motivation and amotivation were positively associated with negative nonverbal feedback or inversely associated with positive or performance-related feedback.

Firstly, the results show that the most self-determined forms of regulation, such as identified and intrinsic motivation, were positively associated with both verbal and nonverbal positive feedback as well as with performance-related feedback, which is consistent with the previous literature. For example, a study by Koka and Hein (2005) in adolescent physical education students showed that positive general feedback was perceived as a stronger predictor of intrinsic motivation. Similarly, Fin et al. (2019) found that students who participated in a specific autonomy-support program exhibited self-determined motivation, greater satisfaction from engaging in physical activity, and higher levels of satisfaction of basic psychological needs compared to the control group.

The results of this study show that both positive general feedback and positive verbal feedback were statistically significant predictors of these forms of motivational regulation. This finding is consistent with the results reported by numerous authors (Koka & Hagger, 2010; Leo et al., 2022; Mouratidis et al., 2008) who have found that positive teacher feedback can foster student enjoyment and increase students' intrinsic motivation to participate in physical activity. Among other reasons, this type of interaction may promote meaningful learning, as it provides students with information about their progress, while also serving as emotional support for engaging in these contexts and individualizing learning to adapt to the needs of each student (Chang et al., 2016; Leo et al., 2020). Therefore, the results underscore the importance of positive feedback as a pedagogical element that enhances perceived competence, autonomy, and relatedness with teachers—three essential factors according to self-determination theory (Leo et al., 2022; Ryan & Deci, 2017).

Similarly, the results highlight the role of verbal and nonverbal feedback in students' development of motivation, which is considered essential to their in-class experience (Simpson et al., 2024). Verbal feedback uses language as a vehicle to transmit information, this being a clear and direct communication channel. However, nonverbal feedback is also a powerful tool for communicating approval and support for students, as other authors have previously noted (Rojo-Ramos et al., 2025). Therefore, it is important to develop strategies that use both types of feedback in order to increase the likelihood of positively impacting student motivation (Zhou et al., 2021). Moreover, although it may not have played a prominent role in the regression models, the performance-related feedback variable was positively associated with intrinsic and identified motivation. As such, it should be taken into consideration, as Zhou et al. (2021) emphasized, given its impact on the progress and consolidation of motor skills in physical education students. These results may also be influenced by contextual factors such as teacher experience, the methodology used, or the prosocial classroom climate, which could affect how students perceive and evaluate different types of feedback (Mouratidis et al., 2008; Rojo-Ramos et al., 2025).

Secondly, external motivational regulation and amotivation were negatively associated with positive general feedback and performance-related feedback, and positively associated with negative nonverbal feedback. These results reveal significant differences in how different types of

teacher feedback are related to motivational regulation patterns, highlighting the importance of teacher interactions in students' development of motivation (Huéscar & Moreno-Murcia, 2012; Koka & Hein, 2003, 2005). Furthermore, the findings suggest that a lack of perceived positive feedback—whether verbal or nonverbal—as well as performance-related feedback, could hinder the development of more self-determined motivation and, consequently, increase external motivation or even amotivation (Rojo-Ramos et al., 2025; Simpson et al., 2024; Zhou et al., 2021). This is particularly relevant in PE, as motivation regulated by external factors or amotivation, in addition to potentially reducing in-class participation, may also affect the development of an active lifestyle and reduce the potential positive effects of physical activity on individuals' well-being (Eime et al., 2013; Wang & Chen, 2022). These findings reinforce the need for teachers to be aware of their behavior and its impact, avoiding actions that could result in negative experiences and hinder the development of self-determined forms of motivation.

In particular, negative nonverbal feedback was a significant predictor of external motivation and amotivation, highlighting the importance of signs of disapproval that physical education teachers may consciously or unconsciously transmit (Rojo-Ramos et al., 2025). Therefore, teachers must be aware of the impact that a gesture or facial expression can have on young students, influencing their enjoyment, perception of classes, and ultimately their participation. Negative nonverbal feedback is most likely to occur when teachers adopt a more controlling interaction style that focuses on performance outcomes. This approach provides students with less emotional support, does not emphasize on the improvement process (Fin et al., 2019), and may further contribute to amotivation in children and adolescents.

Limitations

The present study has several limitations. Firstly, an associative design was used, which allows for the identification of relationships between variables but does not permit causal conclusions. Therefore, longitudinal or quasi-experimental research is needed to determine the developmental processes underlying different forms of motivational regulations. Such studies could also determine whether other factors influence the development of motivation. At a minimum, explanatory research incorporating mediating or moderating variables could provide additional insight into the relationships among the study variables.

Secondly, although our sample was large, it was nonprobabilistic, which limits the generalizability of the results. Future studies could improve the representativeness of the sample to strengthen the conclusions obtained here. In addition, this research did not examine gender differences, which could be an important variable for future studies. Exploring this aspect could provide a more in-depth understanding of how teacher-student interactions may differ by gender, thereby offering valuable insights for designing more effective teaching strategies.

Conclusions

The study results demonstrate the importance of teacher interaction styles, specifically regarding feedback, and their impact on student motivation. This highlights the need to analyze in-class behavior and develop strategies that promote accurate student perceptions, with the aim of fostering motivational regulation models that enhance enjoyment, learning, and adherence to physical education programs (Burgueño et al., 2024; Mazer, 2013). Overall, the results indicate that the most self-determined forms of regulation are associated with positive feedback—both verbal and nonverbal—as well as performance-related feedback. Conversely, amotivation and extrinsic motivation are strongly associated with negative feedback and inversely related to positive and performance-related feedback.

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Multisystem Aquatic Therapy and Emotional Regulation in Students with Autism Spectrum Disorder

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.

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Abstract

It has been shown that aquatic interventions promote significant improvements in psychomotor skills in children with Autism Spectrum Disorder (ASD), although further research is required to confirm their effectiveness in different contexts. Therefore, the objective of this study was to examine the impact of Multisystem Aquatic Therapy (CI-MAT) on aquatic skills and emotional regulation in children diagnosed with ASD in the school context. A sample of 14 children ($N = 14$) was included, comprising 9 boys (64.3%) and 5 girls (35.7%), aged between 7 and 11 years ($M = 8.93$; $SD = 1.439$). With respect to severity levels, 8 children were diagnosed at level 1 (57.1%) and 6 at level 2 (42.8%). The intervention lasted 24 sessions of 40 minutes each, over a period of 12 weeks (two per week). In the experimental group (8 participants, 4 with ASD level 1 and 4 with ASD level 2), the CI-MAT program was implemented, whereas the control group (6 participants, 4 with ASD level 1 and 2 with ASD level 2) did not carry out any type of activity in the aquatic environment. To assess emotional regulation, the Spanish version of the Emotional-Regulation Skill Questionnaire (ERSQ) was used. The Aquatic Skills Checklist (ASC) was used to assess skill development. The principal researcher and an assistant recorded the data directly on the assessment instruments, given the need to ensure recording reliability and to overcome the self-assessment difficulties that children with ASD might present. The results showed that the CI-MAT program had significant effects on improving aquatic skills, as well as emotional regulation, and is therefore presented as a resource to be considered in the educational context for working with children diagnosed with ASD.

Keywords: aquatic exercise, autism, emotional regulation

Introduction

According to the World Health Organization (WHO) (2022), Autism Spectrum Disorder (ASD) is understood as a persistent difficulty in the process of socialization, together with a restricted pattern of interests and sensory limitations. In turn, recent studies (Garrido-Torres et al., 2024; Cuellar-Salazar, 2024; Cano-Villagrana & López-Zamora, 2024) define ASD as a neurodevelopmental disorder, with complex clinical manifestations that arise between 18 and 36 months of age. For these authors, and in line with what is established by the WHO, children with autism are characterized by deficits in social interaction, a restricted range of interests, and repetitive stereotyped behaviors.

This disorder presents complex dysfunctions in the development of the nervous system, manifesting in the early stages of life (González de Rivera Romero et al., 2022). With regard to the educational context, in 2018 it was estimated that the global incidence of ASD among the child population in Spain reached 15.5 per 1,000 preschool children and 10 per 1,000 school-aged children (Morales-Hidalgo et al., 2018).

For children with ASD, participation in physical activities plays a fundamental role in improving socialization (Ketcheson et al., 2017). More recent studies, such as that of López-Díaz et al. (2021), show how physical activity not only contributes to physical well-being, but also positively affects mental health, social interaction, and emotional adaptation. In addition, according to Gómez et al. (2018), physical activity is one of the key dimensions when it comes to achieving a good quality of life in people with ASD, as it allows for the development of motor skills and the generation of positive psychological contexts, as well as behavioral changes.

At present, the lack of physical activity in children with Autism Spectrum Disorder (ASD) is a global phenomenon with significant consequences for their development. In this context, it is essential to analyze the effects of physical activity in the motor, behavioral, and emotional domains of children with ASD, as well as to identify valid strategies to enhance these benefits. According to authors such as Fernández-Díaz et al. (2023), following a plan of 30 minutes of daily moderate physical activity and a healthy lifestyle entails notable benefits and improvements in the behavior and conduct of children with ASD.

At the behavioral level, it has been shown that physical activity reduces levels of aggressiveness, irritability, and depression, while at the same time an increase in self-esteem, social interaction, and communication skills is observed. Along the same lines, Fessia et al. (2018) observed that

physical activity is a unique tool for achieving behavioral changes in children with ASD.

In this context, one of the main characteristics to be addressed in the educational setting with this type of student is impulsivity and the inability to control emotions (Márquez et al., 2023). Hassen et al. (2023) define emotional regulation as the ability of a person to understand, express, and manage their own emotions appropriately, as well as to interpret and respond to the emotions of others.

According to van 't Hooft et al. (2024), activities in the aquatic environment can promote aquatic competence, emotional regulation, and certain social behaviors in schoolchildren with ASD; however, larger and more controlled studies are required to confirm these effects. Pan (2010) argues that the implementation of an exercise program in the aquatic environment allows children with ASD to improve their sensory and motor function.

Caputo et al. (2018) applied the CI-MAT program (Comprehensive Multisystem Aquatic Therapy), which is structured in progressive phases in order to facilitate the adaptation of children with ASD to the aquatic environment. In a first stage, the program focuses on emotional bonding and affective safety, taking advantage of the characteristic attachment behavior of these children to establish physical contact with the therapist in the water. Once this relationship of trust has been consolidated, instruction in aquatic and swimming skills is introduced through exercises specifically adapted to their needs and motor limitations. Finally, the program incorporates a dimension of social integration, fostering interaction and cooperation with peers during activities in the aquatic environment. Overall, this multisystem methodology not only addresses the emotional and social needs of children but also shows promise in promoting improvements in their motor skills.

Among the aquatic intervention protocols considered to be of greatest relevance in the therapeutic field is the so-called Halliwick Therapy, which constitutes a structured, gradual, and objectively measurable program designed to promote the development of fundamental aquatic skills such as postural control, balance, breathing, and locomotion (Vodakova et al., 2022). It was created by McMillan (1977) to teach swimming to people with physical disabilities and, over time, evolved into a broader therapeutic intervention. According to various studies on the subject (Aleksandrovic et al., 2015; Naumann et al., 2021), most of the interventions proposed in the aquatic environment for children with ASD are aimed at improving their motor skills and aquatic skills, but there are few protocols that address aspects related to the regulation of their emotions.

Based on the above, there is a need to further develop an integral intervention approach, such as Multisystem Aquatic Therapy, which combines emotional, motor, social, and functional learning components organized in phases, in order to promote adaptation, skill development, and the inclusion of children with ASD. The present study aims to examine whether Multisystem Aquatic Therapy (CI-MAT) produces significant improvements in aquatic skills and emotional regulation in children with ASD in the school context.

Method

The present study adopted a quantitative approach, employing a quasi-experimental two-group design with pretest and posttest measures and a systematic observational record of participants' behaviors, following the model of Alaniz et al. (2017). Changes were evaluated after the intervention applied to the experimental group and in comparison with the control group, while specific behaviors of interest were documented during the intervention. The study included one independent variable: an aquatic physical activity program (CI-MAT), and two dependent variables: emotional regulation and aquatic skills.

Participants

A total of 14 children ($N = 14$) participated in this study, of whom 9 were boys (64.3%) and 5 were girls (35.7%), aged between 7 and 11 years ($M = 8.93$; $SD = 1.439$). These students were enrolled in third grade ($n = 5$), fourth grade ($n = 5$), and sixth grade of primary education ($n = 4$). The inclusion criteria were: 1) having a diagnosis of ASD, level 1 ("requires support") or 2 ("requires substantial support"), according to the DSM-5 diagnostic criteria guidelines (American Psychiatric Association, 2014); 2) not having

any disabling condition that would prevent participation in physical activity; and 3) not having previously participated in the CI-MAT program. Prior to the intervention, comparisons were conducted between the experimental group and the control group on pre-intervention scores across all dimensions to verify baseline equivalence. No significant differences were found ($p > .05$), indicating that the groups were comparable at the beginning of the study.

Group assignment was carried out by convenience sampling, balancing severity levels. The experimental group, which worked through the CI-MAT program, consisted of 8 participants (6 boys and 2 girls, 4 with ASD level 1 and 4 with ASD level 2), whereas the control group, in which no intervention was carried out, was composed of 6 participants (3 boys and 3 girls, 4 with ASD level 1 and 2 with ASD level 2 (Table 1).

It is necessary to clarify that in the present study the term *level* is used to refer to ASD severity, in accordance with the DSM-5 classification, which distinguishes three levels of support. The use of the term *grade* is avoided, as it is less precise in the diagnostic field. Children with level 1 present good overall functioning with mild social difficulties and rigidity in their behaviors; at level 2, these difficulties are more marked and affect autonomy; and at level 3, limitations are very severe and require very substantial support. Only children with levels 1 and 2 participated in the study, as they presented sufficient functioning to take part in the proposed measurements and tasks (American Psychiatric Association, 2014; Lord et al., 2018).

The parents or legal guardians of the participants signed an informed consent form to participate and were informed of the objectives and characteristics of the study. All procedures were carried out with the approval of the ethics committee of the Catholic University of Murcia, reference code CE012417.

Table 1
Characteristics of the sample by age, gender, and level of ASD severity

Characteristic	Total ($N = 14$)	EG ($n = 8$)	GC ($n = 6$)
Age	8.93 ± (1.43)	9.25 ± (1.48)	8.5 ± (1.37)
Sex			
Boys	9 (64.3 %)	6 (75 %)	3 (50 %)
Girls	5 (35.7 %)	2 (25 %)	3 (50 %)
ASD			
Level 1	8 (57.2 %)	4 (50 %)	4 (66.7 %)
Level 2	6 (42.8 %)	4 (50 %)	2 (33.3 %)

Note. EG: experimental group (worked through the CI-MAT program), CG: control group (no intervention). ASD, level 1 (requires support), ASD, level 2 (requires substantial support) (American Psychiatric Association, 2014).

Instruments

To assess children's emotional regulation, the Spanish version by Orozco-Vargas et al. (2021) of the original Emotional-Regulation Skill Questionnaire (ERSQ) by Berking and Znoj (2008) was used, which is characterized by evaluating a broad spectrum of adaptive skills for successful emotion regulation. The ERSQ is an instrument composed of 27 items that uses a 4-point Likert-type response format ranging from 0 ("not at all") to 4 ("almost always"). It includes nine dimensions (Emotional awareness, Sensation, Clarity, Knowledge, Acceptance, Tolerance, Self-support, Willingness to confront, and Modification) through which cognitive and behavioral strategies are measured. The ERSQ has been used to investigate emotional regulation both in the general population and in clinical populations, specifically in different studies with autistic children (Hendrix et al., 2022; Butterworth et al., 2014). In the present study, the questionnaire was administered by the principal researcher, with the support of another trained researcher, to both the experimental group and the control group, before and after the aquatic intervention. The evaluators received prior training of 6 hours on the correct formulation of the items and the recording of responses. Inter-rater agreement was evaluated in a subsample (0.88 Kappa), indicating high reliability. To ensure comprehension of each item, the researchers asked the questions directly to the children and completed the questionnaire on their behalf, ensuring the reliability and validity of the responses (Table 2).

The Aquatic Skills Checklist (ASC) was used to assess skill development, a tool based on the American Red Cross Water Safety Instructor Manual (2009). This checklist assesses 13 swimming skills: movement in the water, breath control, propulsion, exiting the water, back floating, and turns, among others. Each skill was rated on a scale from zero to three (0: unable to complete the skill; 1: skill completed with physical assistance from the therapist; 2: skill completed with a flotation device; 3: skill completed independently). Participants could obtain a maximum score of 39 points for the total ASC score (Table 3). The ASC was used as a performance observation tool to record the presence/absence (or level) of the indicated aquatic skills. Although the ASC checklist is widely used in training programs, no published evidence of a complete psychometric validation was found. Therefore, in this study, the ASC was used as an operational working tool for skill assessment, and the results are interpreted within that context. The evaluators received prior training of 4 hours on scale administration and item coding. Inter-rater reliability, evaluated using Kappa, was 0.87, and assessments were conducted blind to participants' group assignment.

Studies such as those by Alaniz et al. (2017) and Lawson et al. (2014) also used this tool to assess students' swimming skills. Data collection was conducted before and after the intervention through direct observation of aquatic skills. The researchers used the checklist as a standardized record to document the level of development of these skills.

Table 2

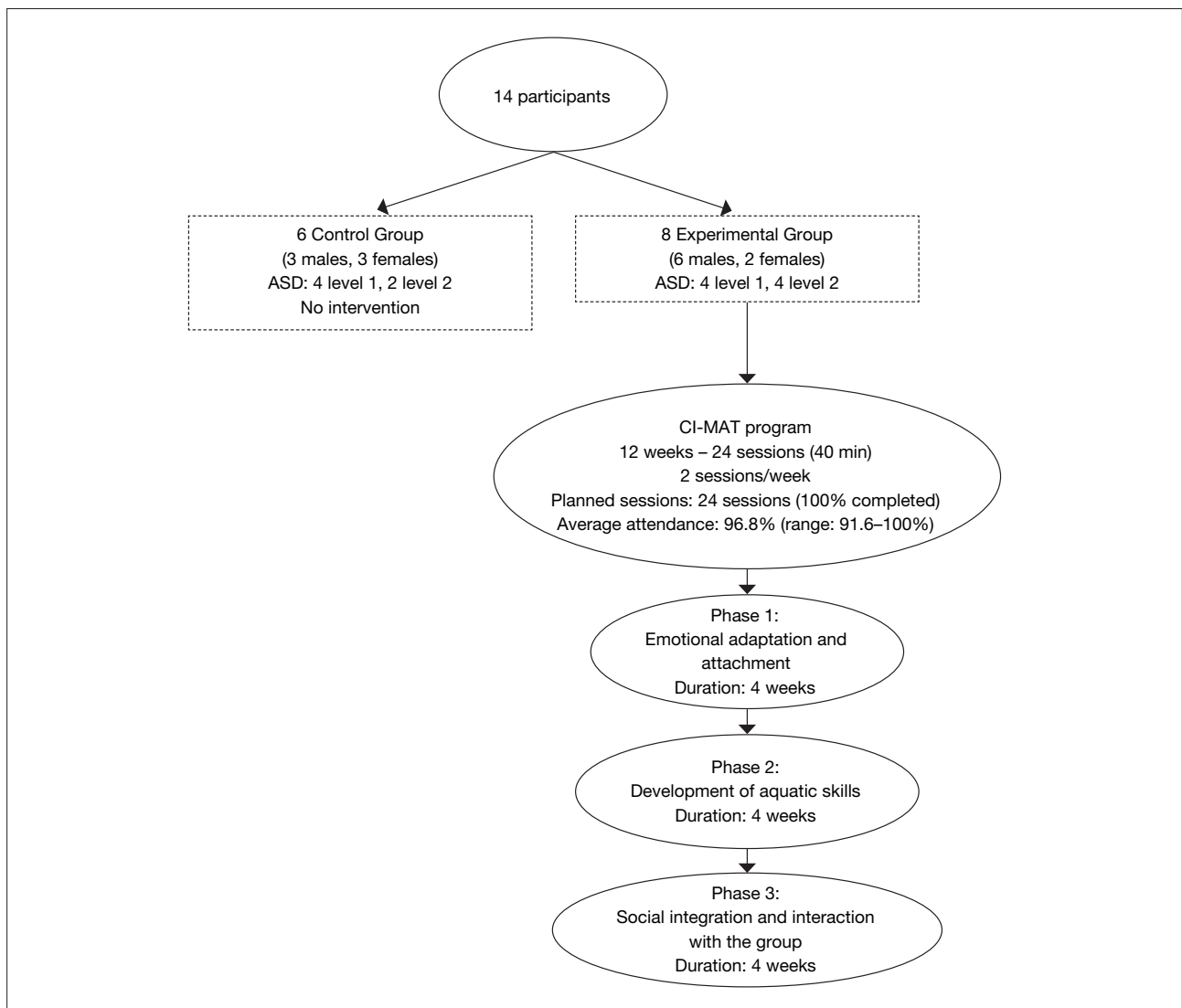
Dimensions and skills assessed by the Emotional-Regulation Skill Questionnaire (ERSQ)

Dimension	Skill	Item
1. Emotional awareness	Becoming aware of one's own emotions at the moment they occur.	1, 2, 3
2. Sensation	Identifying the physical or bodily reactions of emotions.	4, 5, 6
3. Clarity	Identifying and correctly naming the emotion experienced (knowing what one feels).	7, 8, 9
4. Knowledge	Understanding the cause or trigger of the emotion.	10, 11, 12
5. Acceptance	Accepting and not judging one's own emotion.	13, 14, 15
6. Tolerance	Enduring the intensity of an unpleasant emotion without acting impulsively.	16, 17, 18
7. Self-support	Providing comfort or encouragement to oneself when experiencing a difficult emotion.	19, 20, 21
8. Willingness to confront	Facing the situation that caused the emotion instead of avoiding it.	22, 23, 24
9. Modification	Actively changing or regulating the emotion in a constructive manner.	25, 26, 27

Table 3
Aquatic Skills Checklist (ASC)

Item	Aquatic skill	Assessment	Type of skill
1	Water entry and exit	Safety and autonomy when entering and exiting the water.	Safety
2	Breath control	Rhythmic exhalation underwater.	Adaptation
3	Prone floating	Ability to float face down, with or without support.	Adaptation
4	Supine floating	Ability to float on the back, with or without support.	Adaptation
5	Propulsive gliding	Gliding followed by basic kicking.	Movement
6	Sustained kicking	Use of the front crawl kick while maintaining breathing.	Movement
7	Basic propulsion	Movement in the water using simple arm and leg actions.	Movement
8	Survival swimming	Moving a short distance in a safe and controlled manner.	Safety
9	Back turn	Change from prone to supine position to rest and breathe.	Safety
10	Front crawl	Swimming with alternating arm movements and rhythmic breathing.	Formal swimming stroke
11	Backstroke	Backstroke swimming with alternating arm strokes.	Formal swimming stroke
12	Elementary backstroke kick	Use of the whip (wedge) kick in the supine position.	Formal swimming stroke
13	Flutter kick technique	Ability to perform the butterfly kick.	Formal swimming stroke

Figure 1
Procedure



Procedure

The intervention carried out with the CI-MAT program is detailed below. Children who met the established participation criteria completed a total of 24 sessions of 40 minutes each over a period of 12 weeks (two per week). Students were divided into two groups: experimental and control. In the experimental group (8 participants), the CI-MAT program was implemented, whereas the control group (6 participants) did not perform any aquatic activity, following their normal school routine with physical education classes (Figure 1).

The three phases of this program (emotional adaptation and creation of attachment to the instructor; development of aquatic skills; and social integration phase) were divided equally, with 4 weeks allocated to each phase. Average attendance at the sessions was 96.8% (range 91.6–100%). All scheduled sessions were completed.

In the first phase (emotional adaptation and creation of attachment to the instructor), students with ASD worked apart from the rest of the class, interacting exclusively with the instructor, although they shared the aquatic space with the other classmates, who were led by another instructor. Some examples of the activities carried out are shown in Table 4.

In the second phase (development of aquatic skills), progressive work related to motor difficulty and autonomy in the aquatic environment was initiated. The first sessions were conducted with physical contact with the instructor, who assisted the student with ASD in performing activities such as floating, turning, moving in the water while floating in the prone position, and moving to retrieve non-submersible materials or to exit the pool. In the final sessions of this second phase, the aim was for participants to be able to move in the water without assistance or physical contact with the instructor, as well as to be able to submerge to retrieve submersible materials from the bottom of the pool and to be autonomous when exiting the water when instructed by the instructor (examples of activities carried out are shown in Table 4).

Third, the social integration phase was reached, in which students with ASD were included within the class group. Previously, the student with ASD and the instructor worked in the same space as the rest of the class but without direct interaction with the other classmates; from that moment on, the student with ASD began to share space and interactions with the rest of the class (students without ASD). Examples of the activities carried out are shown in Table 4.

Table 4

Examples of aquatic activities applied according to the CI-MAT model for children with ASD

Phase	Main objective	Examples of pool activities
Phase 1: Emotional bonding and affective safety	To promote trust, therapeutic attachment, and adaptation to the aquatic environment.	<ul style="list-style-type: none"> Trust games: being guided by the instructor by the hand from one end of the pool to the other. Friendly bubble-blowing competition underwater. “Aquatic explorers”: searching for nearby floating objects with accompaniment. Songs with simple choreographies in the water.
Phase 2: Teaching aquatic skills and swimming	To promote motor autonomy, coordination, and basic swimming techniques.	<ul style="list-style-type: none"> Independent floating with auxiliary material (pool noodles, kickboards). Gliding races from the wall (with kickboard). Playful submersions: collecting hoops or objects submerged at shallow depth. Progressive introduction to basic strokes (front crawl and backstroke) with visual or demonstrative support.
Phase 3: Social integration and cooperation with peers	To stimulate social interaction, cooperation, and group play.	<ul style="list-style-type: none"> Relays in small teams (transporting floating balls). Group construction with pool noodles/mats (making rafts or figures). Aquatic circle with changes of direction (group coordination). Cooperative symbolic games: “saving the classmate” (carrying them on the mat from one side to the other).

To increase the reliability of measurement with the ASC, the tests were independently evaluated by two trained evaluators. Inter-rater agreement was calculated, and disagreements were resolved through joint review. Likewise, a pilot test was conducted to ensure the applicability of the items to the study population. The questionnaire was administered by the principal researcher and a trained research assistant to both the experimental group and the control group in a quiet, noise-free location. It was administered before the usual physical activity practice, prior to the start of the aquatic intervention, and again at the end of the intervention, after the 12-week period. The researchers completed the questionnaire after asking the children about each item, with the aim of helping them better understand its content. Emphasis was placed on response anonymity, voluntariness, and the need for participants to respond as honestly as possible. The time required to complete all scales was approximately 15 minutes; it varied slightly depending on the participant.

The Aquatic Skills Checklist (ASC) was also administered by the principal researcher and the research assistant. Data collection was conducted before and after the intervention through direct observation of aquatic skills. The researchers used the checklist as a standardized record to document the level of development of these skills.

The intervention was carried out in the school environment, which included children with and without ASD. Children without ASD were not included in the research data. Both the principal researcher and the research assistant held degrees in Physical Activity and Sport Sciences and had prior training in multisystem aquatic methodology. It is important to note that they had previous experience as swimming instructors for students with ASD.

Statistical Analysis

Statistical analysis was performed using the SPSS package for Windows (version 27.0; IBM). Before the intervention, equivalence between the experimental and control groups was examined using independent-samples *t* tests across all variables, in order to ensure baseline comparability. This verification made it possible to attribute subsequent changes more confidently to the intervention rather than to prior differences between groups.

With regard to emotional regulation, descriptive statistics of pretest and posttest scores for both groups were obtained to contextualize participants' initial status. Subsequently,

ERSQ questionnaire items were examined and grouped according to the theoretical dimensions of the instrument, calculating composite scores by dimension and a total score. In the experimental group, paired-samples *t* tests were applied to evaluate the effect of the CI-MAT program on emotional regulation, while equivalent tests were applied in the control group to analyze natural evolution without intervention. Next, intergroup comparisons were conducted using independent-samples *t* tests on posttest scores to determine whether the observed improvements could be attributed to the program. In all analyses, 95% confidence intervals, effect sizes (Cohen's *d* and Hedges' *g*), and bootstrap estimates were calculated.

With regard to aquatic skills, individual differences (pre–post) were calculated for each item of the ASC instrument, and total scores per participant were obtained. Subsequently, a mixed repeated-measures ANOVA was applied with one within-subject factor (Time: pre–post) and one between-subject factor (Group: experimental–control). The primary focus was on the Time × Group interaction as an indicator of the effectiveness of the CI-MAT program in the development of aquatic skills. Partial η^2 was reported as a measure of effect size.

Finally, a priori statistical power was calculated using the G*Power program (paired-samples *t* test, expected medium effect size $d = 0.5$, $\alpha = .05$, power = .80), which indicated a minimum sample size of 34 participants. However, the available sample consisted of 14 students, which reduces statistical power and limits the generalizability of the results. Nevertheless, the findings provided preliminary evidence of the effectiveness of the CI-MAT program, which should be confirmed in studies with larger samples.

Results

CI-MAT and emotional regulation

Before the intervention, baseline equivalence between the experimental and control groups was assessed across all ERSQ dimensions using independent-samples *t* tests. The results indicated that no statistically significant differences were observed in any dimension ($t(12) < 1.25$, $ps > .23$; 95% CI via bootstrap [−3.34, 1.88]), suggesting that both groups were comparable at the beginning of the study. This initial equivalence made it possible to attribute subsequent changes more confidently to the intervention rather than to prior differences between groups (see Table 5).

Table 5

Comparison of means and standard deviations of ERSQ dimensions between groups before the intervention

Dimension	EG M (SD)	CG M (SD)	t(12)	p	95% CI (bootstrap)
Emotional awareness	3.13 (1.10)	2.56 (1.56)	0.81	.436	[-1.10, 1.88]
Sensation	2.71 (0.60)	2.06 (1.58)	1.08	.302	[-0.80, 1.88]
Clarity	2.33 (0.53)	2.06 (0.39)	1.07	.305	[-0.14, 0.79]
Knowledge	1.25 (0.79)	1.06 (0.93)	0.42	.680	[-0.79, 1.10]
Acceptance	1.79 (0.85)	1.44 (0.69)	0.82	.431	[-0.50, 1.07]
Tolerance	2.13 (0.73)	2.17 (1.19)	-0.08	.937	[-1.09, 0.89]
Self-support	1.88 (1.18)	2.22 (0.96)	-0.59	.568	[-1.44, 0.75]
Confrontation	2.96 (0.74)	2.44 (0.78)	1.25	.234	[-0.29, 1.27]
Modification	2.33 (1.25)	3.50 (2.45)	-1.17	.264	[-3.34, 0.78]

Note. EG = Experimental Group; CG = Control Group; M = mean; SD = standard deviation; 95% CI = 95% confidence interval based on bootstrap (1,000 samples). N (EG) = 8; N (CG) = 6.

Table 6

Descriptive statistics and comparison of total emotional regulation scores (Pre and Post) for the experimental and control groups

Group	Measurement	N	Average	SD	Pre-post difference	95% CI Lower	95% CI Upper	Effect size
Experimental	Pre	8	26.50	±5.32	-	-	-	-
	Post	8	34.63	±5.40	8.13*	6.37	9.88	3.87 (Hedges' g)
Control	Pre	6	25.50	±8.48	-	-	-	-
	Post	6	26.50	±6.63	1.00	-3.65	1.65	-
Post-intervention comparison between groups	-	-	-	-	8.13*	1.14	15.11	1.35 (Cohen's d)

Note. $p < .05$. SD = standard deviation; 95% CI = 95% confidence interval based on bootstrap (1,000 samples); N = sample size per group.

Data normality was tested using the Shapiro–Wilk test in both the experimental group and the control group. Both in the pretest (experimental: $p = .359$; control: $p = .748$) and in the posttest (experimental: $p = .869$; control: $p = .926$), data followed a normal distribution, considering a significance level of $\alpha = .05$. With regard to intragroup analysis, in the experimental group, the paired-samples t test showed a significant increase in scores after the intervention (Pre: $M = 26.50$, $SD = 5.32$; Post: $M = 34.63$,

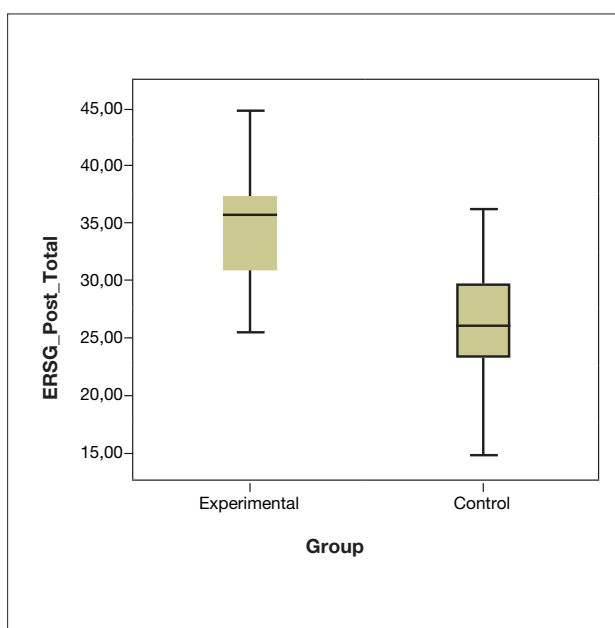
$SD = 5.40$), $t(7) = -10.94$, $p < .001$. The mean difference was 8.13 points (95% CI = 6.37, 9.88), with a very large effect size (Hedges' $g = 3.87$), indicating a substantial improvement in emotional regulation. In the control group, the intragroup comparison showed no significant differences (Pre: $M = 25.50$, $SD = 8.48$; Post: $M = 26.50$, $SD = 6.63$), $t(5) = -0.968$, $p = .377$, with a mean difference of 1 point (95% CI = -3.65, 1.65), indicating that no relevant changes occurred without intervention.

For the post-intervention intergroup comparison, an independent-samples *t* test was conducted to compare posttest data between the experimental group and the control group. Levene's test indicated homogeneity of variances ($F = 0.066$, $p = .802$). The results showed that the experimental group obtained significantly higher posttest values ($M = 34.63$, $SD = 5.40$) than the control group ($M = 26.50$, $SD = 6.63$), $t(12) = 2.533$, $p = .026$, with a mean difference of 8.13 points (95% CI = 1.14, 15.11). The effect size was very large (Cohen's $d = 1.35$), evidencing a substantial effect of the intervention on emotional regulation (Table 6).

As shown in Table 6, the experimental group increased its scores from 26.50 ($SD = 5.32$) at the pre-intervention measurement to 34.63 ($SD = 5.40$) at the post-intervention measurement, with a mean difference of 8.13 points (95% CI [6.37, 9.88]) and a very large effect size according to Hedges' $g = 3.87$. In contrast, the control group showed a non-significant change, increasing from 25.50 ($SD = 8.48$) to 26.50 ($SD = 6.63$), with a mean difference of 1.00 point (95% CI [-3.65, 1.65]). The post-intervention comparison between groups confirmed the effectiveness of the intervention, showing a mean difference of 8.13 points (95% CI [1.14, 15.11]) in favor of the experimental group, with a large effect size according to Cohen's $d = 1.35$. These results indicate that the swimming program significantly improved emotional regulation in children in the experimental group, whereas no relevant changes were observed in the control group (Figure 2).

Figure 2

Results of emotional regulation between the experimental group and the control group



After the global analysis of emotional regulation, the nine dimensions into which the ERSQ is divided were examined in order to identify which specific aspects showed significant changes, thereby allowing a more detailed interpretation of the effects of the CI-MAT program. Pre-post comparisons in the experimental group showed improvements across all dimensions which are significant in *Knowledge* (Pre: $M = 1.25$, $SD = 0.79$; Post: $M = 2.50$, $SD = 0.99$; $t(7) = -4.26$, $p = 0.004$) and *Acceptance* (Pre: $M = 1.79$, $SD = 0.85$; Post: $M = 2.79$, $SD = 0.71$; $t(7) = -4.58$, $p = 0.003$), whereas other dimensions such as Emotional awareness, Sensation, Clarity, Tolerance, Self-support, Willingness to confront, and Modification showed moderate increases, although not statistically significant. In contrast, the control group did not present relevant changes in any dimension between pre-intervention and post-intervention, indicating that the improvements observed in the experimental group are attributable to the intervention. The post-intervention intergroup comparison showed significant differences in favor of the experimental group in *Willingness to confront* (Experimental: $M = 3.46$, $SD = 0.89$; Control: $M = 2.17$, $SD = 0.46$; $t = 3.53$, $p = .005$) and positive trends in *Knowledge* ($p = .078$) and *Acceptance* ($p = .072$), whereas the remaining dimensions presented higher scores in the experimental group without reaching statistical significance. These results show that the CI-MAT program primarily favored the ability to confront emotions, as well as emotional identification and acceptance, and generated moderate improvements in other emotional regulation skills.

Repeated-measures analyses (group \times time ANOVA) showed differential effects in three ERSQ dimensions. In *Knowledge* ($F(1,12) = 8.72$, $p = .012$), the experimental group increased from $M = 1.25$ to 2.50, whereas the control group remained unchanged. In *Acceptance* ($F(1,12) = 7.98$, $p = .015$) and *Confrontation* ($F(1,12) = 10.34$, $p = .007$), significant improvements were also observed in the experimental group compared with the stability of the control group. The remaining dimensions did not reach statistical significance ($p > .05$), although some showed increasing trends in the experimental group.

Overall, these findings indicate that the CI-MAT program had a differential and significant effect on the *Knowledge*, *Acceptance*, and *Willingness to confront* dimensions, whereas the remaining dimensions remained relatively stable; this suggests that the intervention specifically impacted key areas of emotional regulation in the participants.

Table 7*Pre-intervention and post-intervention results by dimension in the experimental and control groups, intragroup differences, and post-intervention comparison*

Dimension	EG Pre M (SD)	EG Post M (SD)	Intragroup difference	<i>t</i>	<i>p</i>	<i>r</i>	CG Pre M (SD)	CG Post M (SD)	Intragroup difference	<i>t</i>	<i>p</i>	<i>t</i> post	<i>p</i> post	95% CI
Emotional awareness	3.12 (1.10)	3.21 (0.80)	0.09	0.31	0.76	0.73*	2.78 (1.53)	2.81 (1.52)	0.03	0.10	0.92	0.69	0.51	-0.93–1.80
Sensation	2.71 (0.60)	3.08 (0.66)	0.37	1.29	0.24	0.15	2.22 (1.71)	2.30 (1.69)	0.08	0.27	0.80	1.32	0.21	-0.57–2.29
Clarity	2.33 (0.53)	3.04 (0.81)	0.71	1.81	0.11	-0.33	2.39 (0.71)	2.46 (0.69)	0.07	0.19	0.85	1.57	0.14	-0.25–1.56
Knowledge	1.25 (0.79)	2.50 (0.99)	1.25	4.26	0.004*	0.59	1.33 (1.17)	1.45 (1.10)	0.12	0.35	0.74	2.02	0.07	-0.09–2.43
Acceptance	1.79 (0.85)	2.79 (0.71)	1.00	4.58	0.003*	0.70	1.94 (0.83)	2.02 (0.82)	0.08	0.26	0.81	2.06	0.06	-0.05–1.74
Tolerance	2.13 (0.73)	2.42 (0.64)	0.29	0.92	0.39	0.15	2.11 (1.22)	2.15 (1.20)	0.04	0.12	0.91	0.61	0.55	-0.79–1.40
Self-support	1.88 (1.18)	2.75 (0.50)	0.88	1.99	0.09	0.08	2.17 (0.69)	2.25 (0.70)	0.08	0.23	0.83	1.85	0.09	-0.11–1.27
Confrontation	2.96 (0.74)	3.46 (0.89)	0.50	1.23	0.26	0.01	2.17 (0.46)	2.22 (0.48)	0.05	0.18	0.86	3.23	0.007*	0.42–2.16
Modification	2.33 (1.25)	3.21 (1.21)	0.88	2.05	0.08	0.52	3.50 (2.45)	3.55 (2.42)	0.05	0.17	0.88	-0.30	0.77	-2.44–1.86

Note. * $p < 0.05$, significant. r = intragroup correlation (Pearson) between pre- and post-test. Intragroup difference = post M – pre M , t and p = paired-samples tests. Post-test t , p , and 95% CI = post-intervention between-group comparison (independent samples). SD = standard deviation

Table 8
Descriptive statistics and mixed ANOVA results for aquatic skills (ASC)

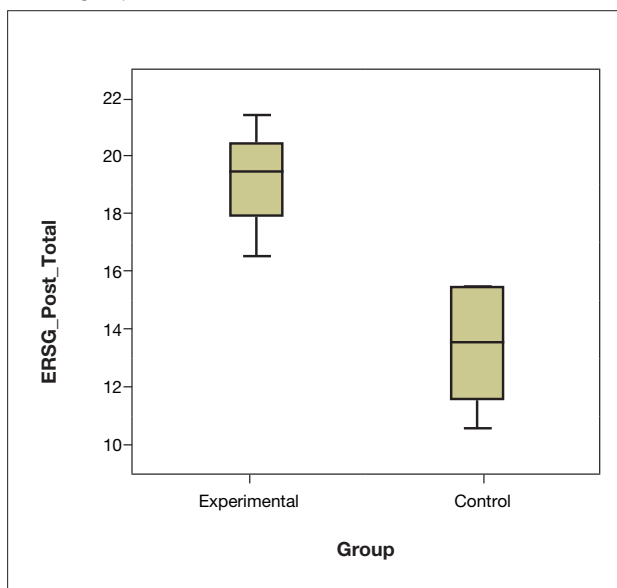
Grup	Pre (Mean ± SD)	Post (Mean ± SD)	Δ (Mean ± SD)	ANOVA F (Time × Group)	g ^l	p	partial η ²
Experimental	13.88 ± 1.96	19.75 ± 1.75	5.87 ± 0.62	25.47	1.12	< .05	.70
Control	13.00 ± 2.37	13.83 ± 2.14	0.83 ± 0.71				

Note. Δ = post - pre; SD = standard deviation; ANOVA F = Time × Group interaction; partial η² = effect size; p < .05 indicates significance.

CI-MAT and aquatic skills

Total ASC scores were analyzed before and after the intervention with the CI-MAT program. The experimental group showed a significant increase in total ASC scores after the CI-MAT intervention, increasing from 13.88 ± 1.96 at pre-assessment to 19.75 ± 1.75 at post-assessment, with a mean change of 5.87 points, whereas the control group showed a much smaller increase, from 13.00 ± 2.37 to 13.83 ± 2.14, with a mean change of 0.83 points. The Time × Group interaction of the mixed repeated-measures ANOVA was significant ($F = 25.47$, $df = 1.12$, $p < .05$, partial $\eta^2 = 0.70$), indicating that improvement in the experimental group was significantly greater than in the control group. Pre- and post-scores showed an approximately normal distribution (Shapiro–Wilk, $p > .05$), which supports the use of parametric analysis to evaluate the effectiveness of the program (Table 8).

Figure 3
Results of aquatic skills between the experimental group and the control group



Therefore, the implementation of the CI-MAT program was associated with significant increases in emotional regulation and aquatic skills in the experimental group, in contrast to the stability observed in the control group.

Discussion

In this study, the effects of a Multisystem Aquatic Therapy (CI-MAT) program on emotional regulation and aquatic skills in children with ASD aged between 7 and 11 years were investigated. The results obtained show clear agreement with the existing scientific literature, reinforcing the idea that Multisystem Aquatic Therapy can be a useful tool for improving emotional regulation and motor skills in children with autism.

The results of the present study, which show a significant improvement in emotional regulation in the experimental group, are consistent with studies such as those by Battaglia et al. (2019), Lourenço et al. (2016), and Bernate et al. (2024), who state that physical exercise promotes emotional regulation in people with autism. Likewise, according to Battaglia et al. (2019), the aquatic environment helps people with autism improve their emotional regulation. These authors agree that the aquatic environment is particularly beneficial for people with autism. Water, by offering a unique sensory environment, can help calm and modulate emotional responses. Buoyancy reduces the force of gravity and provides constant proprioceptive feedback, which can have a calming and organizing effect on the nervous system.

In particular, the CI-MAT program produced significant improvements in the dimensions of Knowledge, Acceptance, and Willingness to confront (Berking & Znoj, 2008; Orozco-Vargas et al., 2021), evidencing a positive impact on the identification, understanding, and coping with emotions. The increase in Knowledge is consistent with what was proposed by Lourenço et al. (2016), who highlight that structured physical activity promotes self-perception and

emotional recognition in people with ASD. With regard to Acceptance, the results are consistent with the findings of Caputo et al. (2018) and Naumann et al. (2021), who demonstrated that aquatic programs facilitate emotional regulation by promoting a safe and predictable environment that reduces avoidance and fosters acceptance of affective states. Finally, the improvement observed in the Willingness to confront dimension is related to the results of Battaglia et al. (2019) and Bernate et al. (2024), in which participation in aquatic and physical exercise programs increased the ability to cope with challenging emotional situations, strengthening self-efficacy and goal-directed behavior.

Overall, these findings are consistent with those reported by Zanobini and Solari (2019) and van 't Hooft et al. (2024), who emphasize that aquatic interventions contribute to emotional development in people with ASD, reinforcing the usefulness of CI-MAT in improving emotional skills. According to the systematic review by Ferreira et al. (2021), it is shown that there are various protocols and activities that help improve emotional regulation in children with autism; however, among them, the aquatic environment stands out as a fundamental element, as in addition to behavioral benefits it also provides physical and motor benefits (Lourenço et al., 2016; Yilmaz et al., 2010).

When analyzing aquatic skills after the application of the CI-MAT program, a substantial improvement in the aquatic competencies of participants with ASD was evidenced. This finding is in line with that described by Pan (2010), who reported that structured swimming programs significantly improve aquatic skills and autonomy in children with ASD.

Similarly, Alaniz et al. (2017) demonstrated that group aquatic therapy increases water safety and motor competence, which has a positive impact on self-confidence and active participation. In addition, the improvement observed in the present research is consistent with the systematic review by Aleksandrovic et al. (2016), which confirms the positive effects of aquatic activities on physical condition and the acquisition of skills in the aquatic environment in this population.

The methodological approach of the CI-MAT program shares foundations with the Halliwick method, described by McMillan (1977) and standardized by the American Red Cross (2009), which promotes aquatic independence through balance control, rotation, and flotation in a safe and playful environment. In this regard, the improvements obtained reflect the effectiveness of progressive and individualized teaching strategies, principles consistent

with those highlighted by Baena Beato et al. (2010), who emphasize the importance of structured guidance to promote motor learning in aquatic contexts.

Likewise, the findings are consistent with those of Battaglia et al. (2019) and Faraji et al. (2023), who observed significant improvements in gross motor skills and aquatic-specific skills following similar systematic interventions. Finally, these results support the conclusions of van 't Hooft et al. (2024) and Naumann et al. (2021), who highlight that adapted aquatic programs represent an effective means to improve motor competence, safety, and participation in people with ASD. Overall, the results of the present study confirm that the CI-MAT program, as a comprehensive aquatic intervention, promotes the development of functional skills and safe adaptation to the aquatic environment, providing children with greater control and autonomy (Yilmaz et al., 2010; Lara & Giménez, 2019)

In line with the results of this research, Caputo et al. (2018) demonstrated how Multisystem Aquatic Therapy can be useful in improving motor deficits in people with autism, as well as in enhancing emotional regulation and aquatic skills. Multisystem Aquatic Therapy is not a one-dimensional intervention, but rather a holistic approach that can simultaneously benefit motor skills and emotional regulation, with a direct and measurable impact on the emotional well-being of participants.

Conclusions

The results of this study indicate that Multisystem Aquatic Therapy (CI-MAT) can contribute to improving emotional regulation and aquatic skills in children with ASD levels 1 and 2, aged between 7 and 11 years. Significant improvements were observed in Knowledge, Acceptance, and Willingness to confront, as well as in motor competence in the aquatic environment. These findings support the value of the aquatic environment as a setting that promotes both emotional and motor development.

However, given the limitation of the sample size, the results should be interpreted with caution, and future research with larger samples and longitudinal designs is recommended to confirm the effectiveness and stability of the observed effects. It would be interesting for future research to implement an active control and a follow-up period of 1 to 3 months post-intervention.

The ASC used does not have a published psychometric validation and was therefore treated as a performance

observation tool. This limits the generalizability of the findings and their interpretation in terms of construct validity. Future studies are recommended to conduct formal validations (internal consistency, inter-rater reliability, construct validity, and test–retest reliability) of the ASC or to use validated instruments such as the SCAS or other validated analogues.

As a practical application, it is recommended that professionals adopt an integrated, progressive, and personalized intervention approach, in which the aquatic environment acts as a setting that enables the global development of children with ASD. To this end, it would be advisable to combine motor and emotional, cognitive, and social work, including moments of adaptation, exploration, and motor learning, while always maintaining a predictable and safe sequence that reduces anxiety and promotes confidence. It would be important to personalize objectives and strategies, taking into account the sensory profile, functional level, and learning style of each child, with adaptations that respect their communicative and motor needs. It is also suggested to promote the child's participation in decision-making, positively reinforcing each achievement. Finally, it would be advisable to systematically record progress in both the motor and emotional domains in order to adjust interventions and evaluate effects in the short- and medium-term.

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Initial Validation of the Teachers' Perception of the Students' Academic Motivation Scale in Physical Education

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.

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Abstract

Teachers' perceptions of their students' motivation play a key role in shaping the teaching-learning process. In Physical Education (PE), these perceptions can influence how teachers design their classes, experience their own motivation, and ultimately impact students' engagement and learning outcomes. Following the framework of self-determination theory, this study aimed to adapt and validate the Teachers' Perceptions of Students' Academic Motivation Scale (TPSAMS). The validation process included two studies. Study 1 assessed content validity through expert review and a pilot test with 6 PE teachers. Study 2 evaluated the psychometric properties of the scale, including factorial validity, internal consistency, discriminant validity, nomological validity, and measurement invariance by gender, using data from 350 PE teachers. The findings indicated that the TPSAMS shows acceptable psychometric properties, supporting its potential usefulness for assessing teachers' perceptions of students' motivation. Nevertheless, further research with broader samples and educational contexts is needed to confirm and extend these results.

Keywords: motivation, physical education, teacher, scale, validation

Introduction

In the educational context, motivational processes play a fundamental role in achieving academic goals and fostering a successful and enriching teaching-learning process among students (Ryan & Deci, 2020). In Physical Education (PE), increasing evidence has demonstrated that motivation can be a key factor in engaging students with the subject, enhancing their satisfaction with learning, and ensuring that this education becomes meaningful and enduring (Leo et al., 2022; Vansteenkiste et al., 2020).

However, it is common for teachers to aim for learning to extend beyond class time and become integrated into students' lifestyles, making motivation toward this subject doubly important. Specifically, a growing body of research shows that students with higher motivation toward PE also exhibit greater levels of personal and emotional satisfaction and well-being (Lei et al., 2018). Furthermore, higher motivation for PE is associated with increased levels of physical activity and the adoption of healthy lifestyle habits among students (Barkoukis et al., 2010; Hagger et al., 2009; Taylor et al., 2010).

Nevertheless, students' motivational processes do not solely influence the emergence of positive and/or negative outcomes for students but can also affect PE teachers themselves (Franco et al., 2024; Taylor & Ntoumanis, 2007). When students demonstrate high levels of motivation and interest in class, teachers may become more engaged and develop a more self-determined motivation to optimize the teaching-learning process (Franco et al., 2024; Pelletier et al., 2002). In fact, teachers' perceptions of students' motivation can be a key factor influencing their own motivation and teaching practices (Matosic et al., 2016; Pelletier et al., 2002). Nevertheless, to our knowledge, few studies have examined teachers' perceptions of students' motivation (Taylor & Ntoumanis, 2007), and there are no validated and reliable instruments specifically designed to measure this construct (Franco et al., 2024). Thus, the purpose of this study was to validate an instrument that assesses PE teachers' perceptions of their students' motivation.

Students' Motivation From Teachers' Perceptions

To rigorously understand the types of motivation developed by students in PE lessons, this study is based on self-determination theory (SDT; Deci & Ryan, 2000), which

allows for the differentiation of various types of motivational regulation—from motivation driven by personal interest and values to motivation driven by external pressures or even a lack of motivation—considering both their quantity and quality in relation to students' behavioral, affective, and cognitive outcomes.

Specifically, according to SDT (Deci & Ryan, 2000), individuals can be intrinsically motivated, extrinsically motivated, or simply amotivated. PE teachers may perceive different types of students' motivation, which can influence their behaviors and actions to varying degrees (Abós, Haerens et al., 2018; Roth et al., 2007). By addressing the entire motivation continuum—from its most self-determined perspective to the lack of self-determination or amotivation (Deci & Ryan, 2000; Ryan & Deci, 2020)—the highest level of self-determination corresponds to intrinsic motivation. This type of motivational regulation represents the purest form of motivation and is associated with intrinsic desire, personal interest, pleasure, and satisfaction inherent in the activity (e.g., teachers perceive that their students are interested in learning new things).

Extrinsic motivation is characterized by behaviors driven by the achievement of a specific purpose (instrumental motivation). That is, this type of motivation is primarily driven by external factors, such as the need to satisfy external demands, obtain a reward, or avoid feelings of guilt (Bartholomew et al., 2018; Ryan & Deci, 2020; Vallerand et al., 2003). Following the motivation continuum, extrinsic motivation can be divided into four types of behavioral regulation (i.e., integrated regulation, identified regulation, introjected regulation and external regulation), each representing a different level of internalization—the process through which external motives are transformed into personally endorsed values and goals (Deci & Ryan, 2000; Ryan & Deci, 2020). Integrated regulation¹ is the most self-determined form of extrinsic motivation and is associated with aspects related to values, beliefs, personality, interests, etc., which require a degree of cognitive, social, and emotional maturity that is still developing during adolescence (Deci & Ryan, 2000; Vallerand, 2007). In addition, this type of regulation presents numerous similarities and a strong correlation with intrinsic motivation (Ryan & Deci, 2020; Vallerand & Rousseau, 2001; Vansteenkiste & Ryan, 2013). Identified regulation is observed when the importance of the action or behavior itself is recognized (e.g., teachers perceive that their students engage in the subject because

¹ For all these reasons, and in line with previous studies (e.g., Leo et al., 2022; Lonsdale et al., 2011; Standage et al., 2005), it was decided not to include integrated regulation.

it is essential for their future). Introjected regulation occurs when behaviors or attitudes are adopted to avoid feelings of guilt or shame, or to attain contingent self-esteem or pride (e.g., teachers perceive that their students participate in PE to avoid feeling bad or out of pride; Assor et al., 2009; Deci & Ryan, 2000). Subsequently, external regulation occurs when an activity or behavior is carried out to obtain a reward or to avoid punishment (Deci & Ryan, 2000; e.g., teachers perceive that their students complete tasks solely to achieve a good grade). Finally, amotivation is characterized by the absence of intrinsic and/or extrinsic reasons, as well as by a lack of purpose or goals to continue (Ntoumanis, 2001; Ryan & Deci, 2000; e.g., teachers perceive that their students believe that what they are studying has no value to them).

The motivation that teachers perceive in their students can influence classroom behaviors and the degree to which they support or thwart their students' basic psychological needs (Franco et al., 2024; Matosic et al., 2016; Pelletier et al., 2002). In an initial approach, Pelletier et al. (2002) pointed out the existence of "bottom-up pressures", which are linked to students' intrinsic motivation and directly impact teachers' motivation and behaviors in the classroom (Franco et al., 2024). In turn, Matosic et al. (2016) proposed a classification of teachers' motivational antecedents, highlighting their perceptions of the degree of student's self-determined motivation (within the perception of others' behaviors) as a relevant antecedent for teachers' own motivation. Finally, Franco et al. (2024) defined a category of contextual antecedents perceived by teachers, identifying students' motivation as a variable that shapes teachers' motivational processes and behaviors.

Although student motivation is highly valued by teachers, it has traditionally been assessed from the students' perspective. Vallerand et al. (1992) developed the Academic Motivation Scale (AMS) to assess student motivation, which has since been widely used and adapted across countries (e.g., Spanish: EME-E, Núñez et al., 2005) and educational stages (e.g., secondary education: EME-S, Núñez et al., 2010), demonstrating strong validity and reliability. Similarly, Moreno-Murcia et al. (2009) validated the Spanish version of the Perceived Locus of Causality Scale (PLOC; Goudas et al., 1994) to examine motivational regulation and behavior perception in secondary students. Additionally, Sánchez-Oliva et al.

(2012) developed and validated the CMEF to assess student motivation in secondary PE, demonstrating strong internal consistency and a robust factorial structure. Later, Leo et al. (2016) adapted it for primary education (CMEF-EP) to explore students' emotional regulation at this stage.

By contrast, student motivation from the teacher's perspective has been scarcely assessed (Franco et al., 2024). To our knowledge, only Taylor and Ntoumanis (2007) have evaluated teachers' perceptions of students' motivation, although they asked teachers exclusively about students' motivation individually, using a single item for each type of motivation. They also calculated the self-determination index (SDI) to reflect teachers' perceptions of students' self-determination. Furthermore, attempts have been made to evaluate teachers' perceptions of students' general motivation (i.e., participation, motivation, task completion, attention, and punctuality/reliability), but they were conducted without a validated instrument or theoretical framework (Brandmiller et al., 2023).

Therefore, developing an instrument to assess teachers' perceptions of students' types of motivation can help understand how these variables influence both the teacher and the teaching-learning process. It also allows us to examine whether the students' types of motivation perceived by teachers correspond to their perceptions of students' engagement in PE lessons. Research has shown that students' motivation is associated with their engagement. Specifically, students with more self-determined motivation showed higher behavioral and emotional engagement in PE lessons, whereas students experiencing amotivation displayed lower engagement (Leo et al., 2022). This suggests that teachers' perceptions of student motivation may similarly be related to their perceptions of students' engagement.

The Present Study

Based on the reviewed literature, there is consensus on the importance of teachers' perceptions of their students' behavior and their influence on the teaching-learning process (Franco et al., 2024; Taylor & Ntoumanis, 2007). While questionnaires have been used to explore motivation from the students' perspective, no instrument systematically assesses teachers' perceptions of their students' motivation. Understanding this perception

with appropriate validity and reliability criteria can provide key insights into how it shapes teachers' own motivational practices and interactions with students (Reeve & Cheon, 2021). Therefore, based on Spanish version of the Academic Motivation Scale (EME-S; Núñez et al., 2010), the objective of this study was to adapt and develop an initial version of a questionnaire to examine student motivation from the teacher's perspective. This instrument seeks to expand the study and understanding of motivational dynamics in the classroom from the teacher's perspective, providing a useful tool for PE research.

Study 1

The objective of the Study 1 was to adapt and examine the content validity and comprehension of the scale in a pilot study developed with PE teachers. A three-phase process was carried out. In Phase 1, the items were adapted by a panel of experts who assessed the content's relevance. Phase 2 involved a pilot study with 6 PE teachers to evaluate the comprehension of the proposed scale. Finally, in Phase 3, adjustments were made following evaluations of the instrument.

Method and Results

The adaptation of the EME-S followed a three-phase procedure (translation and adaptation, content validity and comprehension, and readjustment), in line with international guidelines for test adaptation and validation (Bartram et al., 2018; Lynn, 1986; McGartland et al., 2003; Sireci & Faulkner-Bond, 2014).

Phase 1 - Scale translation and adaptation. We adapted the EME-S (Núñez et al., 2010; Vallerand et al., 1992) to assess the PE teachers' perception about the students' motivation.² The original scale was developed to directly examine students' motivation and is composed of 28 items that measure intrinsic motivation–knowledge, intrinsic motivation–achievement, intrinsic motivation–stimulation, identified regulation, introjected regulation, external regulation and amotivation. For this adaptation, we only used one type of intrinsic motivation: knowledge (four items). The other two intrinsic subfactors (achievement and

stimulating experiences; eight items) were not included because knowledge is the most relevant for assessing teachers' perceptions of students' academic motivation in the context of PE, and focusing on this subfactor allows for a clearer and more interpretable measure of motivation.

Previously, we obtained the necessary permissions from the original authors of the instrument to adapt and reproduce this scale. Then, the 20-item EME-S was adapted by three independent experts. They were selected for their expertise in SDT-based research and teacher education, and they evaluated the items for relevance, representation, and appropriateness (Bartram et al., 2018; Lynn, 1986; McGartland et al., 2003; Sireci & Faulkner-Bond, 2014). These experts carried out an individual adaptation of the scale and shared it. Specifically, a think-aloud protocol with the three proposals about the modifications of the questionnaires was held to highlight the different experts' perspectives, and discuss any discrepancies until a satisfactory version was reached.

No items were removed during this phase, and all modifications involved rewording items to adapt them to teachers' perceptions. The main modifications focused on changing words that referred to the students' motivation so that they referred to PE teachers' perceptions of students' motivations. For instance, the stem sentence used in the EME-S "Why do you study...?" was replaced with "Why do you think that students study...?" Some words in the items were modified to assess teachers' perceptions of students' motivations. For example, "...because my studies allow me to continue learning many things that interest me" was changed to "...because studying will allow them to continue learning many things that interest them."

Phase 2 - Content validity and comprehension. Next, the first version of the scale was administered to 6 PE teachers, selected through convenience sampling, aged between 27 and 40 years ($M = 32.17$, $SD = 4.98$) from primary ($n = 1$) and secondary ($n = 5$) schools. Previously, PE teachers were contacted, informed about the procedure, and asked to participate in the study after providing informed consent. Those who agreed to participate received information about the meaning of each dimension, but they did not know which items belonged to each factor. They were asked to suggest improvements to the items or propose alternatives.

² The EME-S was chosen because it was the first widely used SDT-based instrument and provides a solid and adaptable structure.

Phase 3 – Readjustment of the scale. We received the revised version of the scale from each PE teacher, indicating whether to maintain, modify/revise, or eliminate the items. The three experts identified and discussed these modifications proposed by the PE teachers. No items were removed during this phase. All changes involved adjustments to wording to improve clarity and comprehension. Finally, this phase supported the content validity based on experts' judgments of the other items of the questionnaire and served to establish the scale's name: Teachers' Perception of the Students' Academic Motivation Scale (TPSAMS).

Study 2

The main aim of Study 2 was to test the psychometric properties of the TPSAMS, which analyzes PE teachers' perceptions of students' motivation. Specifically, we tested the factorial validity, internal consistency, discriminant validity, nomological validity and sex invariance of the scale.

Method

Participants

The final version of the TPSAMS was completed by 350 PE teachers (125 females), aged between 24 and 64 years ($M = 39.93$, $SD = 9.17$). The teachers were recruited from various schools across different Spanish regions, ensuring a diverse representation. To assess teaching experience, participants were categorized into three levels: a) High experience (> 10 years), with 45.14% of participants reporting extensive teaching experience; b) Medium experience (5-10 years), with 22.86% of participants indicating moderate teaching experience; c) Low experience (< 5 years), with 31.14% of participants reporting limited teaching experience, and 0.86% having less than one year of teaching experience. The sample was intentionally selected based on prior contact with schools and PE teachers. Regarding the employment status of the teachers, 54.29% were permanent teachers, 35.14% were intern teachers, 8% were substitute teachers, and 2.57% were not actively employed at the time of data collection. The response rate was 98.31%, and all

participants provided informed consent prior to completing the questionnaire.

Procedure

First, ethical approval for both projects (Study 1 and Study 2) was obtained from the Bioethics Committee of the first author's University of Extremadura (Protocol number: 3/2025). Second, the researchers contacted the PE teachers to explain the objectives of the studies and request their participation, following the American Psychological Association's (2009) ethical guidelines regarding consent, confidentiality, and anonymity. Finally, all the PE teachers completed the questionnaires online with the help of a research assistant (via email) to guarantee the quality of the measures. Data collection lasted 10–14 minutes. Two control questions were included in the questionnaires to ensure the accuracy of the teachers' responses (e.g., "Dear teacher, this is a control question, please mark number 4"). Finally, a total of six responses (1.69%) were excluded because they were not considered valid (e.g., more than 50% were not completed or were completed randomly, the control questions were not marked, or a clear response pattern was not observed).

Instruments

PE teachers' perceptions of students' motivation. The final version of the TPSAMS was used. This instrument is composed of the initial stem "Why do you think that students study?..." and is followed by 20 items and five factors (i.e., four items for each variable) to assess intrinsic motivation–knowledge (e.g., "... for the pleasure of learning more about the topics that interest them"), identified regulation (e.g., "... because according to students, education will help them better prepare for the career they are going to choose"), introjected regulation (e.g., "... because being successful in their studies allows them to feel important"), external regulation (e.g., "... so that they can get a more prestigious job later on"), and amotivation (e.g., "... students do not see any reason why they go to school and, frankly, they do not care"). The reasons were scored on a 7-point scale anchored from 1 (*strongly disagree*) to 7 (*strongly agree*), with an average score of 4 (*moderately agree*).

Table 1
Final Version of the TPSAMS

Why do you think that students study?
1. for the pleasure of learning more about the topics that interest them.
2. because according to students, education will help them better prepare for the career they are going to choose.
3. because with only elementary studies students could not find a well-paid job.
4. to prove to themselves that they are intelligent persons.
5. students do not know; they do not really understand what they are doing at school
6. because studying will allow them to continue learning many things that interest them
7. because students believe that education will increase their skills as future workers.
8. so that they can get a more prestigious job later on.
9. because being successful in their studies allows them to feel important.
10. students do not see any reason in why they go to school and, frankly, they do not care.
11. for the pleasure they get from discovering new things never seen before.
12. because their studies will allow them to get into a job they like.
13. they can get a more prestigious job later on.
14. honestly, they do not know; they really feel like they're wasting their time studying.
15. for the pleasure of knowing more about the topics that interest them.
16. because they want to prove to themselves that they are capable of succeeding in their studies.
17. because they believe it will help them to better choose the way of their careers.
18. to get a better salary later.
19. they used to find good reasons to go to school, but now they wonder if they should continue going.
20. to prove to themselves that they are capable of achieving good results in their studies.

Note. Intrinsic motivation – for knowledge = items 1, 6, 11, and 15; Identified regulation = 2, 7, 12, and 17; Introjected regulation = items 4, 9, 16, and 20; External regulation = items 3, 8, 13, and 18; Amotivation = items 5, 10, 14, and 19.

PE teachers' perceptions of students' engagement.

An adapted Spanish version of the Engagement Versus Disaffection with Learning—Teacher Report for the whole class was used (Skinner et al., 2008). The main changes were based on words that referred to teachers' perceptions of the class as a whole rather than individual students' engagement. The questionnaire is composed of 10 items (i.e., five items for each subscale) to assess behavioral

engagement (e.g., “In my class, students work as hard as they can”) and emotional engagement (e.g., “In my class, students are enthusiastic”). All responses are rated on a 5-point scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). A confirmatory factor analysis (CFA) to analyze the psychometric properties was performed: $\chi^2(34) = 157.64$, $p < .001$, CFI = .94, TLI = .92, RMSEA = .10 (95% CI [.08, .13])³, SRMR = .04.

³ RMSEA values are sensible to small samples.

Data Analysis

A first-order five-factor CFA was conducted using Mplus 7.4 (Muthén & Muthén, 2012–2022). Due to the Likert nature of the items and non-normality (i.e., with some kurtosis and skewness values out of the +1 to -1 range), a robust maximum likelihood (MLR) estimator was used, which provides standard errors and robust fit indices. Specifically, we used the following fit indices to carry out the preliminary validation: chi-square (χ^2), degrees of freedom of the model (df), the significance (p), the Comparative Fit Index (CFI), the Tucker-Lewis Index (TLI), the Standardized Root Mean Residual (SRMR), and the Root Mean Square Error of Approximation (RMSEA). Values between .90 and .95 for CFI and TLI, and between .06 and .08 for RMSEA and SRMR are considered adequate, whereas values greater than .95 for CFI and TLI, and values smaller than .06 for RMSEA and SRMR, are considered excellent (Hu & Bentler, 1999).

In addition, descriptive statistics and scale reliability were calculated using Cronbach's alpha (α) and omega (ω) coefficients (Cronbach, 1951; McDonald, 1999) (see Table 1; Brown, 2006). Internal consistency values higher than .70 were considered acceptable (Nunnally & Bernstein, 1994). Furthermore, discriminant validity was examined using latent correlations between factors and the nomological validity was assessed using latent correlations between the TPSAMS factors and teachers' perceptions of students' engagement. In both cases, correlations below .85 were considered acceptable, indicating that factors are related but still represent distinct constructs (Kline, 2023). Finally, factor invariance of the TPSAMS was analyzed as a function of sex, using the following model sequence according to the instrument's multidimensional structure (Bruner & Benson, 2018). Following Cheung and Rensvold (2002), models were considered invariant if they showed adequate fit and changes in CFI and TLI (ΔCFI and ΔTLI) were smaller than .01.

Results

Confirmatory factor analysis. First, the goodness-of-fit statistics and information criteria for the first-order five-factor solution of the TPSAMS showed adequate fit indices: $\chi^2(160) = 386.95$, $p < .001$, CFI = .92, TLI = .91, RMSEA = .06 (95% CI [.05, .06]), SRMR = .06. The standardized factor loadings for the first-order five-factor solution of TPSAMS are presented in Figure 1. Five factors were positively significant and higher than .44 (Brown, 2006): intrinsic motivation–knowledge, $\lambda = .70 - .88$; identified regulation, $\lambda = .61 - .85$; introjected regulation, $\lambda = .60 - .910$;

external regulation, $\lambda = .44 - .84$; amotivation, $\lambda = .45 - .91$. All five factors were significantly correlated with each other ($p < .001$).

Descriptive statistics and reliability. Table 2 displays the descriptive statistics and reliability of the scales. As can be observed regarding teachers' perceptions of students' motivation (range 1–7), although with very similar values, extrinsic regulation and identified regulation showed higher scores than intrinsic motivation, introjected regulation, and amotivation, respectively. On the other hand, behavioral engagement showed a higher score than emotional engagement. Table 2 also shows the internal consistency of all the variables via Cronbach's alpha and omega coefficients (Cronbach, 1951; McDonald, 1985, 1999): all the factors obtained scored higher than .76 in both reliability analyses.

Discriminant validity. Regarding discriminant validity, positive correlations were found among teachers' perceptions of intrinsic motivation and extrinsic regulations ($r = .44 - .87$), and also among teachers' perceptions of extrinsic regulations ($r = .52 - .91$). In addition, negative relationships were found among teachers' perceptions of all types of regulations ($r = -.26 - -.45$).

Nomological validity. Regarding nomological validity, using latent correlations between factors of the TPSAMS and teachers' perceptions of students' behavioral and emotional engagement, the most self-determined types of motivation positively correlated with each other and with both types of students' engagement, and negatively correlated with amotivation. In addition, amotivation was also negatively correlated with both types of engagement. Finally, students' behavioral and emotional engagement were positively correlated with each other ($r = .81$).

Sex invariance. We tested the invariance of the scale as a function of sex: configural invariance, weak invariance, strong measurement, and strict invariance. Specifically, measurement invariance assesses the presence of different types of measurement biases in the context of group comparisons of these four models (Cheung & Rensvold, 2002). The results supported configural invariance for sex, indicating that the questionnaire has the same factor structure for females and males. Findings indicated that factor loadings (metric invariance), item intercepts (scalar invariance), and item uniqueness (strict invariance) were not significantly different across the groups (male vs. female).

Figure 1
Confirmatory Factor Analysis of Study 2

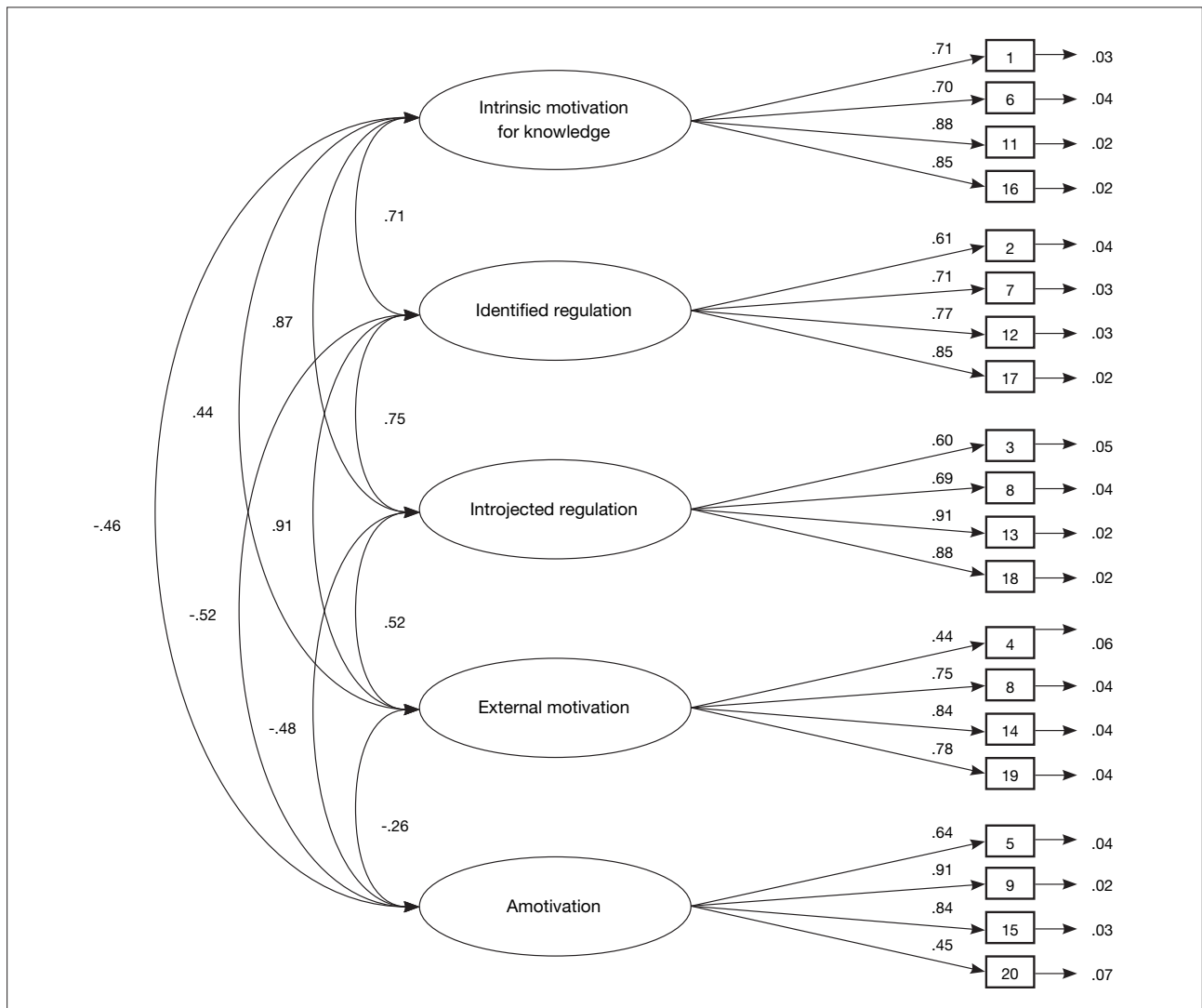


Table 2
Descriptive Statistics, Internal Consistency, Discriminant Validity, and Nomological Validity of the Study of the TPSAMS and Students' Engagement

	M	SD	α	ω	1	2	3	4	5	6	7
1. TP students' intrinsic motivation	4.07	1.34	.86	.86	-						
2. TP students' identified regulation	4.65	1.18	.81	.81	.71***	-					
3. TP students' introjected regulation	4.02	1.24	.85	.86	.87***	.75***	-				
4. TP students' external regulation	4.93	1.08	.77	.77	.44***	.91***	.52***	-			
5. TP students' amotivation	4.08	1.18	.80	.82	-.46***	-.52***	-.48***	-.26**	-		
6. TP behavioral engagement	3.97	0.67	.90	.90	.50***	.28***	.27***	.08	-.28***	-	
7. TP emotional engagement	3.49	0.77	.89	.89	.32**	.18***	.19***	.06	-.17***	.35***	-

Note. * $p < .05$; ** $p < .01$; *** $p < .001$. TP = Teachers' perceptions.

Table 3
Invariance Analysis by Sex of the TPSAMS

	χ^2	$\Delta\chi^2$	<i>df</i>	<i>CFI</i>	ΔCFI	<i>TLI</i>	ΔTLI	<i>RMSEA</i>	$\Delta RMSEA$	<i>SRMR</i>	$\Delta SRMR$
Model 0. Male	302.85	-	160	.92	-	.90	-	.06	-	.07	-
Model 0. Female	296.37	-	160	.91	-	.90	-	.08	-	.07	-
Model 1. Configural invariance	599.51	-	320	.92	-	.90	-	.07	-	.07	-
Model 2. Metric invariance	609.57	10.06	335	.92	< .01	.91	< .01	.07	< .01	.07	< .01
Model 3. Scalar invariance	629.24	19.67	350	.92	< .01	.91	< .01	.07	< .01	.07	< .01
Model 4. Strict invariance	688.99	59.75	390	.91	< .01	.91	< .01	.07	< .01	.09	.02

Discussion

This study aimed to design and validate a scale to assess PE teachers' perceptions of the motivation displayed by their students (TPSAMS). Specifically, the EME-S scale (Nuñez et al., 2010) was used as a reference, and content validity, factorial validity, internal consistency, nomological validity, reliability, as well as factorial invariance based on gender (male and female) were examined (Bartram et al., 2018; Lynn, 1986; McGartland et al., 2003; Sireci & Faulkner-Bond, 2014). Overall, the results indicated that the TPSAMS scale is a valid and reliable instrument for evaluating PE teachers' perceptions of their students' level of motivation.

First, the CFA results showed a good fit for the TPSAMS with five correlated factors (intrinsic motivation, identified regulation, introjected regulation, external regulation, and amotivation). The factor loadings for each item were appropriate and significantly positive (Brown, 2006). These findings are consistent with other scales measuring student motivation in both primary (CMEF-EP; Leo et al., 2016) and secondary education (PLOC, Moreno-Murcia et al., 2009; EME-S, Nuñez et al., 2010; CMEF, Sánchez-Oliva et al., 2012). For example, Sánchez-Oliva et al. (2012) confirmed the factorial validity of a 20-item model divided into five motivational factors, with excellent item loadings. Similarly, the TPSAMS aligns with the CMEF-EP (Leo et al., 2016) and EME-S (Nuñez et al., 2010) scales, both of which also showed high construct validity and appropriate factor loadings for most items.

Regarding the reliability of the instrument, the TPSAMS has proven to be a reliable tool for measuring the perceptions of primary and secondary education teachers regarding students' motivation. All motivation factors demonstrated adequate reliability values, supporting the internal consistency of the instrument for each type of motivation. These reliability results

are similar to, and slightly higher than those of the previously mentioned scales (Leo et al., 2016; Sánchez-Oliva et al., 2012), which could be attributed to the maturity of teachers in both educational stages. Therefore, the TPSAMS scale is proposed as a reliable instrument for measuring teachers' perceptions of their students' types of motivation.

Regarding discriminant validity, the results indicate that, while some positive correlations exist among teachers' perceptions of different types of motivation, most correlations are moderate and consistent with theoretical expectations. Specifically, intrinsic motivation was positively associated with extrinsic regulations, and different forms of extrinsic regulation were also positively interrelated. One notable exception was the relatively high correlation between identified regulation and external regulation, and between intrinsic motivation and introjected regulation, suggesting a slight overlap between these constructs in teachers' perceptions. At the same time, negative associations were observed between the types of regulation and amotivation, supporting the distinction among motivational constructs. Overall, these findings suggest that teachers can differentiate among the various forms of student motivation to a reasonable extent. However, future studies should further investigate discriminant validity, particularly regarding identified and external regulation, to better understand the conceptual distinctions among motivational constructs.

With regard to nomological validity, latent correlations were conducted between each of the TPSAMS factors and teachers' perceptions of their students' behavioral and emotional engagement. Specifically, it is worth noting that motivations classified along the motivational gradient as more self-determined, or certain extrinsic motivations (i.e., intrinsic motivation and/or identified regulation) showed a positive and significant correlation with students' behavioral

and emotional engagement (Leo et al., 2022; Vansteenkiste et al., 2006). The significance of these correlations suggests that the validity of the instrument aligns with the expected outcomes for each type of motivation, as well as with teachers' perceptions of their students' engagement.

On the other hand, and contrary to expectations, external regulation was also positively related to behavioral and emotional engagement, although it showed lower correlation values and less significance compared to other types of motivations. Previous research (Brandmiller et al., 2023; Leo et al., 2022) has also found positive relationships between external regulation and student engagement. This may be attributed to positive reinforcement by teachers regarding extrinsic aspects of learning. For example, offering external rewards for student behavior or emphasizing academic grades during activities may foster greater extrinsic motivation and higher student engagement for these reasons.

Conversely, student amotivation, as perceived by teachers, was negatively related to students' behavioral and emotional engagement. This finding further supports the nomological validity of the instrument, given the expected inverse relationship between amotivation and teacher-perceived student engagement. Previous studies have examined nomological validity with other student outcomes, finding positive relationships between intrinsic and extrinsic types of motivation (i.e., intrinsic motivation, identified regulation, and introjected regulation) and the satisfaction of basic psychological needs (Sánchez-Oliva et al., 2012), positive student behaviors (Leo et al., 2016), or self-concept (Nuñez et al., 2005), as well as negative relationships between amotivation and these same variables.

Finally, the TPSAMS scale demonstrated gender invariance. The model showed an adequate fit, and no notable changes or substantial increases were observed in the fit indices. According to Cheung and Rensvold (2002), the fit index values were appropriate, with increases in CFI and TLI below .01. Thus, it can be stated that the instrument is invariant regarding gender (male and female). In this regard, this study follows the line of other authors who recommend reporting invariance across gender (Lukaszewski & Stone, 2012; Jiménez-Cortés, 2025). Furthermore, it is consistent with other studies in the Spanish context, such as the validated scale that measures teacher motivation in secondary education (Abós, Sevil et al., 2018), which also demonstrated gender invariance.

Lastly, teachers' perceptions of their students' motivation can impact their own motivation and teaching approach (Matosic et al., 2016). For example, teachers who view their students as motivated and engaged are more likely to

support their needs (Franco et al., 2023, 2024). Thus, the TPSAMS effectively measures teachers' perceptions of student motivation. Other studies have explored teachers' perceptions of overall student motivation without a specific theoretical framework, often mixing items related to engagement (e.g., Brandmiller et al., 2023). This instrument contributes to such research by enabling the assessment of these dimensions from the teachers' perspective.

Limitations and Future Directions

Despite the need for an instrument to measure teachers' perceptions of student motivation, some limitations of the present study should be acknowledged. First, we used a cross-sectional design, with each teacher providing only a single response. As a result, it was not possible to evaluate the temporal stability of the instrument. Second, all participating teachers were Spanish, with the majority teaching in secondary education, which may limit the generalizability of the results and the applicability of this instrument to other educational contexts or countries. Future studies involving a larger number of PE teachers from different educational stages are needed to revalidate the factorial structure and reliability of this instrument in other contexts and countries. Finally, the analysis of nomological validity should be interpreted with caution, as the instrument employed to assess teacher engagement showed model fit indices close to, but not fully within, the recommended thresholds. Future studies should further examine this aspect to provide stronger evidence of nomological validity.

Practical Applications

Given the predominantly practical nature of the educational context and the professional trajectory of PE teachers, the TPSAMS instrument can offer a series of practical applications to contribute to the improvement of teaching practices and to the applied study of student motivation from the teachers' perspective. First, at the academic level, this instrument can be used to develop new educational research that analyzes the relationship between students' motivation and the teachers' perceptions of that motivation during the teaching-learning process. This analysis can provide valuable insights into how teachers' perceptions impact students' motivation levels and, in turn, how these perceptions influence the development and effectiveness of educational processes. By better understanding this relationship, strategies can be designed to improve motivation in the classroom, fostering an environment

more conducive to learning. Second, this instrument can also serve to assess the impact of educational programs and interventions. Quantifying students' motivation from the teacher's perspective can help evaluate how interventions modify teachers' perceptions of student motivation and whether these changes enhance academic outcomes or increase student engagement and commitment. Finally, using the TPSAMS to develop teacher training programs can be particularly valuable for training educators in motivation and learning, as well as for quantifying their perceptions of students' motivation. Designing these training programs can enhance teachers' understanding of the motivational processes occurring in the classroom, which, in turn, could optimize the teaching-learning process, making it more effective and enriching.

Conclusion

To sum up, the TPSAMS demonstrates adequate psychometric properties in terms of construct and nomological validity, reliability, and gender invariance among teachers. As such, it stands out as a pioneering instrument for assessing teachers' perceptions of student motivation. Furthermore, the validity demonstrated by the TPSAMS facilitates the measurement and collection of data on teachers' perceptions, thereby promoting the development of further studies analyzing teachers' views on student motivation across primary and secondary education.

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Polar Coordinates to Study Three-Point Shooting in Professional Basketball: Analysis of the Finalist Teams in EuroBasket 2022

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.
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Abstract

The three-point shot has become increasingly important in modern basketball, and today the professional game is inconceivable without technical-tactical work aimed at resolving the offensive phase beyond the 6.75-meter line. The aim of this study was to analyze three-point shooting situations in professional basketball and their relationship with different offensive technical-tactical actions. To this end, a Polar Coordinates analysis was conducted using the positions of the players taking the shots as focal behaviors, allowing a comparison of results between the Spanish and French men's basketball teams at EuroBasket 2022. The ad hoc observation tool developed for this study successfully passed the data quality and generalizability analyses required in observational methodology. A total of 228 offensive actions were recorded, with the unit of observation being the offensive play that ended with a three-point shot. The results revealed the behavioral trends of each team in this specific game situation. The French team mainly sought pick and pop situations, while the Spanish players relied more on direct blocks to generate favorable shooting positions.

Keywords: observational methodology, performance, systematic observation, tactical analysis, three-point shot

Introduction

In recent years, basketball has undergone a significant transformation in its tactical approach, with the three-point shot emerging as a fundamental tool in teams' offensive play. Within the field of research on the tactical aspects of the game, several studies have emphasized the importance of the three-point shot in offensive systems (Gou & Zhang, 2022). At present, the three-point shot is increasingly becoming one of the primary options in offensive strategies, reflecting a shift in game dynamics toward a greater emphasis on long-distance shooting. Although traditionally associated with small forwards and shooting guards, today virtually any player can assume this role, underscoring both the versatility of the skill and its relevance in the current context of basketball. Consequently, analyzing the three-point shot and maximizing its performance is essential for coaches to design offensive strategies aimed at creating optimal shooting situations (Suárez-Cadenas & Courel-Ibáñez, 2017).

The finalization of possessions in basketball has been examined from a technical and statistical perspective in order to identify performance indicators (Romarís et al., 2013), and more recently from a tactical perspective, as demonstrated in the studies by Nunes et al. (2021) and Pastrana-Brincones et al. (2021). This perspective specifically underscores the importance of maximizing the effectiveness of the three-point shot through strategies deliberately designed to create optimal shooting opportunities. Junoy (2009) emphasized the effectiveness of the three-point shot as a tactic to break down defenses, highlighting its ability to generate space and destabilize the opponent's defensive structure. This view suggests that the three-point shot not only contributes directly to scoring, but also exerts a substantial influence on the creation of broader offensive opportunities. Moreover, the necessity of adjusting defensive systems and refining individual technique at this stage of the game becomes evident, as the evolution of both individual and collective speed, coordination, and decision-making has extended the zones of scoring influence beyond the 6.75-meter line, turning the three-point shot into a genuine threat that must be neutralized.

Observational Methodology (OM) has been established as one of the most appropriate tools for studying sport when the aim is to analyze it within its natural context and dynamics (Anguera & Hernández-Mendo, 2013, 2014). This methodology is characterized by both flexibility and rigor: it allows the ad hoc design of observation tools tailored

to each specific situation, while ensuring scientific rigor through the requirement of prior data quality analysis. This guarantees that the data obtained can be reliably extrapolated to subsequent game situations. OM has long been used to obtain valid data and to conduct game analysis in team sports (Anguera & Hernández-Mendo, 2015).

From an observational perspective, Polar Coordinates analysis reveals the relationships between behaviors during the interactions that occur among participants throughout the game (Ávila-Moreno et al., 2018). This technique produces behavioral indicator vectors and establishes activation or inhibition relationships between a focal behavior and the other categories included in the observation tool. Polar Coordinates are grounded in Sequential Analysis (Gorospe & Anguera, 2000), which requires calculating vector values as well as the vector angle, which depends on the quadrant where it is located and determines the nature of the activation or inhibition relationship between behaviors (Castellano & Hernández-Mendo, 2003). The significance level was 2.45, in accordance with the methodological correction proposed by Rodríguez-Medina et al. (in Press).

This technique has been successfully applied in similar studies, both in basketball (Pastrana-Brincones et al., 2021; Morillo-Baro et al., 2020, 2021) and in other team sports (Vázquez-Diz et al., 2019; Jiménez-Salas et al., 2022; Morillo-Baro et al., 2022). Evidence from this body of research has demonstrated that technical-tactical analysis of competitive game situations deepens the understanding of the sport and assists coaches and technical staff in optimizing the planning and development of training to enhance performance. Accordingly, the aim of the present study was to use Polar Coordinates analysis to identify the relationships established between offensive technical-tactical completion behaviors and the three-point shooters of the Spanish and French basketball teams.

Materials and Methods

Research Design

The study was conducted using OM within the theoretical framework of mixed methods (Anguera et al., 2014). Following the classic structure of observational designs (Anguera et al., 2000), data recording was framed within quadrant IV, taking into account the features of nomothetic, follow-up, and multidimensional designs (Anguera et al., 2011). It is considered nomothetic because it involved

the observation of members from two teams; follow-up because there was temporal continuity across the different matches throughout the tournament; and multidimensional because of the plurality of categories incorporated into the validated ad hoc instrument.

Participants

Of the 24 teams that participated in EuroBasket 2022, held from 1 to 18 September in Germany, the Czech Republic, Georgia, and Italy, the two finalist teams, the French and Spanish men's national basketball teams, were selected for analysis. A total of eight matches were observed, four from each team. The number of observations was determined based on the generalizability analysis conducted. The matches analyzed correspond to the knockout phase, beginning with the round of 16 (Table 1), which represents the decisive stage of the competition.

Informed consent from the athletes was not required, as this was an observational study based on publicly available information and conducted in accordance with the basic ethical principles for research involving human subjects outlined in the Belmont Report (Office for Human Research Protections, 1979).

Instruments

The HOISAN software (Hernández-Mendo et al., 2012b, 2014) was used for data recording, coding, data quality analysis, and Polar Coordinates analysis. For the application of Generalizability Theory, the SAGT software (Hernández-Mendo et al., 2012a, 2016) was employed. The ad hoc observation tool was designed by combining the field format with exhaustive and mutually exclusive category systems (Anguera, 1979), and it successfully passed the data quality tests required in OM (Morillo-Baro & Hernández-Mendo, 2015). The tool consists of six criteria and 32 categories (Table 2).

Table 1
Matches analyzed

National Team	Matches	Results
Spain	Round of 16	Spain 102 – Lithuania 94
	Quarter-final	Spain 100 – Finland 90
	Semi-final	Spain 96 – Germany 91
	Final	Spain 88 – France 76
France	Round of 16	France 87 – Turkey 86
	Quarter-final	France 93 – Italy 85
	Semi-final	France 95 – Poland 54
	Final	France 76 – Spain 88

Table 2
List of categories corresponding to each criterion and coding system

Criteria	Categories	Criteria	Categories
1. JPAS Player who passes	BPAS: playmaker	2. APJLAN Previous action	SABD: direction direct block
	EPAS: shooting guard		SABI: direction indirect block
	APAS: small forward		COCONT: fastbreak
	APPAS: power forward		RECEST: static
	PPAS: center		FINT: feint
	NPAS: no one		PAP: pick and pop
3. DEFRIV Opposite defense	IND: individual	4. ZONLAN Shooting area	ZON1: zone 1: right corner
	ZONA: zone		ZON2: zone 2: right back area
	MIX: mixed		ZON3: zone 3: left back area
	PRES: pressing		ZON4: zone 4: left corner
	ENBADE: defensive balance		
5. JLAN Player who throws	BLAN: playmaker	6. RESULT Result	ANOT: success
	ELAN: shooting guard		NANOT: no success
	ALAN: small forward		REFAL: fault
	APLAN: power forward		REFANOT: success and fault
	PLAN: center		PIBA: loses the ball
		SITANO: another situation	

Figure 1
Throwing zones

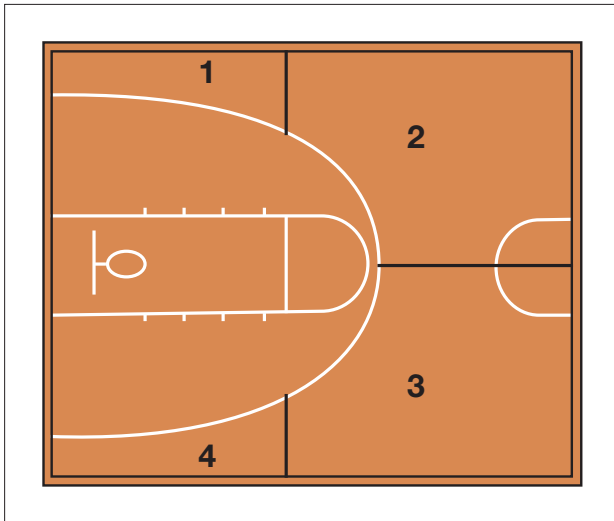


Figure 1 shows the shooting zones referred to in criterion 4 (ZONLAN: shooting area).

Procedure

The tool was designed by professional experts in the discipline. To assess data quality, both qualitative and quantitative aspects of the research process were considered (Blanco-Villaseñor et al., 2003). Regarding the qualitative component, consensual concordance (Anguera, 1990, 2003) was applied, whereby criteria and categories were discussed to define the final design of the tool, and an observation protocol previously agreed upon by the observers was implemented. From the quantitative perspective, two correlation coefficients and a concordance index were calculated to determine observer reliability (Table 3). Interobserver reliability was assessed using data from one

match recorded by two observers, after which one of the observers analyzed the same match again after fifteen days to obtain intraobserver agreement results.

Table 3
Results of correlation coefficients and concordance index

	Reliability Intra Observer	Reliability Inter Observer
Coefficient of Correlation		
Pearson	1	.99
Spearman	1	.99
Concordance Index		
Cohen's Kappa	.97	.91

Subsequently, as in other studies conducted with OM (Pastrana-Brincones et al., 2021), generalizability analysis (Blanco-Villaseñor et al., 2014) was performed using the SAGT 1.0 software (Hernández-Mendo et al., 2012a, 2016). To assess intraobserver and interobserver reliability, a two-facet design of category and observer (C/O) was applied, showing in both cases that variability was highly associated with the facet categories (99.047%). The relative and absolute G coefficients yielded an index of .995. In addition, the homogeneity of the categories was evaluated to validate the observational tool, using a two-facet design of observer and category (O/C). The results indicated that the generalizability coefficients obtained for this design were .000, and therefore excellent in the sense of showing the categories as differentiating. To estimate the minimum number of matches required for accurate generalization, a two-facet design of categories and matches (C/P) was employed. Table 4 presents the evolution of the generalizability index as the number of matches analyzed increases.

Table 4
Results of the coefficients obtained according to the number of matches observed

Name of values	Study 1	Study 2	Study 3	Study 4
C	32	32	32	32
P	2	4	6	8
Total Observations	64	128	192	256
Relative Coefficient	0.91	0.95	0.97	0.97
Absolut Coefficient	0.91	0.95	0.96	0.97

Note. C = Categories; P = Matches.

Once each match had been reviewed and the data recorded, a Polar Coordinates analysis was conducted with HOISAN (Hernández-Mendo et al., 2012b, 2014) for each category of all observations. This analysis generates behavioral vectors and establishes activation or inhibition relationships between a focal behavior and the other categories included in the observation tool. Each quadrant of the Polar Coordinates analysis is defined by the following characteristics (Castellano & Hernández-Mendo, 2003):

Quadrant I: [+,+]: The focal behavior excites the associated behavior in both retrospective and prospective perspectives.

Quadrant II: [-,+]: The focal behavior excites the associated behavior in the retrospective perspective but inhibits it in the prospective perspective.

Quadrant III: [-,-]: The focal behavior inhibits the associated behavior in both retrospective and prospective perspectives.

Quadrant IV: [+,-]: The focal behavior excites the associated behavior in the prospective perspective but inhibits it in the retrospective perspective.

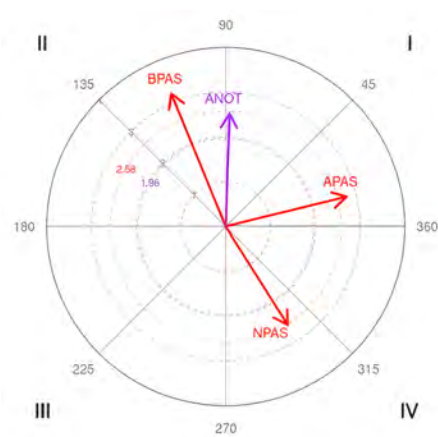
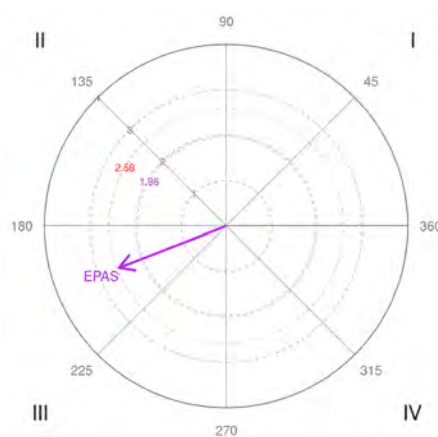
The following categories were chosen as focal behaviors: BLAN: playmaker throws; ELAN: shooting guard throws; ALAN: small forward throws; APLAN: power forward throws; and PLAN: center throws. Finally, the graphical representation of the Polar Coordinates analysis vectors was optimized using an algorithm created in R by Rodríguez-Medina et al. (2019, 2021).

Results

The results of the Polar Coordinates analysis for the five selected focal behaviors are presented in Table 5. For the focal behavior of the power forward, the analysis was conducted; however, no significant associated behaviors were identified for either of the two national teams.

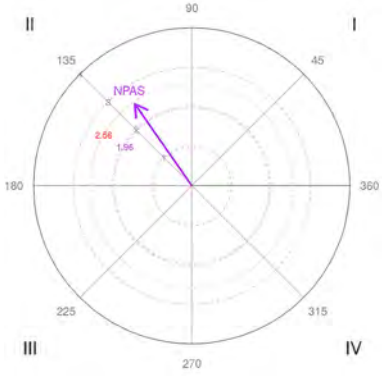
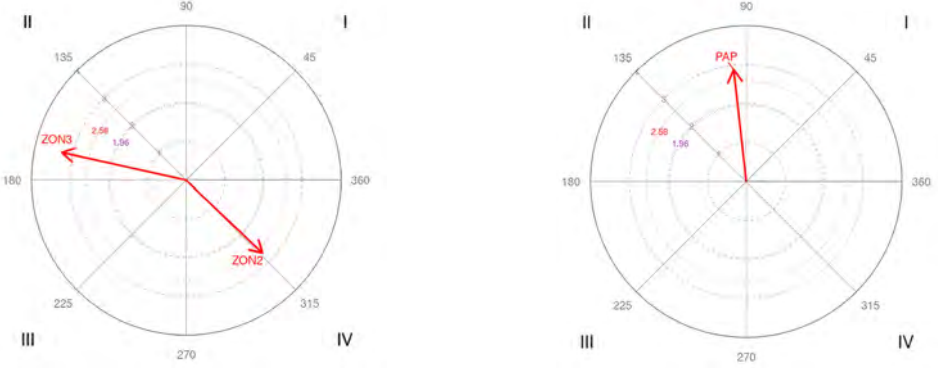
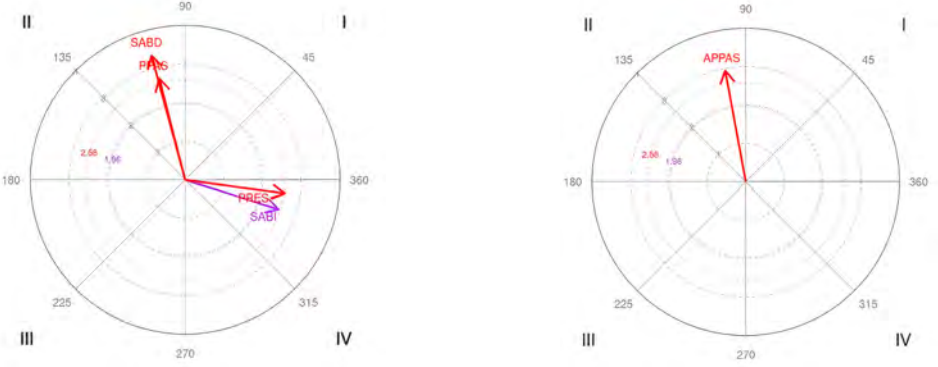
Table 5
Significant relationships and graphical representation of the vectors in each of the quadrants

Focal	Q	SPAIN			FRANCE		
		Behavior	Module	Angle	Behavior	Module	Angle
BLAN	I				APAS	2.78	13.77
					ANOT	2.52	88.1
	II				BPAS	3.21	112.27
	III	EPAS	2.53	201.17			
IV				NPAS	2.59	302.31	



Note. Focal = Focal behavior, Q = Quadrant, BLAN = playmaker throws, ELAN = shooting guard throws, ALAN = small forward throws, PLAN = center throws.

Table 5 (Continued)
Significant relationships and graphical representation of the vectors in each of the quadrants

Focal	Q	SPAIN			FRANCE		
		Behavior	Module	Angle	Behavior	Module	Angle
ELAN	II				NPAS	2.52	124.81
							
ALAN	II				PAP	2.89	96.38
		ZON3	3.29	167.65			
	IV	ZON2	2.72	316.44			
							
PLAN	II	PPAS	2.7	104.31	APPAS	2.94	100.43
		SABD	3.33	105.11			
	IV	SABI	2.53	342.26			
		PRES	2.6	352.17			
							

Note. Focal = Focal behavior, Q = Quadrant, BLAN = playmaker throws, ELAN = shooting guard throws, ALAN = small forward throws, PLAN = center throws.

In Quadrant I, playmaker throws, used as focal behavior in the French team, were related to the associated behavior small forward passes and successful scoring. No significant associations were found in the Spanish team.

In Quadrant II, the results for the focal behavior playmaker throws in the Spanish team revealed no activation of behaviors, while in the French team the playmaker passes behavior appeared with the highest intensity (3.21). For the focal behavior shooting guard throws, no significant associations were found with Spain; however, with France there was activation of the nobody passes behavior. In this same quadrant, the focal behavior small forward throws in the Spanish team activated left back zone shots, with a vector module intensity of 3.29, whereas in the French team it excited pick and pop actions. For the last focal behavior, center throws, the Spanish team showed activation of small forward passes and direct block start, while the French team activated power forward passes.

In Quadrant III, when the focal behavior is playmaker throws, in the Spanish team there was an inhibitory relationship with the category shooting guard passes. This was the only significant relationship found in this quadrant. For the rest of the focal behaviors, no coinciding relationships were identified in either team.

In Quadrant IV, no significant associations were found in the Spanish team using playmaker throws as focal behavior, while in the French team it inhibited the nobody passes behavior in the retrospective perspective and activated it in the prospective perspective. For the focal behavior small forward throws, only right back zone shooting behavior was inhibited in the Spanish team, whereas no significant associations were identified for the French team. Finally, with center throws as the focal behavior, the Spanish team showed inhibition in the retrospective perspective of indirect block exit and pressing defense; and activation in the prospective perspective. In contrast, no significant associations were found in the French team.

Discussions

The aim of this research was to analyze the relationships established between the actions preceding the three-point shot in professional basketball. Specifically, the shooting zones, the actions of the opposing defense, and the player positions executing shots from beyond the 6.75-meter line were examined. Polar Coordinates analyses were performed on the match records of the Spanish and French men's

national teams at EuroBasket 2022. The results revealed the relationships among the behaviors studied, confirming this approach as a useful technique for the tactical analysis of competitive game situations.

Analysis of offensive play in recent decades has shown an evolution in the use of three-point shots, from being a rare occurrence to becoming a fundamental part of offensive strategy (Zajac et al., 2023). This evolution in NBA basketball can also be observed in FIBA basketball (Foteinakis & Pavlidou, 2024), where the three-point line is closer to the basket. Data from reports show a steady increase in their frequency of use and effectiveness (FIBA & WABC, 2020). However, in youth basketball, sequences are less effective (Amatria et al., 2024). The difference, then, lies in how each team structures its offensive procedures to achieve these three-point shooting situations. The players involved, the means of collaboration used, and the use of specific zones describe each team's tendency.

The outcomes of the Polar Coordinates analysis demonstrated significant associations between the focal behaviors selected and the remaining behaviors included in the observation tool, although these differed between the two teams. For example, it is noteworthy that players on the French national team occupying the playmaker position, traditionally considered a game-management role, exhibited a greater number of significant relationships than players in other positions.

The results indicated that the playmaker position was highly effective in orchestrating offensive play. France's performance was particularly successful when the playmaker contributed to both the creation and completion of attacking actions.

In contrast, the analysis of the Spanish team revealed different tendencies. The significant behaviors identified suggested that the Spanish playmaker's play was more oriented toward individual finishing actions, including those following steals. Conversely, the offensive performance of the shooting guard appeared to fall short of expectations, given the traditional responsibilities of this position in facilitating offensive development. With respect to the small forward position, differences between the two teams were again evident: the French team frequently executed shots after pick and pop situations.

Finally, the analyses concerning inside players (power forwards and centers), who are increasingly attempting more shots from perimeter areas (Rolland et al., 2020), did not provide evidence supporting this trend for power

forwards at this EuroBasket for either team. On the other hand, the centers demonstrated substantial involvement in perimeter play in both Spain and France teams: The Spanish centers frequently attempted shots after on-ball screens and engaged in associative play between posts, whereas the French centers were highly effective in converting three-point shots, establishing connections with their power forwards. The importance of the on-ball screen (Muñoz et al., 2015; Nunes et al., 2015) for creating open looks for centers is noteworthy, as highlighted by Serna et al. (2021) as a means of breaking down compact defenses. As noted by Morillo-Baro et al. (2021), these findings reflect the growing trend of inside players finishing possessions further from the hoop and attempting a greater volume of three-point shots, although their optimal scoring zone continues to be near the basket.

One limitation of this study is that the observations were conducted exclusively during the knockout stage, which raises the question of whether the two teams displayed similar tactical patterns during the group stage. Furthermore, it would also be relevant to incorporate additional criteria into the analysis tool, which could provide greater depth in examining technical-tactical aspects. Therefore, future research would benefit from exploring the defensive schemes of the opposing team and their impact on players' decision-making regarding three-point shot attempts. Likewise, it would be valuable to analyze the tactical structures for three-point shooting in relation to contextual variables such as score differential and time remaining in the game, as well as to compare these findings with other competitive contexts, including professional club competitions and women's basketball.

Conclusions

The results revealed certain similarities between the two teams in their approach to three-point shooting, once again highlighting its importance in modern basketball (Foteinakis & Pavlidou, 2024). Regarding the technical-tactical construction of the three-point shot, the French team adopted a more innovative approach, frequently employing pick and pop actions, while the Spanish team followed a more traditional style, resolving shots mainly after on-ball screens. In the French team, this responsibility was primarily assumed by the playmaker. Both teams demonstrated a clear understanding of three-point shot opportunities when the opposing defense was set in defensive balance. Moreover, they acknowledged the strategic importance of involving their inside players in three-point shooting.

Through the analyses conducted, the results revealed the behavioral trends of each team in this specific game situation, providing relevant insights into the dynamics of professional basketball that can assist coaches and technical staff in designing intervention programs aimed at optimizing performance.

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Single Versus Hybrid Models: Impact of Sport Education Associated with Nonlinear Pedagogy in a University Sport Program

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.

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Abstract

The aim of this study was to assess the impact of a hybrid Sport Education (SE) and Nonlinear Pedagogy (NLP) program, in comparison to a single NLP program, on pre-service teachers' motivation and satisfaction during their initial training. The programs were implemented in football teaching at the university level, with the aim of preparing participants to apply these approaches in educational contexts. Participants were 67 pre-service teachers divided into two groups. One group experienced a hybrid SE+NLP program, and the second group experienced the NLP program. A 2 (pedagogical model) x 2 (test time) multivariate analysis of variance was performed. Results showed significant pre-post differences in students' intrinsic motivation, amotivation, and satisfaction with the teaching-learning process (teaching, interaction with others, and fun/enjoyment) only in the hybrid SE+NLP program. These results showed that SE can complement models such NLP to produce positive outcomes. If the goal is to ensure that future in-service teachers can implement pedagogical models effectively, proper training at the college level is required.

Keywords: autonomous motivation, pre-service team sports, satisfaction, self-determination theory

Introduction

Shulman (2005, p. 52) defined signature pedagogies as the “types of teaching that organize the fundamental ways in which future practitioners are educated for their new professions.” Through them, future professionals are educated to think, to perform, and to act with integrity. Parker et al. (2016) believed that signature pedagogies help bridge the theory-practice gap, providing strategies to help present and future PE teachers think about the purpose of schooling, the nature of the discipline, and their role as educators. Shulman (2005) highlighted that signature pedagogies can operate at three levels or dimensions: 1) surface structure: “concrete, operational acts for teaching and learning, of showing and demonstrating, of questioning and answering, of interacting and withholding, of approaching and withdrawing”; 2) deep structure: “a set of assumptions about how best to impart a certain body of knowledge and know-how”; and 3) implicit structure: “a moral dimension that comprises a set of beliefs about professional attitudes, values, and dispositions”. Teacher education in general, and physical education (PE) teacher education in particular, also have signature pedagogies that describe how teaching and learning are conducted and how future PE teachers are prepared. In this context, Hordvik et al. (2017) identified Sport Education (SE) as a signature pedagogy.

Traditionally, teachers have led sports instruction by directing most learning decisions, limiting students’ autonomy (Gil-Arias et al., 2020). Direct instruction, especially in university settings training future PE teachers, has been criticized for insufficiently supporting student autonomy (Pizarro et al., 2019). Autonomy-supportive environments promote adaptive outcomes such as intrinsic motivation and teamwork, contrasting with the usually directive nature of sports teaching (Mossman et al., 2022). One of the theoretical foundations used to understand students’ motivation is Self-Determination Theory (SDT; Ryan & Deci, 2017), applied both in academic (Vasconcellos et al., 2020) and sports contexts, where it has led to training programs such as Empowering Coaching. SDT highlights that motivation lies along a continuum, where three levels of self-determination are distinguished (Ryan & Deci, 2000): a) autonomous motivation: participation for the pleasure of carrying out the activity; b) controlled motivation: participation to achieve other objectives such as social recognition or external rewards; and c) amotivation: lacking reasons for participating (Deci & Ryan, 2000). According to the Hierarchical Model of Motivation (HMM; Vallerand, 2001), the class climate created by the teacher’s pedagogical framework can promote and/or thwart students’

basic psychological needs (BPN), and consequently, their type of motivation. In this regard, Saiz-González et al. (2024) have uncovered that pedagogical models can produce a positive impact on the students’ BPNs, but it must be determined which of them. Direct instructional frameworks have been criticized because they may not be the best fit for the demands of contemporary education (Litchfield & Dempsey, 2015). In contrast, student-centered pedagogical models have been proposed to foster students’ autonomy, allowing them to influence their learning process (Gil-Arias et al., 2020).

Among the pedagogical models that adopt this approach, Sport Education (SE) is probably the most widely implemented and studied in primary and secondary education (Evangelio et al., 2018). SE aims to help participants develop as autonomous and enthusiastic learners while remaining competent through participation in a complete and contextualized sports experience (Siedentop et al., 2019). This model creates an autonomy-supportive context in which students can make decisions and explore alternative roles that require social interaction and teamwork (Chu & Zhang, 2018). The literature provides evidence of the positive effects that SE can have on students’ intrinsic motivation (Gil-Arias et al., 2020). A recent umbrella review uncovered that Sport Education (SE) is the pedagogical model most widely implemented and studied in primary and secondary education (Fernandez-Rio & Iglesias, 2022), but it has been scarcely implemented in initial teacher education at the university level. To our knowledge, only a few studies have been published involving pre-service PE teachers experiencing SE in their university context, adopting the role of students, and “living the curriculum” (Oslin et al., 2001). Hordvik et al. (2017) conducted a self-study with 12 pre-service teachers experiencing a 12-lesson SE unit and uncovered challenges in bridging theory and practice when learning and teaching the model. Liu and Hastie (2021) assessed 18 university students’ calorie consumption in a SE-based tennis class. There appears to be a gap in the literature regarding initial teacher education and pedagogical models that needs to be filled.

In the quest to improve teaching quality, one of the initiatives undertaken has been the hybridization of pedagogical models, whose complementary application could overcome limitations present when they are used in isolation (Shen & Shao, 2022). Again, SE has been the most extensively hybridized model (Fernandez-Rio & Iglesias, 2022; Pizarro et al., 2025), with models like Teaching Games for Understanding (TGfU; Gil-Arias et al., 2020) or Teaching for Personal and Social Responsibility

(González-Víllora et al., 2019). The positive effects that the implementation of hybrid models could bring at the motor, cognitive, affective, and social levels are evident, considering the nested and hierarchical interaction of constraints and effects at different coordinative levels (Balagué et al., 2019). Despite the positive effects of combining SE with different game-based approaches, it has never been hybridized with the Nonlinear Pedagogy (NLP) approach. Empirically verified approaches, such as ecological psychology and dynamical systems theory (Araújo et al., 2019), offer new conceptual perspectives and provide a solid theoretical justification to use NLP during games and sports learning processes. In contrast to other proposals, instead of prescribing movement patterns to students and providing direct feedback on what they need to correct, the main objective of the teacher is to ask questions to students aimed at recognizing possible functional behaviors and the search for possible alternative motor solutions by leveraging the intrinsic processes of self-organization during learning (Pizarro et al., 2019).

Since there is little information on the use of SE in university contexts, and even less in university physical education programs and in combination with NLP, the present study aimed to take a step further in pedagogical model research. The primary goal was to assess the impact of a hybrid SE+NLP program, compared to a single NLP program, on pre-service teachers' motivation and satisfaction during their initial training. The initial hypothesis was that SE would be a beneficial addition to the single model.

Method

Participants

The current study was conducted in two universities located in central Spain. Participants were 67 students (M age = 20.70; SD age = 1.89, 11 females and 56 males) in their first year of the Sport Sciences degree, where they were trained to become PE teachers. All participants experienced the content of soccer; 28 did so through an SE+NLP program (in one university), and 39 through an NLP-only program (in the other participating university). Both groups received two weekly 55-minute sessions over six weeks, for a total of 12 sessions. Students had previously experienced units in other team sports (e.g., basketball) but they had not experienced any pedagogical model. Professors in both groups had 4-5 years of experience using both instructional approaches at the university level.

The present study was approved by the Ethics Committee for Research with Human Beings of the leading university (UNNE-2022-0013) and was conducted in accordance with the principles of the Declaration of Helsinki (2013). Written informed consent was obtained from all participants.

Data Collection

Motivation. The Spanish version (Ferriz et al., 2015) of the Perceived Locus of Causality Questionnaire (Goudas et al., 1994) was used. All items began with the stem: "I participate in the soccer lessons..." and consisted of 24 items that measure six forms of motivation: intrinsic motivation (e.g., "Because I enjoy learning new abilities."); integrated regulation (e.g., "Because I believe that sport is in accordance with my values."); identified regulation (e.g., "Because it is a good way to learn lots of things that could be useful to me in other areas of my life."); introjected regulation (e.g., "Because I would like the teacher to think that I am a good student."); external regulation (e.g., "Because I have to do it."); and amotivation (e.g., "But I don't know why."). Each type of regulation was composed of four items, and previous research in the sport education context has provided support for the factor structure and internal reliability of this measure (Goudas et al., 1994).

Satisfaction. The Spanish version (Sicilia et al., 2014) of the Physical Activity Class Satisfaction Questionnaire (Cunningham, 2007) was used. All items began with the stem: "Show your satisfaction level in PE..." and included 45 items distributed across nine dimensions. In this study, only eight dimensions were measured: teaching (e.g., "the teacher's enthusiasm during classes"); relaxation (e.g., "the way my mind can switch off"); cognitive development (e.g., "what I learn regarding technical-tactical skills"); interaction with others (e.g., "the interaction I had with others in the class"); normative success (e.g., "my ability to do better than other classmates"); fun and enjoyment (e.g., "the pleasant experiences I had in the class"); mastery experiences (e.g., "the opportunity to learn new skills"); and diversionary experience (e.g., "I feel exhilarated during the class."). Previous research in educational contexts has demonstrated acceptable reliability of the instrument (Gil-Arias et al., 2020).

The items of both questionnaires were anchored on a Likert scale ranging from one (strongly disagree) to five (strongly agree).

Intervention

After an initial evaluation, the intervention began. One study group experienced the hybrid program (SE+NLP), while the other study group received a program based only on NLP. However, both intervention programs were conducted over 12 lessons (six weeks), scheduled for 55 minutes twice a week.

Sport Education component. The structure of the program was designed according to the main features of SE (seasons, affiliation, formal competition, record keeping, final event, and festivity), and it included three phases. (a) Learning phase (lessons 1–7): In the first lesson, students were divided into three teams of six or seven students (mixed gender and ability), which persisted throughout the season (teams were formed using guidelines from Siedentop et al., 2019). In each group, students selected three roles (fitness leader, first coach, second coach, captain, equipment manager, statistician) that best fit their interests and/or personal strengths. These roles changed after two lessons, so that every student could experience three. Also, in this first lesson, students played

matches (5 vs. 5), where they were introduced to the roles (e.g., the fitness leader developed the warm-up). From lesson 2 to 7, each learning task was designed by the professor based on the NLP framework. However, both, professors and pre-service PE teachers directed some learning tasks or had responsibilities (see “Roles and duty responsibilities” in Table 1). To support students’ autonomy, the professor offered two tasks for each part for students to choose from. (b) Formal competition phase (lessons 8–11): All teams participated in different competition matches, and new roles appeared (e.g., referee, linesman, etc.). Contrary to the learning phase, the roles changed every lesson. (c) Final event (lesson 12): A final culminating event was carried out to decide the champions, followed by an awards ceremony (winning team; most original team; most organized team; fair play award; best refereeing team). During the formal competition phase, the professor gathered data on these elements. Records were made public throughout the program for each team to see their progress

Table 1
Season plan for the SE component

Lesson	Phase	Format	Roles and duty responsibilities
1	Learning phase	Teacher-directed instruction within-team practice	Development of team identity. Roles. Explanation of the model and competition format.
		5 vs. 5 Initial match	
2-7	Learning phase	Shared-directed instruction	Fitness leader conducted warm-up (5). Second coach conducted the first task (15). First coach conducted the second task (15). Teacher conducted the third task (15). Fitness leaders conducted cool down (5). Captain encouraged teammates and helped them.
		Student-directed: Within-team practice 1 vs. 1⇒2 vs. 2⇒3 vs. 3 + Teacher-directed: With two teams 5 vs. 5	Equipment manager gathered the equipment. Statistician collected data with a checklist to analyze the team (decision-making and execution of technical-tactical skills).
8-11	Formal competition phase	Student directed instruction	<i>Groups that played the match:</i> Equipment manager gathered the equipment. Fitness leader conducted the general warm-up. Second coach conducted the specific warm-up with a technical-tactical task. Using the statistical report, the first coach and captain conducted a pre-match talk. The first coach did not play the match to give instruction to the players.
		5 vs. 5 Championships for season points Scrimmages with opposing teams	<i>Groups that did not play the match:</i> Referee, two liners, and VAR controlled compliance with game rules. Fourth official/delegate completed the match sheet. Journalist wrote a report. Photographer took pictures and interviewed a player after the match.
12	Final event	Student directed instruction 5 vs. 5 Culminating event Festivity Final match	All duties were performed (playing and non-playing teams’ roles) The mascot (new role) appeared with the responsibilities of the photographer.

Table 2
Game phases and tactical principles which are focused to learn

Lesson	Game phase	Tactical principles
1		Learning focused on rules and formations.
2	Attacking phase	<i>Space</i> : Width and depth in attack. <i>Support the attack</i> : Supporting the player with the ball.
3	Attacking phase	<i>Mobility</i> : Interchange of positions, occupation and creation of space, creation of passing lines, maintaining possession. <i>Penetration</i> : Attacking the goal, creating numerical and spatial advantages.
4	Defending phase	<i>Containment</i> : Individual marking of the player with the ball to stop or delay opponent's attack. <i>Concentration</i> : Denying width and depth in the opponent's attack.
5	Defending phase	<i>Defensive cover</i> : Supporting the teammate marking the player with the ball.
6	Attacking transition phase	<i>Mobility</i> : Occupation and creation of space. <i>Penetration</i> : Attacking the goal, creating numerical and spatial advantages.
7	Defending transition phase	<i>Balance</i> : Covering space and free players and cutting passing lines.
8	Attacking phase	<i>Space</i> , <i>Support the attack</i> .
9	Defending phase	<i>Containment</i> , <i>Concentration</i> , <i>Defensive cover</i> .
10	Attacking transition phase	<i>Mobility</i> , <i>Penetration</i> .
11	Defending transition phase	<i>Balance</i> .
12		All phases of gameplay

Nonlinear Pedagogy component: each learning task was designed according to the characteristics of NLP: representative learning design; development of information-movement couplings; manipulation of constraints; dynamization of exploratory behavior; and reduction of conscious movement control (see details in Chow, 2013). For example, smaller formats from 1 vs. 1 to 5 vs. 5 were used to increase students' game involvement (modification representation); small-sided games with numerical superiority in attack, such as 2 vs. 1 or 4 vs. 3, were used to adapt the complexity of the task according to the players' skill level (tactical complexity); and constraints were modified, such as replacing goals with zones to arrive with passes to emphasize mobility —interchange of positions and creating passing lines— to modify game rules and emphasize specific tactical and technical learning objectives (modification exaggeration).

Thus, the main goal pursued by the professor is always to increase the functional diversity potential of the learner

in his or her search for adaptive responses (Pizarro et al., 2019). In this sense, students were not instructed on the movement patterns they had to execute, nor were they provided with direct feedback on what they had to correct or on how to formulate questions.

Finally, each lesson was focused on the learning of a different game phase and tactical principles: attacking phase, defending phase, attacking transition phase and defending transition phase (see Table 2).

In both intervention programs, the format was the same: lessons were highly structured (warm-up, first task, second task, third task, and cool down), increasing the number of players and the technical-tactical complexity as they progressed. However, there were some differences: (a) while in the SE+NLP program pre-service PE teachers directed tasks, in the NLP program the professor was the instructional leader, setting the learning goals and directing the tasks; and (b) while in the SE+NLP program groups were persistent across lessons, in the NLP program groups changed in every task.

Table 3
Instructional checklist

	Items	Present	Absent
1	Groups of students go to a designated home area and begin warming up with their group, conducted by the fitness leader.		
2	Students warm up as a whole class under the direction of the teacher.		
3	Students practice under the direction of the teacher and teammates (shared-directed instruction).		
4	Students practice under the direction of the teacher.		
5	Students perform specialized roles within their group/team.		
6	Students are players, without other specialized roles.		
7	The lesson is highly structured: warm-up, first task, second task, third task, and cool down.		
8	All the tasks are small-sided games (contextualized context).		
9	Learning focuses on both technical and tactical skills.		

Instructional and Treatment Validity

The fidelity of both intervention programs was assessed using a pre-designed checklist. Based upon the instructional checklist of Gil-Arias et al. (2020), items 1, 3, 5 and 2, 4, 6 (Table 3) enabled researchers to assess professors' fidelity to both programs (with SE and without SE, respectively), while items 7, 8, 9 helped researchers to examine professors' fidelity to the NLP component (see Pizarro et al., 2019).

Data Analysis

The statistical program SPSS v24.0 was used for data analysis and processing. Preliminary testing was conducted to check for homogeneity of variances and normality. Levene's and Kolmogorov-Smirnov tests were performed to confirm the assumptions of homogeneity of variances and normality of distribution, respectively ($p > .05$).

For each group (SE+NLP and NLP) at each of the two different phases (pre-intervention and post-intervention), means and standard deviations were calculated. To compare between-group and within-group differences in the dependent variables (motivation and satisfaction), a repeated-measures analysis of variance, MANOVA 2x2 (Test-Time x Group) was conducted. Analysis of differences was performed by means of multivariate contrasts, which are reported in this type of analysis.

Effect sizes were calculated using the partial eta-squared statistic (η_p^2). Effect sizes above .01 were considered small, above .06 medium, and above .14 large [small ($\eta_p^2 \geq .01$), medium ($\geq .06$), and large ($\geq .14$)]. The level of statistical

significance was set at $p \leq .05$, with a 95% confidence interval for differences.

Results

Between-Group Pre-Intervention and Post-Intervention Analysis

Regarding *motivation*, the multivariate contrasts showed that there were significant differences in the pre-intervention phase between the two study groups: Λ Wilks = .745; $F(6, 60) = 3.423$; $p = .006$; $\eta_p^2 = .255$; $SP = .919$. However, these differences were not found in the post-intervention phase: Λ Wilks = .902; $F(6, 60) = 1.089$; $p = .380$; $\eta_p^2 = 0.098$; $SP = .396$.

Regarding *satisfaction*, the multivariate contrasts showed that there were significant differences between the two study groups both in the pre-intervention phase: Λ Wilks = .787; $F(9, 57) = 1.712$; $p = .107$; $\eta_p^2 = .213$; $SP = .719$ and in the post-intervention phase: Λ Wilks = .701; $F(9, 57) = 2.703$; $p = .011$; $\eta_p^2 = .299$; $SP = .920$.

Within-Group Pre-Post-Intervention Analysis (Motivation)

The multivariate contrasts showed that there were significant pre-post differences in the SE+NLP group: Λ Wilks = .803; $F(6, 60) = 2.460$; $p = .034$; $\eta_p^2 = .197$; $SP = .789$. However, these differences were not found in the NLP group: Λ Wilks = .892; $F(6, 60) = 1.209$; $p = .314$; $\eta_p^2 = 108$; $SP = .439$.

Table 4

Descriptive statistics and pairwise comparison of different forms of motivation between the two phases

Variable	Group	Pre-intervention		Post-intervention		Typical error	p	95% confidence interval (CI)
		M	SD	M	SD			
Intrinsic motivation	SE+NLP	5.33	0.73	5.91	0.86	0.187	.003*	[-0.954; -0.206]
	NLP	5.91	0.77	5.77	0.66	0.159	.399	[-0.182; 0.452]
Integrated regulation	SE+NLP	5.86	0.88	6.15	0.75	0.154	.068	[-0.593; 0.021]
	NLP	6.56	0.58	6.39	0.68	0.130	.188	[-0.087; 0.433]
Identified regulation	SE+NLP	5.60	1.03	5.91	0.74	0.167	.066	[-0.646; 0.021]
	NLP	6.26	0.59	6.11	0.77	0.141	.280	[-0.128; 0.436]
Introjected regulation	SE+NLP	4.04	0.05	3.97	1.15	0.232	.759	[-0.393; 0.535]
	NLP	4.17	1.26	3.94	1.13	0.197	.233	[-0.156; 0.630]
External regulation	SE+NLP	3.19	0.07	2.83	1.12	0.258	.171	[-0.158; 0.872]
	NLP	2.85	1.51	2.48	1.06	0.219	.094	[-0.065; 0.808]
Amotivation	SE+NLP	2.18	0.85	1.62	0.61	0.217	.012*	[0.129; 0.996]
	NLP	2.09	1.52	1.76	1.06	0.184	.080	[-0.040; 0.694]

Note. M = mean; SD = standard deviation; * $p < .05$.

Table 5

Descriptive statistics and pairwise comparison of different forms of satisfaction between the two phases

Variable	Group	Pre		Post		Typical error	p	95% confidence interval (CI)
		M	SD	M	SD			
Teaching	SE+NLP	6.08	0.97	6.60	0.94	0.204	.013*	[-0.925; -0.111]
	NLP	6.38	1.30	5.92	1.19	0.173	.009*	[0.117; 0.806]
Relaxation	SE+NLP	6.34	1.27	6.90	0.98	0.226	.016*	[-1.010; -0.109]
	NLP	7.05	1.04	6.93	0.89	0.191	.533	[-0.262; 0.501]
Cognitive development	SE+NLP	6.04	1.20	6.30	0.96	0.209	.211	[-0.682; 0.154]
	NLP	6.61	0.96	6.33	1.04	0.177	.123	[-0.077; 0.631]
Interaction with others	SE+NLP	6.63	1.15	7.21	0.82	0.223	.011*	[-1.028; -0.139]
	NLP	7.11	1.02	6.88	0.89	0.189	.209	[-0.137; 0.616]
Normative success	SE+NLP	4.79	1.49	4.86	1.50	0.294	.809	[-0.660; 0.517]
	NLP	4.68	1.65	4.44	1.55	0.250	.341	[-0.259; 0.738]
Fun and Enjoyment	SE+NLP	6.60	1.15	7.27	0.72	0.224	.004*	[-1.115; -0.219]
	NLP	7.03	1.08	7.12	0.68	0.190	.622	[-0.474; 0.286]
Mastery Experiences	SE+NLP	5.84	1.26	6.57	0.82	0.208	.001*	[-1.142; -0.311]
	NLP	6.58	1.11	6.57	1.02	0.176	.885	[-0.326; 0.378]
Diversionsary Experiences	SE+NLP	6.18	1.25	6.70	0.88	0.216	.019*	[-0.949; -0.087]
	NLP	6.58	1.18	6.57	0.81	0.183	.972	[-0.359; 0.371]

Note. M = mean; SD = standard deviation; * $p < .05$.

The comparisons in pairs between the different phases of the study are presented for each group (Table 4). For the SE+NLP group, significant differences in favor of the post-intervention phase were found in intrinsic motivation ($p = .003$) and amotivation ($p = .012$). For the NLP group, no significant differences were found in any type of motivation. These changes in the SE+NLP group reflected medium-to-large effect sizes (e.g., $\eta_p^2 \approx .20$), indicating meaningful practical impact.

Within-Group Pre-Post-Intervention Analysis (Satisfaction)

The multivariate contrasts showed that there were significant pre-post differences in the SE+NLP group: Λ Wilks = .691; $F(9, 57) = 2.829$; $p = .008$; $\eta_p^2 = .309$; $SP = .933$. However, these differences were not found in the NLP group: Λ Wilks = .681; $F(9, 57) = 1.209$; $p = .319$; $\eta_p^2 = .319$; $SP = .945$.

The comparisons in pairs between the different phases of the study are presented for each group (Table 5). For the SE/NLP group, significant differences in favor of the post-intervention phase were found in teaching ($p = .013$), relaxation ($p = .016$), interaction with others ($p = .011$), fun and enjoyment ($p = .004$), mastery experiences ($p = .001$), and diversionary experiences ($p = .019$). No differences were found in cognitive development and normative success. For the NLP group, significant differences in favor of the pre-intervention phase were found only in teaching ($p = .009$). Significant improvements in several satisfaction variables for the SE+NLP group also showed medium-to-large effects (e.g., $\eta_p^2 \approx .30$), supporting their practical relevance.

Discussion

The basic goal of the present study was to assess the impact of a hybrid SE+NLP program, in comparison to a single NLP program, on pre-service teachers' motivation and satisfaction during their initial training. Results showed significant improvements only in the students that experienced the hybrid program.

The initial hypothesis was that SE would be a beneficial addition to the single model, and results confirmed it. Regarding the first dependent variable, motivation, only participants in the hybrid group significantly increased their intrinsic motivation (autonomous motivation) and significantly decreased their amotivation after the intervention program. Previous studies showed that learning scenarios that support autonomy could be achieved using SE (Wallhead & Ntoumanis, 2004). However, this is the first study conducted in a university PE program with pre-service teachers. Students' roles have been identified as essential to help students gain control over the class, promoting

their feelings of autonomy (Perlman, 2011). According to the SDT (Ryan & Deci, 2017), autonomy is promoted if teachers take the students' perspective into consideration, allowing them to choose some aspects of the process. In the hybrid SEM+NLP program, students chose three roles both in the learning phase and formal competition, which probably favored the increase in their feelings of autonomy support (MacPhail et al., 2008). Findings from the present study reinforce the effectiveness of SE in promoting students' choice in sport units (Perlman, 2011). In addition, through NLP, modified games (SSG; small-sided games) create learning environments in which students develop decision-making processes. Consequently, through SSG, teachers can also promote students' on-task autonomy, facilitating their active exploration of a landscape of available individual and collective affordances to provide opportunities for potential performance solutions (Chow et al., 2015). A recent meta-analysis showed that the more autonomous forms of motivation, characterized by enjoyment and valuation of the activity, are likely to appear when students feel that there is an environment that supports their BPNs such as autonomy (Vasconcellos et al., 2020).

Regarding the NLP group, results did not change after the intervention. Previous research indicated that in some single GBA implementations in educational contexts, it was difficult to observe participants' skill development and tactical awareness (Harvey & Jarrett, 2014). In hybridizations, this problem was addressed by having students perform the role of student-coach, where the learning environments were co-designed (Woods et al., 2021). This could be the reason why the hybrid SEM+NLP program produced better results than the single NLP model program (González-Víllora et al., 2019). These positive outcomes are supported by medium-to-large effect sizes, underscoring the practical educational value of the hybrid SE+NLP model. Thus, results indicate that there is a need to add SE to GBAs (e.g., NLP) to increase students' intrinsic motivation and decrease their amotivation.

Regarding *satisfaction*, the results showed that students in the SEM+NLP group significantly increased several variables after the intervention program: teaching, relaxation, interaction with others, fun and enjoyment, mastery experiences, and diversionary experiences. For the NLP group, no changes were observed, except a decrease in teaching. Regarding *teaching* and *interaction with others*, the results obtained are aligned with previous studies that found SE to be a context that allows for positive social connections between peers and with the teacher (Clarke & Quill, 2003) and comfort in speaking with classmates and with teachers (Kinchin & O'Sullivan, 2003). This could be attributed to the use of consistent teams and fair play guidelines, key elements in SE (Perlman, 2011). The appropriate guidance of the whole process by the professor,

focusing on the students' roles being performed correctly, could also explain the increase in the *teaching* dimension (Leo et al., 2020). Furthermore, the professor interacted with the students who performed the coach role, guiding the teaching-learning process, where interrogative feedback had critical importance. In contrast, there were no changes in the NLP group. These results are aligned with the methodology used (NLP), which focuses on *in situ* learning without emphasis on declarative knowledge. The students in this group probably solved the game situations without interacting with the professor and/or reflecting on their own learning with others (Chow, 2013). Thus, these results seem to indicate that the teacher should interact with students and use interrogative feedback whenever possible.

Relaxation, fun, enjoyment and diversionary experiences are terms that represent similar ideas, and they all increased only after experiencing the SE+NLP model. Previous literature indicated that enjoyment can be promoted through SE when students perform fun roles (e.g., mascot), which can enhance students' creativity and enjoyment through priming strategies (Sassenberg et al., 2017). In addition, SE includes a final event or festivity, which represents a closure based on fun and recognition for the work carried out throughout the program (Siedentop et al., 2019). Therefore, SE added value a plus to the NLP program, expanding its effects in the participating pre-service PE teachers.

Regarding *mastery experiences*, the results obtained in favor of the SE+NLP group, could be explained by the transfer of autonomy from the teacher to the students to lead tasks throughout the lessons, since performing roles such as coach or fitness leader has been found to increase participants' learning (Wallhead & Ntoumanis, 2004). Thus, it is recommended to allow students to lead tasks in order to foster mastery experiences. On the other hand, the main objective of SE is to develop cultured and competent sports individuals (Siedentop et al., 2019), and the results from the present study indicate that students felt that they learned (mastery experiences) only in the SE+NLP group.

SE has been identified as a signature pedagogy (Hordvik et al., 2017), in which pre-service teachers adopt the role of students to "live the curriculum" (Oslin et al., 2001). Signature pedagogies such as SE educate future PE teachers to think, perform and act with integrity in their profession (Shulman, 2005). The results of the present study indicate that SE can be added to NLP to produce positive changes in the initial training of future PE teachers (e.g., intrinsic motivation, interaction with others, enjoyment, mastery). Thus, if we want in-service PE teachers who can correctly implement pedagogical models such as SE in the future, we need to train them properly in college by bridging the theory-practice gap (Parker et al., 2016) and

moving from the surface structure of signature pedagogies to the deep and implicit structures (Shulman, 2005) to produce significant changes in teacher training and meaningful impacts in students. Baseline differences in motivational variables were detected between groups. Although the MANOVA interaction analysis helps isolate change over time, these initial disparities may have influenced the magnitude of the effects. Therefore, the results should be interpreted with caution.

Conclusion

The results from the present study indicate that SE can be added to NLP, increasing pre-service PE teachers' autonomous motivation and satisfaction with their classes. Thus, to generate a favorable learning environment that involves students in decision-making and promotes their autonomy and leadership, PE teachers should use strategies such as allowing students to perform roles like coach or fitness leader (i.e., leading tasks), and using interrogative feedback and small-sided games to practice the sport. To our knowledge, this is the first study to combine SE and NLP. The combination of these consolidated pedagogical approaches opens unexplored lines of investigation for researchers and new teaching perspective for practitioners.

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Towards Predictive Analysis of Behavior and Sports Using LINCE PLUS 4 Software

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High jump athlete in mid-flight, performing the Fosbury Flop technique with maximum extension and control over the bar.
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Abstract

The evolution of new technologies and the rise of artificial intelligence are already affecting how we carry out everyday tasks. Until now, developing a systematic observational study has been an intense and demanding process for researchers, and there seem to be few tools available that ease this workflow. Moreover, most artificial intelligence applications rely on quantitative data, and there are not many systems that enhance the research process for behavior analysis or sports technique analysis within a mixed-methods approach. Over the past two years, we have been working towards this horizon with LINCE PLUS 4, which we now present in this scientific note. This new framework optimizes the overall process, introducing a bridge to cloud-based features and the integration of artificial intelligence within a modern web environment. The new video player for real-time analysis and slow-motion detection includes measurement tools and 2D/3D body-pose detection, enabling a new system that integrates sensor data.

Keywords: artificial intelligence, behavior research, mixed methods, open source, sports analysis, systematic observation

Background

With so many technological complexities involved in using a single software solution that supports all stages of the research process, LINCE PLUS introduced a new tool for conducting systematic behavior analysis in a multipurpose environment. It offers real-time video features for any video format and supports multiple observers within a web-based platform, using a flexible video player and integrating statistical tools such as R on both macOS and Windows (Soto-Fernandez et al., 2019). Multiple observers can evaluate different behavioral episodes across several well-established fields of application, including health, sports, physical activity, and physical education (Soto-Fernandez et al., 2022).

A considerable number of publications validate our software (Chacón-Moscoso et al., 2019), with a presence across practically the entire spectrum of physical activity and sport, but our pace for introducing new features has been limited, and many of them remain overlooked or unknown. On the other hand, it is remarkable how LINCE PLUS stands out as a video annotation tool and is considered, alongside Kinovea, Dartfish, and Observer XT, one of the best annotation tools currently available in the market, with LINCE PLUS and Kinovea being the only options that are free of cost (Fernandes et al., 2025; Leysens et al., 2025).

Existing Foundational Features

Despite the software's multifunctionality and ease of use, many of the features introduced in LINCE PLUS remain unknown to the community, as they appear to be underused. One of the least-known features is that the software allows users to select videos from remote sources such as YouTube, enabling the integration of video streaming with real-time analysis for live-streams. For previously recorded videos, users can upload files in any format, and the platform will automatically convert them to a specific compression to improve performance under the MP4 format thanks to the integration of the FF-MPEG library (Made et al., 2024).

Another point of interest is that LINCE PLUS can be integrated with any other coding platform on the market, such as the R programming language (Ihaka & Gentleman, 1996) or RStudio for statistical analysis. Users can also extend its functionality by incorporating the data into real-time Python applications for artificial intelligence, BI (Business Intelligence) software for data consolidation, or even Office tools through macros, thanks to its REST API-based core. Nevertheless, these features are generally intended for advanced users. At the same time, this API-first approach has laid the foundation for transitioning toward a cloud-native architecture.

Since version 3.2 of LINCE PLUS, we introduced a very important feature that remains robust but relatively unknown: extensibility. LINCE PLUS incorporates Inversion of Control to determine the engine it uses, making the platform fully extendable through interface-driven development, being a well-known feature to improve maintainability in the long term (Yadati, 2023). In fact, the core of the application ensures a layer for common logic across the different stages of the research process, which is shared between our new cloud service, available at <https://www.lince-plus.com>, and the desktop application.

Features

As this article reports on the technical development and architectural design of the software platform LINCE PLUS and does not present data collected from or involve human subjects, formal ethical committee approval was not needed.

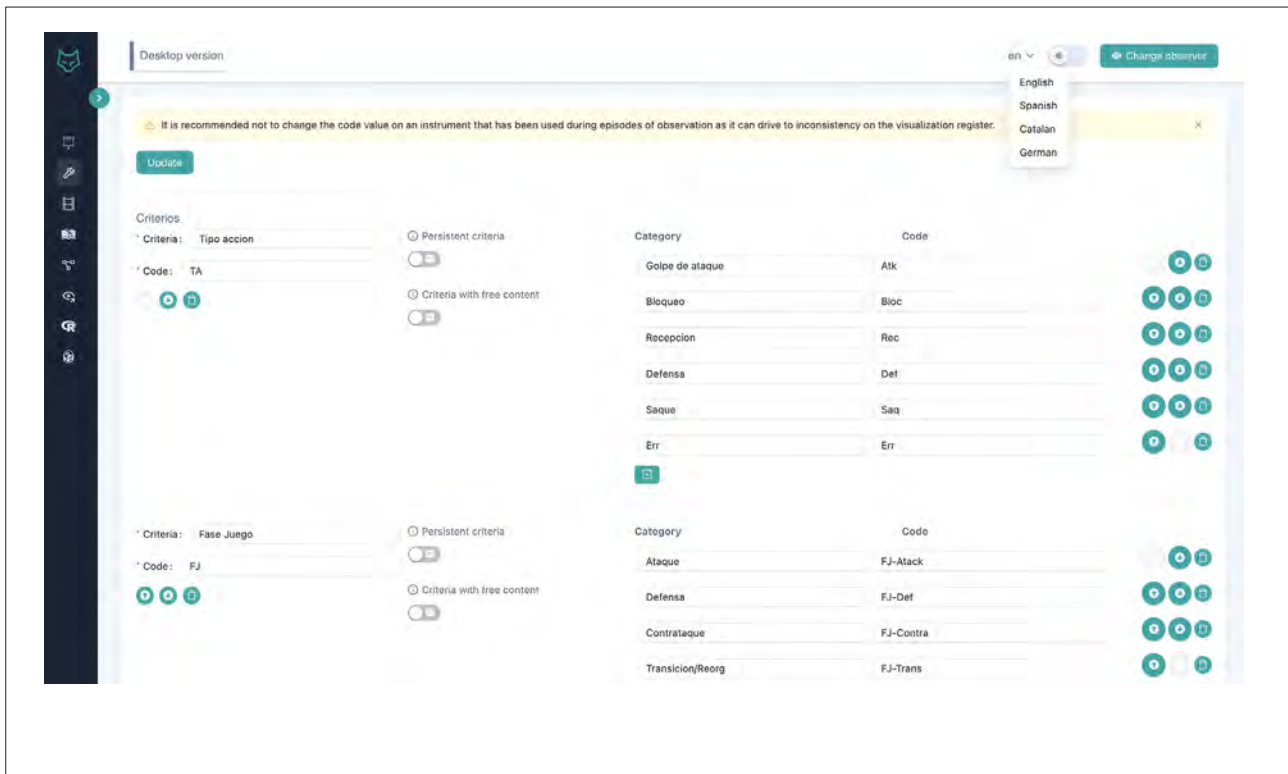
With this solid and professional environment for supporting the research process, we recognized the need to strengthen and adapt our software to emerging market trends. There is a growing demand for tools that integrate artificial intelligence (AI) as an additional means of extracting and interpreting data, with AI being a way of working that can specifically help in mobile applications and health analysis (Almanasra, 2024). To make this possible, we redesigned the entire front end, giving the application improved usability and facilitating the integration of the various functions required in a cloud-native ecosystem—such as secure authentication. This evolution can be summarized through the following key advancements: cloud-native, new look and feel, opening external collaboration, and a new custom video player.

Cloud-Native

Although LINCE PLUS seems like a desktop application, it also launches a microservice that can be hosted online. This design allows the same application to run either on the internet or locally without major complications. In addition, the application now compiles and tests automatically during the build process, which is an important improvement compared to the previous manual steps required to build for each platform. This enhancement has strengthened our build workflow on the cloud, with the generation of an automated installer for the different supported computers and performing some consistency tests, ensuring that users do not encounter unexpected errors and improving the reliability of the application (Gami et al., 2025).

Figure 1

The new redesign has the same way of using and is available in English, Spanish, German and Catalan



New Look and Feel of the Application

When we created the proof of concept for the cloud service at lince-plus.com, we noticed that users were already registering before the platform was fully ready. This highlighted several issues with running the current application on the web, including slowness, maintenance challenges, and translation concerns. The new user interface was designed to closely resemble the previous one, allowing users to start interacting with minimal learning. We also aimed to eliminate the need to duplicate work when switching between the cloud service and the desktop application. The new design consolidates these efforts, using the latest React patterns, ESBuils, and NX for a standardized mono-repo, providing a solid foundation for the long-term features, offering unified versioning and a single source of truth (Potvin & Levenberg, 2016). The same environment adapts seamlessly for both desktop and cloud.

External Collaborators

Previously, collaborative observational studies could only be accessed using a QR code generated at the application's startup. However, this required users with the code to be connected to the same local area network (LAN) or intranet, a significant limitation for external collaboration. In the

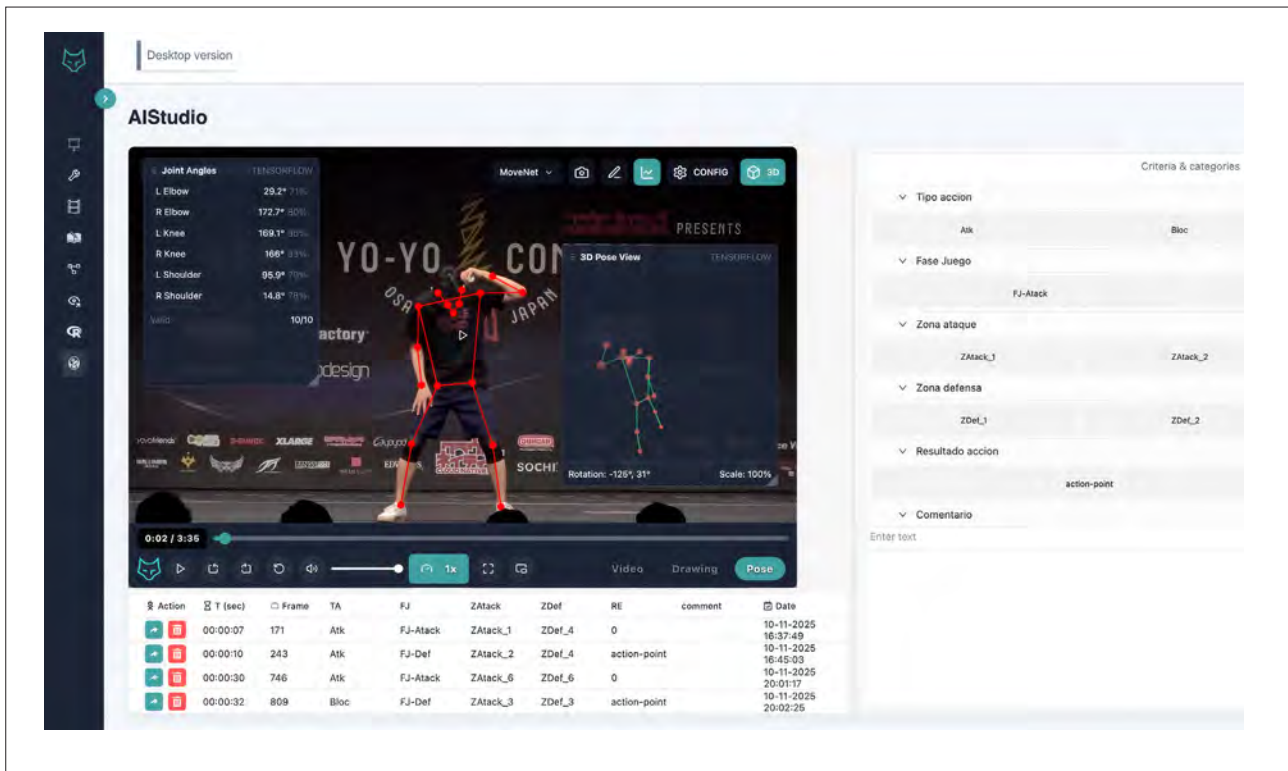
latest release, we have integrated Ngrok, a secure tunneling service that allows the LINCE PLUS desktop application to be temporarily exposed to the public internet via a temporary public address (Karunamurthy et al., 2024). While the QR code sharing mechanism remains the same, it now facilitates robust remote access until the application is closed or the tunneling feature is manually disabled. This architecture enables the external sharing of user projects through a secure token generation mechanism.

Lince Video Player With AI Features

A primary objective for the latest release of LINCE PLUS was the integration of artificial intelligence (AI) capabilities into the application's core architecture, representing a key focus since our previous collaboration. This development addressed the need to incorporate wearable sensor data by generating new data layers within the observation episodes. We initiated this by integrating quantitative data streams into a newly developed custom video player. This player retains all traditional video execution functionalities but introduces a new operational mode allowing users to perform on-screen annotation or activate custom AI models for features like human pose detection. This capability provides novel tools for the measurement of kinematic

Figure 2

The new video player estimates 3D pose with custom AI features, including drawing capabilities



variables, including the estimation of joint angles and body segmentation calculation from the model detection and performance or body composition analysis from wearable data.

Pose estimation is a field of active research, with models such as OpenPose, PoseNet, and MoveNet being widely utilized for their high accuracy (Jo & Kim, 2022). This approach offers significant advantages over traditional motion capture (MoCap), which typically requires complex body markers, specialized multi-camera setups, and extensive post-processing. In contrast, pose estimation can be applied to naturalistic motion in real-time scenarios without compromising recognition capabilities (Takeda et al., 2020).

Our new video player leverages this technology to estimate and generate a 3D kinematic model derived directly from the pose detection output. A key feature is the ability for users to select the optimal pose recognition model for their specific observational needs. The initial release supports both MoveNet and BlazePose, which represent recent additions to validated pose estimation models and have demonstrated strong performance in clinical studies for diagnosing musculoskeletal disorders, tracking rehabilitation progress, and analyzing various sports movements (Roggio et al., 2024).

We plan to integrate additional models as we refine the integration tool and expand model support. This flexibility allows users to customize the trade-off between speed and accuracy and select between single-pose and multi-pose detection algorithms. Furthermore, the architecture supports the incorporation of custom models trained for specific sport actions.

The application features a new video player which enhances core capabilities, including native support for streaming video content hosted on platforms such as YouTube. Plans are underway to enable integration with other streaming providers. Crucially, this player is designed to facilitate the synchronous integration of quantitative data layers directly onto the video stream and also to export them to episodes of observation. This capability establishes a novel framework for integrating derived measurements, such as angle estimation, and raw input from wearable sensor data directly within observational studies.

From a practical point of view, these features allow for easy integration into the observational model, enabling aspects such as body angles and center of mass calculations to be included in the observational record. In addition, although not available at the time of writing, object detection will be enabled. These capabilities will have direct application in sports practice, facilitating biomechanical calculations.

Results

The latest release of LINCE PLUS introduces core architectural advancements for enhanced collaboration and AI-driven analysis. Remote access limitations were resolved by integrating a secure tunneling service, enabling the application to be temporarily exposed to the public internet via a temporary address, thereby facilitating the external sharing of observational projects using QR code and token generation. A new video player was implemented, providing native support for online streaming platforms and establishing a critical framework for the synchronous integration of quantitative data layers. This player allows users to overlay video content with derived measurements, such as angle estimation and wearable sensor data. Furthermore, it incorporates custom AI models for real-time human pose detection, generating a 3D kinematic model from naturalistic motion. The program still has some limitations, such as the consistency of the record in case of modification, complex exports and missing accuracy on the integration with other systems. We also have the limitation that these AI capabilities are not yet automatically integrated with the observational record. For this purpose, we recommend manually entering the information in a free-form field, which allows any value to be recorded in text format. However, it is expected that this process will soon be automated.

On the other hand, we must bear in mind that current technological advances facilitate software development at a much faster pace, and similar applications are expected to emerge. Therefore, the main limitations are the time required for development and the investment needed to bring a product to market. It should also be noted that the validation of artificial intelligence models is rapidly evolving, and their scientific justification remains open to debate, although their practical applications is a point of clear interest.

Conclusions

These features improve LINCE PLUS from a primarily local data recording tool into a powerful, secure platform for global, multimodal, and AI-assisted scientific analysis, significantly accelerating the pace and scope of observational research. It offers a new way of working and will be generating new features, while some of them will be directly available for cloud users and others remain as a foundation for desktop users. With this new

foundational level, we will begin developing the integration of quantitative data and offer updated and secure integration for behavior analysis.

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Observational methodology and its application within a mixed-methods approach have been the core focus of our research team since 1979. The development of the foundations of Observational Methodology in the 1990s is largely attributed to the late Dra. M. Teresa Anguera, who established a comprehensive theoretical, strategic, and technical framework for understanding all types of human behavior in natural contexts. She led the development of the LINCE (2012) and LINCE PLUS (2022) software, which focus on the direct and indirect observation of physical activities, sports, and related health fields. Her innovative vision guided us toward the use of video and its multiple applications as a fundamental tool for studying interactions in sports. We now present the new and improved version 4 of LINCE PLUS as a tribute to her legacy and generosity.

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