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ARTICLE

Physical Education Teacher Education Students' Perceptions of Competencies for Sustainable Development in Their Degree Program

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Abstract
In an era marked by mounting global challenges, education is often envisioned as an agent of transformative action towards a more sustainable future. This research seeks to delve into the students' perceptions concerning competencies for sustainability in Physical Education Teacher Education. Adopting a qualitative approach, a non-probabilistic purposive sample of 57 students (35 males, 22 females, mean age: 21.2 ± 3.2 years) was recruited. Data collection comprised semi-structured interviews. Analysis was facilitated through Atlas.ti v.7.5.18, abiding by established qualitative research paradigms. Participants emphasised the intrinsic value of an interdisciplinary approach. The study discerned a strong inclination towards cooperative and introspective tasks. Moreover, this exploration offers valuable insights for academic institutions, suggesting integrative strategies for environmental education. Therefore, these findings invite to adapt curricular designs, ensuring that educators are aptly prepared to respond the multifaceted challenges of the 21st century, driving our collective stride towards a sustainable, equitable future.

Keywords: Formation; PETE; physical activity; SDG; sustainability; university

Introduction

The concept of sustainable development has gained significant attention in recent decades as societies should seek to balance environmental, social, and economic challenges (United Nations General Assembly, 2015). While sustainable development is widely promoted as a guiding framework, it is not without its complexities and critiques. Scholars have pointed to the risk that sustainability efforts become superficial, focusing on meeting predefined goals rather than addressing the deeper structural changes necessary for long-term transformation (Glavič, 2020).

One of the most pressing issues associated with sustainability is climate change, which has far-reaching implications for ecosystems, economies, and human well-being (IPCC, 2021; Romanello *et al.*, 2022). However, sustainability challenges extend beyond environmental concerns. Social and economic inequalities persist, with significant disparities in access to education, healthcare, and economic opportunities (Halkos & Aslanidis, 2023).

The rapid expansion of sustainability research in recent years highlights the need for continuous updates to theoretical frameworks in education and sustainable development (Global Council for Science and the Environment [GCSE], 2023; Lozano *et al.*, 2024). While classical

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models such as Wiek, Withycombe, and Redman (2011) remain widely referenced, recent research has sought to refine and expand these approaches (Byers *et al.,* 2024). Moreover, UNESCO reports have evolved since 2015, introducing new strategies and guidelines to enhance sustainability education (2023b, UNESCO, 2023a).

Given these challenges, education has been identified as a crucial means of fostering awareness, critical thinking, and agency in addressing sustainability (Rieckmann, Mindt & Gardiner 2017). Yet, integrating sustainable development into educational systems is not a straightforward process. While policies increasingly emphasise sustainability, there is an ongoing debate about how educational initiatives can move beyond symbolic commitments to promote meaningful engagement and structural change (Smaniotto *et al.,* 2020).

In this context, physical education (PE) offers a unique space to explore sustainability from a holistic perspective, considering not only environmental aspects but also social and health-related dimensions (Baena-Morales & González-Víllora, 2022). This study examines how sustainability is approached within PE and how educators navigate the opportunities and limitations of integrating sustainable development into their teaching practices. By critically engaging with the role of education in sustainability, this research contributes to a deeper understanding of how sustainability can be meaningfully embedded in pedagogical contexts.

Educating for a more sustainable future through higher education

Education for sustainable development (ESD) is a pedagogical approach that seeks to promote the learning of knowledge, skills, values and attitudes needed to address the challenges of sustainable development at all levels of education (Rieckmann *et al.,* 2017). However, its implementation raises several concerns. One major issue is that ESD often assumes a shared understanding of sustainability, despite its inherently political and contested nature (Kopnina & Meijers, 2014). In practise, sustainability is frequently framed within existing economic and technological paradigms, reinforcing rather than challenging unsustainable structures (Sterling, 2010). Another challenge is that ESD initiatives focus on integrating sustainability into curricula but lack the institutional support needed for deeper, transformative learning (Huckle & Wals, 2015).

While ESD alone cannot resolve sustainability challenges, every stage of education is important in the formation of conscious and committed citizens. Here, higher education plays a crucial role in advancing ESD. Universities contribute by reorienting curricula, developing innovative teaching approaches, and preparing future professionals who will integrate sustainability into various sectors (UNESCO, 2007). In this regard, higher education marks a transition period in which young people acquire specialised knowledge and professional skills that they will apply in their respective work fields. Moreover, during higher education, students gain greater autonomy and responsibility, which allows them to reflect on their role in society and make more informed and ethical decisions (Cebrián & Junyent, 2015). But it is not only technical learning that takes place; this formative period also offers opportunities to develop soft skills, such as the ability to work in teams, communicate effectively, solve complex problems, and adapt to different contexts and situations (Greenberg & Nilssen, 2015; Scheerens *et al.,* 2020). These skills are essential for addressing the interdisciplinary and multifaceted challenges of sustainable development, which require innovative and collaborative solutions. They are understood as competencies, which prepare future citizens and professionals to face global challenges and contribute to a more sustainable future.

Despite highlighting the role of ESD in higher education for promoting a more sustainable and equitable future, universities often focus primarily on the development of specific hard skills, such as technical knowledge and expertise in a particular field. While these skills are crucial, they are not enough to face with the multifaceted challenges of sustainable development. It is necessary to complement them with soft skills and generic competencies, which allow students to apply their knowledge effectively and adapt to different contexts and situations. Soft skills and generic competencies, in turn, have the characteristic of not being linked to a specific field, but are

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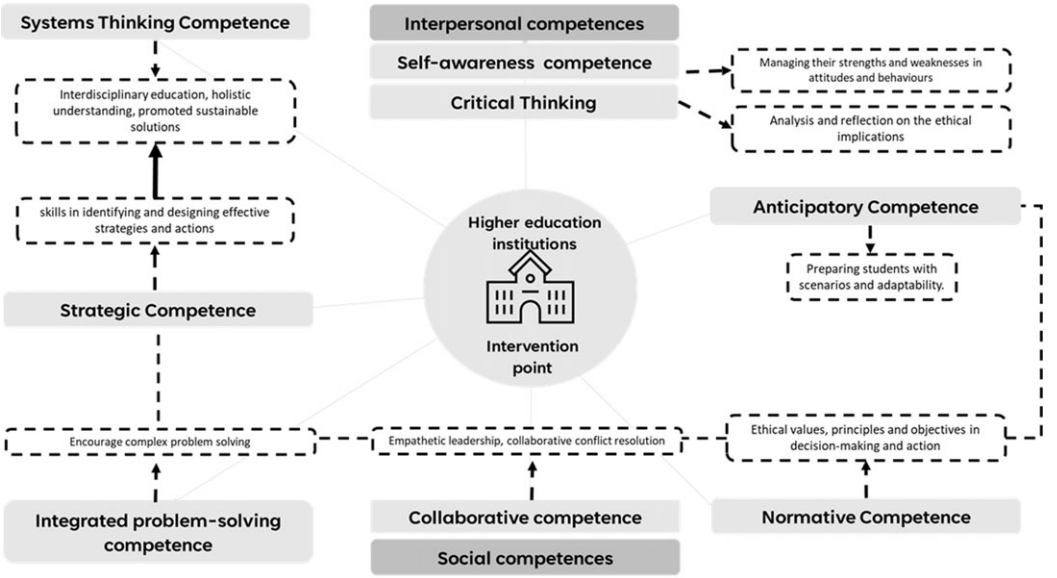


Figure 1. Sustainable development competencies: a flowchart for higher education adapted from Wiek *et al.,* 2011.

transferable between different areas of knowledge and professions. These skills facilitate collaboration, innovation, and informed and responsible decision-making, key elements for addressing the challenges of sustainable development (Costa & Cipolla., 2025). Under this competency-based approach and within the framework of ESD, a series of competencies have been developed that are considered essential for implementation in our teachings if we want to contribute to sustainability. In this regard, Rieckmann (2018) points out the existence of eight competencies for sustainable development, classified into interpersonal and social competences, some of them similar to the proposal made by (Wiek *et al.,* 2011) (see Figure 1).

The sustainability competency framework proposed by Wiek *et al.,* (2011) serves as a foundational model, emphasising the interconnection between key sustainability competencies. Building on this theoretical foundation, UNESCO (2017), through Rieckmann's work, provides an updated and applied perspective on these competencies, refining their relevance for educational contexts. Given its more recent examination and alignment with educational assessment frameworks, the UNESCO (2017) model was selected for the methodological approach presented in Table 1. This study acknowledges the complementarity of both frameworks, where Wiek's model offers a conceptual basis and UNESCO's adaptation extends its applicability in educational settings

By fostering the development of these competencies in higher education, we can prepare students to tackle the challenges of sustainable development effectively and responsibly in their future professions and daily lives. This entails the need for universities to adjust their curricula, pedagogical approaches, and extracurricular activities so that the competencies for sustainable development are coherently integrated into students' training (Costa & Cipolla, 2025). However, the essential role of educational interventions specific to an area of knowledge in developing competencies for sustainable development cannot be underestimated. While it is vital to promote generic skills and competencies, it is also crucial to adapt pedagogical strategies and content to the specific characteristics and needs of each discipline. For example, addressing ESD in environmental sciences, chemistry, or other scientific disciplines will require different approaches than those used in areas as unique as PE. This adaptation allows students to better understand how to apply sustainability principles and practices in their particular field. In this framework of specialisation is where the benefits of PE are particularly relevant, as previous literature indicates

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Table 1. Meta-categories used in the study based on UNESCO's competency approach (UNESCO, 2017, p.10)

Meta-category	Definition
Critical thinking	Abilities to question norms, practices, and opinions.
Systemic thinking	Capacities to recognise and understand relationships and analyse complex systems.
Normative competence	Talents to understand and reflect on the norms and values that underlie our actions and negotiate them.
Integrated competence	Proficiencies to apply different problem-solving frameworks to complex sustainability problems, integrating the rest of the competencies.
Collaborative competence	The skills to learn from others; to understand and respect the needs, perspectives and actions of others (empathy); to understand, empathise and be sensitive to others (empathetic leadership); to deal with conflict in groups; and to facilitate collaborative and participatory problem-solving
Strategic competence	Expertise to collectively develop and implement innovative actions that promote sustainability at the local level and beyond.
Self-awareness competence	Aptitudes to reflect on the role each person has in the local community and society.
Anticipation competence	Skills to understand and evaluate multiple future scenarios and assess the consequences of action

its potential to develop these competencies (Baena-Morales *et al.,* 2021; Fröberg & Lundvall, 2022; Lohmann, Breithecker, Ohl, Gieß-Stüber & Brandl-Bredenbeck 2021; Lohmann & Goller, 2022).

Developing competences from physical education in university teaching

PE, often not perceived as an area directly related to sustainable development, has significant potential to develop the competences mentioned above (Baena-Morales & González-Víllora, 2022; Fröberg & Lundvall, 2022; Lohmann & Goller, 2022). Firstly, PE can contribute to the promotion of healthy lifestyles, which in turn can have a positive impact on public health and quality of life (Marquez *et al.,* 2020), which aligns with sustainable development goal (SDG) 3 (Good Health and Wellbeing) (World Health Organization, n.d). In addition, sport and outdoor physical activities can foster a connection with nature and respect for the environment, which in turn can raise awareness of the importance of sustainability (Peltzer, 2010; Rosa *et al.,* 2018). PE can also be a space to develop soft skills, such as teamwork, communication, conflict resolution and leadership, which are essential to address the challenges of sustainable development in a collaborative and interdisciplinary way (Azzarito *et al.,* 2017; Dyson & Casey, 2012; UNESCO, 2015). For example, team sports can teach students to cooperate, share resources and make ethical and responsible decisions in competitive situations (Lindsey & Chapman, 2017; MINEPS VI, 2017). In addition, PE can integrate sustainability concepts and practices in its programmes and activities, for example the responsible use of resources or the self-construction of materials (Bofill-Herrero *et al.,* 2022), the promotion of sustainable means of transport (Toftager *et al.,* 2011) or the organisation of activities framed around helping disadvantaged sections of society through service learning (García-Rico *et al.,* 2021). These initiatives can serve as practical examples for PE students to understand and apply the principles of sustainability in their daily lives and future professions. In summary, it is essential to adapt educational interventions for sustainable development to the specific needs and characteristics of each area of knowledge (Boned-Gómez, Ferriz-Valero & Baena-Morales, 2025). Therefore, in the previous literature, PE is showing potential to contribute to the three dimensions of sustainable development and the SDGs.

However, there are not enough studies to inform educators on how to develop competencies for sustainable development within the context of PE. Among the previous works, those that adopt a

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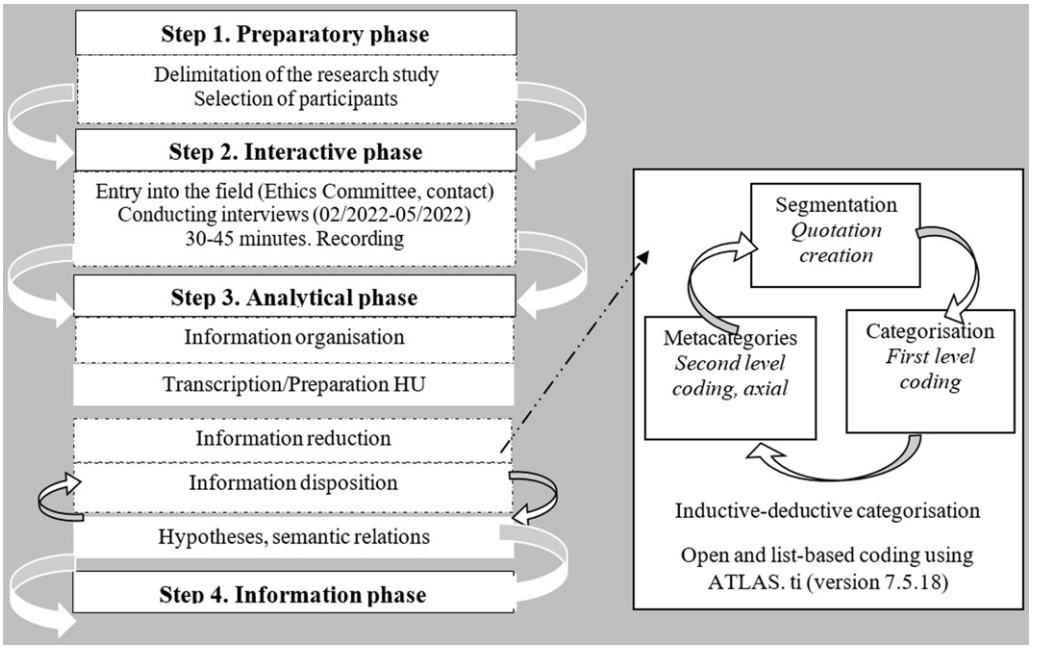


Figure 2. Research procedure.

theoretical perspective stand out (Baena-Morales *et al.,* 2022; Lohmann *et al.,* 2021; Lohmann & Goller, 2022), but none have collected and analysed the voices of Physical Education Teacher Education (PETE) students. Thus, the overall objective of this study is to describe the PETE students' perspectives on the teaching practices required to work on competencies for sustainable development.

Materials and methods

Context and participants

The participants in this study are students in the second year of the bachelor's degree in Physical Activity and Sport Sciences. It is a non-probabilistic purposive sample (Bisquerra, 2004). An invitation was sent out to 82 students, and 57 finally took part, 35 men and 22 women, with an average age of 21.2 ± 3.2 years. This study was conducted in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments. Ethical approval was granted by the Ethics Committee of the University of Alicante (reference code: UA 2024 10 01_2).

Research design and information collection: instrument and procedure

The research procedure from the preparatory phase (step 1) to the information phase (step 4) is summarised in Figure 2.

Within the framework of an interpretive paradigm, a qualitative approach was used to describe the PETE students' perspectives on the teaching practices required to work on competencies for sustainable development. To conduct the study, and in accordance with the research project approved by the Ethics Committee of the reference university (XXX), a single information collection instrument was used, corresponding to the protocol for the development of an in-depth interview. This is a semi-structured interview, designed based on the competencies associated with sustainable development. The interviews were conducted in the facilities of the Faculty of Education, on a date and time agreed with the students. All interviews were conducted by an experienced researcher,

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Table 2. Interview questions on sustainable development competences

Interview questions
How could critical thinking be improved during PETE?
How could systemic thinking be developed during PETE?
How could the anticipation competence be enhanced during PETE?
How could the collaborative competence be expanded during PETE?
How could the normative competence be improved during PETE?
How could the strategic competence be improved during PETE?
How could the self-awareness competence be established during PETE?
How could problem-solving competence be integrated during PETE?

ensuring consistency in data collection. The participants received the presentation and explanation of the research objectives and the definitions of each of the competency integrating the interview, in order to clarify any conceptual doubt (see Table 1). Then they were invited to volunteer, and written permission was requested to record the interview with an audio system for later analysis.

First, the interviewee was asked to indicate their age, and after, the open-ended questions from Table 2 started, on which the interviewer requested clarification based on the participants' responses, ensuring the achievement of the research objectives.

In accordance with the criteria identified by Martín (2011), the validity of the interview was ensured by considering multiple factors: the expertise and neutrality of the interviewer, the structure and consistency of the interview process, and the credibility and authenticity of the participants' responses. More specifically, the interview protocol was pilot tested to refine question clarity and flow, enhancing the reliability of data collection across interviews. The interviewer, trained in qualitative research methods and experienced in conducting interviews in the research area, maintained a neutral stance to minimise bias and ensure unbiased data collection. The interviewer also maintained a consistent structure throughout the interviews and conducted member checking to ensure that the interpretation of the statement accurately reflected the participant's intended meaning.

Data analysis

According to Figure 2, the information analysis was conducted using the program, Atlas.ti v.7.5.18. For this purpose, the usual phases of the qualitative analysis process (Miles *et al.,* 2020) were followed, including organisation, reduction, and disposition of the information. The categories and meta-categories used in the analysis were of a mixed nature (inductive-deductive), establishing relationships through semantic networks that function as a display of results. The analysis process was carried out independently by each of the researchers, contrasting the results to reach a joint conclusion, thus achieving triangulation by covering different perspectives on the same object of study (Flick, 2004). The categories used in the information analysis were all inductive in nature, at the first level of coding. All these categories were doubly coded, assigning a general code and a specific code for the competence for the second-level analysis and subsequent relationships. Once these categories were delimited, the meta-categories used, according to the research objective, were established (see table 1). All of them are deductive categories, based on the theoretical framework.

Moreover, while qualitative research primarily focuses on depth and richness of data, the frequency of mentions of specific ideas was considered as it provides a structured basis for interpreting their significance within the dataset. This approach enhances the interpretive process

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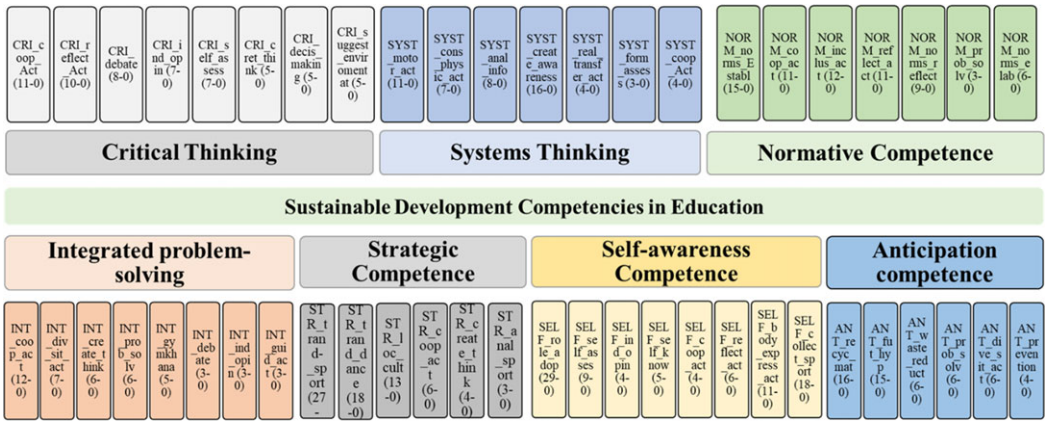


Figure 3. Ideas associated with the development of each competency in the context of physical activity.

by highlighting patterns and variations in participant responses, thereby enriching the qualitative analysis (Miles *et al.,* 2020).

To address the objective of this study, inductive categories derived from the analysis of each of the interview questions have been considered, which analytically correspond to a meta category or family of codes. Based on the competencies for sustainable development, the analysis resulted in a semantic network that reflects the relationships between the deductive meta-categories and the most frequent category within each meta-category.

Results

The semantic relationships identified through the analysis are visually synthesised in Figure 3. Below, the results are presented for each meta-category (e.g., critical thinking), with each category referenced in italics within brackets. For example, the category "Cooperative Activities" is referred to as (*CRI_coop_act*) and can be found in Figure 3, upper row, left hand. Finally, quotes are used to illustrate key ideas expressed by the participating students.

Critical thinking competence

In relation to the development of critical thinking competence, for which questioning norms, practices, and opinions, and reflection are presented as central elements, "Cooperative Activities" (*CRI_coop_act*) ($n = 11$) were most frequently mentioned by students. Some examples of statements were: "I would develop lessons where, in pairs or groups, [students] would be the main content creators" [P31], and "with group activities, introducing challenges and problems, and they, cooperating and dialoguing, have to solve them" [P33]. Sometimes, the students mentioned specific pedagogical techniques, such as "collaborative activities in groups, applying Aronson's puzzle" [P44]. Furthermore, in terms of mentioned frequency, the categories "Reflective Activities" (*CRI_reflect_act*) ($n = 10$) and "Debate" (*CRI_debate*) ($n = 8$) also stand out. For example, one student stated the following: "creating debate groups on the benefits obtained through physical activity, having students prepare a debate on a topic of their own interest so that they acquire reflection, discussion skills . . . " [P44]. Statements similar as this suggest that some students recognise distinct connections between opportunities for reflective activities through debates. Another strategy pointed out by the students as a way to develop critical thinking was "Problem-Solving" (*CRI_prob_solv*), linked to real-life situations, in a competency-based perspective, with some examples of statement being: "an activity where a real-life problem is

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posed that students must solve individually or collectively" [P19], and "[activities where the student] identifies the problem, investigates, asks questions, and finds, presents, and analyses the solution" [P52].

The remaining five categories that were less frequently mentioned were closely linked to each individual, with, for example, the expression of their "Individual Opinion" (*CRI_ind_opin*). In relation to this, some students suggested that: "after each activity, ask the students their opinion, why they liked it or why not" [P21]; and "ask questions where students can give their opinion" [P25]).

Systemic thinking competence

For developing the systemic thinking competence – that is, the skills to recognise and understand relationships in complex systems – the students in this study seem committed to "Creating Awareness" (*SYST_creat_awareness*) ($n = 16$) on both general and more specific aspects. Two statements in relation to this category were: "[activities that] lead to greater awareness to recognise and understand relationships" [P8], and "greater awareness in reducing the prevalence of chronic and non-communicable diseases" [P17]. Similarly, "Motor Activities" (*SYST_motor_act*) ($n = 11$) were mentioned frequently, some of them focusing on awareness-raising. This could be exemplified as some students emphasised the following: "encouraging the correct development of both gross motor skills (more complex movements such as jumps or turns) and fine motor skills (using the hands)" [P2], and that the: "aim will be to ensure the correct acquisition of motor skills in order to raise awareness" [P52].

Activities that promote the "Analysis of Information" (*SYST_anal_info*) ($n = 8$) and "Knowledge of the Consequences of Physical Activity" (*SYST_cons_physic_act*) ($n = 7$) also appear frequently. In relation to these two, some students suggested the following: "individually analysing each competence for sustainable development and seeing what we can do to combat them" [P20].

Normative competence

Regarding the normative competence, its development was perceived by the students as mainly associated with activities of "Establishment of Norms" (*NORM_norms_establ*) ($n = 15$). In this sense, the students indicate that they would "establish a series of norms in relation to inclusion, equal opportunities and coeducation, such as always having mixed groups or teams" [P11], also addressing the consequences of non-compliance. In relation to the latter, students stated that: "In sports, we learn to follow the rules because every time we break them, we get penalised in the game itself, which is enough not to break them" [P25]. The above category is also related with the (although less frequently mentioned) category "Elaboration of Norms" (*NORM_norms_elab*) ($n = 6$), which emphasises the construction of norms by the students themselves, exemplified as: "an invasion sport with a divided court through guided discovery, where an unknown sport is presented with a single rule, and from questions they are guided to put rules that make the sport more dynamic and entertaining to practise" [P6].

Moreover, among those with relatively high frequency, we find the categories "Inclusive Activities" (*NORM_inclus_act*) ($n = 12$), "Cooperative Activities" (*NORM_coop_act*) ($n = 11$), and "Reflective Activities" (*NORM_reflect_act*) ($n = 11$). For example, "Inclusive Activities" was addressed by one participant as follows: "It is important to promote activities in which no group feels discriminated against and avoid certain situations in which boys or girls benefit over each other. Games should be created in which all students can feel winners and it does not just depend on the ability of each one" [P4]). Overall, reflection was deemed a key element in the proposals, with more general ideas around the category of "Reflective Activities" and, more specifically, in relation to the category "Reflection on Norms" (*NORM_norms_reflect*), ($n = 9$) reflecting, for example, that students "should understand that there are a series of norms that must be followed within a group" [P33].

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Integrated problem-solving competence

For the meta category related to the integrated problem-solving competence, participants highlight "Cooperative Activities" (*INT_coop_act*) ($n = 12$) as the main activities, coinciding with other competencies described earlier, such as "using cooperative models to promote analysis, reflection, debate, and the formation of innovative and creative ideas, encouraging teamwork and decision-making in students" [P3], and "through cooperative learning methodology, group activities in which they learn with, from, and for other students" [P18]. Furthermore, "Activities in Diverse Situations" (*INT_div_sit_act*) ($n = 7$) are mentioned by the participants, paying attention to the creation of diverse contexts that involve problem-solving. In relation to this, one student stated: "generating different contexts of action where students in groups face different situations in different social contexts in which they have to find sustainable solutions" [P20]. Related with the description of the competence, "Problem-solving" (*INT_prob_solv*) ($n = 6$) was mentioned as an essential method, yet without elaborating more on specific principles or techniques, as were the need for working on "Creative Thinking (*INT_creat_think*) ($n = 6$). However, the most frequently mentioned specific techniques were "Gymkhana" (*INT_gymkhana*) ($n = 5$) and "Debate" (INT_debate) ($n = 3$). In relation to "Gymkhana," one student argued for the: "execution of a gymkhana, where students have to solve different tests, working as a team, to achieve the final objective" [P54].

Strategic competence

Regarding the development of skills related to promoting sustainability at all levels (local, national, and international), that is, the development of strategic competence, there is a clear trend towards more immediate activities. Several statements were assigned to the categories "Traditional Sports" (*STR_trad_sport*) ($n = 27$), "Traditional Dances" (*STR_trad_dance*) ($n = 18$), and "Local Culture" (*STR_loc_cult*) ($n = 13$). For example, one statement was: "teach and inform students about local products, dances, sports, and propose activities to promote this, such as in the Valencian community organising intramural Valencian ball tournaments since it is a sport linked to the community and its culture and that is increasingly falling into oblivion" [P16]. In addition, categories related to cooperation and creative thinking – "Cooperative Activities" (*STR_coop_act*) ($n = 6$) and "Creative Thinking" (*STR_creat_think*) ($n = 4$) – were present again, with examples of quotes being: "creating contexts and situations in which students must resolve collectively" [P20], and "working in groups or teams where they would have to use creativity and innovation" [P36].

Self-awareness competence

For the development of self-awareness competence, in other words, the development of the ability to reflect on our own place within a community, many suggestions of activities were assigned to the category "Role Adoption" (*SELF_role_adopt*) ($n = 29$). To exemplify, some students stated that: "I would organise the students in such a way that they go through all the roles and know the function of each one" [P15], and "they [the students] are asked to explain their role and importance in their team, their family, their club, their group of friends . . . " [P28]. In terms of mentioned frequency, the category of "Role Adoption" is followed by "Collective Sports" (*SELF_collect_sport*) ($n = 18$). Here, one student stated: "Practising team sports, for example, means that each player must perform their task correctly for their team to win" [P4].

Furthermore, in eleven quotes, reference to "Body Expression Activities" (*SELF_body_express_act*) were identified, such as "expression, music rhythm, feeling, emotions" [P12]), followed by the three other related categories: "Self-Assessment" (*SELF_self_assess*) ($n = 9$), "Reflective Activities" (*SELF_reflect_act*) ($n = 6$), and "Self-Knowledge" (*SELF_self_know*) ($n = 5$). Together, statements within these categories address the importance of self-reflection in

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exercises that prompt individuals to evaluate their role in society, as well as emphasise self-assessment of attitudes and actions, awareness of personal strengths and limitations, and introspection about activities that bring joy and fulfilment.

Anticipation competence

For the development of anticipation competence, students opt for the "Use of Recycled Materials" (*ANT_recyc_mat*) ($n = 16$) and the "Formulation of Future Hypotheses" (*ANT_fut_hyp*) ($n = 15$). Regarding the first category, the use of recycled materials is intended for the construction of new materials, a concept embedded within a pedagogical framework. One student stated: "the pedagogical model of self-construction of materials can be used" [P50]. As for the "Formulation of Future Hypotheses," one student addressed that: "the goal would be to create future scenarios to create their own visions of the future" [P29]. Thus, participating students believe that a future idea must be anticipated, including having students "imagine their perfect future idea" [P7].

Furthermore, related to "Use of Recycled Materials," students suggested "Recycling Activities" (*ANT_recyc_act*) (n=) and "Waste Reduction" (*ANT_waste_reduct*) ($n = 6$). According to the participating students, it is necessary to "carry out activities explaining the importance of taking care of the environment" [P50]. "Waste Reduction" is also exemplified with daily activities, such as "reducing pollution in cities by promoting the use of public transportation, such as trains, buses . . . " [P7]. In addition to these ideas more linked to an environmental approach, "Activities in Diverse Situations" (*ANT_div_sit_act*) ($n = 6$) and "Problem-solving" (*ANT_prob_solv*) ($n = 6$) were also frequently mentioned. In relation to these two categories, student stated that: "I would propose various modified and real situations in which they must act anticipating using the technical tools that have been worked on in the first sessions" [P20], and "present some current problems related to physical activity or anything else" [P43], respectively.

Discussion

The main objective of this study is to describe the perspectives of PETE students on the teaching practices required to work on competencies for sustainable development. To do this, an attempt was made to determine the associated ideas for working on each competency for sustainable development within the framework of university teaching. According to the different contributions from the participants, various strategies, methodologies, and content were shown that could develop competencies for sustainable development. This variety of strategies and activities proposed by the students to develop these competencies has contributed to building a structured knowledge framework. This framework supports the development of a pedagogical model in PE that systematically integrates sustainability principles into teaching and practices.

PETE students mentioned cooperative activities as the main strategy to promote critical thinking, which involves working in groups and facing challenges and problems together. The fact that the students' voices focused on the use of this type of methodology seems coherent since cooperative learning is one of the most used in PE (Dyson *et al.,* 2021). In addition, previous studies focused on the same population showed the benefits of working with the Jigsaw cooperative technique in order to develop goals associated with social SDGs (Botella, Baena-Morales, García-Taibo & Ferriz-Valero 2022). This preference for cooperative activities could indicate that PE students recognise the importance of working in teams to analyse and solve problems together, which could consequently stimulate critical thinking (Mcinerey & Fink, 2003). In addition, reflective activities, debates and problem solving linked to real situations are highlighted, as well as the expression of individual opinions and self-evaluation. These results also seem to be in line with those obtained in previous research where problem solving is recognised as a valid tool for developing students' critical thinking skills (Seibert, 2021). This could indicate how students are aware of the importance of enriching their ability to analyse and evaluate others'

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arguments to improve their own critical thinking. Regarding systemic thinking, on the other hand, the importance of raising awareness about sustainability aspects in conjunction with motor activities is highlighted. They also pointed out the importance of analysing the knowledge about the potential of physical activity on sustainability. Therefore, it seems to indicate how physical activity is perceived as the central axis of any awareness process for sustainable development that takes place within the framework of PE. This idea aligns with the goals and objectives of the subject, as motor skills, along with cognitive, social and emotional skills, have been indicated as the main tool to be used in the course (UNESCO, 2015). In this regard, integrating real-world applications, such as analysing the consequences of using active compared to motorised transport on harmful gasses emissions, can provide students with tangible examples of how individual choices contribute to broader sustainable challenges (Mizdrak *et al.,* 2019). Transferring this simple example to students in the form of an educational project could mobilise systemic thinking, as it would help them understand how individual actions (walking or biking to the university) interact in a complex system of consequences (greenhouse gas emissions).

In addition to critical and systemic thinking, students were asked how they could work on the anticipation competence. They highlighted the use of recycled materials, waste reduction, as well as the formulation of future hypotheses as the main strategies for developing the ability to evaluate probable future scenarios. The use of these types of strategies for reusing materials in PE is common due to the wide variety of materials used in this subject (2022; Méndez-Giménez *et al.,* 2022). This could also indicate that students are developing skills to anticipate and evaluate potential future scenarios based on their current actions. The awareness generated through an active methodology such as self-construction of materials could help develop the anticipation competence and awareness about waste reduction and reuse (Gardiner & Rieckmann, 2015). This competence could also be related to normative competence, understood as the ability to understand and reflect on norms and values. Normative competence is important for building direction and guidance on deliberative change (Wiek *et al.,* 2011). In this sense, students suggest establishing rules and reflecting on them when practising a sport or physical exercise, an idea that could be related to the development of values associated with sustainability (Baena-Morales & Fröberg, 2023; Fröberg & Lundvall, 2021). Transferring this idea to the educational reality, skills could be developed to understand and analyse the values and norms that govern their actions and those of their environment, in order to contribute to the demands of a more sustainable world. The elaboration of rules by the students themselves and the resolution of problems related to norms and values also promote the development of normative competence.

Finally, the development of strategic competence was pointed out as the need to implement actions that promote sustainability at all levels. This was understood by students as an opportunity to work on culture associated with motor skills, traditional sports, traditional dances, and regional games as the main strategies. The inclusion of traditional sports, traditional dances, and local culture in the PE curriculum demonstrates an understanding of the importance of preserving and promoting cultural diversity and local heritage (Saura & Zimmermann, 2021). On the other hand, in relation to self-awareness competency, it has been described as the ability to reflect on each individual's place within a community. In this sense, students suggest adopting a role, practising collective sports, and body expression activities. Furthermore, self-assessment, reflective activities, and self-knowledge are highlighted as relevant strategies. This leading role of formative assessment allows students to develop a greater awareness of their place within a community and how their actions affect others by adopting roles and participating in collective sports and body expression activities. Self-assessment and reflective activities allow them to know their own abilities, limitations, and responsibilities, which is essential for sustainable development.

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Foresight and limitations

The present study has provided valuable information on the perspectives of PETE students on the teaching practices required to work on competencies for sustainable development. However, during the data analysis, some interesting ideas emerged but were not addressed in detail, as they were not the main objective of the study. These ideas could be explored in future research to broaden our understanding of competencies for sustainable development in the context of PE. (1) Common categories in competencies: It was observed that some categories, such as reflective and cooperative activities, are repeated in different competencies. It would be interesting to investigate whether these common categories are fundamental to the development of all competencies and how these activities can be effectively integrated into PE teaching. (2) Specific versus general contents in competencies: Some competencies seem to have specific contents, such as recycling and traditional sports, while others appear to be a mix of more general issues or methods. Future research could explore whether this difference in specific and general contents is necessary or if all competencies could be addressed similarly in the field of PE. (3) Differentiation of competencies: It would be relevant to investigate whether PETE students actually differentiate between the various competencies for sustainable development and if it is necessary to do so when proposing interventions in the field of physical activity. Future research should evaluate whether current pedagogical approaches effectively address these competences or if adjustments are needed to enhance their integration into PE. (4) Effectiveness of competency-based interventions: Future research could examine the effectiveness of specific competency interventions in PE teaching and their impact on achieving the SDGs. This would allow educators and policymakers to better understand which approaches and strategies are most effective in promoting sustainable development in the context of PE. Therefore, future research could focus on analysing the common categories in competencies, the difference between specific and general contents, the differentiation of competencies, and the effectiveness of competency-based interventions in PE teaching. These studies could help further improve teaching practices and teacher training in relation to sustainable development in the field of PE.

The present study has provided valuable insights into PETE students' perspectives on the teaching practices required to address competencies for sustainable development. Further research in these areas could help refine teaching practices and enhance teacher training related to sustainability in PE. Building on this, appropriate didactical strategies grounded in the physical literacy approach encourage students to engage relationally with nature, reflect critically, and take responsibility for socioecological challenges. This perspective reframes PE as a space for embodied, ethical learning connected to sustainability (Peters, 2025). It also resonates with the principles of the Teaching Personal and Social Responsibility model (Hellinson, 2011), suggesting future research could explore its potential to support sustainability-oriented learning in PE.

Certain design and methodological limitations should be considered. The non-probabilistic purposive sample from a single institution may limit the generalisability of findings. Moreover, as the study was conducted within the Spanish educational context, future research should explore the transferability of these findings to other cultural and educational settings, given the global relevance of sustainability. Although the frequency of mentions of specific ideas was considered as a structured basis for interpreting their significance within the dataset, the qualitative approach prioritises depth over quantification. While statistical generalisability is not the goal of this type of inquiry, the findings offer valuable and transferable insights that can inform pedagogical practices in similar educational settings. Self-reported data also pose potential response bias, despite efforts to ensure neutrality. It is also important to acknowledge that complete neutrality is difficult to achieve in qualitative research. Recognising researcher subjectivity can enhance transparency and enrich interpretation (Lincoln & Guba, 1985; Pillow, 2003). Future studies should expand samples, incorporate mixed methods, and include longitudinal assessments to strengthen reliability and applicability of results.

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Conclusions

The findings of this study suggest that PETE students recognise the importance of sustainability competencies and can identify various strategies to integrate them into their teaching practices. Their responses highlight cooperative, reflective, inclusive, and problem-solving activities as essential methodologies for fostering sustainability education in PE. Additionally, students emphasise self-assessment, self-awareness, role adoption, and creative thinking as key elements in their learning process. The results indicate that PETE students are developing competencies that enable them to address sustainability challenges through diverse strategies and activities, aligning with the goals of education for sustainable development. While they demonstrate a solid foundation, it remains essential to explore how these competencies translate into effective educational quality and long-term application.

Future research should evaluate the effectiveness of competency-based approaches in real-world educational settings to enhance sustainability education in PE. In particular, examining how these pedagogical interventions contribute to achieving the SDGs would provide valuable insights for refining and strengthening PETE programmes. These insights illustrate that higher education should continue evolving to support the development of sustainability competencies, through enhancing and reinforcing existing pedagogical strategies.

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Ethical standard. Ethical approval was granted by the Ethics Committee of the University of Alicante (reference code: UA 2024 10 01_2).

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