Physical Literacy Development in Lithuania: Trends, Challenges and the Role of Digital Tools in Pre-school Education[1]

Vilija GERASIMOVIČIENĖ[1] , Brigita KAIRIENĖ[2]

[1]Mykolas Romeris University, Institute of Education and Social Work, Social Innovations Doctoral School, Vilnius, Lithuania.

[2]Mykolas Romeris University, Institute of Education and Social Work, Social Innovations Doctoral School, Vilnius, Lithuania

Corresponding Author:
Vilija GERASIMOVIČIENĖ
gerasivilija@gmail.com

Abstract

Physical Literacy (PL) has received a lot of attention recently as a concept that encompasses and broadens not only the school discipline of physical education (PE) but also the physical education activities carried out in pre-school educational institutions. The concept of PL describes motivation, confidence, physical competence, knowledge, and understanding that individuals develop in order to maintain physical activity at an appropriate level throughout their life. Although recognized by the United Nations as a Sustainable Development Goal for 2030, the integration of Physical Literacy (PL) into education varies significantly across countries. A recent European review highlights definitional inconsistencies as a major challenge for researchers. In Lithuania, PL remains a nascent concept requiring further educational inquiry. WHO reports indicate that physical activity promotion is not prioritized nationally, partly due to the absence of long-term state-funded programs and an undeveloped PL guideline framework. Effective integration of digital technologies in education requires alignment with pedagogical goals to achieve meaningful outcomes. In promoting children's PL, digital tools should complement-rather than replace-movement by enriching diverse physical experiences. This entails fostering motor skills (e.g., strength, speed, balance, coordination) and encouraging positive emotional engagement. However, both pre-school teachers and PE specialists in kindergartens often lack the competencies and practical skills needed to deliver high-quality physical education, using digital tools. This gap poses a challenge to the effective implementation of digital tools-supported Physical Literacy programs and highlights the need for targeted professional development which will be the main focus of the research.

Keywords: Physical Literacy, Physical Education, Pre-School Education, Digital Tools.

Litvanya'da Fiziksel Okuryazarlık Gelişimi: Trendler, Zorluklar ve Okul Öncesi Eğitimde Dijital Araçların Rolü

Öz

Fiziksel Okuryazarlık (FO), sadece okulda verilen beden eğitimi dersini değil, okul öncesi eğitim kurumlarında gerçekleştirilen beden eğitimi faaliyetlerini de kapsayan ve genişleten bir kavram olarak son zamanlarda büyük ilgi görmektedir. FO kavramı, bireylerin yaşamları boyunca fiziksel aktiviteyi uygun bir düzeyde sürdürmek için geliştirdikleri motivasyon, özgüven, fiziksel yeterlilik, bilgi ve anlayışı tanımlamaktadır. Birleşmiş Milletler tarafından 2030 Sürdürülebilir Kalkınma Hedefi olarak kabul edilmesine rağmen, fiziksel okuryazarlığın eğitime entegrasyonu ülkeler arasında önemli ölçüde farklılık göstermektedir. Yakın zamanda yapılan bir Avrupa incelemesi, tanımdaki tutarsızlıkların araştırmacılar için önemli bir zorluk olduğunu vurgulamaktadır. Litvanya'da PL, daha fazla eğitim araştırması gerektiren yeni bir kavram olmaya devam etmektedir. WHO raporları, kısmen uzun vadeli devlet destekli programların olmaması ve gelişmemiş bir FO kılavuz çerçevesinin bulunmaması nedeniyle, fiziksel aktivitenin teşvik edilmesinin ulusal düzeyde öncelikli bir konu olmadığını göstermektedir. Dijital teknolojilerin eğitime etkili bir şekilde entegre edilmesi, anlamlı sonuçlar elde etmek için pedagojik hedeflerle uyumlu olmasını gerektirir. Çocukların fiziksel okuryazarlığını teşvik ederken, dijital araçlar hareketin yerini almak yerine, çeşitli fiziksel deneyimleri zenginleştirerek onu tamamlamalıdır. Bu, motor becerilerin (örneğin güç, hız, denge, koordinasyon) geliştirilmesini ve olumlu duygusal katılımın teşvik edilmesini gerektirir.

Anahtar kelimeler: Fiziksel Okuryazarlık, Beden Eğitimi, Okul Öncesi Eğitim, Dijital Araçlar.

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Introduction

From birth to 6 years of age, children develop certain physical activity habits that become indicators of their physical activity levels later in life (Jones et al., 2013). Early childhood, which spans from 0-8 years of age, is a particularly sensitive period for the development and refinement of children's basic movement skills (Gallahue & Ozmun, 2006). The interplay of appropriate development during this period depends on the tasks given, the child's needs, and the influence of the environment (Haywood & Getchell, 2009). However, certain challenges may arise, such as mismatches between developmental expectations and individual readiness, limited access to supportive resources, or environmental factors that hinder rather than foster growth. One significant challenge is the shortage of qualified teachers, which can lead to insufficient guidance, reduced individual attention, and a lack of pedagogical strategies tailored to diverse developmental needs.

To address this challenge, efforts are being made to ensure consistent developmental support and the nurturing of motor skills from the pre-school stage onward, recognizing that such early interventions are essential for fostering long-term well-being and a good quality of life. According to the Lithuanian Education Monitoring System, as of 2019, there are 123 public kindergartens and over 106 positions of teachers for Physical Education (PE) who are working in pre-school education institutions in Vilnius city. This fact justifies that in the changing educational paradigm, pre-school education remains the first step in a child's healthy lifestyle education system. Therefore, qualified professionals, such as teachers of PE, should be employed in pre-school institutions not only in Vilnius but also throughout Lithuania.

When analyzing the trends of Physical Literacy Development in Lithuania, it is essential to highlight the necessity of physical activity. A lack of physical activity can lead to consequences such as increased body weight, which in turn may result in even greater challenges. Since 2012, European countries have seen fluctuations in overweight rates ranging from 8% to 30% and obesity rates from 1% to 13% among pre-school children. The WHO (2020) recommends for children a minimum of 3-4 hours of movement per day, seven days per week. But children are moving less and less already at pre-school age. It was investigated that children aged 3-5 years move 34 minutes per day in free outdoor play (Kahan et al., 2016). Outdoor physical activity, especially in early childhood, is essential for children's physical and mental development (Lithuanian Health Programme 2014-2025, 2014; WHO, 2018). Studies have shown that children who regularly participate in outdoor physical activity have better physical outcomes such as muscle strength, bone development, motor development, physical coordination and motor skills (Webster et al., 2019). At the same time, they develop social skills and cognitive abilities (Bidzan-Bluma & Lipowska, 2018; Hinkley et al., 2018; Makutienė et al., 2022).

In order for children to participate in a wide range of activities that promote PE, they need to acquire the skills that are essential components of PL: self-confidence, motivation to start and continue physical activity, the positive benefits of movement, etc. More physically active children are more skilled than their sedentary peers (Wrotniak et al., 2006). Therefore, the development of basic movement skills is manifested through PE directly linked to physical activity. Children who have well-developed functional movement skills, and who make an effort to be physically active have better health outcomes than their peers with low levels of physical activity and high levels of sedentary behaviour (Robinson et al., 2017). Adults need to understand the importance of physical activity and PL education in the early years to help young children develop a desire to be physically active (Newport, 2013). To address this challenge, efforts are being made to ensure consistent developmental support and the nurturing of motor skills from the pre-school stage onward, recognizing that such early interventions are essential for fostering long-term well-being and a good quality of life. A growing body of research highlights the connection between PL development and teachers' effective use of technology in early childhood institutions. These activities must be thoughtfully organized and supervised by qualified pre-school teachers, as the quality of early physical education is closely tied to the competence of the staff. As Peeters et al. (2016) emphasize, early childhood teachers must themselves be PL to successfully promote PL in children and create engaging, developmentally appropriate learning environments.

So far, teachers of PE working in Lithuanian pre-school education institutions do not have sufficient competencies and practical skills to organise high-quality PE and healthy lifestyle activities (Gudžinskienė & Česnavičienė, 2013). According to foreign experts, Australian pre-school teachers identified a limited understanding of the concept of PL (Keegan et al., 2013). The need for PL training programmes for teachers, which is lacking, was identified by teachers in Switzerland and the UK (Foulkes et al., 2020). It is no longer enough for teachers to develop only the skills that encourage children to be physically active. Both teachers and children need to be able to work successfully with digital content to be physically literate and acquire the skills, knowledge, and understanding necessary for the 21st century (Lankshear and Knobel, 2008). It is important to keep in mind the stages of children's physical development when the need for digital technologies arises, and to ensure that these technologies contribute meaningfully to their engagement. This is particularly important given the rapid evolution of digital tools, which are changing communication habits and shaping new forms of collaboration, making advanced learning environments an inevitable reality.

The early childhood education environment offers a unique context in which children aged 0–5 can begin to explore and engage with digital technologies in meaningful ways (Kontkanen et al., 2023). In today's increasingly digital society, the ability to creatively and responsibly navigate diverse digital applications is considered a foundational competence, necessitating early and balanced

exposure to such environments (Eshet-Alkalai, 2004; Redecker & Punie, 2017). Digital tools hold significant potential for supporting multiple dimensions of early childhood development, including cognitive, social, emotional, and moral growth. For instance, digital devices have been shown to contribute to character development in young children by fostering self-awareness and interpersonal understanding (Jumiatmoko et al., 2024). Furthermore, the Early Childhood Education for Sustainability (ECEfS) framework emphasizes the cultivation of values such as self-respect, respect for others, and environmental stewardship, positioning digital engagement as a means to reinforce these principles when applied thoughtfully and in alignment with pedagogical goals (Wolff et al., 2020).

This raises a crucial question: what fundamental skills should children develop to effectively reach these learning objectives? The learning process is seen as comprising the following elements: learning and practice of technological skills, application of digital technologies, and motivation to participate by engaging in the digital environment (Kontkanen et al., 2023).

However, when educating in digital environments, it is important to remember the importance of ensuring the diversity of a child's movement and developing a physically literate personality, not only by using digital tools, but also by getting the child to move as much as possible, by encouraging the development of physical qualities such as strength, speed, balance and coordination, and by evoking positive emotions (Robbins et al., 2004). These emotions lead to smoother social and emotional development and promote children's language, literacy, and numeracy skills (Cremin et al., 2017), which are directly linked to the benefits of physical education. These advantages are reflected in the development of PL, which encompasses not only physical movement but also the ability to interpret and respond effectively to one's surroundings. It involves fostering motivation, self-confidence, and a deep understanding of actions through intentional physical exercise and activities that engage physical, psychological, social, and cognitive skills (Whitehead, 2013a; Dudley, 2015).

Currently, there are many challenges of PL development in Lithuania. Lithuanian pre-school teachers lack the necessary competencies and practical skills to effectively implement high-quality PE and healthy lifestyle programs. Similar challenges have been observed internationally: Australian pre-school teachers exhibit a limited understanding of PL, while teachers in Switzerland and the UK emphasize the absence of adequate PL training programs, highlighting the need to improve teacher preparation in this area. PL extends beyond movement-it involves understanding and responding to one's environment while fostering motivation, confidence, and knowledge. Purposeful physical activity contributes to development across physical, psychological, social, and cognitive domains. However, effective engagement with digital content is also crucial for both teachers and children. As digital tools rapidly transform communication and collaboration, integrating technology into physical

education is essential to ensure meaningful learning and adaptation to evolving educational environments.

The choice of the research topic, based on the perspective of kindergarten teachers of PE on the use of digital tools in physical education activities in pre-school education institutions, was prompted by the following problematic questions: why are the physical activity rates of children in Lithuania still so poor (Žaltauskė, 2017; Emeljanovas et al., 2022)? What digital tools do teachers consider effective for developing physical literacy, and what criteria do they use to evaluate them (Stoilova, Livingstone et al., 2020), which significantly promotes intense mental activity but little mobile leisure? How do teachers for PE who are working in pre-school education institutions in Vilnius city? What factors related to teachers' attitudes and institutional support promote or limit the integration of digital tools into physical education practices in pre-school education?

The pilot study aimed to analyse the attitudes of pre-school PE teachers towards the use of digital tools in physical education activities, with a focus on how these tools contribute to the development of physical literacy in early childhood education. **Hypothesis:**

H_1: To investigate the use of digital tools by pre-school teachers of physical education in pre-school education institutions.

H_2: To uncover the theoretical assumptions influencing the use of digital tools in physical literacy education in pre-school institutions.

Materials and Methods

Data Collection Tools

In order to analyse the attitudes of pre-school teachers for PE towards the use of digital tools in PE activities within pre-school institutions, a quantitative research strategy was employed. As this was a pilot study, the instrument has not yet undergone full psychometric validation. However, initial expert review and internal consistency analysis (Cronbach's $\alpha = 0.70$) suggest acceptable reliability. A structured questionnaire was developed based on methodological guidelines provided by Rumrill, Cook, and Wiley (2011) and adapted to the Lithuanian educational context following Rupšienė and Rutkienė (2016).

The instrument used was a researcher-designed questionnaire comprising both closed-ended and Likert-type scale items. The scale applied was a 5-point Likert scale, ranging from "strongly disagree" to "strongly agree," which allowed for the assessment of respondents' attitudes and perceptions regarding the integration of digital tools in PE activities. The scale was designed to be suitable for adult respondents working in educational institutions and was validated through expert review prior to data collection. The questionnaire aimed to capture dimensions such as perceived

usefulness, ease of use, institutional support, and pedagogical relevance of digital tools in promoting children's physical literacy.

Population and Sample

Participants were selected using a purposive sampling strategy, targeting professionals directly involved in the physical education of children in pre-school institutions. The sample consisted of 98 PE teachers for PE who are working in pre-school education institutions in Vilnius city. This was a non-probability, non-representative sample appropriate for a pilot study, intended to explore initial trends and inform future research. Inclusion criteria required that participants be currently employed in pre-school institutions and actively engaged in PE activities. The age range of the target group was not restricted, but all participants were qualified teachers working with children aged 3 to 6 years. Data were analysed quantitatively, and adjustments were made based on the completeness and consistency of responses.

Data Collection Tools

The whole pilot study took place between February and May. The survey sample was calculated and in accordance with the survey sampling rules. Due to the ease of access to the population, a margin of error of 3% and a probability of 95% were applied. According to the 2023 Education Management Information System report, the number of preschool teachers for PE was about 106 out of 123 public pre-schools in Vilnius city. The sample consisted of 98 pre-school teachers of PE working in Vilnius city. The lack of research describing the practical application of effective digital tools in physical education activities in pre-school institutions in the context of PL led to the choice of a quantitative research strategy.

Ethics of Research

Participants voluntarily agreed to complete the questionnaire. Participants were informed about the protection of their personal data before the questionnaire was administered. Participants were given the opportunity to refuse to participate in the study. The ethics of the study was determined by the chosen context of the study. Due to the law on the legal protection of personal data, in order to collect data from the respondents more quickly, the project managers of Vilnius City Municipality, the Vilnius Centre for Educational Progress "EDU Vilnius", who are in charge of the physical education programmes in Vilnius, were contacted. Questionnaires were also sent to all 123 pre-school settings. This allowed us to recruit 98 pre-school teachers of PE working in pre-school education institutions in Vilnius city to participate in the study. The questionnaire was administered on a voluntary basis, i.e. the participants were free to decide whether to participate in the study. In this study, the openness and transparency of the neighbourhood process was ensured by the teachers and

the researcher participating in virtual discussions in the teacher community, sharing and improving good practices that reflect the context of the study. Statistical conclusions cannot be drawn for the population as a whole based on the results obtained from this sample.

Procedures

The methods of systematic, comparative and structural analysis of scientific literature were applied in defining the key concepts of the study, identifying their components and preparing the methodological part. The study analyses methodological literature, applies the methods of theoretical modelling, classification and interpretation. The objectives and methodological framework of the study are based on quantitative research (questionnaire/survey). Statistical analysis of the questionnaire/survey data was carried out using SPSS 27.0 software. According to the Ethics Statement, this study was approved by the Mykolas Romeris University, Institute of Education and Social Work (No.1 dated 31.03.2024).

Results

An analysis of pre-school teachers' of PE perspectives on the integration of digital tools (smart boards, smart floors, "WordWall" platform, AR Glasses, AR Apps, Didactic tools: Bee-bots/Photon robots) in physical education activities indicates that 66% of respondents utilizing such tools, while 34% do not. The primary barriers to adoption include the limited accessibility of interactive smart boards, which are often located in multipurpose spaces and thus unavailable when needed (35.9%). Additionally, 22.6% of participants noted that these resources are predominantly used by pre-school teachers, resulting in restricted opportunities for teachers of PE due to competing demands for shared facilities such as group environment or music hall.

Several barriers were identified by teachers regarding the implementation of digital tools in physical education for children. Notably, 31.5% avoid using interactive, smart floors, citing that children lose interest in traditional teacher-led activities afterward. Likewise, 29.1% consider the digital platform "WordWall" ineffective, viewing it as a time-consuming distraction during physical education activities. A lack of digital competence and ICT skills was reported by 26.5% of respondents, limiting their confidence to integrate such tools. In terms of specific technologies, 36% of teachers expressed reservations about using Augmented reality (AR) glasses, arguing they do not contribute to the development of children's physical literacy or healthy lifestyle habits. Additionally, 31.1% reported that their educational institutions lack the necessary infrastructure to support digital integration. AR applications, such as QR codes, Quiver and Animal 4D+, were deemed linguistically inaccessible by 31.5% of teachers as limited digital resources available in Lithuanian, due to the predominance of digital content in foreign languages.

According to demographic data was revealed that in Vilnius 58 teachers hold a bachelor's degree, 24 a master's, and 11 a higher education (vocational) level qualification; 5 have secondary education but are pursuing bachelor's studies. In terms of pedagogical qualifications, 47% are certified teachers, 42% are senior teachers, 8% are teachers-methodologists, and one has an expert-level qualification. Insight into teacher qualifications provides to look of teachers' academic and professional backgrounds, allowing policymakers and administrators to better understand the strengths and areas for growth within the teaching academic experience. Understanding the distribution of pedagogical qualifications allows for strategically targeted selection of more qualified staff. Recognizing the existing expertise levels among teachers contributes to efforts aimed at enhancing instructional quality and fostering leadership within schools. Analyzing teacher qualifications offers valuable insights into teachers' academic and professional profiles, enabling evidence-based staffing decisions and targeted development strategies. Understanding the distribution of pedagogical credentials also supports efforts to enhance instructional quality and cultivate educational leadership.

Statistically significant differences ($p < 0.05$) were observed based on children's age, teacher gender, and the number of institutions where they work. A majority of female teachers (73%) are employed at a single preschool, with 57% teaching children aged 1.5–5 years and 54% instructing those aged 5–7, aiming to enhance activity quality through digital tools. Among male respondents, 27% work across two kindergartens. Of these, 43% conduct physical education activities for children aged 1.5–5, while 45% focus on the 5–7 age group. Their engagement with digital tools is comparatively lower, attributed to time constraints and the demands of working in multiple institutions, which limit opportunities to implement innovative practices.

A comparative analysis of indicator expression by teacher education level, children group location, and children's age groups revealed that 63% of teachers holding a bachelor's degree most frequently conducted physical education activities for children aged 1.5–5 years in music halls, where more spacious conditions facilitated physical activity. Data indicate that 55% of teachers holding a bachelor's degree conduct PE activities for children aged 5–7 years, predominantly in gyms and outdoor spaces, depending on institutional facilities. In contrast, 31% of teachers with a master's degree who possess higher pedagogical competencies - more frequently engage with children aged 1.5–3 years in group-based settings. These teachers tend to demonstrate greater creativity and digital fluency, are more likely to develop diverse instructional content, and more frequently utilize smartboards (38.9%) and educational applications such as QR codes, Quiver, and Animal 4D+, which support the development of fundamental motor skills (15.8%).

Bee-Bots are employed by 10.7% of teachers to facilitate children's understanding of safe and effective digital tool usage. Additionally, 27% of Master's-degree teachers conduct PE activities with

children aged 3–6 years in gyms and outdoor settings, contingent upon the infrastructural resources available within their institutions. Based on the identified digital tools and their associated attributes aligned with PL components, the study findings confirm the role of digital tools in fostering PL, which is critical to the advancement of children's physical education. Table 1 presents the statistically significant attributes of PL in relation to specific digital tools, highlighting those that most effectively support teachers in enhancing educational outcomes.

Table 1

Teachers' Use of Digital Tools in the Context of Physical Literacy

Digital Tool	Knowledge ($\mu \pm \sigma$)	Physical Competence ($\mu \pm \sigma$)	Motivation ($\mu \pm \sigma$)
Smart Boards	29.5 ± 4.3	27.2 ± 2.4	25.7 ± 2.3
Smart Floors	26.4 ± 2.8	32.6 ± 3.9	25.3 ± 2.1
"WordWall"	10.2 ± 2.7	6.7 ± 0.7	11.6 ± 2.4
AR Glasses	9.4 ± 2.0	10.8 ± 3.1	12.5 ± 2.5
AR Apps	14.2 ± 0.5	12.3 ± 2.0	15.3 ± 0.6
Bee-bots	10.3 ± 2.8	8.0 ± 1.5	11.1 ± 1.4

> μ – mean (%), σ – standard deviation (%)

Based on the results of the descriptive statistical analysis, including calculations of means, standard deviations and coefficients of variation, the comparative effectiveness of the selected digital tools (smart boards, interactive/smart floors, "WordWall", AR glasses, AR apps, Bee-bots) can be summarized as follows: interactive floors (28.1%) and smart boards (27.4%) demonstrated the highest overall effectiveness across the three PL components (knowledge, physical competence and motivation). It relatively consistent performance suggests to be considered among the most universally applicable digital tools for PL development, increasing children's knowledge of PL and developing their understanding of how, why, when they move, also helping children to understand the importance of purposeful physical activity, which can improve their quality of life (knowledge and understanding).

Physical competence appears encouraging the development of children's basic movement skills and in improving children's flexibility. Motivation and confidence mostly encourages children to gain more confidence in their own strengths and abilities, provides opportunities for motivated exercise, promotes children's self-esteem, integrity and respect for others. AR glasses provides more memorable experiences for children in spatial movement and Improves children's motivation and digital perception of tasks (physical competence), provides opportunities for motivated exercise (motivation and confidence). Meanwhile, tools such as the "WordWall" educational platform (9.5%) and Bee-bots (9.8%) were characterized by lower mean effectiveness values and higher coefficients of variation (exceeding 20%). This indicates greater inconsistency in outcomes and suggests that these tools may be more appropriate for applications or as complementary resources when integrated

within broader educational strategies. Because "WordWall" develops social skills to be active with others (knowledge and uderstanding); improves children's motivation and digital perception of tasks (motivation and confidence).

Bee-bots develops social skills to be active with others (knowing and understanding), enriching the educational environment with digital content to increase children's physical activity (motivation and confidence). Furthermore, our analysis indicates that digital tools, specifically the "WordWall" platform (9.5%) and Bee-bots (9.8%) exhibited significantly lower effectiveness along with markedly elevated coefficients of variation (exceeding 20%). This substantial variability in performance suggests that these tools may be optimally utilized in targeted teaching contexts or integrated as supplementary components within a broader, multifaceted educational framework.

Discussion and Conclusion

A review of theoretical and empirical research indicates that the emergence of technological innovations, accompanied by emerging threats to physical movement, has led to trends in physical inactivity being regarded as a national crisis. While digital technologies are widely employed in early childhood education through diverse learning modalities to support the development of young children's literacy skills (Jack & Higgins, 2019; Soyoof et al., 2023), the negative consequences arising from reduced physical activity raise serious concerns regarding the decline of physical activity at the national level. This underscores the critical importance of movement that fosters PL. Interaction with stationary computers, educational software, games and e-books has been shown to have a positive effect on language development in young children (Van Scoter, 2008, Sylla et al., 2016). However, modern mobile devices (e.g., touchscreen tablets and smartphones) provide young children with an easy tactile interface with finger-based control functions (Nacher et al., 2015). As a result, the ability to touch, point or swipe with the fingers has allowed young children to immerse themselves in the digital world much earlier than previous generations (Hoffman & Paciga, 2014; Price et al., 2015). When integrated appropriately, today's digital technologies enhance young children's development and learning (Rogow, 2014). Although the research is generally inconclusive, digital learning activities are generally considered to be as effective as traditional early childhood activities, and the interaction between digital technologies and young children is generally considered to be an important factor in the effectiveness of digital learning in early childhood. Whether used independently by young children or assisted by adults, digital technologies can support learning and literacy development in a variety of ways (Baker, 2017; Dutta, 2017; Karemaker et al., 2017).

Through an empirical examination of pre-school physical education teachers' attitudes toward digital tools, this study advances the scholarly dialogue at the intersection of physical literacy and digital pedagogy in early childhood education. It illuminates how practitioners interpret and enact the

principles of physical literacy within digitally enriched learning environments. The results articulate nuanced perceptions of the affordances and limitations associated with digital interventions, offering evidence to guide policy development and the design of inclusive, movement-centered curricula. Moreover, by embedding global discussions on physical literacy within the specific pedagogical landscape of Lithuanian early childhood institutions, this research fills a notable gap in the national educational literature by contextualising global discussions on physical literacy within local pedagogical realities.

There are some limitations of this research. The study involved 98 pre-school teachers of PE employed in pre-school education institutions within Vilnius city. As the findings are based on data obtained from this pilot sample, they do not permit the formulation of statistical generalizations regarding the national population of pre-school teachers. Surveying only pre-school teachers of PE provides an insufficient basis for comprehensive analysis. The sampling frame should be expanded to include all teachers and specialists who engage directly with children in pre-school settings, and a broader quantitative investigation should be undertaken accordingly. In addition among the challenges related to the implementation of PL, teachers' knowledge and representations of this concept can be identified as an obstacle. Future studies should focus to ensure that children be more physically literate throughout their lives, it is imperative that pre-school teachers will use purposeful physical activities, which include physical, psychological, social, cognitive and digital skills.

The results suggest that while digital tools are not universally embraced, many educators recognise their potential to enrich physical education experiences when aligned with pedagogical goals. This underscores the importance of professional development and institutional support in fostering meaningful integration. The study's implications point to the need for clearer guidelines on how digital resources can be used to support physical literacy outcomes, particularly in early childhood settings where foundational movement skills are formed.

Conclusion

An analysis of the digital tools employed by pre-school teachers of PE in early childhood education institutions revealed that the most frequently used tools for physically active, interactive activities included interactive smart boards, interactive, smart floors and to a moderate extent the "Wordwall" platform. Smart boards and smart floors were the most frequently used to encourage children to be more active, while AR apps were used on average. Smart boards were the most commonly used for presenting and testing relevant video content, while smart floors were used on average. To diversify the team tasks, smart boards were the most frequently used smart floors were moderately used, AR apps were very rarely used and AR glasses were never used. Findings indicate that teachers see smart boards as the most effective tool for enhancing children's PL, safety awareness and social interaction during physical activities, while a smaller proportion recognize the role of other

digital tools, such as "Wordwall", AR apps and educational robots - in supporting children's motivation and confidence to engage in movement.

According to the attributes of PL physical competence identified that pre-school teachers of PE most frequently used interactive smart boards and smart floors for promoting physical activity, delivering video content, and facilitating team-based tasks, while tools like "Wordwall" and AR applications were used moderately or rarely. AR glasses were almost never utilized. On the basis of the PL attributes of motivation and confidence teachers emphasized that smart boards and smart floors significantly contribute to fostering children's self-confidence, motivation and engagement with digital tasks. These technologies also support imaginative thinking, particularly among children with mobility or spatial limitations. In addition, teachers noted that a broader range of digital tools - including AR applications, the "Wordwall" platform, AR glasses, and Bee-boots play a meaningful role in promoting key aspects of social-emotional development, such as self-esteem, honesty, and respect for others. Overall, the investigation confirmed that pre-school PE teachers actively integrate a variety of digital tools - particularly smart boards and smart floors into their teaching practices to promote physical activity and enrich children's learning experiences in early childhood education institutions. This integration reflects a growing pedagogical shift toward technology-enhanced learning environments, where digital tools are not only used to stimulate physical engagement but also to foster cognitive, social, and emotional development. The findings underscore the importance of equipping educators with both the resources and competencies necessary to leverage these technologies effectively, thereby aligning early childhood education with contemporary physical literacy framework.

The theoretical assumptions influencing the development of PL through the use of digital tools in pre-school education are revealed. All 6 digital tools selected and investigated contribute to PL education in pre-school institutions. According to the characteristics of the PL components: knowledge and understanding, physical competence, motivation and confidence, it is clear that pre-schoolers, with the support of their PE teachers, are developing their knowledge of PL in a targeted way, and that they are gradually beginning to realise the importance of purposeful physical activity and the importance of being physically active, as well as the importance of safe behaviour and quality use of digital tools. Through the use of digital tools, children engage in fundamental movement activities across diverse settings, enhancing the memorability of their spatial experiences and supporting the development of key physical attributes such as coordination and flexibility. According to teachers, digital tools play an integral role in fostering physical literacy by boosting children's motivation, task engagement, and self-confidence. These tools also encourage imaginative responses to spatial limitations and contribute to children's self-esteem, sense of fairness, and respect for peers in collaborative environments.

Practical implications

Future research may focus on exploring both the existing and lacking physical literacy competencies among teachers, within the broader context of fostering PL in early childhood. The participants in this study were a specific demographic group (teachers of PE working in Vilnius city). Comparable investigations may be conducted involving a diverse range of educational professionals and stakeholders across Lithuania - including pre-school and pre-primary teachers, teachers for musical education, child support specialists within early childhood institutions, pre-school administration and parents to identify opportunities for enhancing the cohesive integration of PL within pre-school environments. Implications of the research for daily practice revealed that teachers of PE who work systematically and strive for diversity of educational content use digital tools in physical education activities in a variety of environments and with children of different ages. The results of the study confirmed the usefulness of digital tools for PL education. Most teachers manage to coordinate and integrate the content of the digital tools within the recommended time limit for the use of digital devices. The combination of PL and the use of digital tools, as demonstrated by their work and approach, suggests that, thanks to the teachers' competences, the children are also acquiring the necessary skills and self-confidence to take part in a range of physical activities that motivate them and make them want to continue with them, experiencing the positive joy and benefits of movement.

In line with the results obtained from the research, the following recommendations have been developed.

1. To develop and adopt national guidelines on PL competences, defining the knowledge and skills needed by professionals in different fields of education to ensure quality of PL education in pre-school institutions.

2. To foster interdisciplinary cooperation ensuring greater collaboration between physical, musical education and child support specialists to create a holistic environment for PL development.

3. To target enhancement of teachers' competences and qualifications: the development of a continuous professional development programme aimed at strengthening teachers' knowledge and practical skills regarding the importance of PL and its integration methods through the use of digital tools. By exploring and applying diverse digital tools, these tools could be effectively incorporated into physical education practices to promote greater inclusivity, accessibility and alignment with the developmental needs of contemporary children.

Ethical Approval Information

This study was approved by the Mykolas Romeris University, Institute of Education and Social Work, Social Innovations Doctoral School Attestation Commission Decision, No.1 dated 31.03.2024.

Author Contribution Statement

Both authors contributed equally to all stages of the research

Conflict of Interest Statement

No potential conflict of interest was reported by the authors.

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