

## Central Lancashire Online Knowledge (CLOK)

|          |                                                                                                                                                                                                                                                                                                                                                  |
|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Title    | Exploratory Physical Education teachers' perspectives and intentions to use VR in the classroom context: A Cross-Sectional Qualitative Study                                                                                                                                                                                                     |
| Type     | Article                                                                                                                                                                                                                                                                                                                                          |
| URL      | <a href="https://knowledge.lancashire.ac.uk/id/eprint/57244/">https://knowledge.lancashire.ac.uk/id/eprint/57244/</a>                                                                                                                                                                                                                            |
| DOI      | <a href="https://doi.org/10.3389/frvir.2025.1628684">https://doi.org/10.3389/frvir.2025.1628684</a>                                                                                                                                                                                                                                              |
| Date     | 2025                                                                                                                                                                                                                                                                                                                                             |
| Citation | Amoroso, José Pedro, Tsivitanidou, Olia, Sarens, Marc, Christodoulides, Efsthios, Antoniou, Kyriaki, Silva, David, Coelho, Luis and Cools, Woulter (2025) Exploratory Physical Education teachers' perspectives and intentions to use VR in the classroom context: A Cross-Sectional Qualitative Study. <i>Frontiers in Virtual Reality</i> , 6. |
| Creators | Amoroso, José Pedro, Tsivitanidou, Olia, Sarens, Marc, Christodoulides, Efsthios, Antoniou, Kyriaki, Silva, David, Coelho, Luis and Cools, Woulter                                                                                                                                                                                               |

It is advisable to refer to the publisher's version if you intend to cite from the work.  
<https://doi.org/10.3389/frvir.2025.1628684>

For information about Research at UCLan please go to <http://www.uclan.ac.uk/research/>

All outputs in CLOK are protected by Intellectual Property Rights law, including Copyright law. Copyright, IPR and Moral Rights for the works on this site are retained by the individual authors and/or other copyright owners. Terms and conditions for use of this material are defined in the <http://clock.uclan.ac.uk/policies/>



## OPEN ACCESS

## EDITED BY

Salvatore Livatino,  
University of Hertfordshire, United Kingdom

## REVIEWED BY

Salvador Pérez Muñoz,  
Pontifical University of Salamanca, Spain  
Qinghua Qiu,  
Linyi University, China

## \*CORRESPONDENCE

José Pedro Amoroso,  
✉ jose.amoroso@ipleiria.pt

RECEIVED 14 May 2025

REVISED 09 October 2025

ACCEPTED 17 October 2025

PUBLISHED 24 November 2025

## CITATION

Amoroso JP, Tsivitanidou O, Sarens M,  
Christodoulides E, Antoniou K, Silva D, Coelho L  
and Cools W (2025) Exploratory physical  
education teachers' perspectives and intentions  
to use VR in the classroom context: a cross-  
sectional qualitative study.  
*Front. Virtual Real.* 6:1628684.  
doi: 10.3389/frvir.2025.1628684

## COPYRIGHT

© 2025 Amoroso, Tsivitanidou, Sarens,  
Christodoulides, Antoniou, Silva, Coelho and  
Cools. This is an open-access article distributed  
under the terms of the [Creative Commons  
Attribution License \(CC BY\)](#). The use,  
distribution or reproduction in other forums is  
permitted, provided the original author(s) and  
the copyright owner(s) are credited and that the  
original publication in this journal is cited, in  
accordance with accepted academic practice.  
No use, distribution or reproduction is  
permitted which does not comply with these  
terms.

# Exploratory physical education teachers' perspectives and intentions to use VR in the classroom context: a cross-sectional qualitative study

José Pedro Amoroso<sup>1,2\*</sup>, Olia Tsivitanidou<sup>3</sup>, Marc Sarens<sup>4</sup>,  
Efsthios Christodoulides<sup>5</sup>, Kyriaki Antoniou<sup>3</sup>, David Silva<sup>1,2</sup>,  
Luís Coelho<sup>1,6</sup> and Wouter Cools<sup>7,8</sup>

<sup>1</sup>ESECS—Polytechnic University of Leiria, Leiria, Portugal, <sup>2</sup>CIEQV/LQRC - Life Quality Research Center, Polytechnic of Leiria, Santarém, Portugal, <sup>3</sup>INQUIRIUM Ltd., Nicosia, Cyprus, <sup>4</sup>Faculty of Movement and Sport Sciences, Movement and Nutrition for Health and Performance, Vrije Universiteit Brussel, Brussels, Belgium, <sup>5</sup>Sports and Exercise Science, School of Sciences, University of Central Lancashire Cyprus, Pyla, Cyprus, <sup>6</sup>CIDESD - Research Center in Sport, Health, and Human Development, Vila Real, Portugal, <sup>7</sup>Vrije Universiteit Brussel, Multidisciplinair Instituut Lerarenopleiding, Brussels Research Institute for Teacher Education, Brussels, Belgium, <sup>8</sup>Artevelde University College, Gent, Belgium

**Introduction:** This study explored the potential role of emerging technologies, particularly active Virtual Reality (VR), from a Physical Education (PE) teacher's perspective. VR technologies, which provide three-dimensional (immersive) simulation environments, have become more accessible and cost-effective in recent years. Using this technology to train students in various PE areas may add value.

**Objectives:** The study aimed to understand PE teachers' knowledge of VR and their expectations for teaching PE using VR in classroom settings. Specifically, we explored the experiences, challenges, and potential benefits perceived by PE teachers across four European countries.

**Participants:** Thirty-eight PE teachers from Portugal, Belgium, Italy, and Cyprus participated voluntarily.

**Design:** This qualitative study employed a phenomenological approach. Data were collected between March and May 2024 in public and private secondary schools with ethical approval.

**Methods:** Data was gathered through open-ended focus group questions and analysed using a thematic analysis approach.

**Results:** Responses revealed varied experience levels with VR. Most participants expressed a willingness to use VR in PE, showing enthusiasm for new technologies and cautious optimism about integration. While recognizing its potential, respondents highlighted limitations. Technical barriers included Internet issues, limited technical skills, and lack of IT support. These reflect the challenges of implementing VR in schools. Teachers valued VR's potential to expose students to otherwise inaccessible sports and activities. They also discussed its use for improving specific skills, such as first aid, game tactics, and individual sports techniques.

**Conclusion:** Integrating VR into PE presents both challenges and opportunities. Addressing training, financial, and logistical issues may enhance student engagement and learning outcomes.

#### KEYWORDS

virtual reality, physical education, training and education, qualitative design, technology

## 1 Introduction

Education is a changing field that is constantly under scrutiny. The persistent patterns in student success and failure suggest that we need to spend more time thinking about what it means to teach for diversity (Rowan et al., 2021). According to James and Augustin (2018) and Jastrow et al. (2022), a key research focus is developing pedagogical strategies that enhance students' skills through digital technologies in physical education. Previous literature has noted that physical education (PE) teachers differ from classroom teachers in terms of the physical structure of the classroom, the characteristics of the content taught, professional duties, and the status of the subject and teachers (Koustelios and Tsigilis, 2005; Tsigilis et al., 2011; Lee, 2019). As societies undergo through sociocultural changes, educational system is affected, and the field of PE is also part of this reformation (Christodoulides et al., 2022).

Educational practice teaches us that teachers still face significant challenges when integrating emerging technologies into their teaching. Many PE teachers and coaches in youth sports are keen to incorporate digital technologies into their teaching practice (Koekoek and van Hilvoorde, 2018). This aligns with Bohnsack's (2014) perspective from the documentary method, which emphasizes the importance of understanding the underlying social contexts and interpretive frameworks that shape how educators adopt and implement new technologies in their practice. Similarly, Daum and Ervin-Kassab (2023) highlight that the integration of technology in physical education often occurs inconsistently "only when it is raining" suggesting that contextual factors, teacher beliefs, and situational constraints continue to influence how and when digital tools are used in PE settings. According to the Technological Pedagogical Content Knowledge (TPACK) framework, effectively integrating technology to positively impact student learning requires the proficient utilization of three key skills: technological, pedagogical, and content knowledge (Sullivan et al., 2024). Although theoretical frameworks such as the TPACK model (Mishra and Koehler, 2006) help to see the different aspects that need attention in building teacher competence, it is quite a complex matter to realise effective and efficient realisation of technology use in education.

Correspondingly, the field of PE does not escape the challenges of integration and has to stretch in different areas to enrich teacher skills such as: Technological Pedagogical Knowledge which contains the relationships and interactions between technological tools and specific pedagogical practices, the Pedagogical Content Knowledge contains the same between pedagogical practices and specific learning objectives and finally the Technological Content Knowledge which contains the relationships and interfaces between technologies and learning objectives (Koehler and Mishra, 2015). Although there are still areas requiring further investigation, existing literature increasingly explores the use of Virtual Reality (VR) in PE and extracurricular sports activities

(Kuleva, 2024). As evidenced in the work of Horvat et al. (2022), immersive and non-immersive VR technologies have been employed for decades to support physical training, highlighting the continuing evolution of virtual learning environments. The effective integration of VR as a pedagogical tool or strategy in PE lessons requires careful planning and alignment with learning objectives, as the perceived value of technology-enhanced tasks depends greatly on how digital tools are embedded within meaningful, inquiry-based learning contexts (Heindl and Nader, 2018). Teachers may struggle to integrate VR seamlessly into their lesson plans without proper guidance and support (Calabuig-Moreno et al., 2020). Edyburn (2023) notes that, although educators appreciate technology, they often feel ill-equipped, recognizing contextual challenges but viewing technology as a potential ally in achieving educational goals. The Declaration on Digital Rights and Principles (European Commission, 2023) emphasizes that everyone should have the opportunity to develop both fundamental and advanced digital skills. However, 46% of older Europeans currently lack basic digital competencies, which hinders their ability to utilise digital technologies for daily activities and to access online services (European Commission, 2023). Similarly, research highlights the importance of developing teachers' pedagogical digital competence, as it significantly influences students' academic motivation and performance in physical education (Von Reniel et al., 2023). A whole-school approach is needed to promote an atmosphere in which PE and sport are valued and encouraged by all members, recognizing that all aspects of the school community can affect the health and wellbeing of students, and that more effective schools are characterized by a shared vision among teachers and principals who act on behalf of the learning and education of all students (Gomes et al., 2023; Jarl et al., 2021).

However, providing the technology, information, and communication skills needed for the 21st century learners challenges schools to move beyond conventional methods of teaching and learning and beyond the traditional boundaries of the school day and school walls (Shapley et al., 2011). All of this highlights the significant interest within the educational community in investigating the use of technology across various teaching approaches. VR is not a new technology, nor is its application in education. The first recorded implementation of a digital VR system appeared in the 1966, in the form of a flight simulator designed for training purposes for the United States air force (Page, 2000; Kavanagh et al., 2017). Numerous research efforts have been undertaken regarding the use and efficacy of VR in educational settings and training programs since the 1980s (Pantelidis, 2010). In the field of PE, with pioneering technology such VR, can lead to different problems and difficulties for researchers themselves (Bores-García et al., 2024). Teachers are the key agents in navigating the VR learning experience. They should be adept in both the technological and pedagogical aspects of VR to effectively guide and support students (Martín-Gutiérrez et al., 2016).

Nevertheless, before we can teach how to use VR in PE, it is useful to understand PE teachers' experiences, fears and difficulties, so that they can learn how to teach more effectively (Fernández-Rivas and Espada-Mateos, 2019; Lee, 2019). Numerous suggestions have been put forth in scholarly works to tackle the identified issue, with nearly all the proposed solutions advocating for the integration of information and communication technologies into the educational process (Wang et al., 2014; Woreta et al., 2013; Monroy Reyes et al., 2016).

VR systems incorporating advanced technologies made their debut in the sports arenas of the United States and Europe in the early 1990s (Lee, 2004). Typical sports that have utilized VR systems encompass American football, archery, tennis, shooting, and golf. These technologies have been extensively employed for simulation and mental training purposes aimed at enhancing the competitive performance of elite athletes (Lee, 2004). VR sports systems leverage advanced technology to combine motion feedback platforms with real sports activities, allowing users to experience the sensation of physical exercise within a virtual environment. This immersive experience is anticipated to provide significant benefits akin to those of actual physical activity. Consequently, VR systems are increasingly favoured by athletes in both training and rehabilitation contexts to boost their performance, as well as being integrated into school PE classes and recreational activities (Bum et al., 2018).

As noted by Carayannis et al. (2015), the study of VR technology has a broad, inter- and transdisciplinary character. With the continuous advancement of interface technologies, VR is expected to become increasingly widespread and transformative, facilitating work processes, fostering innovation, and serving as an effective teaching platform for modern physical education (Ahsan, 2024). Not only will the limitations of time and space be transcended, but we will be able to demonstrate and control canonical athletic motions from arbitrary angles in a scientific and rational manner, and also demonstrate dynamic sports strategies in a continuous manner (Zhang and Liu, 2012).

VR captivates and maintains students' focus, as evidenced by findings from multiple research studies (Merchan et al., 2014; Calabuig-Moreno et al., 2020). According to Hew and Cheung (2009), students often experience a sense of excitement and challenge when engaging with three-dimensional virtual environments, where they can explore, interact, and construct their own immersive learning spaces. VR offers a more precise and realistic representation of specific characteristics and processes compared to traditional methods (Seth et al., 2010). It enables detailed examination of objects up close, fostering new insights through unique perspectives. Viewing the model of an object from the inside, top, or bottom reveals areas never before seen (Pantelidis, 2010).

In recent years, the integration of virtual reality (VR) technologies into education has received increasing attention, particularly within the field of physical education (PE). VR offers immersive and interactive learning experiences that can enhance students' motivation, engagement, and understanding of physical concepts compared to traditional methods (Hew and Cheung, 2009; Seth et al., 2010). The use of VR in PE has been associated with improved skill acquisition, greater learner autonomy, and new

opportunities for inclusive and adaptive learning environments (Ahsan, 2024).

However, despite these advantages, several challenges remain regarding teachers' preparedness, access to resources, and professional development related to the effective integration of VR into PE teaching (Edyburn, 2023). Many teachers appreciate the pedagogical potential of technology but often feel underprepared or lack the confidence and training necessary to incorporate it successfully into their teaching practice (James and Augustin, 2018). Furthermore, understanding the inter- and transdisciplinary nature of VR in education linking technological, pedagogical, and content knowledge is crucial to supporting teachers' professional growth (Carayannis et al., 2015; Koehler and Mishra, 2015).

Building on this context and acknowledging the need for alignment between teaching practices and curriculum goals (Yanik et al., 2023), the present study aims to explore the intentions, willingness, and professional development needs of PE teachers to enhance their competence and confidence in implementing VR within physical education settings. It also seeks to capture teachers' perspectives on their current knowledge of VR, as well as their expectations and perceptions regarding its use in teaching and learning contexts. Previous research (e.g., Bum et al., 2018) has highlighted the potential of VR to enhance engagement, motivation, and participation by offering immersive and accessible environments. Consequently, investigating how these principles can be translated into practical educational and training contexts is crucial for advancing both theoretical understanding and applied practice in the integration of VR into PE.

## 2 Materials and methods

In this study, we aim to explore the intentions, willingness, and professional development needs of physical education (PE) teachers to better understand how they can become more competent and confident in implementing virtual reality (VR) within PE settings. The study also seeks to capture PE teachers' perspectives on their current knowledge of VR, as well as their expectations and perceptions regarding the use of VR technologies in teaching and learning contexts.

To achieve these objectives, this research is guided by the following questions, which aim to bridge existing knowledge gaps and provide new insights into how VR can inform PE teaching practices and professional growth:

- Q1. What are PE teachers' current experiences with using VR technology in their teaching, either personally or professionally?
- Q2. What is the level of willingness among PE teachers to integrate VR technology into their PE classes?
- Q3. How do PE teachers perceive their own competence in using VR technology within PE lessons?
- Q4. What challenges and barriers PE teachers identify regarding the integration of VR technology into PE?
- Q5. What potential benefits and opportunities do PE teachers associate with integrating VR into PE teaching?

Q6. What changes in PE teaching do teachers expect to occur in the near future?

## 2.1 Study design and participants

This qualitative study employed a phenomenological design to explore physical education (PE) teachers' perceptions, experiences, and expressed needs regarding the development of Technological Pedagogical Content Knowledge (TPACK) competencies, with a specific focus on the integration of virtual reality (VR) in PE classes. This design allowed for an in-depth understanding of participants' lived experiences and the contextual factors shaping their attitudes toward VR use in educational practice (Liamputtong and Ezzy, 2005; Morgan, 1998).

A total of thirty-eight in-service PE teachers participated in the study, representing four European countries: Portugal ( $n = 10$ ), Belgium ( $n = 9$ ), Italy ( $n = 9$ ), and Cyprus ( $n = 10$ ). Participants were recruited from both public and private secondary schools through institutional partnerships established within the project consortium. Recruitment was conducted in collaboration with school administrations, ensuring that schools from diverse educational contexts were represented.

The selection of participants followed a purposive sampling approach (Patton, 2015), which is appropriate for qualitative research aimed at eliciting rich, relevant, and diverse perspectives. Selection criteria included: (a) active employment as PE teachers, (b) experience teaching students in Years 10 and 11 (Key Stage 4; ages 14–16), and (c) willingness to participate in focus group discussions. These criteria ensured consistency across participating schools and alignment with the broader project objectives.

The final sample consisted of 22 male (57.9%) and 16 female (42.1%) participants. Teaching experience ranged from 2 to 28 years, representing early-career, mid-career, and senior teachers. This diversity allowed for comparison across varying levels of professional experience and digital competence. Preliminary observations suggested that younger teachers tended to express greater familiarity and confidence with digital tools, whereas more experienced teachers provided valuable insights into pedagogical challenges and institutional constraints.

Differences between countries were not analyzed in depth in the current study due to the exploratory nature of the research; however, contextual diversity was ensured by including schools of different sizes, infrastructures, and curricular orientations. Future research will expand on these cross-national comparisons to better understand local variations in technology adoption and training needs.

## 2.2 Recruitment and ethical considerations

Participant recruitment was coordinated through agreements with school administrations and involved prior meetings with school headmasters to establish feasibility. Teachers were provided with detailed information about the study's purpose, procedures, and their rights as participants. Written informed

consent was obtained from all participants prior to data collection. Participants were assured that their involvement was voluntary, that they could withdraw at any time without consequence, and that data confidentiality would be strictly maintained. All focus groups were anonymized using participant codes and nicknames. The study was approved by the Cyprus National Bioethics Committee (Approval No. EEBK EPI 2023.01.328).

## 2.3 Data collection

Data were collected through focus group discussions, guided by a semi-structured interview protocol specifically developed for this study (Liamputtong and Ezzy, 2005; Krueger and Casey, 2014; Morgan, 1998). The focus groups aimed to elicit detailed insights into PE teachers' current practices, challenges, needs, and expectations regarding VR integration in PE.

### 2.3.1 Focus group development

The interview protocol was developed collaboratively by the research team after a thorough review of the relevant literature. Experts from the project partner countries (Portugal, Belgium, Italy, Cyprus) contributed to the refinement and validation of the protocol to ensure cultural and contextual relevance. The final protocol consisted of introductory, core, exploratory, and concluding questions, which were then translated into the native languages of each participating country.

The final focus group guide included six key questions:

- Two introductory questions assessing familiarity with VR.
- Four core questions aimed at exploring teachers' perceptions of PE, VR integration, and the potential impact of VR on school curricula.

The complete list of focus group questions is provided in Table 1.

Four focus groups (one per country) were conducted between 15 March 2024, and 15 April 2024, in quiet rooms within the participants' schools. Each session lasted approximately 60 min and was facilitated by a trained moderator using the standardized protocol. A second researcher was present in each session as a non-participating observer, taking detailed field notes to capture non-verbal cues and group dynamics. All discussions were audio-recorded and transcribed verbatim to ensure data accuracy.

## 2.4 Data analysis

The transcribed data were analyzed using thematic analysis (Braun & Clarke, 2006), a method suitable for identifying, organizing, and interpreting patterns of meaning within qualitative data. The process involved several iterative steps:

1. Familiarization with the data through repeated reading of transcripts and observation notes.
2. Initial coding, where meaningful segments were labeled to capture essential ideas.



TABLE 1 Focus group questions.

| Categories                                       | Questions                                                                                               |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------|
| Current knowledge of VR in PE teaching practices | 1. Have you ever had any experience using VR technology in your teaching, personally or professionally? |
|                                                  | 2. How willing are you to use VR in your PE classes?                                                    |
| Incorporation of VR in PE                        | 3. How competent do you feel about using VR in your PE classes?                                         |
| Challenges of VR in PE                           | 4. Do you see any potential challenges and/or barriers in the incorporation of VR in PE?                |
| Potential benefits                               | 5. Do you see any potential benefits and opportunities associated with integrating VR into PE teaching? |
| Future direction                                 | 6. Do you see PE delivery changing in the near future?                                                  |

3. Collation of codes into broader potential themes reflecting recurring concepts and relationships.
4. Review and refinement of themes to ensure consistency and alignment with the research objectives.
5. Definition and naming of final themes to accurately represent the data.

To ensure analytical rigor, two researchers independently coded the transcripts. Coding discrepancies were discussed and resolved by consensus, and inter-coder reliability was verified following Nili et al. (2020). The analysis was conducted using MAXQDA Analytics Pro 2024, which facilitated the systematic organization of codes, memos, and analytical notes. A detailed audit trail was maintained throughout the process to enhance transparency and replicability (Sandelowski and Barroso, 2003).

This approach ensured that the analysis was data-driven and inductive, allowing the main themes to emerge directly from participants' narratives, while maintaining methodological consistency and credibility.

The analysis involved identifying, classifying, and coding findings (O'Connor and Penney, 2020). The first author conducted the initial coding of the text. To ensure consistency and reliability, the process incorporated a verification step for inter-coder reliability, which is crucial for maintaining analytical rigor (Nili et al., 2020). Analytic documentation was maintained throughout the coding, categorization, and comparison processes, as recommended by Sandelowski and Barroso (2003).

In the second phase, the researchers identified similarities and differences within the discussions from the focus group sessions. The second author conducted an independent verification by coding a randomly selected portion of the transcripts and performing additional checks on a selection of codes applied to other groups. The analysis was conducted collaboratively by three authors using MAXQDA® Analytics Pro 2024 (version 24.03.0). The data were systematically organized within MAXQDA, including folder structures, text-specific overviews, coding schemes, and accompanying analytic memos (Berlin, 2008).

The coding process was supervised by the senior author. Regular meetings with the core study team were held twice a month over a 2-month period to minimize subjectivity and ensure coherence (see Table 2). An inductive method was consistently employed, allowing coding themes to emerge directly from the data. An interpretive framework was adopted to provide analytical context, guide methodological decisions, and shape the research questions posed to the data (Bohnsack, 2014). This approach enabled the

TABLE 2 Methodological characteristics (categories/sub-categories).

| Categories     | Sub-categories                |
|----------------|-------------------------------|
| a) Information | 1. Experience and motivation  |
| b) Application | 2. Competences                |
| c) Challenges  | 3. Challenges and/or barriers |
| d) Evaluation  | 4. Benefits and opportunities |
| e) Development | 5. Changes                    |

development of initial codes and the conceptualization of thematic categories (O'Connor and Penney, 2020).

Following the methodological principles outlined in grounded theory, the analysis allowed key issues to emerge naturally from the data, rather than forcing them into predefined categories (Oktay, 2012; Charmaz and Mitchell, 1996). In the final phase, the codes were grouped into categories to assess PE teachers' knowledge across five key areas: (a) Information, (b) Application, (c) Challenge, (d) Evaluation, and (e) Development.

Citations considered to represent the same meaning were grouped together and allocated a label, while quotes considered to represent a different perception were given a new label. All data were examined until all significant data had been identified, clustered and labelled. The resulting labels were then scrutinized and organized into themes, each theme comprising labels considered conceptually similar.

The documents containing the focus group transcripts were removed and organized by question, aligning all responses from the different countries to minimize the possibility of data bias.

Initially, only one focus group was analysed, based on the thematic analysis procedures comparing common themes in the focus groups. This depended on the ideas expressed in each question, which could be words, phrases or parts of sentences and paragraphs. In each recording unit or context, mutual exclusion of categories took place, considering accuracy and consistency to encode, create categories, filter and question the information. This was done in order to integrate all information while giving it a logical meaning in answering the research questions (Shea et al., 2007). The act of coding and recoding inherently involves a degree of subjectivity. One of the drawbacks of qualitative research is the unavoidable subjectivity involved in developing a codebook that focuses on educational concepts (Silver, 2023).

Cultural and contextual considerations: Differences between countries were not considered given the type of questions. In the preparatory phase, the topic was addressed, but we have planned to leave it for a future study.

### 3 Results

A thematic analysis was employed to explore teachers' perceptions and expressed needs regarding the use of VR in PE, following Braun and Clarke's (2006) six-phase framework. This approach allowed the researchers to inductively identify themes emerging from the participants' responses.

#### 3.1 Experience with VR technology

Participants reported a wide disparity in their experience with VR technology. Out of the 38 participants (Table 3):

- 24 participants had no prior experience with VR in any context, underscoring a significant gap in familiarity within the educational setting. Representative quote: "No, I have never used VR in either a personal or professional context."
- 10 participants had used VR in a personal capacity (e.g., gaming) but not in educational settings. Representative quote: "I happen to use VR privately for gaming purposes."
- six participants had some professional experience using VR in education, though typically outside the PE context. Representative quote: "Yes, I have had some experience with VR, but outside the sports context."
- 5 participants demonstrated familiarity with examples of VR in PE or sports training, indicating awareness of VR's potential applications.

Representative quote: "The use of VR provides an opportunity to train the mind and manage tensions through immersion in certain environments."

Analysis of the focus group responses regarding the willingness to use VR in PE (Table 4) indicates a general openness to the concept, though participants highlighted several conditions and concerns that would shape their acceptance. Thirty participants explicitly expressed a willingness to incorporate VR into their PE lessons, demonstrating enthusiasm for integrating innovative technologies to enrich the learning experience. Representative comments include: "Yes, I am willing to use VR because I see the application of new approaches in PE as positive" and "Yes, I am willing to use VR in my teaching, even with apps."

However, fifteen participants noted that their willingness would depend on receiving adequate training and support. Many emphasised the importance of gaining the necessary skills and confidence to use VR effectively before implementing it in their teaching. This was further reinforced by twenty participants who expressed limited competence with VR technology and highlighted the need for targeted training. For example, one participant remarked, "I do not feel competent at the moment, but if I use VR for a while I think I'll be successful." Another stated, "This is difficult to answer. I feel capable of learning both theory and practice, but with the VR glasses I do not know how they work."

Despite these concerns (Table 5), fifteen participants recognised the potential benefits of VR for enhancing PE, even while acknowledging their current unfamiliarity with the technology. This reflects a cautious optimism, where participants see value in

VR but are aware of its limitations. As one participant noted, "Having never used this technology, I do not feel fully competent in this area, but I do see the potential of the tool."

Additionally, twelve participants identified specific areas where VR could enhance teaching, such as simulating scenarios that are difficult to achieve in traditional PE settings and providing more engaging methods for teaching sports and physical activities. One participant shared, "I think it could be interesting to integrate activities that simulate scenarios that are difficult to achieve in training."

However, practical concerns were raised by ten participants, including challenges related to managing large classes, providing effective feedback while students use VR, and potential disruptions to traditional teaching methods. As one participant questioned, "How will you be able to give feedback to students if you do not know what they are doing in the VR glasses?"

#### 3.2 Challenges of VR in PE

During the focus group, participants further elaborated and explained their rationale. Key themes that emerged during the discussion included financial, technical, personal, infrastructural, and pedagogical concerns (Table 6). Financial barriers emerged as the most common challenge, mentioned by twenty participants. Participants expressed concerns about the high cost of VR equipment and the financial limitations of schools. For example, one participant noted, "Financial constraints, beyond teachers' control, are a significant barrier", highlighting the mismatch between teachers' aspirations and school budgets. Another participant said, "The only barrier I can think of is economic. Headsets are still expensive, and I find it hard to imagine that schools can afford to buy them for all pupils". Technical barriers were identified by eighteen participants, including issues related to internet connectivity, lack of technical skills, and the need for IT support and infrastructure. These barriers reflect the practical challenges of implementing VR in an educational setting. Another participant expressed concerns about the Internet infrastructure, noting "I doubt that the Internet infrastructure in schools can support this technology".

In addition to technical and pedagogical considerations, participants also identified a range of personal and practical barriers that could affect the successful implementation of VR in PE. Personal barriers were highlighted by fifteen participants and included teacher resistance to change, concerns about the impact of VR on physical engagement and personal reservations about the technology. These barriers highlight the human factor in the adoption of new technologies. One participant noted "The reluctance of some 'old-fashioned' colleagues to open up to new educational frontiers". Another mentioned: "I think there are some challenges and barriers. There may be challenges in terms of teacher training and skills". Infrastructure and logistical issues were mentioned by 10 participants, who pointed out the practical difficulties of integrating VR into PE. These issues include space constraints, managing equipment and coordinating use across multiple classes.

Another highlighted logistical challenges such as "equipment maintenance, hygiene issues, e.g., sweat, how to clean equipment, recharging equipment, time to wear VR, storage, transport".

**TABLE 3** Emerged themes from participants' responses to the question (Q1): "Have you ever had any experience using VR technology in your teaching, personally or professionally?"

| Theme                                             | Number of participants | Indicative quotes                                                                                                        |
|---------------------------------------------------|------------------------|--------------------------------------------------------------------------------------------------------------------------|
| No experience with VR                             | 24                     | "No, I have never used virtual reality either in a personal or work context"                                             |
| Personal experience with VR, but not in Education | 10                     | "I happen to use VR privately for gaming purposes"                                                                       |
| Professional experience with VR in Education      | 6                      | "Yes, I have had some experiences with virtual reality but outside the sporting context"                                 |
| Knowledge of VR in PE and Sports Education        | 2                      | "We know of a 2012 study conducted by Judith Deutsch, in which a cycling program was developed with virtual reality"     |
| Potential of VR in PE and Sports Education        | 2                      | "The use of VR provides the opportunity to train the mind and manage tensions through immersion in certain environments" |

**TABLE 4** Emerged themes from participants' responses to the question (Q2): "How willing are you to use VR in your PE classes?"

| Theme                                             | Number of participants | Indicative quotes                                                                                                                      |
|---------------------------------------------------|------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Willing to use VR                                 | 30                     | "Yes, I am willing to use virtual reality because I consider the application of new approaches in physical education classes positive" |
| Conditional willingness (training/support needed) | 15                     | "Yes, provided I am trained"                                                                                                           |
| Concerns about technical knowledge                | 12                     | "I am a layman and do not know any apps"                                                                                               |
| Concerns about practical implementation           | 10                     | "I am concerned about the cost to the school"                                                                                          |
| Not willing to use VR                             | 2                      | "No, I would not. I do not feel competent about it"                                                                                    |

**TABLE 5** Emerged themes from participants' responses to the question (Q3): "How competent do you feel about using VR in your PE classes?"

| Theme                                            | Number of participants | Indicative quotes                                                                                                                 |
|--------------------------------------------------|------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Limited competence and need for training         | 20                     | "I do not feel competent at the moment, but if I use VR for a while, I think I will succeed"                                      |
| Recognition of potential but lack of familiarity | 15                     | "Having never used this technology, I do not feel absolutely competent on the subject, but I recognize the potential of the tool" |
| Linking VR to curriculum and pedagogy            | 8                      | "I believe that with some explanations and with some reading on my part, I believe that I will be able to use it"                 |
| Specific areas for VR enhancement                | 12                     | "I think it could be interesting to integrate activities, simulating scenarios that are difficult to achieve in training"         |
| Concerns about practical implementation          | 10                     | "How will you be able to give feedback to the students if you do not know what they are doing in the VR glasses"                  |

Pedagogical concerns were discussed by eight participants who raised questions about the pedagogical implications of using VR in PE. These concerns include the potential for VR to isolate students, affect their social interactions and detract from the physical aspects of PE. One participant remarked: "Pedagogically, it can isolate children, affect their behaviour towards other children, problematic behaviour that occurs during the lesson". Another mentioned: "If I feel that VR can replace me, I will not use it in the classroom. It is best for the children to do it on their own at home."

The most prominent benefit identified by twenty-six of the thirty-eight participants, is the potential to engage more students

in physical activity, particularly those who typically show less interest in traditional PE activities. Providing opportunities for students with physical disabilities to participate in adapted physical activities was cited by eighteen respondents, highlighting the inclusivity potential of VR. Introducing novel and varied forms of physical activity not possible in a traditional PE setting was selected by twelve respondents, while nine noted the benefit of allowing students to practice and improve at their own pace. Using VR to simulate outdoor environments or sports was chosen by ten respondents. In addition, eight respondents identified the benefits of bridging gaps in access to different physical activities due to geographical or resource limitations and



**TABLE 6** Emerged themes from participants' responses to the question (Q4): "Do you see any potential challenges and/or barriers in the incorporation of VR in PE?"

| Theme                                | Number of participants | Indicative quotes                                                                                                                                 |
|--------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------|
| Financial barriers                   | 20                     | "Financial constraints, beyond teachers' control, are a significant barrier."                                                                     |
| Technical barriers                   | 18                     | "The quality of the Internet is still a little unstable. Training, which I think people need in general, we all need accessible training."        |
| Personal barriers                    | 15                     | "The reluctance of some 'old-fashioned' colleagues to open to new educational frontiers."                                                         |
| Infrastructure and logistical issues | 10                     | "The place we will need, because for now the classes are held outside."                                                                           |
| Pedagogical concerns                 | 8                      | "Pedagogically, it can isolate children, influence their behaviour towards other children, problematic behaviours that appear during the lesson." |

**TABLE 7** Emerged themes from participants' responses to the question (Q5): "Do you see any potential benefits and opportunities associated with integrating VR into PE teaching?"

| Theme                                       | Number of participants | Indicative quotes                                                                                                                                                                                    |
|---------------------------------------------|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Increased motivation and engagement         | 15                     | "More motivation for some students to participate in the PE lesson."                                                                                                                                 |
| Inclusivity and accessibility               | 10                     | "Virtual reality could serve as motivation for class participation; on the other hand, it can also benefit students with special educational needs and those who have some motor skills impairment." |
| Enhanced learning and skill development     | 12                     | "Students who have difficulties performing a certain technique could first practice in VR and then apply it in the real game."                                                                       |
| Opportunity to experience diverse sports    | 8                      | "You can offer different sports through the different apps in the VR glasses."                                                                                                                       |
| Overcoming physical and logistical barriers | 5                      | "Space savings when there is only a limited sports hall available."                                                                                                                                  |

**TABLE 8** Emerged themes from participants' responses to the question (Q6): "Do you see PE delivery changing in the near future?"

| Theme                                          | Number of participants | Indicative quotes                                                                                                                           |
|------------------------------------------------|------------------------|---------------------------------------------------------------------------------------------------------------------------------------------|
| Changes in PE delivery                         | 20                     | "I see my job changing a lot. I never learned to teach subjects such as ergonomics, anatomy or first aid to students, while I do that now." |
| VR as a complementary tool                     | 15                     | "I see it as an additional activity that can be used occasionally in PE lessons."                                                           |
| Need for professional training and development | 10                     | "There must be professional training, but all this must be balanced with healthy activity done in the fields."                              |
| Concerns about over-reliance on technology     | 8                      | "Physical education means exercising myself naturally. If I use extra tools, like technology to exercise, it's not the same."               |
| Potential for enhancing specific skills        | 12                     | "I see opportunities to teach first aid in VR. I think you can present a lifelike situation this way."                                      |

providing detailed visual and interactive feedback to aid understanding of complex movements or sports strategies. These findings highlight the wide range of benefits that VR can bring to PE, improving engagement, inclusivity and educational outcomes.

Analysis of the focus group responses regarding the potential benefits and opportunities of integrating VR into PE lessons revealed several key themes, particularly in the areas of motivation, inclusivity, enhanced learning, and the ability to address logistical challenges (Table 7).

Increased motivation and engagement emerged as one of the most prominent potential benefits, highlighted by fifteen participants. Many participants emphasized that VR could significantly boost student interest and participation, particularly among those who are usually less active or less inclined to engage in traditional PE activities. The novelty and immersive nature of VR were seen as powerful tools to capture students' attention and foster greater enthusiasm. For example, one participant observed, "More motivation for some students to participate in PE," while another commented, "Today's children will be excited by VR, so their

participation in class will increase.” These responses suggest that VR could offer new pathways to involve disengaged students and enhance their overall learning experience.

Inclusivity and accessibility were also strongly emphasized, cited by ten participants as a key advantage of using VR in PE. Technology was viewed to promote equal opportunities by making physical activities more accessible to students who face barriers to participation, such as those with disabilities or special educational needs. One respondent noted, “Virtual reality could serve as a motivation for class participation. On the other hand, it can also benefit students with special educational needs and those who have some motor impairment.” These perspectives highlight the potential for VR to create more inclusive learning environments, where all students can participate meaningfully, regardless of their physical abilities.

Enhanced learning and skill development were identified as significant advantages of integrating VR into PE lessons, as noted by twelve participants. These participants recognized that VR could offer unique, controlled environments where students could safely practice and refine physical skills before applying them in real-world scenarios. This virtual practice could be especially beneficial for students who find it challenging to master certain techniques through traditional instruction alone. As one participant explained, “Students who are struggling to perform a certain technique could practice it in VR first and then use it in the real game.” This suggests that VR may serve as a valuable tool to support differentiated learning, allowing students to progress at their own pace and build confidence in their abilities.

In addition to supporting skill development, eight participants highlighted the potential of VR to expose students to a broader range of sports and physical activities that are typically inaccessible within the conventional PE curriculum. These participants appreciated VR’s capacity to introduce students to sports that may be limited by geographical, financial, or safety constraints. For example, activities such as skiing, sailing, or rock climbing are often difficult to organize in school settings, which could be simulated through VR, offering students a more diverse and enriching educational experience. This expanded access could increase students’ exposure to new interests and potentially foster lifelong engagement with physical activity.

Furthermore, overcoming physical and logistical barriers was mentioned by five participants as a practical advantage of VR integration in PE. Schools frequently face challenges related to limited gym space, restricted access to sports equipment, or scheduling conflicts that hinder the variety of physical activities offered. VR was seen as a potential solution to these constraints by providing virtual alternatives that do not rely on physical resources. As one participant noted, “Saving space when there is limited gym space.” VR could allow students to engage in meaningful physical activities within smaller or less-equipped environments, thereby expanding the possibilities for instruction and learning.

The thematic analysis of the focus group responses regarding the future direction of PE and the potential role of VR revealed several interconnected themes. These themes reflect participants’ perceptions of how PE is evolving and how VR might contribute to this evolution (Table 8).

One of the most prominent themes was the recognition of ongoing changes in the delivery of PE, discussed by twenty participants. These respondents emphasized the shifting

landscape of PE, noting that the role of the PE teacher is expanding beyond traditional sports instruction. For many, this shift includes the integration of new subjects and teaching approaches that reflect broader educational goals. One participant remarked, “I see my job changing a lot. I never learnt to teach subjects like ergonomics, anatomy or first aid to students, whereas now I do.” This illustrates the dynamic nature of PE and suggests that the integration of VR could be a natural extension of these emerging responsibilities, aligning with broader curricular changes and modern educational trends.

Another key theme identified by fifteen participants was the view of VR as a complementary tool rather than a replacement for traditional PE activities. Participants consistently expressed the belief that VR should be used to enhance, not substitute, physical engagement and real-world sports experiences. VR was seen as an innovative support mechanism that could enrich the learning process, offer new perspectives, and introduce students to activities that might not otherwise be accessible. However, the respondents were clear that the core objective of PE, promoting physical activity and real movement, must remain central. This balanced view highlights a thoughtful approach to technology integration, where VR is positioned as an educational ally rather than a threat to traditional teaching practices.

The importance of professional training for teachers emerged as a critical theme among the focus group participants. Many emphasised that to successfully integrate VR into PE, teachers must first be adequately prepared. Professional development was seen as essential to ensuring that educators have both the technical knowledge and pedagogical strategies needed to use VR effectively and meaningfully in their lessons. One participant stressed this point by saying, “There needs to be professional training, but all this needs to be balanced with healthy activity in the field.” This comment reflects the shared belief that while VR presents valuable educational opportunities, its integration must not come at the expense of the core physical aspects of PE. Training should therefore focus on blending VR with active, movement-based learning, not replacing it.

Concerns about over-reliance on technology were raised by eight participants, who expressed caution regarding the potential risks of prioritising digital tools over physical engagement. Some participants warned that excessive use of VR could lead to a diminished focus on the essential goals of PE, such as promoting natural movement, physical fitness, and social interaction through sports. One participant succinctly captured this concern, stating, “Physical education is about exercising naturally. If I use extra tools like technology to exercise, it’s not the same.” This perspective underscores the importance of maintaining a healthy balance between innovation and tradition, ensuring that technology complements, rather than replaces, physical activity.

The potential of VR to enhance specific skill development within PE was discussed by twelve participants. They identified that VR could be particularly valuable for teaching complex or high-risk content in a safe and controlled virtual environment. Participants suggested that VR could support the development of key skills such as first aid procedures, tactical decision-making in team sports, and technical refinement in individual sports. By allowing students to visualise, practise, and repeat scenarios that may be difficult to replicate in real life, VR was seen as a promising tool for improving learning outcomes in these specialised areas.

Finally, participants highlighted the potential of VR to enhance the teaching of specific skills within PE. These included areas such as tactical awareness, decision-making, and visualisation of complex movements, which could be more effectively demonstrated and practised in a virtual environment. This potential was seen as particularly valuable for improving student understanding and engagement in theoretical or technically demanding aspects of PE.

The analysis accurately reflects the participants' varying levels of experience with VR technology, highlighting a general lack of familiarity among most respondents (see Figure 1). However, it is important to note that some survey questions allowed for more than one applicable response, and not all participants answered every question, which may slightly affect the distribution of totals and interpretation of the data.

## 4 Discussion

### 4.1 Limited experience with VR among PE teachers

Most of the participants (63%) in this study indicated that they lacked experience with VR, highlighting the need for targeted training and professional development to enhance the integration of this technology as a valid pedagogical strategy and instrument in PE classes. Such measures could potentially improve the effectiveness and efficiency of the teaching and learning process, as mobile augmented reality systems have been shown to support interactive and practical learning experiences in educational environments (Monroy Reyes, Vergara Villegas, Miranda Bojórquez, Cruz Sánchez and Nandayapa, 2016).

The thematic analysis of focus group data revealed that 30% had some experience with VR, whereas over 70% had none. Improving the digital technology competences of PE teachers can help them enrich their teaching methods and improve classroom effectiveness (Maksimović and Lazić, 2023). Similarly, Hamizi et al. (2022) emphasized that the successful implementation of VR in physical

education requires careful instructional design, structured training, and ongoing support to ensure teachers can effectively integrate this technology into their teaching practices. Their findings further reinforce the importance of developing educators' confidence and competence in utilizing VR to create engaging and immersive learning environments.

### 4.2 Digital literacy dimensions

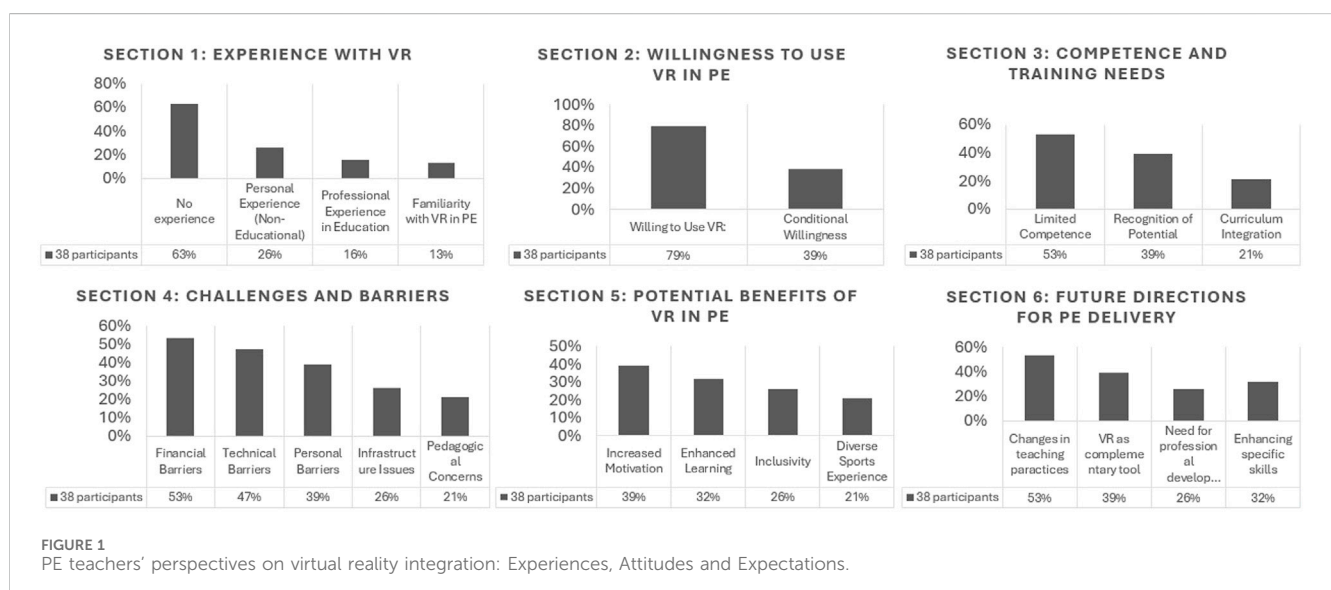
Based on the theoretical framework of digital literacy, PE teachers' digital competence can be summarised into four dimensions: digital awareness, digital teaching, digital communication and collaboration, and digital evaluation (Ze et al., 2024). Student-centred teaching approaches, such as flipped learning environments, could also provide opportunities to integrate ICT into PE teaching (Østerlie et al., 2022; Wohlfart, Mödinger and Wagner, 2013).

### 4.3 Competence gaps and generational differences

During the focus group discussions, many participants expressed limited competence in using VR technology and emphasized the need for training. Younger teachers, pre-service teachers, or digital natives appeared more comfortable with new technologies, while older teachers or digital immigrants faced a steeper learning curve (Sa'diyah and Prasetyo, 2023).

### 4.4 Pedagogical benefits of VR

VR has the potential to enhance PE by allowing students to overcome time and space limitations and by providing deeper insights into challenges in sports training (Li et al., 2021). Teachers stressed that VR could support inclusive education and



student engagement, but also highlighted the need for content, guidance, and safe-use strategies. Thangavel (2025) further emphasized that the integration of VR and AR technologies can transform traditional educational practices by promoting immersive, interactive, and personalized learning experiences. However, the author also noted that successful implementation requires addressing challenges related to accessibility, teacher preparedness, and infrastructure to ensure equitable and sustainable adoption across educational contexts.

## 4.5 Barriers to implementation

The core challenges identified include financial, technical, personal, infrastructural, and pedagogical barriers. Financial constraints were most frequently cited, followed by lack of time and training opportunities (Wallace et al., 2023; Hamizi et al., 2022). Similarly, Akinradewo et al. (2025) highlighted that barriers such as limited funding, inadequate infrastructure, insufficient technical expertise, and lack of institutional support significantly hinder the adoption of immersive technologies like AR and VR in educational and training contexts, particularly in developing countries. Despite these challenges, participants acknowledged VR's potential to foster innovation and inclusion in PE settings.

## 4.6 Teacher autonomy and the TPACK framework

A key aspect of the TPACK framework is teacher autonomy and the ability to act as designers of technology integration (Koehler and Mishra, 2008; Mishra et al., 2009). Improving teachers' digital literacy is crucial for effective VR integration. However, without proper training and support, many may struggle to use VR seamlessly (Calabuig-Moreno et al., 2020). In this regard, Chiu (2025) expanded on the TPACK model by introducing the Intelligent-TPACK (I-TPACK) framework, which integrates AI literacy and competency to enhance teachers' technological pedagogical decision-making. This framework underscores the importance of developing educators' adaptive expertise and data-informed instructional design skills to effectively implement emerging technologies like VR in teaching and learning environments, as research has shown that virtual reality-based instruction can significantly enhance students' learning outcomes across educational settings (Merchant et al., 2014).

## 5 Limitations of the study

This study has several limitations. The findings are based on a relatively small, context-specific sample of PE teachers, which may limit generalisability. As the data were self-reported, responses may have been influenced by social desirability bias. Moreover, the study provides only a snapshot at one point in time, without tracking long-term changes. The dynamics of focus groups may also have shaped responses. An additional limitation that should be acknowledged is that the thematic analysis results are inductive, as they remain directly linked to the interview questions. Further categorisation

and abstraction of themes might yield new insights and alternative interpretations.

## 5.1 Future research directions

Future research should address these limitations by including larger, more diverse samples, examining different educational settings, and adopting longitudinal approaches. There is a pressing need for empirical studies evaluating VR's impact on learning outcomes, motivation, and engagement. Research into policy frameworks, funding models, and infrastructure is also required to support sustainable adoption.

## 6 Conclusion

This study found that the level of VR experience among PE teachers is low, with over 70% having no experience and 30% having some exposure. Although teachers expressed general openness towards VR integration, significant barriers remain—particularly financial constraints, time limitations, and insufficient training. While enthusiasm is evident, these challenges must be addressed to enable effective and sustainable implementation.

The findings underscore the need for targeted professional development to build competence in VR use, investment in resources and infrastructure, and the adoption of inclusive, student-centred pedagogical approaches. Schools and policymakers should prioritise structured training, mentorship, and cross-disciplinary collaboration to ensure VR becomes a meaningful tool for enhancing PE teaching and learning.

Ultimately, VR offers unique opportunities to enrich PE by enabling innovative, inclusive, and engaging activities. However, its successful integration will depend on strategic planning, adequate funding, and sustained professional support for teachers. Addressing these factors can enhance both teacher preparedness and student learning outcomes in a digitally evolving educational landscape.

## Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

## Ethics statement

The studies involving humans were approved by the Cyprus National Bioethics Committee (Approval No. EEBK EII 2023.01.328). The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

## Author contributions

JA: Writing – original draft, Writing – review and editing, Methodology, Project administration. OT: Methodology, Project

administration, Writing – review and editing. MS: Writing – review and editing. EC: Writing – review and editing. KA: Writing – review and editing. DS: Writing – review and editing. LC: Data curation, Methodology, Supervision, Validation, Writing – review and editing. WC: Methodology, Project administration, Writing – review and editing, Writing – original draft.

## Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This research project has received funding from the European Union with the Erasmus+ Sport programme under Project number: 101133143 (Project VIBES – “Virtual reality sports Interaction Between European Schools”).

## Acknowledgements

The authors thank all participants who contributed to this study. Main thanks to the school principals and all the physical education teachers who participated voluntarily in the focus groups. In particular, the authors of this work thank their project partners from Centro Universitario Sportivo di Palermo e dell’ASD Cus Palermo, Rosario Genchi and Vito Rizza who made a valuable contribution to the VIBES project.

## Conflict of interest

Author OT was employed by the company Inquirium Ltd.

## References

- Ahsan, M. (2024). The use of modern technology in physical education teaching and learning process. *Int. J. Sports Phys. Educ.* 10 (1), 14–16. doi:10.20431/2454-6380.1001003
- Akinradewo, O., Hafez, M., Aliu, J., Oke, A., Aigbavboa, C., and Adekunle, S. (2025). Barriers to the adoption of augmented reality technologies for education and training in the built environment: a developing country context. *Technologies* 13 (2), 62. doi:10.3390/technologies13020062
- Berlin, K. S. (2008). Book information. *J. Afr. Stud.* 73, 89–91. doi:10.11619/africa1964.2008.73\_89
- Bohnsack, R. (2014). “Documentary method,” in *Documentary method*. Editor U. Flick (SAGE Publications Ltd), 217–233. doi:10.4135/9781446282243.n15
- Bores-García, D., Cano-de-la-Cuerda, R., Espada, M., Romero-Parra, N., Fernández-Vázquez, D., Delfa-De-La-Morena, J. M., et al. (2024). Educational research on the use of virtual reality combined with a practice teaching style in physical education: a qualitative study from the perspective of researchers. *Educ. Sci.* 14 (3), 291. doi:10.3390/educsci14030291
- Braun, V., and Clarke, V. (2006). Using thematic analysis in psychology. *Qual. Res. Psychol.* 3 (2), 77–101. doi:10.1191/1478088706qp0630a
- Bum, C.-H., Mahoney, T., and Choi, C. (2018). A comparative analysis of satisfaction and sustainable participation in actual leisure sports and virtual reality leisure sports. *Sustainability* 10 (10), 3475. doi:10.3390/su10103475
- Calabuig-Moreno, F., Huertas González-Serrano, M., Fombona, J., and García-Tascón, M. (2020). The emergence of technology in physical education: a general bibliometric analysis with a focus on virtual and augmented reality. *Sustainability* 12 (7), 2728. doi:10.3390/su12072728
- Carayannis, E., Hens, L., and Nicolopoulou-Stamati, P. (2015). Trans-disciplinarity and growth: nature and characteristics of trans-disciplinary training programs on the human-environment interphase. *J. Knowl. Econ.* 8 (1), 1–22. doi:10.1007/s13132-015-0294-z
- Charmaz, K., and Mitchell, R. G. (1996). The myth of silent authorship: self, substance, and style in ethnographic writing. *Symb. Interact.* 19, 285–302. doi:10.1525/si.1996.19.4.285
- Chiu, T. K. F. (2025). Developing intelligent-TPACK (I-TPACK) framework from unpacking AI literacy and competency: implementation strategies and future research direction. *Interact. Learn. Environ.* 33 (7), 4189–4192. doi:10.1080/10494820.2025.2545053
- Christodoulides, E., Tsivitanidou, O., and Hadjimatheou, A. (2022). “Port didactics in Cyprus: learning from the past, in the present and for the future,” in *Sports didactics in Europe: history, current trends and future developments* (Waxmann), 333–352.
- Daum, D. N., and Ervin-Kassab, L. (2023). Only when it is raining: technology in physical education. *Phys. Educ.* 80 (1). doi:10.18666/TPE-2023-V80-11-11116
- Edyburn, D. L. (2023). “Reimagining the future of special education technology,” in *Reimagining education: studies and stories for effective learning in an evolving digital environment*, 281–292. doi:10.1007/978-3-031-25102-3\_23
- European Commission (2022). European declaration on digital rights and principles. Available online at: <https://digital-strategy.ec.europa.eu/en/library/european-declaration-digital-rights-and-principles>.
- European Commission (2023). *Directorate-general for education, youth, sport and culture, digital education action plan 2021–2027, improving the provision of digital skills in education and training*. Publications Office of the European Union. Available online at: <https://data.europa.eu/doi/10.2766/149764>.
- Fernández-Rivas, M., and Espada-Mateos, M. (2019). The knowledge, continuing education and use of teaching styles in physical education teachers. *J. Hum. Sport Exerc.* 14 (1). doi:10.14198/jhse.2019.141.08
- Gomes, L., Martins, J., Ramos, M., and Carreiro da Costa, F. (2023). The impact of non-physical education teachers’ perceptions on the promotion of active and healthy lifestyles: a

The remaining authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

## Generative AI statement

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

## Publisher’s note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

## Author disclaimer

Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Education and Culture Executive Agency (EACEA). Neither the European Union nor EACEA can be held responsible for them. [Project number: 101133143].



cross-sectional qualitative study *international journal of environmental research and public health*. *Int. J. Environ. Res. Public Health* 20 (3), 2026. doi:10.3390/ijerph20032026

Hamizi, M. A. B. M., Mokmin, N., and Ariffin, U. (2022). Virtual reality technology in physical education: a systematic review in instructional design & implementation. *Adv. J. Tech. Vocat. Educ.* 6 (1), 6–12. doi:10.26666/rmp.ajtve.2022.1.2

Heindl, M., and Nader, M. (2018). Digital technologies in a design and technology lesson and their influence on a learner's situationally perceived value of a task when engaged in inquiry-based learning. *J. Comput. Math. Sci. Teach.* 37 (3), 239–263.

Hew, K. F., and Cheung, W. S. (2009). Use of three-dimensional (3-D) immersive virtual worlds in K-12 and higher education settings: a review of the research. *Br. J. Educ. Technol.* 41 (1), 33–55. doi:10.1111/j.1467-8535.2008.00900.x

Horvat, N., Martinez, T., Perišić, M. M., and Škeć, S. (2022). Comparing design review outcomes in immersive and non-immersive collaborative virtual environments. *Procedia CIRP* 109, 173–178. doi:10.1016/j.procir.2022.05.232

James, F., and Augustin, D. S. (2018). Improving teachers' pedagogical and instructional practice through action research: potential and problems. *Improv. Teachers' Pedagogical Instr. Pract. Through Action Res. Potential Problems. Educ. Action Res.* 26 (2), 333–348. doi:10.1080/09650792.2017.1332655

Jarl, M., Andersson, K., and Blossing, U. (2021). Organizational characteristics of successful and failing schools: a theoretical framework for explaining variation in student achievement. *Sch. Eff. Sch. Improv.* 32 (3): 448–464. doi:10.1080/09243453.2021.1903941

Jastrow, F., Greve, S., Thumel, M., Diekhoff, H., and Stüßenbach, J. (2022). Digital technology in physical education: a systematic review of research from 2009 to 2020. *Ger. J. Exerc. Sport Res.* 52 (4), 504–528. doi:10.1007/s12662-022-00848-5

Kavanagh, S., Luxton-Reilly, A., Wuensche, B., and Plimmer, B. (2017). A systematic review of virtual reality in education. *Themes Sci. Technol. Educ.* 10 (2): 85–119.

Koehler, M., and Mishra, P. (2008). "Introducing TPACK," in *Handbook of technological pedagogical content knowledge for educators* (New York, NY: Routledge), 3–29.

Koehler, M., and Mishra, P. (2015). "TPack (technological pedagogical content knowledge)," *SAGE Encycl. Educ. Technol.* 2, 783–785. doi:10.4135/9781483346397.n318

Koekoek, J., and van Hilvoorde, I. (2018). *Digital technology in physical education: global perspectives*. 1st ed. (New York: Routledge). doi:10.4324/9780203704011

Koustelios, A., and Tsigilis, N. (2005). The relationship between burnout and job satisfaction among physical education teachers: a multivariate approach. *Eur. Phys. Educ. Rev.* 11 (2), 189–203. doi:10.1177/1356336x05052896

Krueger, R. A., and Casey, M. A. (2014). *Focus groups: a practical guide for applied research*. Incorporated: SAGE Publications.

Kuleva, M. (2024). Exploring the integration of virtual reality in physical education: a comprehensive review. *Environ. Technol. Resour. Proc. Int. Sci. Pract. Conf.* 2, 197–201. doi:10.17770/etr2024vol2.8057

Lee, K.-C. (2004). Future directions for an applications of virtual reality in physical education. *Korean J. Phys. Educ.* 43 (6), 337–348.

Lee, Y. H. (2019). Emotional labor, teacher burnout, and turnover intention in high-school physical education teaching. *Eur. Phys. Educ. Rev.* 25 (1), 236–253. doi:10.1177/1356336X171719559

Li, D., Yi, C., and Gu, Y. (2021). Research on college physical education and sports training based on virtual reality technology. *Math. Problems Eng.* 4 (1), 1–8. doi:10.1155/2021/6625529

Liampittong, P., and Ezzy, D. (2005). *Qualitative research methods*. New York: Oxford University Press.

Maksimović, J., and Lazić, N. N. (2023). *Competences of physical education teachers in education supported by digital technology*. International Journal of Cognitive.

Martín-Gutiérrez, J. (2016). Virtual technologies trends in education. *EURASIA J. Math. Sci. Technol. Educ.* 13 (1). doi:10.12973/eurasia.2017.00626a

Merchant, Z., Goetz, E. T., Cifuentes, L., Keeney-Kennicutt, W., and Davis, T. J. (2014). Effectiveness of virtual reality-based instruction on students' learning outcomes in K-12 and higher education: a meta-analysis. *Comput. and Educ.* 70, 29–40. doi:10.1016/j.compedu.2013.07.033

Mishra, P., and Koehler, M. J. (2006). Technological pedagogical content knowledge: a framework for teacher knowledge. *Teach. Coll. Rec.* 108 (6), 1017–1054. doi:10.1111/j.1467-9620.2006.00684.x

Mishra, P., Koehler, M., and Kereluik, K. (2009). The song remains the same: looking back to the future of educational technology. *TechTrends* 53, 48–53. doi:10.1007/s11528-009-0325-3

Monroy Reyes, A., Vergara Villegas, O. O., Miranda Bojórquez, E., Cruz Sánchez, V. G., and Nandayapa, M. (2016). A Mobile augmented reality system to support machinery operations in scholar environments. *Comput. Appl. Eng. Educ.* 24 (6), 967–981. doi:10.1002/cae.21772

Morgan, D. L. (1998). *Focus groups as qualitative research*. Thousand Oaks: Sage.

Nili, A., Tate, M., Barros, A., and Johnstone, D. (2020). An approach for selecting and using a method of inter-coder reliability in information management research. *Int. J. Inf. Manag.* 54, 102154. doi:10.1016/j.ijinfomgt.2020.102154

Oktaç, J. S. (2012). *Grounded theory*. Oxford University Press. doi:10.1093/acprof:oso/9780199753697.001.0001

Østerlie, O., Sargent, J., Killian, C., Garcia-Jaen, M., García-Martínez, S., and Ferriz-Valero, A. (2022). Flipped learning in physical education: a scoping review. *Eur. Phys. Educ. Rev.* 29 (1), 125–144. doi:10.1177/1356336x221120939

O'Connor, J., and Penney, D. (2020). Informal sport and curriculum futures: an investigation of the knowledge, skills and understandings for participation and the possibilities for physical education. *Eur. Phys. Educ. Rev.* 27 (1), 3–26. doi:10.1177/1356336x20915937

Page, R. L. (2000). "Brief history of flight simulation," in *SimTecT 2000 proceedings*, 1–11. Available online at: <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.132.5428&rep=rep1&type=pdf>.

Pantelidis, V. S. (2010). Reasons to use virtual reality in education and training courses and a model to determine when to use virtual reality. *Themes Sci. Technol. Educ.* 2 (1–2), 59–70.

Patton, M. Q. (2015). *Qualitative Research And Evaluation Methods: Integrating Theory And Practice* (4th ed.). Thousand Oaks, CA: Sage Publications.

Research in Science (2025). *Eng. Educ. (IJCRSEE)* 11 (2), 331–341. doi:10.23947/2334-8496-2023-11-2-331-341

Rowan, L., Bourke, T., L' E strange, L., Lunn Brownlee, J., Ryan, M., Walker, S., et al. (2021). How does initial teacher education research frame the challenge of preparing future teachers for student diversity in schools? A systematic review of literature. *Rev. Educ. Res.* 91 (1), 112–158. doi:10.3102/0034654320979171

Sa'diyah, H., and Prasetyo, W. H. (2023). "Digital native teacher vs digital immigrant teacher: a systematic literature review and research agenda," in *Proceedings of the International Conference on Learning and Advanced Education (ICOLAE 2022)*. Editors M. H. Hikmat 902–916. doi:10.2991/978-2-38476-086-2\_77

Sandelowski, M., and Barroso, J. (2003). Classifying the findings in qualitative studies. *Qual. Health Res.* 13 (7), 905–923. doi:10.1177/1049732303253488

Sandelowski, M., and Barroso, J. (2003). Writing the proposal for a qualitative research methodology project. *Qual. Health Res.* 13 (6), 781–820. doi:10.1177/1049732303013006003

Seth, A., Vance, J. M., and Oliver, J. H. (2010). Virtual reality for assembly methods prototyping: a review. *Virtual Real.* 15 (1), 5–20. doi:10.1007/s10055-009-0153-y

Shapley, K., Sheehan, D., Maloney, C., and Caranikas-Walker, V. (2011). Effects of technology immersion on middle school students' learning opportunities and achievement. *J. Educ. Res.* 104 (5), 299–315. doi:10.1080/00220671003767615

Shea, B. J., Grimshaw, J. M., Wells, G. A., Boers, M., Andersson, N., Hamel, C., et al. (2007). Development of AMSTAR: a measurement tool to assess the methodological quality of systematic reviews. *BMC Med. Res. Methodol.* 7 (1), 10. doi:10.1186/1471-2288-7-10

Silver, C. (2023). *Harnessing MAXQDA for qualitative and mixed-methods data analysis*. Instats Inc. doi:10.61700/qyq655podq518469

Sullivan, R., Wintle, J., Campbell, N., and Roberts, W. M. (2024). Using the technological pedagogical content knowledge framework (TPACK) model to analyse teachers' use of information communication technology (ICT) in primary physical education. *Cogent Soc. Sci.* 10 (1), 2356719. doi:10.1080/23311886.2024.2356719

Thangavel, S. (2025). Revolutionizing education through augmented reality (AR) and virtual reality (VR): innovations, challenges and future prospects. *SSRN Electron. J.* doi:10.2139/ssrn.5195697

Tsigilis, N., Zournatzi, E., and Koustelios, A. (2011). Burnout among physical education teachers in primary and secondary schools. *Int. J. Humanit. Soc. Sci.* 1 (7), 53–58.

Von, R. M., Rodriguez, R., Vincent, J., and Gimpaya, J. (2023). Teachers' pedagogical digital competence as relevant factors on academic motivation and performance in physical education. *Int. J. Sci. Manag. Res.* 06 (06), 45–58. doi:10.37502/ijsmr.2023.6604

Wallace, J., Scanlon, D., and Calderón, A. (2023). Digital technology and teacher digital competency in physical education: a holistic view of teacher and student perspectives. *Curriculum Stud. Health Phys. Educ.* 14 (3), 271–287. doi:10.1080/25742981.2022.2106881

Wang, S. K., Hsu, H. Y., Reeves, T. C., and Coster, D. C. (2014). Professional development to enhance teachers' practices in using information and communication technologies (ICTs) as cognitive tools: lessons learned from a design-based research study. *Comput. Educ.* 79, 101–115. doi:10.1016/j.compedu.2014.07.006

Woreta, S. A., Kebede, Y., and Zegeye, D. T. (2013). Knowledge and utilization of information communication technology (ICT) among health science students at the university of gondar, north Western Ethiopia. *BMC Med. Inf. Decis. Mak.* 13 (1), 31. doi:10.1186/1472-6947-13-31

Yanik, M., Balci, T., and Goktas, Z. (2023). The congruence of teaching styles used by Turkish physical education teachers with national curriculum' goals and learning outcomes. *Eurasian J. Sport Sci. Educ.* 5 (2), 95–115. doi:10.47778/ejsse.1323148

Ze, Z., Zhao, X., and Chen, R. (2024). Research on the cultivation path of digital literacy of PE teachers under the background of education digital transformation. *Adv. Educ. Humanit. Soc. Sci. Res.* 9 (1), 259–264. doi:10.56028/aehtssr.9.1.259.2024

Zhang, L., and Liu, Q. (2012). "Application of simulation and virtual reality to physical education and athletic training," in *Transactions on edutainment VII. Lecture notes in computer science*. Editors Z. Pan, A. D. Cheok, W. Müller, M. Chang, and M. Zhang (Berlin, Heidelberg: Springer), 7145, 24–33. doi:10.1007/978-3-642-29050-3\_3