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Education for sustainability and physical education: a systematic scoping review

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ABSTRACT

Education for sustainability (EfS) in the school context is recognized scientifically and politically as fundamental for training citizens who are capable of transforming future society. Physical education (PE) represents a singular way to complement cognitive approaches by drawing on the bodily dimension and learning in action as well as affective and sensory aspects. Furthermore, relevant research could lead to the qualitative implementation of EfS in PE. Thus, the aim of this systematic scoping review was to summarize the results of related research into the implementation of EfS in PE and to identify avenues for future studies aimed at establishing EfS sequences within PE. A 5-step methodological framework, incorporating the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) methodology, was used to carry out this scoping review, in which 30 studies were considered. The results showed that the research was current, was performed mainly in Europe, and frequently referred to the institutional framework of the Sustainable Development Goals. Additionally, the results highlighted that PE programs make few explicit references to the concept of sustainability or EfS; furthermore, PE teachers, while they may be inclined to implement EfS in PE, lack control of the concepts and training. Finally, the EfS learning sequences in PE have limitations regarding the definition and characteristics of effective EfS, particularly a lack of pluralism and holism. Recommendations for future research and for practical implementation were made, particularly with respect to PE teacher training, PE programs and EfS learning sequences in PE.

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KEYWORDS
Education for sustainability; physical education; scoping review; sustainability; sustainable development

The role of education in addressing sustainability challenges is not new (Wals, 2012). There is an essential need to raise awareness and educate future citizens to build a more sustainable world. Although education for sustainability (EfS) has been present in United Nations (UN) frameworks for several decades, its concrete implementation in classes remains difficult (Madsen, 2013). In particular, EfS seems to have a limited presence in physical education (PE) classes (Baena-Morales, Jerez-Mayorga, et al., 2021; Baena-Morales, Merma-Molina, et al., 2023), even though this discipline could significantly contribute to the issue of EfS; furthermore, the UN recommends the integration

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of EfS into all school subjects. Therefore, the purpose of this paper was to establish a state-of-the-art method for implementing EfS in PE.

Sustainability: a complex and controversial concept

The Bruntland Commission defined sustainable development as 'meeting the needs and aspirations of the present generation without compromising the ability of future generations to meet their needs' (Bruntland, 1987, p. 292). At an international and institutional level, the United Nations established the *Agenda 2030* in 2015, a concrete action plan for humanity, the planet and prosperity (Nations, 2015). This plan resulted in 17 sustainable development goals (SDGs) and 169 targets (sub-objectives), which must be achieved by 2030. Although some studies have highlighted the advantages of this plan, particularly in helping countries promote sustainable development within their own borders for the benefit of their populations (Leal Filho et al., 2019), an SDG-based approach has been discussed from a scientific perspective. The concept of sustainable development has been widely criticized as oxymoronic because it fosters the erroneous illusion of combining endless economic growth on a finite planet with social justice and environmental protection (Adelman, 2018). Therefore, the rhetoric of sustainable development has been commonly regarded as anthropocentric and economically focused (Bonnett, 2007; Kopnina, 2018). Agenda 2030 and the SDGs reflect this criticism. Some authors highlight the incompatibility of certain SDGs (Hickel, 2019; Kopnina, 2016; Spaiser et al., 2017), particularly in prioritizing commercial and economic interests over social and environmental interests (Weber, 2018). The ideological rhetoric underpinning the concept of sustainable development (Ruggerio, 2021) and the SDGs has led us to broaden our focus beyond institutional frameworks in this study and refer to the concept of 'sustainability' and not to investigate EfS issues solely through the SDGs.

Currently, three models concerning sustainability could be predominant. These models systematically integrate three dimensions, i.e. economic, social, and environmental dimensions, but their relationships diverge in each model. First, a 'triple bottom line' model emerged with the three dimensions mentioned above (Figure 1(a)). In the regular discussion of sustainability, which has taken place particularly within a scientific context, this notion can imply, depending on one's point of view, that environmental capital or social capital could be interchangeable with economic capital (Norton, 2005). In other words, economically directed action could compensate for social or environmental threats or losses. While it is still based on this three-pillar model, it is commonly considered that any work dealing with environmental, social, or economic aspects contributes to sustainability by minimizing the necessary link between these pillars at the origin of the model. This vision of sustainability has led to a 'weak' sustainability model (Figure 1(b)). From its inception, this weak sustainability

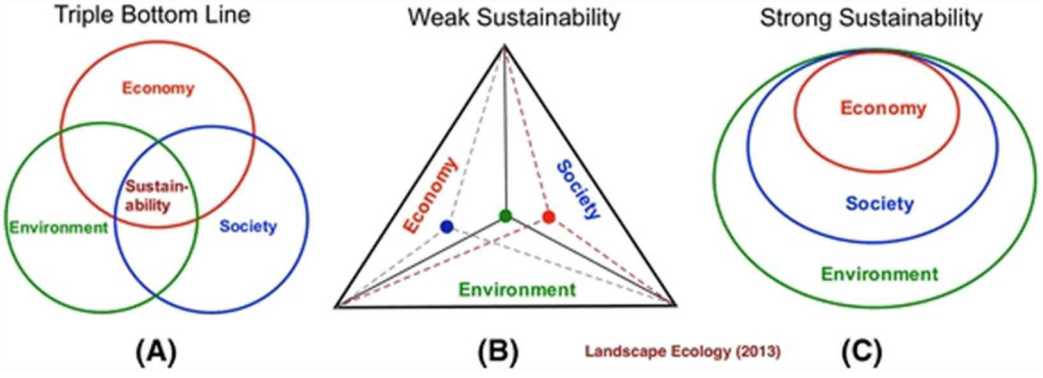

Figure 1. Illustration of the triple bottom line definition of sustainability (a) and weak (b) versus strong sustainability (c) (Wu, 2013).

model has been questioned, and a strong sustainability (Figure 1(c)) model was proposed to reject the tenet of substitutability by indicating that social and economic capital are derived from environmental capital (Cobb & Daly, 1989). On the basis of a 'strong' sustainability model, Raworth (2017) proposed an economic model shaped like a 'doughnut' (Figure 2). In this model, the outer edge is defined by environmental limits, as proposed by planetary boundaries (Rockström et al., 2009), whereas the inner edge represents social needs. To ensure a 'safe and just' economy, it must operate within these bounds, respecting both planetary safety and human rights.

There is no consensus on the definition of sustainability (Osorio et al., 2005). However, a holistic approach that considers the interconnectedness of the environmental, social, and economic dimensions is scientifically supported (Imran et al., 2014). In summary, what matters in EfS learning sequences is not just the conceptual model used but rather equipping students to comprehend the complexity of sustainability challenges and empowering them to take meaningful action to address them.

Education for sustainability: an emergent fragmented concept

EfS aims to cultivate skilled and active citizens who are informed and motivated to live sustainably and contribute to a more sustainable society (Carbach & Fischer, 2017). In this definition, EfS is characterized by a focus on capacity building and critical thinking rather than instrumental goals

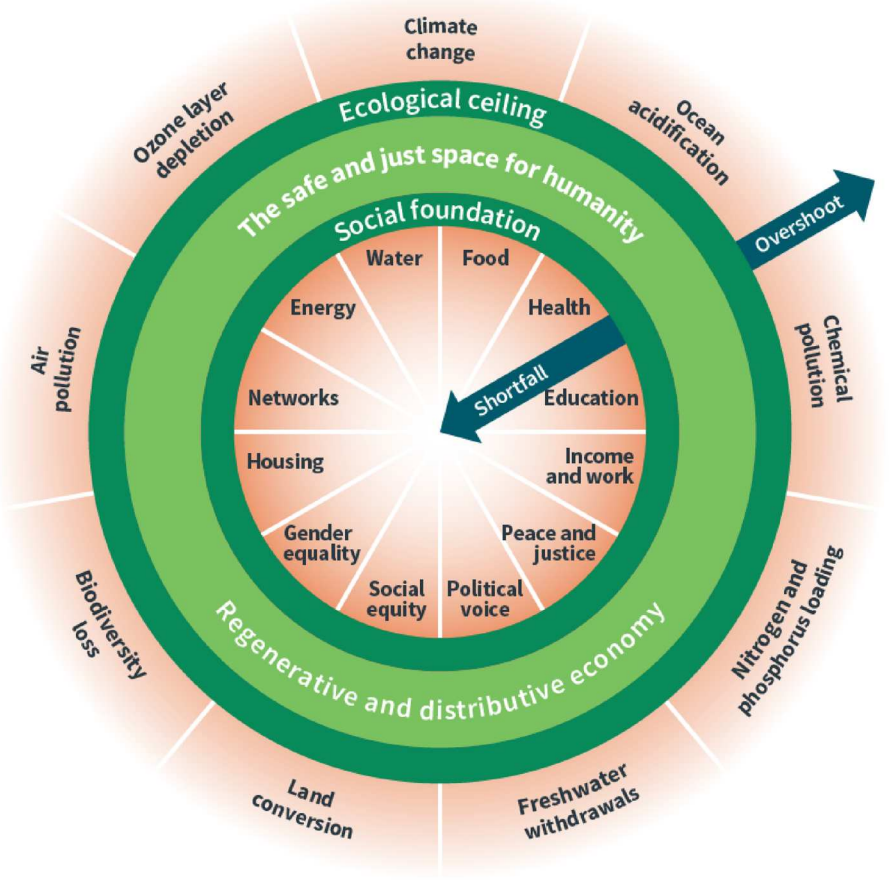

Figure 2. The doughnut theory of Raworth (2017).

such as directly changing learners' behaviours (Wals, 2011). The concept also underscores the importance of self-initiated 'action'. This perspective is consistent with the recommendations made by some authors for EfS to be more than just education about the SDGs, which could extend to uncritical acceptance of the SDGs as universally beneficial (Kopnina, 2018, 2020). Nevertheless, the theoretical framework of EfS is fragmented, and an emancipatory definition of EfS is often opposed to an instrumental definition (Wals et al., 2008), in which the role of education is to modify ways of thinking and behaving that are deemed unsustainable according to instructors, curriculum designers, administrators, and society at large (Ribó, 2023). Historically, a focus on a content-based approach has been replaced by a focus on learning outcomes (Wiek et al., 2011), which explains why the emancipatory approach of EfS is now dominant at the institutional and scientific levels. In this sense, many teaching models that meet this definition have been studied in educational research. Among other concepts, some papers highlighted interest in fostering critical (Hasslöf & Malmberg, 2015), systematic (Molderez & Ceulemans, 2018) and creative thinking (Karlusch et al., 2018); reinforcing intrinsic values (Murray et al., 2014); and promoting active (Emblen-Perry, 2022) and inter- or transdisciplinary learning (Nordén, 2018). In summary, holism, pluralism and action can be identified as key characteristics of effective EfS (Sass et al., 2020; Sass et al., 2023; Sinakou et al., 2019). Therefore, to foster a successful EfS implementation, PE, like other school subjects, should comply with these general principles.

Education for sustainability in physical education

EfS implementation in PE is of particular interest because of its specific characteristics (physical practices, embodied actions, and affective/emotional experiences). The link between EfS and PE has been discussed since at least 2001 (Lake et al., 2001). Indeed, some research has demonstrated that physical activity could contribute to sustainable development goals (Nigg & Nigg, 2021) or to EfS by, among other things, promoting embodied, experiential and holistic learning (Thurm et al., 2023).

In this sense, PE also presents several internal characteristics that enable us to regard it as a singular way to implement EfS. Active learning forms an integral part of PE, and some works have proposed integrating active learning into the EfS teaching model to be successfully implemented (Howell, 2021). Moreover, behavioural science approaches highlight the role of emotion in sustainable actions (Brosch & Steg, 2021). By engaging the affective and sensory body, PE could provide a sensory and artistic way to teach EfS (Heinrichs, 2021; Paintendre et al., 2021). Studies adopting a critical approach to dance have offered an embodied reflection on socioenvironmental issues (Foster & Turkki, 2023; Kloetzel, 2023; Pollitt et al., 2021), potentially opening new advances in PE. Some authors have also investigated how EfS could occur in the PE context. Baena-Morales and Gonzalez-Villora (2023) discussed the link between health and physical education (HPE) and the EfS competencies of UNESCO. Previous studies have consistently supported a positive relationship between holistic HPE and the three dimensions of sustainability: *social development*, by promoting health and generating participatory and equitable spaces; *environmental development*, by connecting with the natural environment and using homemade materials; and *economic development*, by generating physical exercise habits, student productivity and transfer to the workplace, and employability. On a pedagogic level, ways to include system and critical thinking in an EfS objective in PE have also been discussed (Baena-Morales, Merma-Molina, et al., 2023). Work on critical pedagogy in PE (Fitzpatrick & Santamaría, 2015; Kirk, 2019; Luguetti & McLachlan, 2021), particularly as it applies to social issues (e.g. inequalities between girls and boys, ethnic groups, precarity, etc.), could be an effective approach to implement EfS in PE. On the other hand, contemporary PEs could be unsuitable for EfS implementation (Lundvall & Froberg, 2023) without requiring changes. For example, some research has shown that PE is an exclusionary and marginalizing environment for some students (Barber, 2018), which means that PE could be unsustainable on a social level. In addition, contents concerning physical activity and sports could be critically discussed in PE from a sustainability point of view, as exemplified by mountain biking, which could have a negative impact on wildlife and vegetation (Kuwaczka et al., 2023). To summarize, there is a need for reflection on EfS

implementation in PE and for high-quality PE based on a holistic approach that considers physical factors combined with cognitive, social, and emotional aspects.

Study relevance and purpose

The purpose of this paper is to provide an overview of the research concerning the implementation of EfS in PE. This study is relevant for three reasons. First, it fills a gap in the literature since there have been no previous papers that establish the state of the art in research on EfS in PE. Several previous studies have considered how to link PE and EfS on a theoretical and reflexive level only (Baena-Morales & Gonzalez-Villora, 2023; Lundvall & Froberg, 2023). These studies have called, in particular, for more empirical studies concerning the implementation of EfS in PE. Second, previous papers aimed to synthetize or explore the literature concerning EfS from an educational perspective (Güler Yıldız et al., 2021; Lim et al., 2022; Wu & Shen, 2016) or other subjects (Li & Tsai, 2022). In the field of PE, reviews have been performed concerning teachers' professional competence in ESD, with a particular emphasis on PE teachers (Lohmann et al., 2021) and on the link between PE and the SDGs (Baena-Morales & Ferriz-Valero, 2023; Froberg & Lundvall, 2021). While the important Baena-Morales and Ferriz-Valero (2023) study also highlighted a scoping review methodology, it differed greatly from the one presented in this article, both in terms of methodological process and the results presented (Table 1). Moreover, as argued above, the institutional framework of the SDGs has been not only scientifically debated but also seen as too restrictive to establish a state of the art in research concerning EfS in the PE. Since EfS extends beyond the SDG framework, it is pertinent to conduct a review from the broader perspective of EfS. Therefore, the aim of this study is not to assess the contribution of PE to the SDGs but rather to adopt a different and broader analytical framework that includes, but is not limited to, the SDGs. To date, no study has examined the precise concept of EfS in relation to PE to consider how research is conducted on a certain subject or field and to identify and analyse gaps in knowledge. In this case, Munn et al.

Table 1. Comparison with the scoping review of Baena-Morales and Ferriz-Valero (2023).

	PE and EfS scoping review (present article)	PE and SDGs scoping review (Baena-Morales & Ferriz-Valero, 2023)
Timeline considered	Not limited	Since 2015
Data Sources	Web of Science ERIC Taylor and Francis Science direct	Web of Science SPORTDiscuss Scopus Google Scholar PROQuest
Inclusion Criteria	EfS (or synonym) mentioned explicitly and linked with PE Focus on PE in an educational context (primary, secondary (including upper secondary school), higher education) Peer-reviewed Article published in English	Establish a clear relationship between PE and the SDGs Mention how PE could contribute to sustainable development in general or the SDGs specifically Research articles, reports and institutional documents
Exclusion Criteria	Authors do not adopt an EfS approach Focus on PA or sports Not peer-reviewed, book, book chapter Article published in a language other than English	Not Physical Education Not English text
Thematic results	PE and education for SDGs Education for Sustainability in Physical Education Programs Physical Education Teachers Facing Education for Sustainability Implementing Education for Sustainability in Physical Education Classes	The Sustainable Development Goals and specific targets related to physical education

(2018) indicated that a scoping review would be useful for examining emerging evidence when it is still unclear what specific questions can be posed and valuably addressed by a more precise systematic review. Third, this scoping review is essential and will be helpful for the development of future research on the topic by contributing to theoretical and critical reflexive research and providing recommendations on an empirical level.

In summary, this scoping review aims to investigate the research on EfS in PE across all educational levels on the basis of a synthesis of the current literature to identify key findings and challenges. In accordance with the methodology of this type of study, more specific questions are expected to emerge from the initial stages of this research.

Methods

As in other recent scoping reviews on PE (Baena-Morales & Ferriz-Valero, 2023; Herrick & Duncan, 2023; Iannucci & Parker, 2022), in this paper, a five-step methodological framework (Arksey & O'Malley, 2005) was followed: (1) identifying the research questions, (2) identifying relevant studies, (3) selecting studies, (4) organizing the data, and (5) collating, summarizing, and reporting the results.

Step 1 – Identifying the research questions

The first step of the process was to identify the research questions, which serve as a guide for the literature review. According to Peters et al. (2021), in a systematic scoping review, to be clear, questions must incorporate the elements of the PCC guidelines (population, concept, and context) to steer the development of the inclusion criteria, facilitate the literature search and provide a robust structure for overall development. To perform a comprehensive mapping, this scoping review collected data on all educational levels of PE that were explicitly linked with ESD. We chose to structure our scoping review around two research questions:

1. What kind of research has been conducted on the EfS in PE in primary, secondary and higher education?
2. What are the most important results of this research on EfS in PE? More precisely, what are the research results concerning the implementation of EfS learning sequences in PE classes?

Step 2 – Identifying relevant studies

The identification of relevant studies in this review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses for Scoping Reviews (PRISMA-ScR) method proposed by Tricco et al. (2018). The search was conducted on 4th October 2023 on four different databases: Taylor and Francis, Web of Science, ERIC, and ScienceDirect. These databases were chosen because of their relevance to the educational context. Given the limited literature on the link between EfS and PE, we chose not to set a date limit for our search. We used the following words to search titles and abstracts: '*physical education*' and ('*education for sustainable development*' OR '*education for sustainability*' OR '*sustainable development*' OR '*sustainability*'). We chose to include a search concerning sustainable development and sustainability because some articles focus on synonyms of EfS or education for sustainable development with other expressions (e.g. 'Sustainability-oriented learning'). This protocol enabled us to expand the scope of the research to include articles of this type.

Step 3 – Study selection

Our database search resulted in a total of 327 articles. After removing duplicates with both automated software (EndNote) and double manual checks, 263 articles remained. All titles and abstracts

Table 2. Inclusion and exclusion criteria.

Inclusion Criteria	Exclusion Criteria
EfS (or synonym) mentioned explicitly and linked with PE	Authors do not adopt an EfS approach
Focus on PE in an educational context (primary, secondary (including upper secondary school), higher education)	Focus on PA or sports
Peer-reviewed	Not peer-reviewed, book, book chapter
Article published in English	Article published in a language other than English

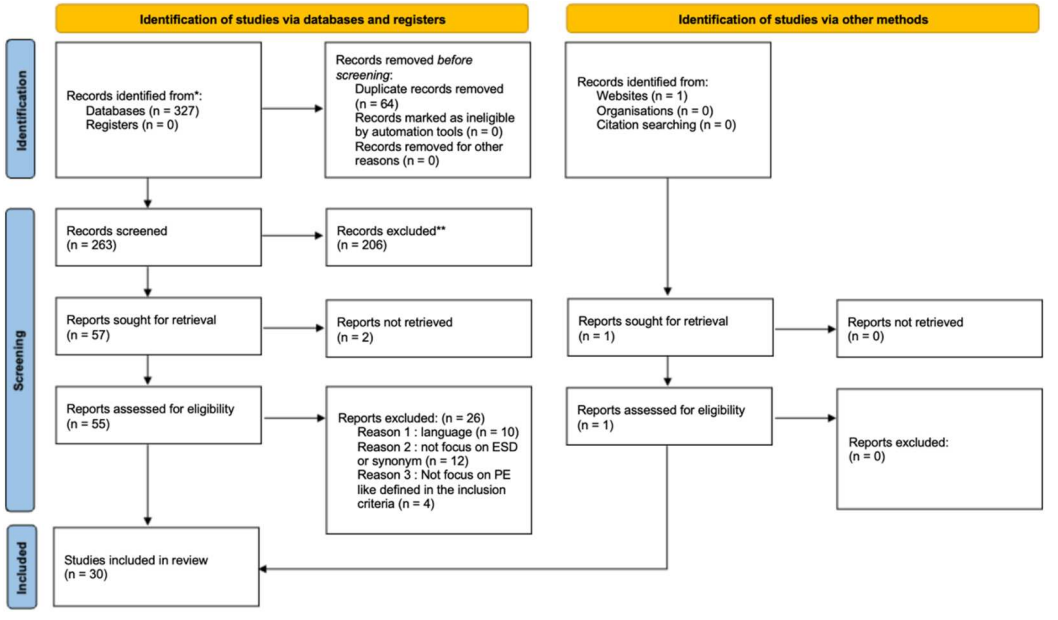

Figure 3. The PRISMA flow chart of the selection of the articles.

were read to verify whether the articles met the inclusion criteria. After this process, 57 articles remained. At this step, two researchers read the full texts of the articles. After a first reading, it was felt that it was necessary to specify the inclusion and exclusion criteria, particularly those concerning explicit reference to EfS and not only to sustainability or to sustainable development goals. Importantly, we included only the studies that explicitly referred to EfS in PE, even if the protocol implemented was far from EfS as defined by the experts. Following scoping review recommendations, it is important to discuss how the authors involved in PE engage with EfS, regardless of the quality of the implementation that follows. For example, studies that made explicit reference to EfS in the context of PE were included, even if the protocol subsequently proposed did not highlight a proper EfS approach as defined above. Our final inclusion and exclusion criteria are shown in Table 2. After the inclusion or exclusion criteria of the articles were pooled by the two researchers (the researchers did not agree on three articles, two were excluded, and one was included) and included one article identified via another method (identified in the article bibliography), 30 articles were included in the scoping review. The entire process is summarized in the PRISMA flow chart presented in Figure 3.

Step 4 – Organizing the data

To organize and interpret the information included in the texts, each article was summarized in a table that included the following information: author(s) and year of publication, location, study

type, study objectives, methods, outcome measures, EfS approach, and main findings. The full table is presented in Appendix 1.

Step 5 – Collating, summarizing, and reporting the results

After summarizing and organizing the main data and information contained in the included studies, we were able to present our narrative account of the findings in two ways. First, we presented a map of the literature concerning EfS in PE, which was organized into three sections. The first section focused on the geographical distribution of the studies included in this scoping review. This section highlights areas of study that have garnered the greatest attention in the question of EfS in PE. The second section of this first part focused on the types of studies included. It also highlighted what type of knowledge (theoretical and empirical) was produced concerning EfS in PE. Finally, a third section focused on the number of studies by year of publication, which allowed us to summarize the nature of recent research into the place of EfS in PE. This first part provides a broader focus on our topic, which is an important step to take before moving to a more detailed and in-depth analysis. The studies were evaluated according to scientifically validated scales. In view of the methodology used in scoping reviews, which include studies of various types and methodologies, different scales have been used for reviews (Aromataris et al., 2015), qualitative studies (Lockwood et al., 2015), quasi-experimental studies (Barker et al., 2024), cross-sectional studies (Moola et al., 2017), expert opinions (McArthur et al., 2020), and questionnaire validation studies (Terwee et al., 2012). The scores obtained for each of the scales were translated into a 5-point score. The quartile of each study was obtained via Scimago. Second, the literature was organized thematically according to four emergent themes: EfS in PE linked to the framework of the Sustainable Development Goals (SDGs); EfS in PE programs; PE teachers facing EfS; and implementing ESD in PE in schools. These themes must be viewed as funnels that progress from the broader framework implemented by the United Nations to the classes in which PE is taught to pupils.

Results and discussion

The results are presented in two different sections. In the first section, the purpose was to highlight the broad focus of the research concerning EfS in PE by mapping the literature. This broad focus allowed us to provide precise knowledge about the location and type of studies, the year of publication and the type of studies by year of publication. Thereafter, we presented in greater depth the main results of the body of studies that make up our scoping review following the four produced themes.

Mapping of the literature concerning education for sustainability in physical education: recent and diverse research focused in Europe

First, the mapping analysis revealed that the majority of studies (96.6%) were conducted in Europe. Only one study was conducted in Australia (Oceania) (Figure 4). Moreover, 19 studies were performed in Spain, representing 63.3% of the included studies. There is a large predominance of research conducted in the field of EfS in PE by the research team in Alicante (Spain), which produced 16 studies included in this paper (53.3%). In addition, research teams located in Sweden, especially in Gothenburg, and in Germany seem to be particularly active in the field of EfS in PE. The absence of studies located in North and South America, Asia and Africa must be noted. These results were in line with a scoping review on the SDGs linked to PE (Baena-Morales & Ferriz-Valero, 2023), which identified Europe as the predominant publishing location and found an absence of studies located in the U.S. Given the international nature of ONU and UNESCO, these results are surprising, especially as work on environmental issues is underway in PE in some South American (e.g. Pazos-Couto et al., 2021) and North American (e.g. Maziade et al., 2018) countries.

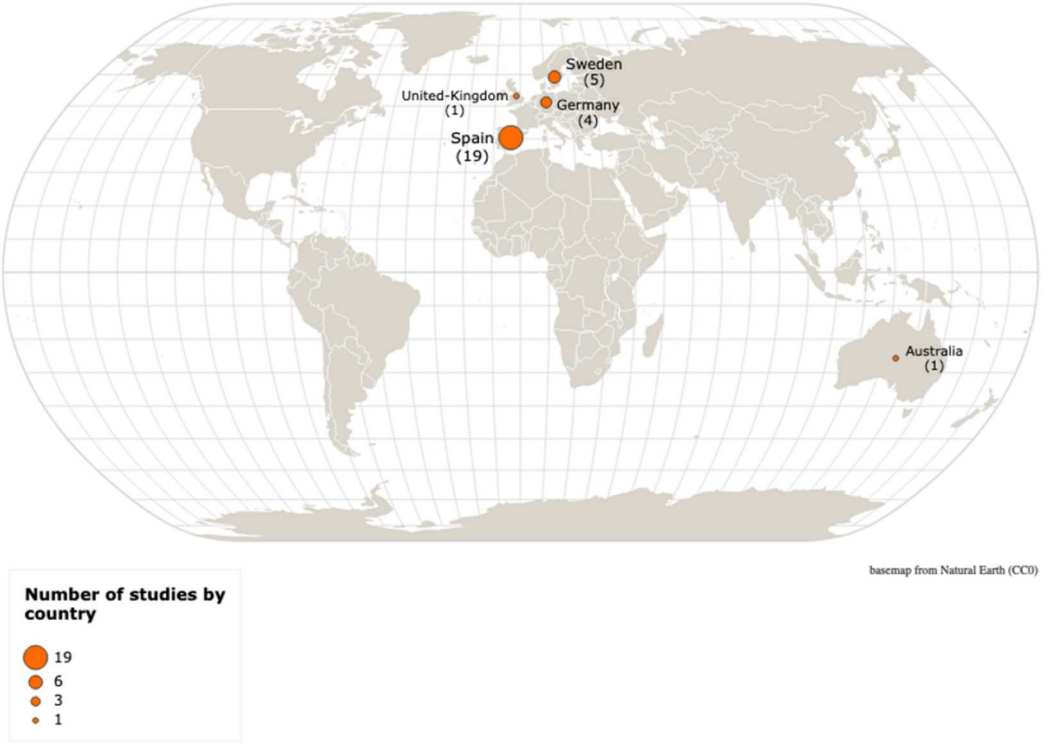

Figure 4. Location by country of the studies included in the scoping review.

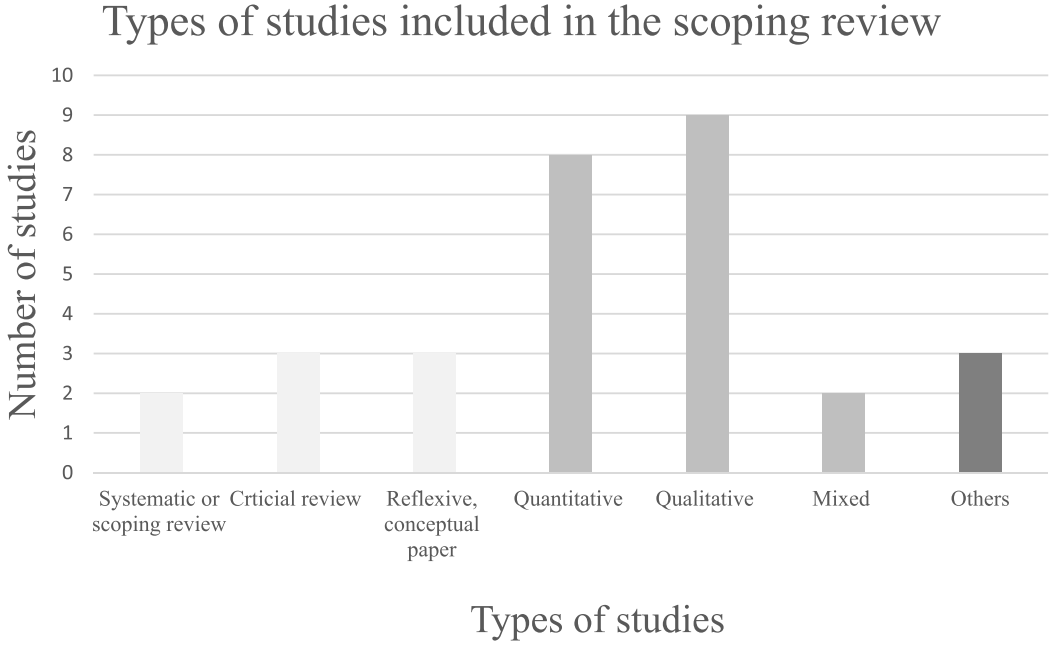

Figure 5. Types of studies included in the scoping review.

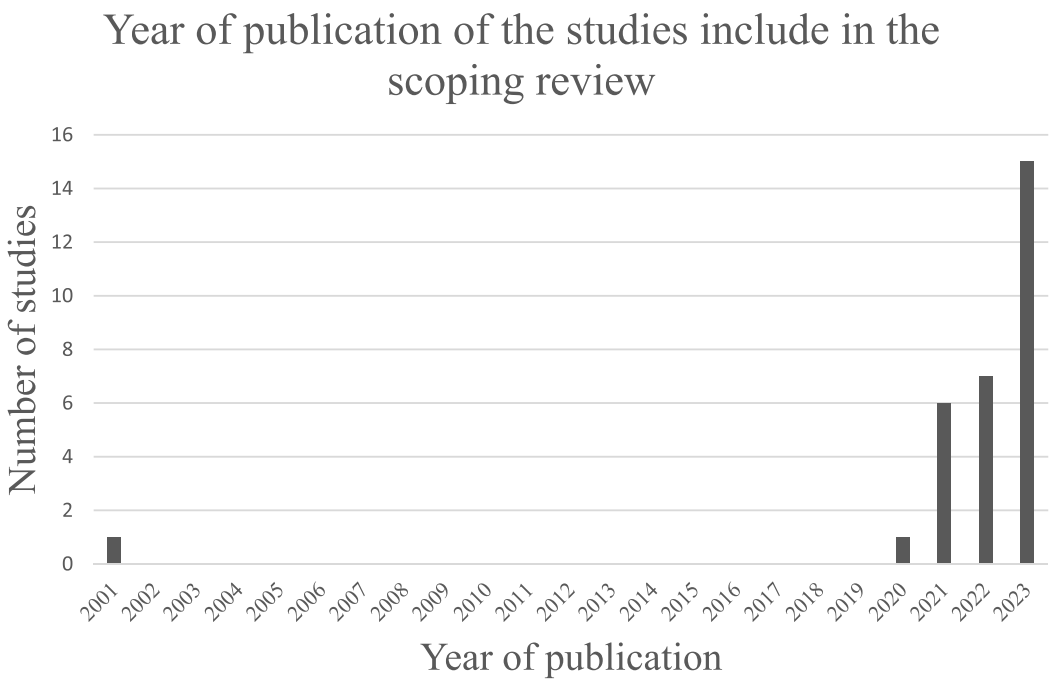

Figure 6. Number of studies by year of publication.

Second, two types of studies were identified: theoretical and empirical. The results are summarized and presented in Figure 5. In all, eight of the 30 studies (26.6%) were considered theoretical and included systematic or scoping reviews (two articles), critical reviews (three) and reflexive or conceptual papers (three). Furthermore, 19 of the 30 studies were considered empirical (63.3%). Among these studies, nine used qualitative research methods, eight used quantitative research methods, and two used mixed methods approaches. We decided to introduce one category, '*Others*' (10% of the studies included), which includes two questionnaire validation studies and a protocol paper. Even though EfS in PE seems to be an emergent field, empirical research represented above half of the included studies. This result may come as a surprise given the early age of the field, but it corresponds to the needs of the educational community.

Third, Figure 6 presents the number of studies by year of publication. Notably, except for one study published in 2001 (Lake et al., 2001), all the studies included in the review were published between 2020 and 2023, with a turning point occurring in 2021. This result highlights the emergent and recent nature of this topic and is in line with the findings of previous scoping reviews on the SDGs and PE (Baena-Morales & Ferriz-Valero, 2023). As underlined by Baena-Morales and Ferriz-Valero (2023), this turning point can be explained by recent institutional invitations to perform research on EfS. Moreover, 16 of the 30 studies were published in 2023, which means that more than half of the included studies were published in the current year. By cross-referencing the data presented in Figure 5 and Figure 6, we can observe the types of studies published by year (Figure 7). Therefore, all types of studies are in development. However, among all the types of studies, empirical research in the field of EfS in PE has undergone exponential development. In 2021, there was as much theoretical research as empirical research concerning EfS in PE. In contrast, in 2023, empirical research represented 56.25% of the total research concerning EfS in PE compared with theoretical research, which represented 25% of the total. This could be explained by the fact that the theoretical underpinnings are common to different disciplines and are not specific to PE. As a result, empirical studies concerning EfS could be established quickly and in relatively large numbers within the framework of PE.

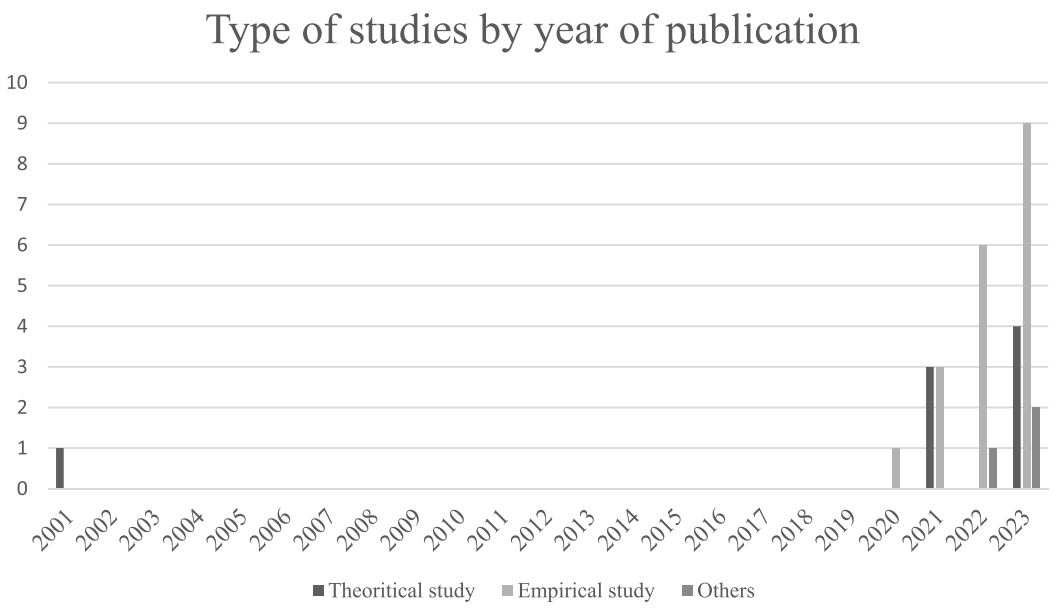

Figure 7. Type of studies by year of publication.

Finally, the assessment of the included studies resulted in an overall score of 3.82/5 (56.7% of the papers in quartile 1; 43.3% of the papers in quartile 2). More precisely, the average score was 3.6 for reviews (100% quartile 1), 4.33 for opinion papers (100% quartile 1), 3.75 for quantitative studies (25% quartile 1; 75% quartile 2), 3.73 for qualitative studies (73.6% quartile 1, 26.4% quartile 2), and 3.75 for questionnaire validation (100% quartile 2). Considering the different types of studies and methodologies, it is important to be cautious with these results and to avoid overinterpretation. Overall, the quality of the studies included in this assessment was satisfactory.

Research results on education for sustainability in physical education: a thematic presentation

Physical education and education for sustainable development goals (SDGs)

Several studies included in this scoping review highlighted results within the particular framework of the Sustainable Development Goals (SDGs). This emergent theme is not surprising because of the importance of this framework at the international level and the number of relevant studies included. The SDGs are part of the United Nations *Agenda 2030* (United Nations, 2015), and on a political level, this model is dominant. In this framework, one of the characteristics of EfS is that each of the educational specializations must implement an appropriate strategy to contribute to the SDGs (Baena-Morales & Ferriz-Valero, 2023).

First, several studies have aimed to determine which SDGs could be involved in PE. Baena-Morales, Jerez-Mayorga, et al. (2021) demonstrated that 24 of the 169 specific goals of the SDGs can be integrated into PE classes. In another study, Baena-Morales and Ferriz-Valero (2023) showed that SDG 4 (quality education), SDG 3 (health and well-being) and SDG 5 (gender equality) are the most closely linked to PE. Moreover, they reported that 52 out of 169 targets were related to PE.

Additionally, some studies have investigated the possibility of addressing the SDGs in PE as an objective of EfS, which can be viewed as education for the SDGs in this context (Rieckmann, 2017). In this vein, Baena-Morales, Merma-Molina, et al. (2023) proposed a process for developing critical and systemic thinking oriented towards SD in PE, with the example of the integration of

self-made materials[1] in a sequence of Ultimate frisbee[2] by working on specific targets 12.5 of the SDGs.[3] Another example showed that a social-learning sequence could improve PE teachers' knowledge of and interest in the SDGs (Garcia-Rico et al., 2021).

The perceptions of PE teachers in contributing to the SDGs are also highlighted. When analysing the links between the SDGs and PE, preservice PE teachers of physical activity and sport science believe that the most closely related goals are SDG 3 (health and well-being), SDG 4 (quality education), SDG 5 (gender equality), and SDG 10 (reducing inequalities) (Merma-Molina et al., 2023). The results also revealed that there is ambiguity and no agreement on whether it is feasible to contribute to the SDGs through PE sessions (Baena-Morales et al., 2022).

Moreover, some authors have considered how the SDGs are included in the PE curriculum, particularly in the Swedish context. For example, the analysis by Froberg and Lundvall (2022) suggested that learning objectives and competencies for five of the 17 SDGs (#3, good health and well-being; #4, quality education; #5, gender equality; #10, reduced inequalities; and #16, peace, justice, and strong institutions) could be linked to different themes of learning outcomes in PE teacher course syllabi. A second study showed through an analysis of physical education and health syllabi for compulsory school and upper secondary school in Sweden that six themes (e.g. 'healthy lifestyle' and 'cooperation and respect') were developed to create implicit links with sustainability and, in particular, with the SDGs (Froberg et al., 2023). For example, for the compulsory school physical education and health syllabus, the authors could link themes to learning objectives and competencies for SDGs 3, 5, 10, 16 and 17.

In sum, education related to the SDGs was omnipresent in the studies included in our scoping review, which is not surprising given the dominance of this framework at the international and political levels. The predominance of studies carried out by a research team in Alicante, Spain, could also explain these results. This research team refers almost systematically to the SDG framework in its works and represents 53.3% of the studies included in this paper. However, it is important to consider the scientifically supported concept of sustainability, which emphasizes a holistic and complex approach. This understanding represents a major objective of EfS; such an approach can be overlooked when referring to a specific SDG. EfS requires an understanding of the interrelationship of the SDGs and the avoidance of a compartmentalized interpretation of the SDGs. This criticism of a segmented approach to the SDGs led researchers at the Stockholm Resilience Center to propose the 'wedding cake' mode, which prioritizes and organizes the SDGs in an interconnected manner (Center, 2016). This strong EfS approach involves enabling students to understand the complexity of sustainability issues, which means moving away from the view of the SDGs as being fragmented and separate. Approaches focused on the SDG model, defining EfS as education for the SDGs, should be aware of this limitation, and their approach should be designed to help students understand the interconnections among the SDGs. This approach could also foster a critical perspective on the SDG model (Kopnina, 2018, 2020), considering challenges identified in achieving some goals (Hickel, 2019; Kopnina, 2016; Spaiser et al., 2017). Such an approach could align with an emancipatory approach to EfS, as defended by specialists in the field (Wiek et al., 2011).

Education for sustainability in physical education programs

The necessity of building a curriculum that promotes sustainable active living and care for the earth is not new (Lake et al., 2001). The research highlighted a lack of data on the specific form and degree of inclusion of EfS in PE programs. Moreover, only a few existing studies have described the limited elements that can be linked to EfS in PE curricula in two different contexts.

In a Swedish context, Froberg and Lundvall (2022) showed that PE teacher education syllabi from higher education institutions that prepare PE teachers to teach pupils in compulsory and upper secondary schools in Sweden presented only eight learning outcomes (e.g. 'Analyse and evaluate different styles of 'friluftsliv[4]' from a health and sustainability perspective') which are explicitly related to sustainability perspectives. When the authors used the UNESCO (Rieckmann, 2017) and Commonwealth (Osman et al., 2017) frameworks, they reported that 37 and 31 learning objectives,

respectively, could be linked to their learning outcome themes (e.g. 'Development of expertise and research in health-related issues and policies'; 'Applied knowledge and understanding to promote active living'; …). Considering once more the Swedish context, Froberg et al. (2023) showed that six themes and four themes of the physical education and health syllabi, respectively, for compulsory school and upper secondary school could be implicitly linked to sustainability (e.g. 'plan, implement and adapt movements activities'; 'healthy lifestyle'; 'cooperation and respect'). In the same study, in the first analysis, no explicit link could be made. In line with these results, Lundvall and Froberg (2023) suggested a critical analysis and revision of curricula and steering documents to review which parts of Agenda 2030 and which SDGs are applicable to or appropriate for EfS in PE teacher education and PE.

In the Australian context, Olive and Enright (2021) found limited engagement in the Australian Curriculum in Health and PE (AC:HPE) with the sustainability cross-curriculum priority: 'Sustainability' – as indicated by a leaf symbol – being flagged in only two of the 103 content descriptions of the AC: HPE when they performed a search with online tools. When they applied an ecofeminist approach to the AC:HPE, they argued that the topics of health, sports, and physical activity offer great potential for engaging students in ethical and critical sustainability knowledge and practices, starting in their school spaces and communities.

These results suggested that the EfS was not explicitly implemented in PE programs, nor was it incorporated into secondary education or higher education. This finding was consistent with other findings concerning the difficulty of introducing EfS in the K-12 curriculum (Lee & Efird, 2014), particularly because this concept is broad and ill defined (Bourn et al., 2017). This reflected the relative failure of the UN Decade of ESD (Huckle & Wals, 2015) to create a dynamic for incorporating new educational content and models. It is therefore necessary to critically analyse and rethink PE programs to ensure that they explicitly include sustainability-oriented learning. This step is identified as necessary and a priority for adopting educative aspects of sustainability (Lundvall & Froberg, 2023).

Physical education teachers facing education for sustainability

Research focusing on PE teachers and how they confront the concepts of sustainability and EfS is becoming increasingly important. This was evidenced by the recent development of specific tools and scales aimed at measuring the beliefs (Lohmann et al., 2023) and competencies (Baena-Morales, Urrea-Solano, et al., 2023) of preservice or future PE teachers.

PE teachers were identified as essential components in the implementation of quality EfS in PE. It was therefore necessary to study their knowledge of the concepts of sustainability and EfS. Lohmann and Goller (2023) highlighted that PE teacher educators described the dimensions of the sustainability concept at different depths and emphasized different levels of action that are needed to reach sustainability. Their results show that PE teachers may have a stronger sense of the scientific definition of sustainability in one dimension but a weaker sense in other dimensions. On EfS, the authors showed that some PE teachers' subjective theories seem to be inconsistent. They also reported that some teachers combined their perceptions of the concepts of sustainability and EfS, especially when labelling elements of sustainability as EfS. Similarly, Baena-Morales et al. (2022) showed that PE teachers have not demonstrated that they comprehend the multidimensionality of the vision of sustainability, mainly highlighting the environmental perspective and, to a lesser extent, relating sustainability to social and economic relationships. Merma-Molina et al. (2023) also revealed that preservice PE teachers' perceptions of sustainability present a certain degree of inaccuracy and vagueness. Similarly, when they related sustainability to other associated terms, they emphasized mainly the environmental aspect and overlooked the social and economic dimensions of the construct. The concepts of sustainability and EfS seem to be unclear for both preservice and in-service PE teachers; thus, implementing EfS in PE classes could be problematic.

To implement EfS in PE classes, PE teachers must also have a high level of sustainability consciousness (Baena-Morales, Ferriz-Valero, et al., 2021). The authors reported that PE teachers reported high

scores for knowledge and attitudes towards sustainability in three dimensions, whereas PE teachers' women received higher scores on all the items of the questionnaire. These results are in line with the results of Lohmann et al. (2023), who highlighted that PE teachers may, in principle, have a positive attitude towards EfS in PE but only if EfS is not incorporated at the expense of a high amount of physical activity. In another study previously mentioned, Lohmann and Goller (2023) provided evidence that PE teachers found it important to implement EfS and work towards sustainable institutions, but they lacked concrete ideas about how EfS can be implemented in the specific context of sports, play and movement and how to foster EfS-specific professional competence in prospective PE teachers.

Indeed, PE teachers must acquire and integrate EfS-specific aspects of professional competence into their PE-specific professional selves (Lohmann et al., 2021). Using a PE teacher-specific questionnaire[5], Baena-Morales, Garcia-Taibo, et al. (2023) showed that preservice PE teachers had a high self-perception of competences related to sustainability and its three dimensions. Froberg et al. (2022) also reported that the score was greater for the PESD-FT items that concerned the social dimension of sustainability than for those that concerned the economic and environmental dimensions. They reported that relatively few teachers (26%) had taught their pupils about sustainability in physical education and health and that most teachers perceived that they needed professional development training in the area of sustainability. López-Morales et al. (2023) were specifically interested in PE secondary teachers' coeducational teaching intervention and training. In this study, competencies developed in coeducational teaching were identified as improving the sustainability attitudes of students. This method could enable PE teachers to promote more equitable education between girls and boys, in line with SDG 5 and the social sustainability dimension. Most teachers are aware of the importance of adopting a coeducational attitude in PE classes and overcoming gender stereotypes and attitudes, some behaviours, and methodologies.

In summary, PE teachers and future PE teachers seem to have unclear knowledge of the fields of sustainability and EfS. These results were also found among future teachers in other disciplines (Maijala et al., 2023). Nonetheless, some of the results suggest that PE and future PE teachers could be major assets in the implementation of EfS in PE. First, they presented a high level of consciousness of sustainability, particularly in terms of knowledge and attitudes, which was also demonstrated for future primary teachers (Marcos-Merino et al., 2020). Second, they identified PE as relevant for including EfS, as long as they received training in this subject. Therefore, it seems necessary to go beyond the diagnostic stage and to offer initial and continuing education courses for PE teachers. While knowledge of the key concepts used by PE teachers was important for implementing EfS in PE, the development of EfS-specific competences is essential. Some of the included studies supported this recommendation. First, Garcia-Rico et al. (2021) argued that service learning could be an important tool for developing knowledge and professional competences during initial training. The study revealed that service-learning experience promoted, for example, the construction of strong and effective social networks for collaborative work. The participants of the study also developed an active commitment to social transformation by implementing the professional skills acquired in assisting other vulnerable groups. On the other hand, Arteaga-Checa et al. (2022) tried to demonstrate that 13-week and eight-session interventions in subject expression and body communication could improve the wisdom of participants, which could be applied to help implement transformative EfS. The results revealed that students showed improvement in reflective wisdom, with no identifiable difference between genders, and no significant differences in the affective or cognitive variables before or after the intervention. These two examples highlight the need to reflect on the initial and in-service training given to PE teachers. Not only on sustainability and EfS concepts but also about the key competencies (e.g. systemic and critical thinking, collaboration, prospective thinking, etc.) that will be essential for implementing EfS in PE.

Implementing education for sustainability in physical education classes

Examples of learning sequences or sessions that propose EfS in PE classes are still rare (eight studies, which represent 26.6% of the included studies). Nonetheless, several studies included in our scoping

review presented different input modes for integrating EfS into PE classes, including those of primary, secondary and higher education students.

First, three studies presented interventions aimed at improving the environmental awareness of students. Botella et al. (2022) conducted a PE intervention in which the methodology used was the self-construction of materials by 6th-year primary students. The data did not indicate significant changes in students' pro-environmental attitudes before and after the intervention of eight sessions of 50–60 minutes each. Another study aimed to analyse the effect of a plogging[6] didactic unit on the environmental awareness of high school students in physical education (Martínez-Mirambell et al., 2023). A greater number of positive responses were obtained after the intervention for all the factors analysed in the questionnaire, which supports the improvements associated with the plogging program. Another study examined the implementation of a plogging program, and its objective was to assess students' perceptions of this innovative activity (Martinez-Mirambell et al., 2023). The participants emphasized their increased awareness of the environmental deterioration caused by human actions and highlighted the environmental benefits of engaging in plogging. In these examples, sustainability awareness, in its environmental dimension, was related to ESD.

Other authors have chosen to integrate ESD in PE in different ways, such as working on social competences, which is another dimension of sustainability. For example, Bassachs et al. (2020) investigated the effects of a pedagogical intervention based on an interdisciplinary educational approach on primary school students' cooperative learning and EfS competences. The results showed that the intervention allowed individuals to develop social and interpersonal skills. Moreover, the educational approach promoted the acquisition of a set of EfS competences, as well as increased knowledge of scientific and physical parameters and greater interaction with the physical world. The school students showed stronger perceptions of systems thinking, critical thinking and analysis, interpersonal relations, collaboration and strategic action. Another study conducted by Delgado-Montoro et al. (2022) aimed to assess the effects of mindfulness practices included in PE classes on the ability of high school students to focus their attention on external, internal, or kinesthetic factors; awareness of acting; and acceptance. These abilities and the implementation of mindfulness in PE were linked to EfS because this work allowed us to improve social and emotional skills, which are essential competences in EfS. The results revealed that the implementation of mindfulness in PE significantly increased internal attention compared with that in the control group but did not increase external or kinesthetic attention. To improve social competencies while promoting sustainability objectives, Lavega-Burgues et al. (2023) showed how a traditional game (*Bear, Guardian, or Hunter*) could improve emotional and social competencies and, ultimately, enable the implementation of EfS in PE. To conclude, with studies that considered the EfS concept in terms of emotional and social competencies, Martinez et al. (2023) aimed to verify whether a sequence of PE activities based on cooperation and coeducation was a useful resource for making progress in terms of body stereotypes, social behaviour, skills and abilities, emotions, affective expression, and social responsibility. Despite the success in the promotion of gender equality and in developing a coeducational intervention with the experimental group, the results were not as expected, since there was evidence of the permanence of some gender stereotypes.

The authors of the last study in this section described the systematic development and content of a program using intervention mapping that includes EfS in regular PE (Bucht et al., 2022). The article led to the production of a program that included, in multiple ways and activities, holistic EfS in PE. Considering the physical education curriculum with its multiple objectives, the authors highlighted four mains behavioural outcomes for students as results of the EfS learning sequences: reduction in clothing consumption, change in diet, improved waste management, and increased usage of bike/public transportation. In this case, all three dimensions (i.e. societal, economic, and environmental) of sustainability were considered, and behaviour change methods were specifically selected to be suitable for physical education. The implementation of the program and the results for students in EfS have not yet been published.

These studies, in light of the definition of sustainability and the characteristics of an effective EfS as set out in the introduction, encourage critical examination. First, in this section, most of the studies implementing EfS learning sequences in PE have mostly considered the EfS concept as a standalone dimension, either social or environmental. These results contrast with the holistic dimension of sustainability defined in the introduction section (Imran et al., 2014; Raworth, 2017). As we highlighted in the SDGs section, there is a risk of overlooking a fundamental principle of the concept of sustainability, namely, the interdependence of its components. However, this understanding of the holistic and complex dimension of sustainability issues by students is scientifically defended as a major challenge in EfS (Sass et al., 2020). The difficulties in comprehending the concepts of sustainability and EfS, which are emergent and new concepts for the discipline, could explain why no proposition has been made for considering EfS in a holistic way in PE lessons. Furthermore, although some studies have clearly shown that pupils are taking concrete action on sustainability issues (e.g. constructing equipment, collecting waste), they appear to have little involvement in the reflections and choices made to address these issues. Thus, it will be a challenge for future applied research to align more closely with the challenge of helping students understand the complexity of sustainability issues and involving them in finding solutions. Approaches based on critical pedagogy in PE (Kirk, 2019) and a critical approach to dance (Foster & Turkki, 2023; Kloetzel, 2023; Pollitt et al., 2021), applied to sustainability issues, could be explored. Second, the studies mentioned above either focus on (1) promoting behaviours for a more sustainable lifestyle (e.g. recycling, waste collection), which leans towards an instrumental EfS approach, or (2) developing skills identified as fundamental in the context of EfS (e.g. cooperation) without explicitly mentioning sustainability issues to students. In other words, no study included in this review seems fully integrated into an emancipatory approach to ESD, which aims to develop fundamental skills (e.g. critical thinking, complex thinking, cooperation), while at the same time enabling students to reflect, construct knowledge, and act on sustainability issues in PE. Therefore, there is a need for applied research that implements EfS learning sequences in PE, fitting with this comprehensive definition of EfS. The existing propositions on sustainability have most often focused on social dimensions, followed by environmental dimensions, and they have not considered economic dimensions. These results were not completely surprising; the social dimension has been identified as a backbone of PE for several decades (Opstoel et al., 2019). This dimension represents the majority of current work concerning sustainability in PE, as it aligns with recent trends in the literature concerning EfS in PE. Importantly, this may have led the authors to explicitly define a link between their protocol and the social dimension of EfS, even though they subsequently did not formally subscribe to an EfS approach (e.g. Lavega-Burgues et al., 2023). On the other hand, practitioners and researchers are calling for the consideration of the environmental dimension of PE (Gottsmann & Hugedet, 2023), for pupils to be taken outdoors, and for them to be in contact with nature (Beauchamp et al., 2022). In this sense, more works claiming to be related to EfS in PE that focus on the environmental side are expected. Finally, the absence of the economic dimension in the propositions highlights the difficulty of incorporating this sustainability dimension in the PE field. To address this dimension in PE, it could be necessary to link it with societal and environmental dimensions, reiterating the need for a holistic approach to the concept of sustainability. Finally, none of the included studies measured motor, physical learning or physical activity in their protocols, despite this being a core element of the PE discipline. These results suggest that future research protocols should incorporate this parameter.

Limitations and perspective

Finally, our study has several limitations. First, we chose to work on the specific concept of EfS (or the synonym used). Therefore, a set of works focusing on similar themes, particularly environmental issues, were not included in the review. In particular, studies that claimed to use the concepts of the concept of outdoor education or environmental education in PE without explicitly using the words ‘sustainability’ or ‘EfS’ were not included in the study. These concepts could cover content

and themes close to those of the EfS and be part of similar teaching models. Second, owing to the extensive nature of this topic, this scoping review will require regular updates so that it does not quickly become obsolete. It therefore seems essential to monitor the literature on this subject.

Conclusion and practical perspectives

This scoping review on EfS in PE showed that the literature is current and predominantly concentrated in Europe. A major part of the literature concerning EfS in PE is based on the framework of the SDGs (and therefore of education for the SDGs), which risks leading to a segmented and uncritical approach to EfS. Additionally, the analysis of PE programs in relation to the EfS highlighted the near absence of the latter, reflecting the difficulty of implementing EfS in the official PE curriculum. Furthermore, while PE teachers were able to implement EfS, they lacked conceptual understanding and adequate initial and in-service training, limiting the effective implementation of EfS in the PE classroom. Finally, the EfS learning sequences in PE have limitations with respect to the definition and characteristics of effective EfS, particularly a lack of pluralism and holism. By focusing on the implementation of EfS within the discipline, this study provided a new perspective on the way in which PE could help to build a more sustainable world, complementing the summary work about PE and SDGs by Baena-Morales and Ferriz-Valero (2023).

On the basis of these conclusions, it is possible to make a few recommendations (1) for future research into EfS in PE and (2) for practical implementation of EfS in PE.

On the one hand, the results suggest that further research is needed on the following points:

(1) Conduct specific studies to identify the levers and barriers experienced by PE teachers in implementing EfS in PE. Develop and evaluate initial and in-service training programs for current and future PE teachers.
(2) Conceptualize and test learning sequences in PE in line with emancipatory, holistic, pluralist and action-centred EfS and include measures of motor or physical learning outcomes to ensure comprehensive educational benefits.
(3) Develop specific assessment tools to measure the impact and effectiveness of EfS sequences in PE with students.

In addition, for practical implementation:

(1) Encourage institutional leaders to consider the role of EfS in the PE, particularly within the framework of official curricula and programs.
(2) Integrate specific training on EfS in PE into both initial and in-service training of PE teachers.
(3) Promote a collaborative pedagogical approach among teachers, promoting project-based learning that empowers students to take action and reflect within the context of EfS in PE.
(4) Take a holistic approach to EfS, addressing the complex interrelationships among the environmental, social and economic dimensions.

To conclude, implementing an emancipatory EfS in PE has the potential to address not only future fundamental challenges but also the quality of PE by fostering holistic physical, cognitive, emotional and social education. It could in many cases require a change in conception and type of practice, which in turn requires time. In particular in the context of PE, which is often criticized as being conservative, and where curricula reforms and different forms of new content have problems to be implemented.

Notes

1. The self-made materials are designed to encourage pupils to use existing objects to build their own equipment, which will then be used in a given sequence.

2. Sport played with a frisbee between two teams.
3. This corresponds to target 5 of SDG 12.
4. The term "friluftsliv" is the Scandinavian variant of outdoor education.
5. Physical Education Scale for Sustainable Development in Future Teachers (PESD-FT) (Baena-Morales, Urrea-Solano, et al., 2023).
6. Swedish concept combining running and waste collection.

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