

Supporting Primary School Teachers in Creating Enjoyable Physical Education Experiences to Enhance Children's Physical Activity Behavior

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Enjoyable Physical Education Experiences to Enhance
Children's Physical Activity Behavior**

Anoek Adank

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**Supporting Primary School Teachers in Creating
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PROEFSCHRIFT

ter verkrijging van de graad van doctor
aan de Technische Universiteit Eindhoven,
op gezag van de rector magnificus prof. dr. S.K. Lenaerts,
voor een commissie aangewezen door het College voor Promoties,
in het openbaar te verdedigen
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door

Anoek Maria Adank - Heij

geboren te Breda

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Het onderzoek dat in dit proefschrift wordt beschreven is uitgevoerd in overeenstemming met de TU/e Gedragscode Wetenschapsbeoefening.

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CHAPTER 1

GENERAL INTRODUCTION

1. FOSTERING ACTIVE LIFESTYLES IN CHILDHOOD

1.1. The need to counteract inactive lifestyles

Physical inactivity and sedentary behavior are increasingly prevalent among children and adolescents worldwide (Bueno-Antequera & Munguía-Izquierdo, 2023; World Health Organization, 2022a). Several factors contribute to this trend, including rising screen time, greater reliance on motorized transport, ongoing urbanization, and the influence of digital lifestyles, all of which reduce opportunities for active living (Arundell et al., 2016; Sengkey et al., 2023; Woessner et al., 2021). In the Netherlands, similar patterns are observed. In 2024, 38.5% of children aged 4-11 years did not meet the recommended guideline of at least 60 minutes of moderate-to-vigorous physical activity (Korthagen & Nuijten, 2022; Maksimović & Jelena, 2018) per day (RIVM, 2024). Among Dutch adolescents, the proportion not meeting this recommendation is even higher, with nearly 60% falling short. Dutch boys consistently achieve higher compliance than girls (RIVM, 2024). Furthermore, Dutch youth are among Europe's highest in sedentary time, with an average of 7.3 hours per day among children aged 4-11 years and 10.4 hours per day among adolescents aged 12-17 years (RIVM, 2023).

This failure to meet the recommended physical activity (PA) guidelines is concerning, as insufficient PA and prolonged SB during childhood are negatively associated with mental, physical, social, cognitive and emotional outcomes (Poitras et al., 2016). Moreover, inactivity in the early years often persists into adulthood, increasing the risk of long-term mental health and physical health issues such as depression, obesity, cardiovascular diseases, and type 2 diabetes (Hoare et al., 2016; Kallio et al., 2021; Redig et al., 2022). In contrast, regular PA early in life fosters healthier habits, reduces the risk of conditions like obesity, improves mental and physical well-being, and establishes a foundation for an active lifestyle throughout life (Anderson & Durstine, 2019; Batista et al., 2019; Howie et al., 2020). These combined findings emphasize the urgent need to promote PA and reduce SB during childhood. They also highlight the importance to understand the factors influencing children's PA patterns to inform effective interventions and guiding policy strategies that support sustained active lifestyles from early years.

1.2. Key individual factors

Children's physical activity (PA) and SB are shaped by a dynamic interplay of factors operating at multiple levels, as conceptualized in the socio-ecological model (Hu et al., 2021). This framework posits that behavior, such as children's PA and SB, is not solely shaped by individual factors such as physical, motor, cognitive, and motivational characteristics, age and gender but also from the interaction between these individual

factors and contextual influences including peer and family support, teachers, neighborhood and sport environments, societal norms and policy structures (Sallis et al., 2006). Understanding individual factors and their interplay with contextual factors is critical for designing effective interventions that promote active lifestyles among children.

Two key individual factors that influence children's PA patterns are motor competence and PA enjoyment (Zhang et al., 2015). Motor competence, i.e. the ability to skillfully perform a range of motor tasks and coordinated movements, is negatively associated with SB (Engel et al., 2018; Hardy et al., 2012; Lopes et al., 2012) and positively associated with higher levels of PA (Barnett et al., 2016; De Meester et al., 2018). This relationship is considered reciprocal, meaning that greater motor competence promotes more PA participation, and increased PA, in turn, enhances motor skills (Lima et al., 2017; Stodden et al., 2008). Despite the importance of motor competence, children worldwide generally have moderate motor skills (Bolger et al., 2021). In the Netherlands children's level of motor skills are even declining (Mombarg et al., 2023). This trend may be partly explained by reduced outdoor play and increased sedentary screen time among children.

PA enjoyment is another factor influencing children's PA levels (Eberline et al., 2018; Haas et al., 2021). It refers to the positive affective experience that comes with being physically active (Bajamal et al., 2024; Kawabata & Mallett, 2022). It is a key feature of autonomous motivation, as outlined in the Self Determination Theory (SDT) (Deci & Ryan, 2000). Children who are autonomously motivated have a high level of self-determination and strong willingness to engage in physical activities. This motivation arises from interest and satisfaction with physical activities itself (intrinsic motivation) or from personally valuing the goals associated with the physical activities (internalized extrinsic motivation). Studies have shown that PA enjoyment not only fosters positive attitudes toward PA, but also increases participation, enhances long-term engagement (Eberline et al., 2018) and reduces time spent in sedentary behavior (Bai et al., 2018). However, PA enjoyment tends to decline during late childhood and adolescence (Haas et al., 2021), particularly among children with lower motor competence and girls (Cairney et al., 2012), and those involved in overly competitive or highly structured sports environments (Battaglia et al., 2024; Crane & Temple, 2015).

Promoting both motor competence and PA enjoyment, especially in combination, is a powerful strategy for fostering active lifestyles in children. Encouraging PA as a regular and enjoyable part of daily routines can help reduce long-term health risks associated with inactivity. However, individual factors interact and are embedded within broader physical and social environments. Among these contextual influences, the school setting is of particular importance, as children spend a substantial portion of their week at school

(Hills et al., 2015). Physical education (PE) is a key environmental context through which structured opportunities are provided to develop motor skills and promote PA enjoyment. Physical characteristics such as facilities and available equipment, policy-related factors including the allocated time and frequency of PE lessons, and the social characteristics i.e. peers and the supportive role of teachers, all influence children's attitudes toward and engagement in PA and SB (House et al., 2025; Ommundsen & Kvalø, 2007; Sallis et al., 2001; World Health Organization, 2022b). Importantly, recent research indicates that children's perceived motor competence and intrinsic motivation for PE influence their PA levels outside school (Brazendale et al., 2015; Carcamo-Oyarzun et al., 2025; den Uil et al., 2023). Understanding how PE teachers' teaching practices and PE learning climate foster active lifestyles is therefore crucial.

1.3. Primary school physical education

PE is a mandatory component of the Dutch primary school curriculum, with the government requiring all primary schools to provide at least two PE lessons per week (45 minutes per lesson) (Rijksoverheid, 2023). This makes PE a unique context in which all children are reached and given structured opportunities to learn about and participate in physical activities, highlighting the importance of ensuring high-quality PE. Similar to other countries, PE in the Netherlands aims to provide enjoyable learning experiences that help children develop skills, e.g., fundamental movement skills, social skills, self-regulation, attitudes and knowledge that foster motivation for and participation in physical activity and sports throughout life (KVLO, 2025; Whitehead, 2020). Such enjoyable and meaningful PE experiences are essential in encouraging children to adopt active lifestyles (Fletcher & Ní Chróinín, 2022; Hagger & Chatzisarantis, 2016; Ntoulis et al., 2015; Pérez-González et al., 2019). Research informed by the trans-contextual model of motivation has shown that children's autonomous motivation in PE is associated with their motivation to engage in physical activity in other contexts (Viciano et al., 2019). Applying this transfer principle to affective experiences suggests that children who enjoy PE are more likely to develop positive attitudes towards PA and to continue enjoying and engaging in physical activities outside of school (Fletcher & Ní Chróinín, 2022; Hagger & Chatzisarantis, 2016; Ntoulis et al., 2015; Pérez-González et al., 2019).

PE teachers play a pivotal role in designing and providing lessons that promote children's learning, development, and enjoyment. Studies grounded in motivational frameworks such as Self Determination Theory (SDT) and Achievement Goal Theory (AGT) have shown that PE teachers influence children's PE motivation and enjoyment by creating a motivational climate (Chen et al., 2020; Di Battista et al., 2018; Jaakkola et al., 2017; Morgan, 2017; Ommundsen & Kvalø, 2007). In line with the Meaningful PE approach (Beni et al., 2017; Fletcher & Ní Chróinín, 2022), teachers should provide PE

lessons that children experience as enjoyable, purposeful, and personally relevant, while also supporting their motor development. Pedagogical teaching principles from SDT and AGT are key to this. According to SDT, a need-supportive PE climate in which children feel a sense of autonomy (choice and influence on decisions), competence (confidence in one's abilities), and relatedness (positive connections with teachers and peers) enhances children's PE motivation and enjoyment (Chen & Hypnar, 2015; Pérez-González et al., 2019; van Aart et al., 2015). Similarly, AGT highlights the benefits of a mastery-oriented climate in which the teacher emphasizes skill development, effort, and personal improvement over competition, which is associated with greater PE enjoyment and more positive attitudes toward PE compared to an ego-oriented climate (Gråstén & Anthony, 2017; Jaitner et al., 2019).

Providing high-quality, enjoyable PE is complex and challenging. Teachers must respond to children's diverse interests, needs and motor skill levels, maintain physical and social safety in constantly moving environments and work in gym facilities that differ substantially across Dutch primary schools in size, condition, and available equipment. In the Netherlands, PE lessons are provided by teachers with varying qualifications to teach PE. Primary school PE is taught by generalist classroom teachers qualified to deliver primary school PE, by PE specialists or through a combination of both. The Dutch primary school system is generally organized into grades, ranging from grades 1 to 8 for children aged 4 to 12 years, with a distinction between grades 1-2 (preschool for children aged 4-5 years) and grades 3-8 (primary school for children aged 6-12 years). For grades 3 to 8, 54% of the Dutch primary schools rely exclusively on PE specialists. In 24% of the schools, PE lessons are provided by a combination of PE specialists and generalist teachers, whereas 22% rely solely on generalist teachers. For grade 1 and 2, these distributions differ: 22% of the schools rely exclusively on PE specialist, 34% use a combination of PE specialists and generalist teachers, and 54% rely solely on generalist teachers. For all grades, there is a clear trend toward PE being taught only by PE specialists (Mulier Instituut, 2025). These structural differences add to the complexity of PE provision, as teachers' different training backgrounds, i.e., PE teacher education versus primary school teacher education with additional PE training, influence their pedagogical expertise, confidence and teaching practices (Gerovac et al., 2025; Truelove, Bruijns, et al., 2021; Truelove, Johnson, et al., 2021). Both types of teachers are responsible for ensuring that children experience enjoyable, developmentally appropriate, and inclusive lessons that challenge them at their own level. To achieve this, teachers must understand children's individual needs and be aware of the teaching practices that influence their PE enjoyment. This requires that teachers have strong professional competences, i.e., skills, knowledge, and abilities to respond effectively to children's diverse interests, needs, skill levels, social abilities and

cognitive development. Regular reflective practice is essential for identifying strengths and areas for improvement (Korthagen & Nuijten, 2022) and is therefore an essential key component in enhancing PE teaching.

1.4. Reflective thinking as part of continuous professional development

Teachers have a significant impact on children's PE experiences and the overall quality of PE. To address the pedagogical, content-specific, and didactical challenges in PE, critical reflection is essential (Korthagen & Nuijten, 2022; Maksimović & Jelena, 2018; Rollett et al., 2021). It enables teachers to adapt their practices to better meet children's abilities, knowledge, needs and interests. Furthermore, critical reflection is a key component of teachers' continuous professional development. Through reflective practices, teachers evaluate and assess their teaching by reviewing their actions, decisions, thoughts, feelings, and their children's responses (Korthagen & Nuijten, 2022; Maksimović & Jelena, 2018; Rollett et al., 2021). These insights help teachers to identify areas for improvement, explore alternative teaching strategies, implement them, and initiate a new cycle of reflection (Korthagen & Nuijten, 2022).

Evaluating PE lessons and gathering feedback from children (Golding & Adam, 2016; Mandouit, 2018) and colleagues (Bjørke & Casey, 2024; Morgan et al., 2019; Parker et al., 2021) are crucial for deepening the reflective process. By incorporating feedback, teachers refine their self-evaluation and develop a more comprehensive understanding of their teaching practices. Children provide valuable insights into teaching practices that positively influence their PE experiences and those they feel insufficiently applied by the teacher. Additionally, collaboration with colleagues and other PE specialists brings expert advice and alternative teaching strategies through asking critical questions, sharing best practices, and exploring new approaches. This collaborative process may also motivate teachers to attend workshops, seminars, or engage with relevant literature, thereby advancing their professional development. Gathering and integrating diverse feedback contributes to a thorough evaluation of one's teaching, facilitating deeper reflection and informed professional growth (Korthagen & Nuijten, 2022; Rollett et al., 2021).

Despite the well-documented benefits of reflective practices in professional development (Crawford et al., 2012; Dervent, 2015; Korthagen & Nuijten, 2022; Korthagen & Vasalos, 2005; Moon & Lee, 2022), they are not consistently applied by teachers, especially in primary education. Several barriers contribute to this, including limited time, heavy workloads, insufficient support or resources from schools, and a lack of knowledge and skills in collecting constructive feedback (Armour & Yelling, 2007; Iannucci & Parker, 2022; Jaeger, 2013; Korthagen & Nuijten, 2022). Moreover, although

there has been a growing emphasis on valuing children's voices, primary education teachers still rarely ask for feedback from children regarding PE (Iannucci & Parker, 2022). When feedback is collected, teachers often fail to respond or inform children about how their feedback is used, leaving the feedback loop unclosed. One reason for the limited use of children's feedback could be teachers' doubts about children's ability to evaluate their PE experiences and offer meaningful insights. Another reason may be a lack of feedback literacy, with teachers being unsure of what questions to ask or how to interpret children's feedback (Rollett et al., 2021). Furthermore, obtaining feedback from colleagues or PE experts can be challenging. Primary school teachers often teach PE lessons alone, without the presence of colleagues, limiting opportunities for peer feedback. Additionally, teachers may feel hesitant to ask for feedback from their colleagues, fearing judgement or criticism based on different teaching styles. These concerns may lead to negative emotions such as shame, disappointment, or a sense of failure (Jaeger, 2013; Saric & Steh, 2017). Ultimately, the limited use of feedback hinders the potential for professional development and growth.

Previous studies have shown that methods such as reflective logs, reflective interviews, group seminars, and peer assessment - especially when combined - can enhance reflective thinking and practice (Bjørke et al., 2023; Crawford et al., 2012; Dervent, 2015; Moon & Lee, 2022). These methods encourage teachers to critically assess their teaching experiences, thoughts and feelings, and engage in dialogue with others to explore aspects of their teaching that they may not have previously considered. This fosters a deeper understanding of PE teaching and promotes professional development through reflection and collaborative learning.

1.5. Educational technology to enhance quality PE teaching

Although traditional reflective methods, such as written logs, observations, and group discussions are valuable (Bjørke et al., 2023; Crawford et al., 2012; Dervent, 2015; Moon & Lee, 2022), they can be time-consuming and require careful documentation for systematic reflection (Jaeger, 2013; Korthagen & Nuijten, 2022; Korthagen & Vasalos, 2005). Technology offers a promising solution to these challenges by providing reflection tools tailored to teachers' needs and the specific contexts, making reflection more flexible and accessible. Over the past decade, the use of educational technology has increased significantly (Amiel & Reeves, 2008; Hennessy et al., 2022; Scherer et al., 2019; Taiwo & Downe, 2013). As a result, teachers and children have become more familiar with technological devices and applications, including in PE lessons. For example, interactive games, exergames, and devices and applications that assist teachers in measuring children's learning outcomes and providing feedback on skill performances, such as video analysis and editing tools, are increasingly utilized (Jastrow et al., 2022;

Martín-Rodríguez & Madrigal-Cerezo, 2025; Saiz-González et al., 2025). These examples reflect a broader trend, as there is a growing influence of digital technologies in global PE practice (Koekoek & van Hilvoorde, 2018).

While educational technology in PE is primarily used by teachers to enhance children's learning, it also has significant potential for supporting teachers' professional development. Technology can facilitate reflective thinking and foster continuous learning (Prieto et al., 2020;). Previous studies have shown that tools like video recording, analyzing and editing software, online journals, and electronic portfolios effectively support teachers' reflection (Krause et al., 2020; Moon & Lee, 2022; Zhao et al., 2025). For instance, digital questionnaires and analytics enable teachers to collect feedback from children, enriching the reflective process by providing direct insights into children's experiences and needs. Video recording and editing tools allow teachers to relive, review and analyze their PE lessons, helping them identify strengths and areas for improvement (Koekoek et al., 2018). Feedback can be integrated directly into videos, making it context-specific and more impactful for reflective thinking. Online platforms provide teachers opportunities to collaborate, share experiences, discuss teaching strategies and gain diverse perspectives, which can enhance their teaching practices. Additionally, digital tools like journals and portfolios help teachers systematically document their thoughts, evaluations, analyses, plans for improvement, thereby supporting continuous professional development.

However, the use of technology to promote teachers' reflection comes with challenges, especially within the context of PE (Ma, 2025; Weeldenburg, 2023). From a Human-Computer Interaction perspective, teachers' technology acceptance and adoption of educational technology largely depend on the perceived relevance, usefulness, ease of use, and added value of the technological tools within their specific teaching context. These factors are widely recognized in technology acceptance models (Scherer et al., 2019; Nouredine et al., 2025). In PE, challenges related to the research, acceptance, and practical application of technology include teachers' limited competence in the pedagogical use of technology, perceived workload and limited time for tool use and professional development (Šabić et al., 2022). Moreover, the dynamic PE environment in which teachers must simultaneously ensure physical safety and respond to the diverse interests, needs, and skill levels of children, combined with budgetary and facility constraints, make the acceptance and use of technological tools particularly challenging (Ma, 2025; Weeldenburg, 2023;). To optimize reflective practices, reflection tools must therefore be designed with a deep understanding of the specific needs of PE teachers and their teaching context. Adopting a user-centered, research-through-design approach, in which teachers are actively involved throughout the design and testing

process, rather than having tools designed for them, can support the development of technological tools that effectively enhance both teaching practices and professional development (Amiel & Reeves, 2008; Prieto et al., 2020).

2. THE PRESENT DISSERTATION

2.1. Research aim and sub-aims

PE has the potential to directly and indirectly encourage children to adopt active lifestyles, i.e., engaging in sufficient moderate-to-vigorous PA and limiting prolonged SB. PE lessons provide structured opportunities for physical activity during school hours, directly contributing to children's physical activity behavior. At the same time, PE helps develop the knowledge, attitudes and skills that encourage children to be physically active beyond school, providing an indirect contribution to an active lifestyle. Although research has demonstrated relationships between MC, PA enjoyment, and PA, longitudinal studies in this area remain scarce. Moreover, studies exploring the impact of children's PE experiences and activity levels outside of school, as well as how PE teaching strategies can foster this impact, are still limited. Gaining more insight into these aspects and relationships can support primary school teachers, both generalists and PE specialists, in adapting their teaching practices to ensure children enjoy learning and being physically active during PE, while also positively influencing children's current and future PA patterns.

In addition to understanding which teaching strategies foster enjoyment and support active lifestyles, it is essential to consider how teachers reflect on their lessons and use feedback to improve their practices. While technology offers new opportunities to support teaching and address educational challenges, its application in primary schools PE remains underutilized. Technological tools could be helpful for teachers to collect and analyze feedback, facilitate reflective thinking, and improve their teaching practices. By integrating technology into PE, teachers could gain valuable insights into how to enhance enjoyment and engagement, and support children's physical activity levels both during and outside PE. However, research on how such tools, tailored to the unique PE context and the needs of teachers and children, can be designed to effectively support PE teachers is scarce.

Building on the research gaps, this dissertation aims to explore how primary school PE teachers, both generalists and specialists, can foster children's enjoyment in PE and support active lifestyles. It examines the indirect influence of PE-related factors on children's daily PA and SB patterns, identifies teaching practices that contribute to these outcomes, and explores how teachers currently reflect on their practice and how

technological tools can be designed to support this process. These tools are intended to improve teaching quality, better meet children's needs, contribute to teachers' professional development, and encourage active lifestyles among children. To achieve this overarching aim, the dissertation focuses on the following sub-aims:

1. Examining the associations between primary school children's MC, enjoyment of PA, satisfaction of basic psychological needs (BPN) in PE, and their daily patterns of PA and SB over time.
2. Exploring children's perspectives on teaching practices that foster PE enjoyment and the extent to which these practices are applied by primary school PE teachers, i.e., generalist teachers and PE specialists.
3. Exploring teachers' perspectives on enjoyable PE lessons and reflective practices, how teachers currently engage in reflection, and identifying the barriers they experience in both reflective practices and in delivering enjoyable PE lessons.
4. Identifying design considerations for technological feedback and reflection tools aimed at supporting PE teachers in effectively using reflective practices to improve their teaching and better meet children's needs for PE enjoyment.

2.2. Outline

This thesis consists of seven chapters. Chapter 2 to chapter 6 present the studies conducted to address the research questions (see Table 1.1), while chapter 7 offers a general discussion, summarizing the main findings and providing considerations, implications, and practical recommendations related to the subject of this dissertation. Chapter 2 and 3 focus on the physical activity levels of primary school children. Chapter 2 explores the relationship between children's motor competence, physical activity, and sedentary behavior. Chapter 3 shifts focus to the longitudinal associations between motor competence and both physical activity and sedentary behavior, as well as the relationship between enjoyment of physical activity and both physical activity and sedentary behavior among boys and girls. Additionally, Chapter 3 examines whether children's perceived satisfaction of basic psychological needs in PE can predict their enjoyment of physical activity. Chapter 4 identifies teaching practices that, according to children, foster their PE enjoyment and explores the extent to which teachers currently apply these practices in PE lessons. Chapter 5 and 6 focus on teachers' reflective thinking as an essential component of continuous professional development. Chapter 5 describes a study that explores teachers' current use of feedback and reflective thinking, and the challenges they face in using these strategies. Chapter 6 investigates how technology can facilitate teachers' reflective practices by exploring design considerations for a feedback and reflection toolkit, and by developing, prototyping, and testing potential solutions.

2.3. Contributions

This dissertation provides empirical, methodological, and artifactual contributions. Chapter 2 and 3 focus on empirical contributions, extending existing knowledge about PE-related factors and their influence on primary school children's physical activity and sedentary behavior. Chapter 4 offers a deeper understanding of teaching practices that foster children's PE enjoyment by hearing children's voice. Observations of PE lessons, based on these insights, also provide a methodological contribution. Chapter 5 presents an empirical contribution by providing new data about primary school PE teachers' use of feedback and reflection on teaching to improve their lessons to ensure enjoyable PE learning experiences for children. Chapter 6 combines both methodological and artifactual contributions, proposing design considerations and prototypes for developing feedback and reflection tools tailored to the primary school PE context. Based on these contributions, Chapter 7 offers recommendations for future research and practical implications aimed at enhancing primary school PE.

Table 1.1. Overview of the studies in this dissertation

Chapter	Sub-aim and Objective	Methods	Contribution
2	Sub-aim 1 Examining the association between MC and PA levels among primary school children	Cross-sectional; n = 595 children; MC (AST), PA levels (ActiGraph); mixed-model analyses	Empirical
3	Sub-aim 1 Examining longitudinal associations of MC and PA enjoyment with SB and MVPA and the role of basic psychological needs (BPN) in physical education (PE).	Longitudinal; n = 371 children; MC (AST), PA and SB (ActiGraph), PA enjoyment (PACES questionnaire), BPN in PE (CARR questionnaire); repeated measures mixed-model analyses	Empirical
4	Sub-aim 2 Exploring primary school children's perspectives on TPs that foster PE enjoyment	Qualitative; 4 focus groups (n = 24 children), 31 PE lessons observed; inductive coding	Empirical; Methodological
5	Sub-aim 3 Exploring Dutch primary school teachers' perspectives on enjoyable PE and reflective practices.	Cross-sectional; n = 173 teachers; online questionnaire; Chi-square Mann-Whitney U, logistic regression	Empirical
6	Sub-aim 4 Exploring design considerations of feedback and reflection tools tailored to primary school PE	Design-based; user-centered iterative approach; PE lesson observations, focus groups, questionnaires, prototyping, user-testing	Methodological; Artifactual

Note. MC = motor competence; PA = physical activity; SB = sedentary behavior; MVPA = moderate-to-vigorous physical activity; PE = physical education; BPN = basic psychological needs; TP = teaching practice; AST = Athletic Skills Track.

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CHAPTER 2

ASSOCIATIONS BETWEEN MOTOR COMPETENCE AND PHYSICAL ACTIVITY PATTERNS

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1. ABSTRACT

Children's motor competence (MC) has declined in the past decades, while sedentary behavior (SB) has increased. This study examined the association between MC and physical activity (PA) levels among primary schoolchildren. Demographics, body height and weight, MC (Athletic Skills Track), and PA levels (ActiGraph, GT3X+) were assessed among 595 children (291 boys, mean age = 9.2 years, SD = 1.1). MC was standardized into five categories: from very low to very high. PA levels were classified into SB, light PA (LPA), and moderate-to-vigorous PA (MVPA). Mixed-model analyses were conducted with PA levels as dependent variables and MC as the independent variable, while adjusting for age, gender, and body mass index (BMI) z-score on the individual level. A negative association between MC and SB and a positive association between MC and MVPA were found. The strength of both associations increased as children expressed lower or higher levels of MC. MC is an important correlate of both SB and MVPA, particularly for children with very high or low MC. Developing and improving children's MC may contribute to spending less time in SB and more time in MVPA, particularly for high-risk groups, i.e., children with low MC. Moreover, addressing MC development and PA promotion simultaneously might create positive feedback loops for both children's MC and PA levels.

2. INTRODUCTION

Physical activity (PA) and sedentary behavior (SB) are important health determinants. Sufficient regular PA has positive effects on physical and psychological well-being (Weggemans et al., 2018), while excessive SB is associated with negative health outcomes (Hoare et al., 2016; Owen et al., 2010). PA and SB patterns in childhood lay the foundation for a healthy lifestyle in adulthood (Jones et al., 2013; Telama, 2009). Inactive children and adolescents have a greater likelihood of becoming physically inactive adults than active children, emphasizing the importance of increasing PA and limiting SB among children. Nevertheless, children's physical inactivity and sedentary lifestyles are still increasing worldwide (Hallal et al., 2012). Similar to children in other countries, 45% of the Dutch primary schoolchildren do not meet the World Health Organization's recommendation of at least 60 min of moderate-to-vigorous PA (MVPA) a day (Burghard et al., 2016).

Socioecological frameworks of health behavior, such as the Environmental Research framework for weight Gain prevention (EnRG framework) (Kremers et al., 2006), consider PA and SB to be a result of an interaction between individual and environmental factors. From this ecological viewpoint, motor competence (MC) can be affected by environmental factors, e.g., physical education (PE) lessons, and forms an individual predictive variable for PA and SB. Studies by De Meester et al. (2018) and Lubans et al. (2010) support this hypothesis by showing positive associations between children's level of MC and the time children spent in PA. MC is ideally learned and developed during childhood (Wormhoudt et al., 2018), yet declines in children's MC have been reported over the last years (Runhaar et al., 2010; Tester et al., 2014).

According to the concept of physical literacy (Roetert et al., 2018), physical competence (including MC) and engagement in PA are interconnected key elements for the development of active lifestyle patterns. This suggests a reciprocal relationship between MC and PA; children with high MC are more likely to participate in PA than children with low MC, and vice versa (Lima et al., 2017; Stodden et al., 2008).

The impact of the relationship between MC, PA, and SB might be influenced by a set of individual demographic variables. First, children's weight status is recognized as a strong correlate of PA and SB. Overweight and obese children have higher levels of SB (da Costa et al., 2017) and lower levels of PA than children with a normal weight (Keane et al., 2017). In addition, body mass index (BMI) and MC are negatively associated (Lubans et al., 2010). Non-overweight children perform better on locomotor skills than overweight children (Okely et al., 2004). Gender differences have also been found in PA

and SB. Girls are more sedentary than boys (da Costa et al., 2017) and spend less time on MVPA than boys (Fowweather et al., 2015; Slykerman et al., 2016; Telford et al., 2016). Age is also a confounder in the relationship between MC, MVPA, and SB. Older children spend more time in sedentary activities (Ishii et al., 2015; Pearce et al., 2012; Wang et al., 2013) and engage in PA for shorter times than younger children (Farooq et al., 2018; Telford et al., 2016; Trost et al., 2002; Van Kann et al., 2016), independently of their MC.

Increased insight into the relationship between MC, PA, and SB and the confounding effects of important demographic variables (i.e., BMI, gender, and age) on this association is necessary to develop strategies that enhance healthy lifestyles in children. However, studies addressing this relationship are scarce, particularly considering daily time spent in SB.

Therefore, the purpose of this study was to investigate the association between primary schoolchildren's MC, daily PA, and SB as well as studying the potential confounding effects of BMI, gender, and age on the relationship between MC and PA, and MC and SB, respectively.

3. MATERIALS AND METHODS

For the current study, baseline data were taken from the SALTO study. The SALTO study focused on the relationship between PE characteristics and daily SB and PA among primary schoolchildren. It included 10 primary schools in Eindhoven and Maastricht, two cities in the southern part of the Netherlands (over 200,000 and 100,000 citizens, respectively). Schools were recruited in collaboration with two local school boards. The selection criteria were "socioeconomic status (Mooses et al.) of the neighborhood in which schools are located" and "an equal number of schools with and without specialist PE teachers". First, schools in Eindhoven with specialist PE teachers were recruited, followed by comparable schools (based on SES) without specialist PE teachers in Maastricht.

Children in grade 4 (aged 7–9 years) and grade 6 (aged 9–11 years) were invited to participate in the SALTO study. Data collection took place between May and July 2017. The children were verbally informed about the content of the SALTO study by researchers during school visits. The parents were asked to provide written informed consent for their children's anthropometry and PA measurements. All children were invited to take part in the measurement for MC during a regular physical education (PE) lesson. The SALTO study obtained ethical approval from the Ethical Research Committee of Fontys University of Applied Sciences (reference number FCEO 24-03 Adank).

In total, 1126 children were invited to participate in the SALTO study, of whom 728 (64.7%) provided written parental informed consent to conduct anthropometry and PA measurements. Children who did not provide complete data on all variables, e.g., due to invalid accelerometer data or absence during measurements, were excluded from the analyses.

3.1. Physical activity and sedentary behavior

Accelerometers (ActiGraph GT3X+; 30 Hz; 10 s Epoch) were used to objectively measure daily SB and PA. Participating children were equipped with an accelerometer during classroom visits conducted by a researcher and research assistant. The researcher checked that the children wore the elastic belt with the accelerometer positioned on the right hip. Children were instructed to wear the accelerometer for seven consecutive days, except during water-related activities and when asleep. The parents received written information about the accelerometer.

The collected data were analyzed using the ActiLife software, version 6.10.4. Evenson's cut-off points (Evenson et al., 2008) were used to categorize PA into three levels: SB (<101 counts per minute (CPM)), light PA (LPA) (101–2295 CPM), and MVPA (>2295 CPM). Choi's (Choi et al., 2011) wear time validation criteria were applied; a valid school day was defined as the provision of at least 480 min of valid wear time between 6:00 a.m. and 11:00 p.m. The first measurement day was deleted to prevent equipment reactivity (Dössegger et al., 2014). Children providing at least three valid school days of PA data were included for further analyses. In the current study, weekend days were excluded.

3.2. Anthropometry

Children's body height was measured using a SECA portable stadiometer (*model 213*; SECA, Germany). Body weight was measured using a calibrated portable electronic scale (*model 803*; SECA, Germany). A trained research assistant carried out these measurements in a separate section during a PE lesson. For standardization, all children wore light clothes (shorts and t-shirt) and no shoes. BMI z-scores were calculated using a Dutch reference population to standardize for age and gender (Schönbeck et al., 2011) and were classified by weight status according to the 2007 recommendations (Barlow, 2007), resulting in four categories (underweight (BMI z-score ≤ -1.65), healthy weight ($-1.64 \leq$ BMI z-score ≤ 1.03), overweight ($1.04 \leq$ BMI z-score ≤ 1.64), and obese (BMI z-score ≥ 1.65)).

3.3. Motor competence

The Athletic Skills Track (AST) was used to assess children's MC. MC in the current study is defined as the degree of skilled performance in a wide range of motor tasks as well as the movement coordination and control underlying a particular motor outcome

(d'Hondt et al., 2009). The AST is a feasible, valid, and reliable assessment tool for measuring MC that can easily be incorporated in PE (Hoeboer et al., 2017; Hoeboer et al., 2018). The track is an obstacle course consisting of seven fundamental motor skills tasks: balancing, bunny hopping, hopping, walking on the hands and feet, running, rolling, and clambering. The track differs in task complexity for grade-4 children (AST-2) and grade-6 children (AST-3) and should be completed as fast as possible.

The measurement took place during a PE lesson. The class was divided into three groups. A trained research assistant demonstrated and explained the AST to the group (8–10 children). After this instruction, the children were asked to practice running the track three times. During this try-out, the children received feedback from the research assistant as necessary. The children then individually performed the track as quickly as possible, while the research assistant measured the time with a stopwatch. The individual raw completion scores (time in 0.1 s) were recorded. Time scores were standardized, conforming to the age- and gender-specific AST norm scores, ranging from 1 (MC far below average) to 5 (MC way above average) (Hoeboer et al., 2018).

3.4. Procedure

Involved researchers ($N = 3$), research assistants ($N = 2$), and PE teachers ($N = 7$) were trained to assess an MC test during an afternoon session lasting 3 h by two developers of the AST and received instructions on the measurement protocol for anthropometry and PA assessment. Gender and age (date of birth) were received for all children with parental consent.

3.5. Statistical analyses

Data were analyzed using SPSS Statistics, version 24 (IBM Corp., Armonk, NY, USA). PA levels were converted into daily share of time spent in SB, LPA, and MVPA during school days. Share of time spent in SB, LPA, and MVPA during school days was the dependent variable. Standardized MC scores, gender, age, and BMI z-scores were considered independent variables. For all analyses, the statistical significance was set at $p < 0.05$.

Descriptive statistics were calculated for demographic variables, MC, SB, LPA, and MVPA outcomes. Independent samples *t*-tests were used to compare the outcomes between boys and girls, between grade-4 and grade-6 children, and between non-overweight and overweight children. Mixed-model analyses were conducted to understand the association between the independent variables and PA levels (SB, LPA, and MVPA). School was specified as a random intercept to correct for a nested structure of the data within schools. On a second level, individual characteristics were included to examine the association between MC on PA levels while correcting for age, gender, and BMI

z-scores. The standardized MC scores were recoded into dummy variables. The baseline category was MC3 (normal level of MC).

4. RESULTS

In total, 595 children (mean age = 9.2, SD = 1.1) provided complete data on all variables. The sample was equally distributed among boys ($N = 291$) and girls ($N = 304$). There was a slight overrepresentation of grade-6 children ($N = 307/52\%$). The mean score for MC was 3.18 (SD = 1.01, range 1–5). A total of 17% ($N = 103$) of the sample scored below average (score 1 or 2), and 30% ($N = 178$) scored above average (score 4 or 5). No gender difference was found for MC. The mean score was significantly higher in grade-4 children than in grade 6-children. Overweight children scored significantly lower on MC than non-overweight children (Table 2.1).

For BMI z-scores, there were no significant gender differences nor differences between grade-4 and grade 6-children found (Table 2.1). Based on BMI z-scores, 6.9% of the children were underweight, 8.1% were overweight, and 3.2% were obese.

The mean accelerometer wear time on a school day was 766 min (SD = 64.7). Children were sedentary for 480 min (SD = 66.6) on a school day. They spent 228 min (SD = 40.7) of the time in LPA and 58 min (SD = 21.0) in MVPA. Gender differences were found for SB as well as for LPA and MVPA. Girls spent significantly more minutes a day in SB than boys (492 min vs. 467 min) and fewer minutes in LPA (224 vs. 233 min) and MVPA than boys (50 min vs. 67 min). Children in grade 4 showed significantly lower levels of SB than grade-6 children (456 min vs. 502 min). Children in grade 4 spent significantly more time in LPA (238 vs. 220 min) and MVPA than grade-6 children (59 vs. 57 min). Overweight children spent significantly less time in MVPA compared to non-overweight children (Table 2.1).

Table 2.1. Descriptive characteristics (mean and standard deviation); total and stratified by gender and grade

	School day									
	Total Mean (SD) N = 595	Boys Mean (SD) N = 291	Girls Mean (SD) N = 304	Boys-Girls p (t)	Grade 4 Mean (SD) N = 288	Grade 6 Mean (SD) N = 307	Grade 4- Grade 6 p (t)	Non-Overweight Mean (SD) N = 528	Overweight Mean (SD) N = 67	Non-Overweight - Overweight p (t)
Age	9.1 (1.1)	9.1 (1.1)	9.2 (1.1)	ns	8.1 (0.4)	10.1 (0.5)	<0.01 (-57.54)	9.1 (1.1)	9.1 (1.1)	ns
MC	3.18 (1.01)	3.25 (1.07)	3.12 (0.95)	ns	3.49 (0.92)	2.90 (1.01)	<0.01 (7.36)	3.23 (1.0)	2.85 (0.9)	<0.01 (2.88)
BMI (z-score) *	-0.22 (0.96)	-0.27 (1.01)	-0.17 (0.92)	ns	-0.19 (0.92)	-0.24 (1.00)	ns	-0.44 (0.77)	1.52 (0.44)	<0.01 (-30.71)
Wear time	766.4 (64.7)	766.6 (64.3)	766.2 (65.3)	ns	752.5 (62.8)	779.5 (63.9)	<0.01 (-5.19)	767.4 (64.2)	758.3 (68.6)	ns
% SB	62.6 (6.4)	60.9 (6.7)	64.2 (5.6)	<0.01 (6.56)	60.5 (6.2)	64.5 (6.0)	<0.01 (-7.83)	62.6 (6.2)	62.6 (7.8)	ns
% LPA	29.8 (4.9)	30.4 (5.1)	29.2 (4.6)	<0.01 (-3.04)	31.6 (4.5)	28.2 (4.6)	<0.01 (9.25)	29.8 (4.7)	30.4 (5.9)	ns
% MVPA	7.6 (2.7)	8.7 (2.8)	6.6 (2.1)	<0.01 (-10.57)	7.9 (2.7)	7.4 (2.7)	<0.05 (2.19)	7.7 (2.7)	7.0 (2.6)	<0.05 (2.11)

Note. * Compared with the Fifth Dutch growth study (Schönbeck et al., 2011). MC = motor competence; wear time duration is expressed in minutes; BMI = body mass index; SB = sedentary behavior; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; ns = not significant at $p < .05$.

Mixed-model analyses were conducted for SB, LPA, and MVPA separately. The best fitted models for SB, LPA, and MVPA included main effects of MC as well as gender, age, and BMI z-scores (Table 2.2). Regarding SB, children who scored below average (score 1 or 2) spent significantly more time in SB than children with an average score (score 3). Moreover, children with an extremely high score on MC (score 5) spent significantly less time in SB than those who had a normal score (score 3). Age (older) and gender (girl) also significantly predicted time spent in SB. The strength of the association between MC and SB increased when children expressed higher and lower MC (scores 5 and 1). The least competent children spent 3.17% (24.3 min per day) more time in SB per day compared to children with an average MC score. The most competent children spent 1.72% (13.2 min per day) less time in SB per day than children in the average MC category. For MVPA, the opposite linear association was found; compared to referent children (MC3), the least competent children spent 1.41% (10.8 min per day) less time in MVPA, whereas the most competent children spent 1.16% (8.9 min per day) more time in MVPA (Figure 2.1).

Table 2.2. Associations between MC, BMI z-score, age, gender, and percentage of time spent in SB, LPA and MVPA on an average school day

Data (N = 622)	% SB		% LPA		% MVPA	
	Beta (95% CI)	p	Beta (95% CI)	p	Beta (95% CI)	p
Age	1.46 (1.02–1.90)	<0.01	–1.42 (–1.76––1.08)	<0.01	–0.04 (–0.23–0.14)	0.64
BMI-z score	–0.26 (–0.73–0.21)	0.28	0.37 (–0.01–0.74)	<0.05	–0.11 (–0.31–0.08)	0.26
Gender (ref = female)	–3.25 (–4.15––2.35)	<0.01	1.19 (0.49–1.89)	<0.01	2.06 (1.69–2.44)	<0.01
Motor Competence (ref = average)						
Very low	3.17 (1.28–5.05)	<0.01	–1.75 (–3.21––0.29)	<0.05	–1.41 (–2.19––0.63)	<0.01
Low	1.97 (0.44–3.49)	<0.05	–1.15 (–2.34–0.03)	0.06	–0.81 (–1.44––0.18)	<0.05
High	–0.45 (–1.71–0.81)	0.48	0.08 (–.90–1.06)	0.87	0.37 (–0.16–0.89)	0.17
Very high	–1.72 (–3.18––0.27)	<0.05	0.56 (–0.57–1.69)	0.33	1.16 (0.56–1.76)	<0.01

Note. Ref = referent; SB = sedentary behavior; LPA = light physical activity; MVPA = moderate-to-vigorous physical activity; FMS = fundamental movement skills; BMI = body mass index. **Bold** = significant association.

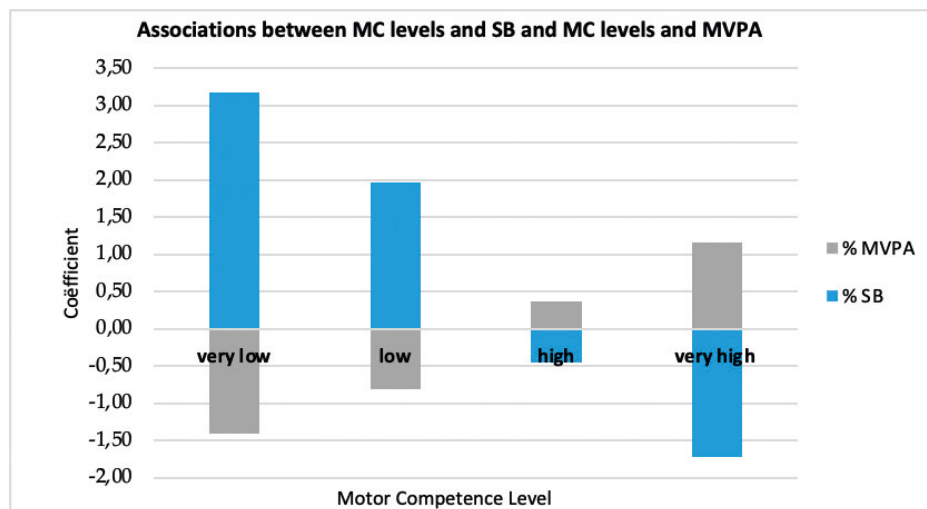


Figure 2.1. Associations (coefficients) between MC categories (MC1 = very low; MC2 = low; MC4 = high, MC5 = very high. Referent is MC3 = average MC) and % time spent in SB and between MC and % time spent in MVPA

With respect to LPA, children with very low MC (score 1) spent significantly less time in LPA than children with an average level of MC (score 3). There was a significant negative association between age and LPA. Boys spent more time in LPA than girls. The higher the BMI z-scores of children, the more time children spent in LPA. Children with low MC (score 1 or 2) spent less time in MVPA than other children. Compared with children who had average MC, children with very high MC spent significantly more time in MVPA. Boys spent more time in MVPA than girls during a school day.

5. DISCUSSION

This study examined the associations between motor competence, sedentary behavior, and physical activity. In line with previous studies (Barnett et al., 2016; Castelli & Valley, 2007; Cohen et al., 2014; Fisher et al., 2005; Lubans et al., 2010), MC was positively associated with time children spent in MVPA. Interestingly, our results revealed an even stronger negative association between MC and SB.

Although studies on the relationship between MC and SB are scarce, existing studies found similar patterns to those in the current study (Engel et al., 2018; Hardy et al., 2012; Lopes et al., 2012; Loprinzi et al., 2015; Wrotniak et al., 2007), underlining the importance of SB in relation to current declines in children's MC. The impact of MC on SB and MVPA

varied across levels of MC (Figure 1). Higher or lower levels of MC had stronger impacts on SB and MVPA in comparison with normal levels of MC. The association between MC and SB was stronger than the association between MC and MVPA.

Our findings indicate the need to focus on children's MC as a factor that influences not only time children spent in MVPA but also sedentary time. It suggests that improvement in children's MC, especially for those who have low MC, could be a promising strategy in reducing SB and increasing the time children spend in MVPA. The cross-sectional design limited the opportunity to test causality in the relationship between MC and SB and MVPA, respectively. Nevertheless, a reciprocal association between MC and PA levels could be hypothesized (Roetert et al., 2018; Runhaar et al., 2010). Reducing time spent in SB and increasing time spent in MVPA could positively affect children's MC (Roetert et al., 2018), which offers a new opportunity to decrease the negative trend in children's MC (Barnett et al., 2013; Runhaar et al., 2010). On the contrary, increasing MC has the potential to decrease levels of SB and increase levels of PA. According to a systemic view, it is recommended to focus on both behaviors simultaneously to optimize conditions in which positive feedback loops can result in sustainable behavioral improvements. Yet, school-based PA programs proved that it is challenging to reach sustainable effects on PA (Verjans-Janssen et al., 2018), so it would be better to focus on increasing MC to initiate a positive feedback loop (Lima et al., 2017; Stodden et al., 2008), e.g., through high-quality physical education lessons. Alongside developing MC, PA promotion and SB reduction remain crucial to initiate the positive feedback loops.

There were, in line with previous studies (Ishii et al., 2015; Trost et al., 2002; Verloigne et al., 2012), quite strong significant gender differences in sedentary time and time spent in LPA and MVPA. Girls spent more time in SB than boys, and boys engaged longer in LPA and MVPA than girls. This finding stresses the need to develop effective interventions specifically targeting girls' PA levels. In line with other studies (Farooq et al., 2018; Telford et al., 2013; Telford et al., 2016; Trost et al., 2002; Van Kann et al., 2016; World Health Organization, 2016), which showed that older children are less active than younger children, we found significant differences in time spent in LPA and MVPA between grade-4 and grade-6 children. Moreover, like other studies (Ishii et al., 2015; Pearce et al., 2012; Wang et al., 2013), we found a positive correlation between age and SB. In general, older children go to bed at a later time, and this extended duration of waking hours might be responsible for this finding, i.e., more television watching, computer gaming, and using social media.

In contrast to studies by Da Costa et al. and Keane et al. (da Costa et al., 2017; Keane et al., 2017), we found no significant relationship between BMI and SB and between

BMI and MVPA. It is possible that BMI as a predictor for SB and MVPA changes with age. Perhaps BMI differences between children and their impact on SB and MVPA become stronger and more apparent in adolescence. Our relatively small sample size of overweight children ($N = 67$ children; 11.3%) could also have impacted the lack of significant association in the current study.

Furthermore, children spent on average 8 h (of 11.5 h wear time) in SB on a school day, which is comparable with other studies (Barnes et al., 2013; Burghard et al., 2016; Konstabel et al., 2014). These extremely high levels of SB during school days may be largely affected by the current form of school curricula in which children are obliged to sit most of the time. More active alternatives in curricula, such as integrating PA in regular educational activities (Brittin et al., 2017; Kriemler et al., 2011) and providing less sedentary physical classroom environments (Brittin et al., 2017; Hegarty et al., 2016) could be beneficial to decreasing sedentary time at school and subsequently affect MC positively.

Besides strengths like sample size and objective measures, the current study is also subject to some limitations. First, this study used MC as an independent variable. Most other studies focused specifically on locomotor skills, object control skills, and stability skills as a measurement of fundamental motor skills, rather than the comprehensive measure of MC. Second, participating schools were located in neighborhoods with an average or high SES. The neighborhood SES could be a confounding variable as children raised in high SES families might have been slightly over-represented in the current study compared to average levels in the Netherlands. This may have affected the generalizability of the present study results. Yet, MC outcomes were standardized based on a national representative sample and therefore did not affect the association between MC and PA levels. Moreover, sensitivity analyses (data not shown) revealed no statistical differences in MC, i.e., selection bias, between participating and nonparticipating children in the SALTO study. Third, the outcome of SB and PA could be biased by seasonality. Children spend more time sedentary and less time in MVPA in winter (Atkin et al., 2016). Our data collection took place during the summer. Furthermore, this study focused only on school days. Further investigation of PA behavioral patterns on weekend days is recommended (Bürge & de Bruin, 2016).

6. CONCLUSION

This study demonstrates a positive association between MC and MVPA and an even stronger association between MC and SB in children aged 7–11 years. Although

reciprocal associations between MC and PA levels are still unclear, MC should receive more attention as a potential, crucial factor to counter the alarming declines in PA and increase of SB among children. We emphasize the prominent role physical education in primary schools should play in developing and improving children's MC. In line with the reciprocal view, PA-supportive and SB-inhibiting activities are needed in addition to MC development to optimize PA development in children.

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CHAPTER 3

LONGITUDINAL ASSOCIATIONS BETWEEN PHYSICAL EDUCATION- RELATED FACTORS AND PHYSICAL ACTIVITY PATTERNS

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1. ABSTRACT

This study examined longitudinal associations of motor competence (MC) and physical activity (PA) enjoyment with moderate-to-vigorous PA (MVPA) and sedentary behavior (SB) among boys and girls aged 10-12 years old. In addition, this study explored the predictive strength of satisfaction of basic psychological needs (BPN) in physical education (PE) and PA enjoyment. At three time points (baseline,+1 year,+2 years) PA levels, MC, PA enjoyment, satisfaction of BPN in PE and height and weight of 371 children were measured. Data were analyzed using repeated measures linear mixed model analyses stratified for gender and adjusted for relevant covariates. SB increased over time and was significantly predicted by PA enjoyment in boys and by PA enjoyment and MC in girls. Boys' MVPA decreased over time and was predicted by MC, whereas girls' MVPA remained low, yet stable over time and was predicted by PA enjoyment and MC. Further, children's need for competence and teacher-relatedness (girls only) during PE significantly predicted PA enjoyment. Children need sufficient and well-designed opportunities to improve their MC and PA enjoyment. PE may be pivotal in advancing PA enjoyment, indicating that PE could have more beneficial effects on PA levels in children, especially in girls.

2. INTRODUCTION

Stimulating active lifestyles among children is receiving increased attention. Regular physical activity (PA), and limited sedentary behavior (SB) in youth are associated with favorable health outcomes (Cliff et al., 2016; Weggemans et al., 2018). Despite the awareness of the benefits of an active lifestyle, physical inactivity is still high (Guthold et al., 2018). Similar to other countries, 44% of the Dutch children aged 4-11 years and 59% of the adolescents (aged 12-18 years) do not meet daily recommended PA guidelines (RIVM, 2020). In addition, moderate-to-vigorous PA (MVPA) decreases while SB increases with age, already starting during middle childhood (Basterfield et al., 2011; Farooq et al., 2018; Jago et al., 2020; Kallio et al., 2020; Nader et al., 2008; Schwarzfischer et al., 2019). Insight into factors that affect PA-levels among children during late childhood helps to design strategies to promote MVPA, mitigate SB and to attenuate age-related PA decline and SB increase.

BMI and gender are both individual variables correlated with children's PA and SB. Higher BMI is associated with higher levels of SB and lower levels of MVPA (Cooper et al., 2015; Jago et al., 2020; Schwarzfischer et al., 2019). Girls are less physically active than boys and spend more time in SB (Cooper et al., 2015; Ishii et al., 2015; Nader et al., 2008). To date, findings on gender-related changes in PA and SB levels during middle and late childhood are inconsistent. Some studies have shown that declines in MVPA (Basterfield et al., 2011; Jago et al., 2017) and increases in SB were higher in girls than in boys (Basterfield et al., 2011). Schwarzfischer et al. (2019) and Kallio et al. (2020) reported a greater decline in boys' MVPA. Other studies showed no gender differences in the rate of changes in MVPA (Farooq et al., 2018; Nader et al., 2008) and SB (Jago et al., 2017; Schwarzfischer et al., 2019).

PA enjoyment is one of the key factors in developing and maintaining healthy MVPA levels in children. PA enjoyment positively affects the intention, involvement and maintenance in PA (Eberline et al., 2018; Woods et al., 2007). Children who are intrinsically motivated towards PA engage in physical activities due to the satisfaction and enjoyment derived from the activities themselves. To encourage children's PA, opportunities for PA and enjoyable PA experiences should be provided across different contexts. The school context has a great influence, because children spend most of their waking hours at school (Hills et al., 2015). PA-supportive school environments could be created by for instance actively commuting to school, PA programs after school, active (unstructured) recess, classroom-based PA, and physical education (PE).

PE is compulsory in Dutch primary schools and therefore plays a prominent role in encouraging children to develop positive attitudes towards PA by emphasizing enjoyment in PA. Based on the trans-contextual model, previous studies have shown positive relations between PA enjoyment in PE, and PA and PA intentions in leisure time (Chen & Hypnar, 2015; Fin et al., 2017; Kalajas-Tilga et al., 2020; Ntovolis et al., 2015). Satisfaction of the basic psychological needs (BPN) (i.e. competence, autonomy and relatedness) is considered to be essential to achieve enjoyment in PE. Studies have corroborated this, which means that children in a PE context need to feel confident and capable of doing physical activities (competence), feel a sense of choice and volition (autonomy) and to feel connected to others (relatedness) (Chen & Hypnar, 2015; Gråstén & Anthony, 2017; Huhtiniemi et al., 2019; Kalajas-Tilga et al., 2020). Gender-specific associations have been found between satisfaction of BPN in PE and children's positive feelings towards PA (Cairney et al., 2012; Gråstén & Anthony, 2017; Huhtiniemi et al., 2019).

Motor competence (MC) is another well-known predictor of PA and SB. MC is positively associated with PA and negatively associated with SB (Adank et al., 2018; Loprinzi et al., 2015; Robinson et al., 2015; Tsuda et al., 2020). Age and gender are factors influencing children's motor skills (Bolger et al., 2018; Gosselin et al., 2020). Although little research has examined the relationship between MC and PA enjoyment, some previous studies suggest that both concepts are related (Chan et al., 2018; Loprinzi et al., 2015).

Although many studies have identified factors that are related to PA levels and PA enjoyment among children, longitudinal studies using the transfer from a PE context to out-of-school contexts in predicting children's daily PA and SB are scarce. In addition, there is inconsistent evidence about gender related PA levels changes during late childhood. Therefore, the main purpose of this study was to investigate the longitudinal associations between MC and PA enjoyment with daily MVPA and SB in boys and girls from 10 to 12 years of age. Additionally, this study explored whether PA enjoyment is influenced by PE-related factors, both in boys and girls.

3. METHODS

3.1. Study design and participants

For the present study, we used data from the SALTO study (Adank et al., 2018), a longitudinal study examining the relationship between PE characteristics and PA and SB patterns among primary schoolchildren. Ten primary schools in the south of the Netherlands agreed to participate in the SALTO study. The study was approved by the

Ethical Research Committee of Fontys University of Applied Sciences (reference number FCEO 24-03 Adank).

Children in grade 6 (age range 8-11 years; $n = 548$) were invited to participate in the study, with annual follow-ups in grades 7 and 8. Besides children's willingness to participate in the study written parental consent was required for children's PA and anthropometry measurements. At baseline, 371 grade-6 children (67.7%) received permission from the parents to wear an accelerometer for PA measurement. Only these children were approached for the first (T1) and second (T2) follow-up PA and anthropometry measurements. Parental consent for gender and age (date of birth) was received for all children. In addition to PA and anthropometry, all children took part in an MC measurement and were asked to fill out a questionnaire. Children could refuse to participate in the measurements at any time. Data collection took place every year between May and July, starting T0 in 2017.

3.2. Measurements

3.2.1. Physical activity and sedentary behavior

Children's PA and SB were measured by accelerometers (ActiGraph GT3X+; 30 Hz; 10s Epoch). Accelerometers were distributed to children during classroom visits. The researcher assisted children in fastening a waist belt with accelerometer positioned on the right hip. Children received verbal and written instructions. They were asked to wear the accelerometer during waking hours for seven consecutive days, except during water-related activities.

ActiLife software (version 6.13.3) was used to process PA data. Based on Evenson's cut-off values (Evenson et al., 2008), accelerometer counts were categorized into three levels: SB (<101 counts per minute (CPM)), light PA (LPA) (101–2295 CPM), and MVPA (>2295 CPM). The current study's focus was on weekdays, with a valid weekday defined as a minimum of 480 minutes of wear time between 6:00 a.m. and 11:00 p.m. (Choi et al., 2011). To prevent potential equipment reactivity, data on the first measurement day were excluded. Only children who provided valid PA data for at least two weekdays were included in the analyses. Weekend days and holidays were excluded.

3.2.2. Body mass index

Children's weight (kg) and height (Evenson et al.) were measured using a portable electronic scale (model 803; SECA, Germany) and SECA portable stadiometer (model 213; SECA, Germany) respectively. Measurement took place in a separate section of the gym during a PE class by a trained research assistant, with children wearing light clothes and no shoes. Values were recorded to one decimal. BMI was calculated and

converted into BMI z-scores based on the fifth Dutch growth study (Schönbeck et al., 2011) to standardize for age and gender.

3.2.3. Motor competence

MC was measured by the age-specific version of the Athletic Skills Track (AST-3 for grades 6-8). This is an obstacle course consisting of locomotor and stability tasks, which is valid and is easy to use in a PE class (Hoeboer et al., 2017). MC assessment was conducted during a PE class. A trained research assistant demonstrated and explained the track to a small group of children ($n = 8-10$). After three practice runs, children were asked to individually perform the track as fast as possible. The time score (in 0.1s) was recorded and standardized into age- and gender-specific AST categories, ranging from 1 (MC far below average) to 5 (MC far above average) (Hoeboer et al., 2018).

3.2.4. Psychological factors

Questionnaires were used to measure PA enjoyment and satisfaction of BPN in PE. A researcher briefly explained the purpose of the questionnaires and how these questionnaires had to be completed in classroom. A sample item was used to ensure that children understood the response scale. Instructions were also included on the questionnaires. To prevent socially desirable responses children were told there were no good or bad answers. Children were asked to fill out the questionnaires individually. They were allowed to request clarification of items when needed.

3.2.5. Physical activity enjoyment

Enjoyment in PA was assessed by the Dutch translation of the revised Physical Activity Enjoyment Scale (PACES) (Moore et al., 2009). The questionnaire included 16 statements with responses ranging from 1 (absolutely agree) to 4 (absolutely disagree) and 'I don't know'. Nine items were positively worded (e.g. I enjoy being physically active) and seven items were negatively worded (e.g. I dislike being physically active). Values of the positively formulated items were recoded to ensure that higher values of all items represent more PA enjoyment. Questionnaires with three or more invalid values (e.g. 'I don't know', multiple answers to a question) or missing values were excluded for further analysis. For children with a maximum of two invalid or missing values, missing values were replaced by the child's mean score for the other items. For analysis, an average PA enjoyment score was calculated. Cronbach's alpha for the PACES in the present study was 0.88.

3.2.6. Satisfaction of basic psychological needs in physical education

Satisfaction of the basic psychological needs in PE was assessed using the CARR scale (van Aart et al., 2015). This 18-item questionnaire, developed and validated in Dutch and

based on the BPNES (Vlachopoulos & Michailidou, 2006), consists of four subscales; autonomy (n=4), competence (n=4), classmate relatedness (n=4) and teacher relatedness (n=6). The items were preceded by the stem 'during the PE classes...'. Responses were categorized on a five-level Likert scale ranging from 1 (totally disagree) to 5 (totally agree). The CARR scale showed sufficient reliability of all subscales except autonomy. In the current study, the Cronbach's alpha for the four subscales were 0.63 (autonomy), 0.76 (competence), 0.82 (classmate relatedness) and 0.83 (teacher relatedness). Missing data were replaced by individual's mean score on subscales when not exceeding one missing variable per subscale and two in total. Otherwise, respondents were excluded.

3.3. Statistical analyses

Analyses were conducted using SPSS Statistics, version 26 (IBM Corp., Armonk, NY, USA). For all analyses, the statistical significance was set at $p < 0.05$. Descriptive statistics were performed for all study variables at T0, T1 and T2, including SB and MVPA in minutes. To correct for wear time variation, minutes in SB and MVPA were presented as a proportion of time spent in SB and MVPA, which was derived by dividing the absolute minutes in SB and MVPA by total wear time. Independent samples t-tests were used to study differences between boys and girls. Repeated measures linear mixed model analyses with four levels were performed to explore associations over time between independent variables, and each dependent variable, i.e. SB, MVPA and PA enjoyment. Time (T0, T1 and T2 coded as 0, 1 and 2 respectively) was entered as the level 1 variable and children as the level 2 variable nested within classes (level 3) and schools (level 4). Gender stratification was applied in all analyses, due to the gender differences in PA levels and in change of PA levels over time reported in previous research (Basterfield et al., 2011; Farooq et al., 2020). All models were adjusted for BMI z-scores and age. Time was added as a fixed effect to analyze development of SB, MVPA and PA enjoyment over time. For the SB and MVPA models, random intercepts at school level were used because they improved the models' fit. MC and PA enjoyment were tested as potential predictors. For the model examining the development of PA enjoyment, no random intercept at school level was used. The influence of satisfaction of all basic psychological needs (autonomy, competence, classmate relatedness and teacher relatedness) in PE on PA enjoyment was investigated. MC, SB and MVPA were entered separately as covariates and were kept as the model fit improved.

4. RESULTS

At baseline, 371 children (mean age = 10.1, SD = 0.5, 52.3% girls) participated in this study. Twelve children (3.2%, N = 3 at T1 and N = 9 at T2) were lost to follow-up at T2,

mostly due to leaving school in the two-year follow-up period. Valid PA measurement data declined from 93.5% at T0 to 79.9% at T1 and 68.5% at T2.

At baseline, children spent 502 minutes (SD = 65.7) per weekday in SB. This time in SB accounted for 64.7% of the wear time. At T2, this percentage increased to 67.5% of the wear time (537 minutes, SD = 111.7; Table 1). Boys' average daily MVPA declined below the daily recommended 60 minutes during the two-year follow-up (T0: 64.5 min vs. T2: 58.9 min). Girls' average daily MVPA did not meet the guideline at any time (T0: 48.9 min vs. T2: 48.7 min). Compared to girls, boys spent significantly fewer minutes in SB and more minutes in MVPA at every time point (Table 3.1). Girls' perceptions of competence in PE between T1 and T2 showed a steeper decline than that of boys, resulting in a significant gender difference at T2. Other significant gender differences were found for autonomy at all time points and teacher relatedness at T0 and T1, in which girls showed higher scores. PA enjoyment, MC, BMI z-scores and classmate relatedness showed no significant gender differences (Table 3.1).

Repeated measures linear mixed model analyses stratified for gender were conducted for the outcome variables SB, MVPA and PA enjoyment. Regarding SB, time was significantly positively associated with SB, indicating that children's SB increased from sixth to eighth grade. Moreover, significant negative associations between PA enjoyment and SB were also observed. MC was negatively associated with SB in girls, but this association was non-significant for boys (Table 3.2).

Table 3.1. Descriptive characteristics stratified by time points and gender

	Weekday											
	T0 / grade 6				T1 / grade 7				T2 / grade 8			
	Total Mean (SD)	Boys Mean (SD)	Girls Mean (SD)	Boys- Girls p (t)	Total Mean (SD)	Boys Mean (SD)	Girls Mean (SD)	Boys- Girls p (t)	Total Mean (SD)	Boys Mean (SD)	Girls Mean (SD)	Boys- Girls p (t)
Age	10.1 (0.5)	10.1 (0.5)	10.1 (0.5)	ns	11.1 (0.5)	11.1 (0.5)	11.1 (0.5)	ns	12.1 (0.4)	12.1 (0.5)	12.1 (0.5)	ns
Wear time	775.8 (70.7)	777.8 (71.1)	774.0 (70.4)	ns	777.6 (75.8)	772.7 (76.4)	782.3 (75.2)	ns	792.1 (109.8)	789.5 (95.3)	794.2 (120.7)	ns
% SB	64.7 (6.0)	63.3 (6.3)	65.9 (5.5)	<.01 (3.98)	65.7 (6.3)	64.7 (6.6)	66.8 (5.9)	<.01 (2.92)	67.5 (7.8)	65.5 (8.0)	69.2 (7.3)	<.01 (3.76)
% MVPA	7.2 (2.7)	8.3 (2.8)	6.3 (2.1)	<.01 (-7.28)	7.3 (3.1)	8.1 (3.3)	6.4 (2.7)	<.01 (-4.89)	6.8 (3.0)	7.5 (3.0)	6.2 (2.8)	<.01 (-3.45)
MC	2.83 (0.95)	2.78 (0.94)	2.89 (0.96)	ns	3.16 (1.02)	3.18 (1.05)	3.15 (1.00)	ns	3.29 (0.91)	3.31 (0.94)	3.27 (0.88)	ns
BMI (z-score)*	-0.23 (0.98)	-0.32 (1.04)	-0.15 (0.90)	ns	-0.21 (1.00)	-0.24 (1.08)	-0.19 (0.92)	ns	-0.21 (1.00)	-0.27 (1.07)	-0.15 (0.92)	ns
PA enjoyment	3.73 (0.30)	3.70 (0.29)	3.75 (0.30)	ns	3.70 (0.37)	3.66 (0.37)	3.72 (0.37)	ns	3.65 (0.41)	3.64 (0.36)	3.65 (0.44)	ns
BPN												
Autonomy	2.72 (0.59)	2.63 (0.64)	2.80 (0.53)	<.01 (2.70)	2.68 (0.63)	2.53 (0.64)	2.82 (0.58)	<.01 (4.51)	2.80 (0.66)	2.68 (0.72)	2.89 (0.60)	<.01 (2.89)
Competence	4.15 (0.64)	4.19 (0.62)	4.10 (0.67)	ns	4.16 (0.65)	4.21 (0.63)	4.12 (0.66)	ns	4.02 (0.67)	4.13 (0.64)	3.93 (0.69)	<.01 (-2.76)
Classmates relatedness	4.14 (0.68)	4.13 (0.68)	4.14 (0.68)	ns	4.09 (0.63)	4.07 (0.63)	4.11 (0.62)	ns	4.16 (0.64)	4.12 (0.61)	4.19 (0.67)	ns
Teacher relatedness	4.09 (0.60)	4.02 (0.60)	4.16 (0.59)	<.05 (2.82)	4.18 (0.68)	4.04 (0.72)	4.31 (0.61)	<.01 (3.80)	4.21 (0.62)	4.15 (0.62)	4.26 (0.61)	ns

Note. SB = sedentary behavior; MVPA = moderate-to-vigorous physical activity; MC = motor competence; BMI = body mass index; PA = physical activity; BPN = basic psychological needs. Wear time duration in minutes; SB and MVPA in percentages of daily share of time; MC ranging from 1-5; * Compared with the Fifth Dutch growth study (Schönbeck et al., 2011); PA enjoyment ranging from 1-4; satisfaction of BPN in physical education (autonomy, competence, classmates relatedness, classmates and teacher relatedness) ranging from 1-5; ns = not significant at $p < .05$.

Table 3.2. Linear mixed models examining factors related to children's SB development between T0 (grade 6) and T2 (grade 8) stratified for boys and girls

	% SB Boys			% SB Girls		
	est.	95% CI	p	est.	95% CI	p
Intercept	63.35	43.89 – 82.81	<0.01	65.47	48.51 – 82.43	<0.01
Time	1.06	0.28 – 1.84	<0.01	1.47	0.82 – 2.13	<0.01
PA enjoyment	-2.75	-4.79 – -0.72	<0.01	-2.22	-3.86 – -0.57	<0.01
MC	-0.65	-1.44 – 0.15	0.11	-0.83	-1.54 – -0.13	<0.05

Note. SB = sedentary behavior; PA = physical activity; est. = estimates of fixed effects; MC = motor competence. Repeated measures linear mixed model analyses adjusted for age at baseline and Body Mass Index z-score; SB in percentages of daily share of time; **Bold** = significant association. Model fit (-2 restricted log likelihood) boys = 2427.40; girls = 2466.91.

Boys' MVPA significantly declined over time, whereas girls' MVPA remained stable, although these levels were already low at baseline. PA enjoyment and MC were both significantly positive predictors of MVPA among girls, while in boys only MC was found to be a significantly positively associated with MVPA (Table 3.3). There were no significant associations found between BMI z-scores and the outcome variables SB and MVPA for both genders (data not shown). Regarding PA enjoyment, children's need for competence was positively related to PA enjoyment. Gender differences in the prediction of PA enjoyment were also found. SB was a significant negative predictor of PA enjoyment among boys. Time (negatively) and the need for teacher relatedness (positively) were significant predictors of girls' PA enjoyment (Table 3.4).

Table 3.3. Linear mixed models examining factors related to children's MVPA development between T0 (grade 6) and T2 (grade 8) stratified for boys and girls

	% MVPA Boys			% MVPA Girls		
	est.	95% CI	p	est.	95% CI	p
Intercept	7.22	-0.97 – 15.42	0.08	4.66	-2.29 – 11.61	0.19
Time	-0.41	-0.77 – -0.06	<0.05	-0.02	-0.29 – 0.25	0.87
PA enjoyment	0.83	-0.07 – 1.73	0.07	0.77	0.09 – 1.45	<0.05
MC	0.48	0.13 – 0.83	<0.01	0.33	0.04 – 0.62	<0.05

Note. MVPA = moderate-to-vigorous physical activity; est. = estimates of fixed effects; PA = physical activity; MC = motor competence. Repeated measures linear mixed model analyses adjusted for age at baseline and Body Mass Index z-score; MVPA in percentages of daily share of time; **Bold** = significant association. Model fit (-2 restricted log likelihood) for boys = 1837.754; girls = 1782.174.

Table 3.4. Linear mixed model examining factors related to PA enjoyment development between T0 (grade 6) and T2 (grade 8) stratified for gender

	PA enjoyment Boys			PA enjoyment Girls		
	est.	95% CI	p	est.	95% CI	p
Intercept	3.45	2.40 – 4.51	<0.01	3.07	1.96 – 4.18	<0.01
Time	-0.02	-0.06 – 0.01	0.22	-0.04	-0.08 – 0.00	0.05
MC	0.03	-0.01 – 0.07	0.15	0.02	-0.02 – 0.06	0.31
% SB	-0.01	-0.02 – 0.00	<0.05	0.00	-0.01 – 0.00	0.44
% MVPA	-0.01	-0.03 – 0.01	0.30	0.01	-0.01 – 0.03	0.28
<i>BPN</i>						
Autonomy	0.03	-0.03 – 0.08	0.40	0.03	-0.04 – 0.09	0.41
Competence	0.12	0.05 – 0.17	<0.01	0.11	0.05 – 0.17	<0.01
Classmate relatedness	0.03	- 0.02 – 0.09	0.23	0.03	-0.03 – 0.08	0.33
Teacher relatedness	0.02	- 0.04 – 0.09	0.49	0.11	0.05 – 0.18	<0.01

Note. PA = physical activity; est. = estimates of fixed effects; MC = motor competence; SB = sedentary behavior; MVPA = moderate-to-vigorous physical activity; BPN = basic psychological needs. Repeated measures linear mixed model analyses adjusted for age at baseline and Body Mass Index z-score; SB and MVPA in percentages of daily share of time; **Bold** = significant association. Model fit (-2 restricted log likelihood) boys = 210.684; girls = 239.832.

5. DISCUSSION

The main aim of the present study was to investigate the longitudinal associations between motor competence and physical activity enjoyment with daily physical activity levels among boys and girls from 10 to 12 years of age. Further, we explored the gender-specific associations between physical education-related factors and physical activity enjoyment.

SB increased over time for both genders, which is consistent with previous studies in this age category (Basterfield et al., 2011; Kallio et al., 2020; Schwarzfischer et al., 2019). This change could partially be explained by an increase of inactive play time (i.e. screen watching and video gaming) and an increase of sitting time in school and after school (i.e. due to homework) as children become older. Aligned with previous studies, we found girls to spend more time in sedentary behavior and less time in MVPA than boys (Cooper et al., 2015; Ishii et al., 2015). Regarding the change of MVPA over time, we found significant gender differences. Girls' MVPA remained stable from age 10 to 12 whereas boys' MVPA declined in this period. This is contrary to other studies reporting MVPA declines for both boys and girls during primary school (Farooq et al., 2020; Farooq et al., 2018; Schwarzfischer et al., 2019). Although these studies were not consistent about gender differences in the rate of MVPA decline during childhood, decline in

MVPA tends to start earlier in girls compared to boys (Farooq et al., 2020; Nader et al., 2008; Schwarzfischer et al., 2019). This developmental pattern is also seen in the current study, in which the level of MVPA in girls at baseline ($\pm$ 10 years old) was already substantially lower compared to boys, yet stabilized over the two-year follow-up period.

We found no longitudinal association between child's BMI and SB or MVPA. Based on Jago et al. (2020) and Schwarzfischer et al. (2019), it was expected that children with higher BMI z-scores would spend less time in MVPA or more time in SB. The impact of BMI on PA levels possibly changes as children become older and might be stronger during early adolescence. Therefore, exploring the nature and the predictive value of BMI on SB and MVPA during childhood and adolescence is warranted. The negative average BMI z-score may also explain the current study result.

In line with previous research, PA levels were influenced by MC (Adank et al., 2018; Loprinzi et al., 2015; Robinson et al., 2015). In girls, MC was negatively associated with SB and positively associated with MVPA. For boys, MC was associated only with MVPA. This differential effect of MC on PA levels may be partly explained by gender-specific motor abilities (Slykerman et al., 2016; Tsuda et al., 2020). The AST includes locomotor skills and stability skills but excludes object control skills. In addition, our study found no evidence for MC as a predictor for PA enjoyment.

PA enjoyment positively predicted MVPA in girls, which is in contrast with other studies reporting this association for both genders (Eberline et al., 2018; Woods et al., 2007). Similar to the results of Bai et al. (2019), PA enjoyment was a negative predictor of SB for both sexes. Moreover, PA enjoyment among boys predicted SB, and boys' SB predicted PA enjoyment. Based on our results, we therefore suggest a reciprocal relationship between PA enjoyment and SB for boys. The more boys experience fun in physical activities, the less time they spend in SB. In turn, less time sedentary provides boys with more opportunities to take part in physical activities and the more they experience PA enjoyment. Our findings emphasize the potential impact of PA enjoyment on SB.

Furthermore, we demonstrated gender differences in the satisfaction of need for autonomy, competence and teacher relatedness. Previous studies also reported lower perceived competence in girls during PE (van Aart et al., 2015; Zhang et al., 2015). The difference in perceived autonomy between boys and girls might be explained by a possible greater need among boys for opportunities to make their own choices and decisions in PE activities than among girls. Similar to other studies, the levels of perceived autonomy in both genders were low compared to the levels of perceived competence and relatedness (Gråstén et al., 2019; Huhtiniemi et al., 2019; van Aart

et al., 2015). Likely, this could be explained by a teacher-centered teaching style in which PE teachers determine goals and content of PE lessons. This may limit children's perception of autonomy during PE. In addition, we also revealed gender differences in the association between satisfaction of BPN and PA enjoyment. Need for competence in both genders and girls' need for teacher relatedness in PE positively predict PA enjoyment outside the school context, which in turn stimulates MVPA and mitigates SB. Our findings emphasize the importance of autonomy supportive climates (Reeve & Jang, 2006) that foster children's BPN satisfaction. PE teachers can create these climates by i.e. providing choices and differentiation in activities, providing positive feedback, recognizing children's feelings and interests, using a warm communication style, encouraging children's initiative taking (Hagger & Chatzisarantis, 2016; Reeve & Jang, 2006). Herewith PE teachers should acknowledge children's differential needs, in particular between boys and girls, to positively influence BPN in PE and PA enjoyment and adapt their teaching styles accordingly. This study highlights the importance of the PE context as an important condition for the development of a favorable set of competencies to be physically active. Those competencies continuously need to be further developed in non-PE contexts in order to create synergistic effects of PE and non-PE contexts on children's daily PA, SB and PA enjoyment (Barkoukis et al., 2021; Hagger & Chatzisarantis, 2016). The interaction between different contexts, i.e. PE and for instance the playability of home environments, follows the assumptions of the trans-contextual model in which PE-related factors, such as BPN, influence PA levels in other contexts.

5.1. Strengths and weaknesses

Strengths of this study are: (i) the longitudinal design providing insight into the changes of MVPA and SB in children over a two-year period; and (ii) variables across contexts, specifically BPN satisfaction in PE context and PA enjoyment, MVPA and SB outside the school context have been related to each other.

Although PA levels SB and MVPA were objectively measured using accelerometers, certain limitations apply. Firstly, accelerometer compliance declined with follow-up measurements, yet no selective drop-out was noted and follow-up rates were comparable with other studies using a similar protocol and study design in this age-category (Verjans-Janssen et al., 2020). Secondly, SB and PA data could be biased since measurements took place on weekdays during summer season and there was no adjustment for seasonality or weather effects. This potentially impact comparability of PA levels to studies with measurements in other seasons or during weekend days. In addition, our MVPA outcomes may be underestimated because accelerometers do not detect children's PA during water-related activities (i.e. swimming).

Another limitation is our study focus. Although SB and PA patterns are influenced by a multitude of individual and environmental variables, this study focused solely on a set of individual variables. Furthermore, a relatively low proportion of children in our sample suffered from overweight or obesity. Within our sample however, sensitivity analyses (data not shown) demonstrated no selection bias. The increase in MC and maintenance of PA enjoyment over time were also seen in children who did not engage in PA or anthropometry measurements. Finally, the variation in PA enjoyment was limited. As in many other studies, children tend to score relatively high on the PACES scale. This may raise the question of whether PACES is the best scale for capturing real feelings of enjoyment in PA in children. In addition, Likert scales may be prone to response biases. Considering the use of qualitative methods to assess children's BPN fulfillment in PE and their PA enjoyment is recommended.

6. CONCLUSION

This study demonstrated substantial differences in PA and SB between boys and girls during their late primary school career. Girls' maximum level of MVPA seemed to be established before the age of 10 and were consistently low over time. Boys' MVPA levels were over 30% higher compared to girls, yet this gender difference tended to decline slowly over time. This emphasizes the need for interventions promoting MVPA and reducing SB to start in early childhood. This study revealed MC and PA enjoyment to be important factors for influencing SB and MVPA patterns. Interventions should focus on positive and successful experiences in sports and unstructured physical activities. School environments, in particular PE, deserve specific attention because of their potential for laying a foundation for an active lifestyle. The PE contexts should be relatedness-supportive in which all children experience fun, feel physically competent and learn the motor skills required to be physically active in different contexts. Evidence-based teaching strategies are necessary and useful for creating safe and supportive PE contexts that meet the needs of every child, regardless of his or her motor skill level, age or gender.

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CHAPTER 4

TEACHING PRACTICES FOSTERING PHYSICAL EDUCATION ENJOYMENT

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1. ABSTRACT

Enjoyment in primary physical education (PE) is a key factor in increasing children's physical activity engagement in PE and leisure time. While existing PE research has largely focused on a motivational PE climate and meaningful experiences in PE, research on children's perceptions of enjoyable teaching practices (TPs) in PE is limited. Therefore, this study aimed to explore primary school children's perspectives on TPs that foster PE enjoyment. In addition, we observed to what extent these TPs are applied in daily PE practice. Four focus groups with 10- to 12-year-old children (12 boys, 12 girls) from four primary schools were formed and inductive analysis resulted in 32 child-identified TPs categorized into 10 dimensions. Thirty-one PE lessons taught by 19 different PE teachers (11 generalists, 8 PE specialists) were recorded and coded using the child-identified TPs. Teachers regularly performed a substantial number of these TPs during their PE lessons. However, TPs such as the use of cooperative learning, instructional methods to promote children's (social) learning process, an emphasis on children's individual improvements, and consciously grouping were rarely observed. Moreover, PE specialists showed TPs supporting exploratory learning and children's individual learning processes more frequently than generalists. In addition, PE specialists provided challenging, differentiated tasks with a creative use of equipment more often than generalists. Including children's perspectives contributes to a comprehensive understanding of PE enjoyment and TPs that can promote enjoyable PE experiences. Children's voices need to be heard continuously by PE teachers to ensure enjoyable PE experiences for all children.

2. INTRODUCTION

Enjoyment of physical education (PE) is associated with PE engagement (Navarro-Patón et al., 2019) and the intention to engage in physical activities outside the school context (Hagger & Chatzisarantis, 2016; Huhtiniemi et al., 2019; Ntouolis et al., 2015; Pérez-González et al., 2019). Therefore, teachers should optimally support children's PE enjoyment. Children who enjoy PE perceive it as fun, interesting, and exciting (Cairney et al., 2012; Moore et al., 2009). Creating enjoyable PE lessons is challenging, as children vary in their characteristics, perceptions of the environment, and learning requirements (Barić et al., 2014; Marron et al., 2021). A comprehensive understanding of children's PE enjoyment (what makes PE fun?) is necessary to provide primary PE teachers, both generalists and PE specialists, with practical tools to enhance children's enjoyment in PE.

Children's PE enjoyment has been studied through several theoretical lenses, e.g. through motivational theories such as the Achievement Goal Theory (AGT) and the Self-Determination Theory (SDT), and the Meaningful Physical Education (MPE) approach. According to AGT (Ames & Archer, 1988), differences in children's achievement goal orientations lead to differences in PE-related outcomes, such as PE enjoyment and engagement (Duda & Ntoumanis, 2003). Task-oriented children focus on learning, developing their competence, and gaining mastery in PE tasks using self-referenced standards. In contrast, ego-oriented children focus on outperforming others, and demonstrating and validating their competence based on normative standards. Children's goal orientations in PE are influenced by individual goal preferences and the PE class climate. Compared to an ego-oriented PE class climate, a task-oriented climate is related to more positive outcomes, such as PE enjoyment, cooperation, satisfaction, persistence, embracing challenges, and autonomous motivation (Gråstén & Anthony, 2017; Jaakkola et al., 2015; Jaitner et al., 2019; Liu et al., 2017), and high levels of physical activity engagement in PE and outside the school context (Kokkonen et al., 2019).

According to SDT (Deci & Ryan, 2000), children differ in their levels of self-determined motivation. Children with low self-determined motivation participate in PE primarily because of the anticipated consequences, such as getting a reward or avoiding punishment. In contrast, highly self-determined, autonomously motivated children actively participate in PE because of the interest and satisfaction derived from the PE activities or the personally valued importance of the PE activities. Autonomous motivation in PE is positively associated with PE enjoyment (Huhtiniemi et al., 2019; Navarro-Patón et al., 2019; Pérez-González et al., 2019; Pulido et al., 2014). A need-supportive PE climate that fosters the satisfaction of the basic psychological needs, i.e. competence, autonomy, and relatedness, is essential to enhance children's autonomous

motivation (Chang et al., 2016; Chen & Hypnar, 2015; Pérez-González et al., 2019; Sun et al., 2017; van Aart et al., 2015) and PE enjoyment (Chen & Hypnar, 2015; Curran & Standage, 2017; Pérez-González et al., 2019).

PE during childhood is regarded as important in providing meaningful experiences in physical activity to children (Beni et al., 2017; Kretchmar, 2006). According to MPE, PE experiences should have personal significance for children. PE teachers should emphasize the purpose and goals of movement for an individual, give attention to the personal significance of the emotional value of the experience and provide a sense of coherence by connecting PE to experiences outside of school (Fletcher & Ní Chróinín, 2022). Enjoyment is seen as a key element for meaningful PE experiences in addition to social interaction, challenge, motor competence, personally relevant learning, and delight. Pedagogical strategies that facilitate these elements positively contribute to children's PE enjoyment (Beni et al., 2017; Beni et al., 2019; Ní Chróinín et al., 2018).

Recently, an increasing number of studies have blended principles of AGT and SDT (Chen et al., 2020; Di Battista et al., 2018; Jaakkola et al., 2017; Ommundsen & Kvalø, 2007; Vansteenkiste et al., 2014; Weeldenburg et al., 2020) for several purposes. Blending the principles of AGT and SDT in combination with principles of MPE might result in a guiding framework for teachers to facilitate children's PE enjoyment. Di Battista et al. (2018) showed that a mastery-oriented, need-supportive PE climate leads to meaningful experiences and fosters children's PE enjoyment. Although these studies usually include some theory-based practical advice for teachers on how to create a mastery-oriented, need-supportive PE climate the number of studies on concrete teaching practices (TPs) to stimulate children's PE enjoyment is limited. In addition, it is unclear whether children value the theory-based implications as being the most crucial for influencing their PE enjoyment.

Children's perspectives on enjoyable PE are highly relevant in designing meaningful PE lessons (Harvey et al., 2018; Iannucci & Parker, 2022). Therefore, this study investigated primary school children's perspectives on TPs that foster their enjoyment. Moreover, this study focuses on the extent in which PE teachers put these child-identified enjoyable TPs into practice. In the Dutch primary school context, PE lessons are provided by PE specialists, generalists (classroom teachers) or a combination of both. It is unknown whether differences exist in applying child-identified enjoyable TPs between generalists' and specialists' teaching of primary PE. Therefore, we additionally studied the potential differences in bringing these TPs into practice by generalists and PE specialists.

3. METHODS

3.1. Study design

The current study was part of the SALTO study, the Dutch acronym for Stimulating an Active Lifestyle Through physical educatiOn. This is a longitudinal study examining the relationship between PE characteristics and daily physical activity and sedentary behavior patterns among primary school children. The study obtained ethical approval from the Ethical Research Committee of Fontys University of Applied Sciences (reference number FCEO 24-03 Adank).

Of the 10 primary schools participating in this study, four schools work with PE specialists, four with generalists, and two with a combination of PE specialists and generalists. We used a mixed methods study design in which two successive steps can be distinguished. The first step (S1) was identifying TPs associated with children's PE enjoyment. The second step (S2) was observing PE lessons to determine the extent to which the teachers applied these TPs in practice.

3.2. Participants

3.2.1. Focus groups

The identification of the TPs (S1) was based on input from end-users, i.e. primary school children, obtained from four focus group interviews. Based on convenience sampling, four of the ten primary schools participating in the SALTO study were invited to take part in the focus groups for children, all of which accepted. Each school was requested to select a group of six grade-7 children (aged 10-12 years) for the focus group per school. Criteria for this selection included children's willingness to participate, verbal parental consent, three boys and three girls, and a representation of children that their classroom teacher considered to have different motor skill levels. In all, four focus groups with 24 10- to 12-year-old children (12 boys, 12 girls) were created.

3.2.2. Observations

For S2, PE specialists ($n = 8$) and generalists ($n = 11$) at the 10 participating schools that performed PE lessons for 8- to 12-year-old children, i.e. grade-6 and grade-8 in the Dutch primary school system, were asked for approval to record regular PE lessons. All teachers gave permission for their PE lessons to be audio- and videotaped. To record PE lessons, parental informed consent was required as well. Children without parental written informed consent did not attend the observed PE lessons or participated in these PE lessons in areas not covered by the recording system. In schools with more than two classes within the same grade, a maximum of two classes per grade were

observed. This resulted in 31 observed PE lessons, of which 11 PE lessons were with generalists and 20 with PE specialists.

3.3. Instruments

3.3.1. Focus groups

Each focus group session was conducted during school hours in a quiet room within the school by a trained moderator and an assistant moderator. The moderators discussed the purpose of the focus groups and the interview protocol, including the interview questions and procedure agreements. During the focus group sessions, the moderator guided the focus group, and the assistant monitored the digital voice recorder and the session duration, took notes, and observed children's non-verbal language. The moderator started the focus group session with a brief introduction in which the purpose and process were explained, and each participant was asked to introduce themselves briefly.

The focus group sessions were used to gain insight into children's perspectives of teacher-related factors that are linked to PE enjoyment. To achieve this, the discussion was semi-structured using four main topics, i.e. current feelings about PE lessons; the enjoyable PE lesson; PE teacher practices in enjoyable PE lessons; and room for improvement. By using a "how" question (Adler et al., 2019) first, i.e. "How do you feel about your PE lessons?", children were invited to share their feelings and experiences toward PE lessons. With the questions "How would you describe PE lessons you like?" and "What characterizes the teacher behaviors in PE lessons you like?" we went into more detail about PE lessons and PE situations that children experience as being pleasant and fun, and which PE teaching practices play a role in this. Finally, asking for teacher advice to ensure the class becomes even more excited about PE helped to further identify and understand teaching practices that contribute to children's PE enjoyment and PE engagement. The moderator then summarized the key points from the discussion and gave participants the opportunity to add an issue or opinion that had not been addressed in the discussion. The average duration of the focus group sessions with children was 46 minutes (SD = 2 min).

3.3.2. Observations

In S2, PE lessons were recorded and observed. These lessons were recorded from the moment teachers started the instruction until teachers ended the class. A GoPro camera (GoPro HERO 5) placed on a high jump standard at a height of 2.25 meters in the corner of the gym captured the entire PE environment. In addition, teachers wore a voice recorder (Olympus digital voice recorder WS-851) as a necklace to capture their

voices. The observer synchronized audio recording and video recordings of each PE lesson prior to coding.

The 32 child-identified TPs derived from S1 were observed and scored. The observer indicated to what extent each TP was observed in the recorded PE lesson using a 4-point scale ranging from 0 to 3 (0 = never observed; 1 = observed sometimes; 2 = observed often; 3 = observed all the time). An observational guide was available for the observers in which each TP and the corresponding scores were clarified. For example, the TP 'designs learning tasks with maximal learning time' was described as ensuring optimal physical activity time for children, e.g. by using brief instructions before and during physical activities and using methods to avoid waiting in activities. To ensure reliability, the three observers practiced coding of the first recorded PE lesson with an observation guide including the TPs, PE examples for each TP, and scale description for each TP. After independently coding this PE lesson, the researchers discussed their coding differences, refined the observation guide, and collaborated to produce final ratings. This method was repeated for all other observations. Observer one, and observer two or observer three, independently rated the 32 TPs for each recorded PE lesson. Based on the observers' discussions, final ratings were agreed on for all recorded PE lessons. The final ratings were used for further analysis.

3.4. Data analysis

3.4.1. Focus groups

All focus group sessions were transcribed verbatim and analyzed using ATLAS.ti, version 8 (Scientific Software Development GmbH, Berlin, Germany). A general inductive approach (Thomas, 2006) was used to analyze the transcripts. Steps taken in the thematic analysis were based on phases described in Nowell et al. (2017). After reading the transcript of the first focus group session several times, two independent researchers assigned initial codes to relevant words and phrases. These codes were compared and discussed, leading to an initial code list. This code list was used by the first researcher to analyze the other focus group session transcripts, adding new codes to the list as needed. Next, the two researchers who were familiar with the four transcripts, the fieldnotes, and the code list, categorized the codes into several separate themes together, i.e. 10 overarching dimensions. In the case of doubt a third researcher assisted. Finally, codes saying the same thing in different words, were merged into one code. The focus groups were conducted in Dutch. Quotes from the transcripts used to illustrate our findings were translated into English by the first author. The second author checked the translations to ensure children's voices are correctly conveyed in English.

3.4.2. Observations

Observation data were analyzed using SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA). The mean observation scores per TP were used to distinguish TPs that were rarely seen in practice (mean score < 1.5) and TPs that were observed regularly (mean score from ≥ 1.5). As the mean scores per TP were not normally distributed and the research group was relatively small, the Mann-Whitney Test with Bonferroni correction for multiple comparison (Noble, 2009) was used to compare the mean scores between PE specialists and generalists. The statistical significance was set at $p < .05$. The weighted Cohen's kappa was calculated to test inter-rater reliability. The inter-rater reliability between observer one and observer two was .68 and between observer one and observer three was .72.

4. RESULTS

4.1. Child-identified teaching practices clustered into dimensions

Children mentioned 32 unique TPs that positively contribute to their perception of PE enjoyment. These 32 child-identified TPs were clustered into 10 dimensions of PE enjoyment. Descriptive statistics for all dimensions and related TPs are shown in Table 1.

4.1.1. Exploratory learning

Children reported that free choices between and within tasks and opportunities to explore physical activities contribute to children's PE enjoyment. Free choice is defined as an act or activity without direct instructions or without interference of the teacher. For example:

When we play tag, then we are sometimes allowed to choose ... for example add other rules to play with. If only it has to do with playing tag. I like that [FG1, child 6].

I like it when you are allowed to come up with physical activities yourself [FG4, child 4].

Children indicated that a sense of independence can not only be created by teachers, for example by letting children initiate, adjust, and design physical activities but also by letting children, when divided into small groups, choose who to work with and make teams themselves. For example:

I would like it if we could also make groups ourselves, because then ... then you have more fun [FG3, child 3].

4.1.2. Tasks

Variation and innovation emerged as influential task characteristics related to PE enjoyment. According to children in the focus groups, a variety of new and familiar physical activities and diverse situations with the same task difficulty contribute to children's enjoyment, whereas tasks that are offered repeatedly impact PE enjoyment negatively. For example:

I get excited when we play with new equipment or when we learn to use things [materials] in different ways in a variety of physical activities [FG3, child 2].

I like it [PE], but if we play a game too many times, I don't like it so much anymore [FG1, child 5].

Children acknowledged their differences in preferences, interests, skill, and ability levels. They emphasized their need for challenges and success experiences to enjoy PE. Children valued differentiated tasks and tasks that can easily be modified to every child's level. For example:

I think it's important that everyone can join in the fun. And that, for example, children who are very good and the average children who are good but ... just not as good as the others, that the teacher can help that group and ... that the teacher give the children who are a little better for example a more difficult task [FG4, child 5].

4.1.3. Communication

Children identified the interaction style between teacher and children as a factor related to their PE enjoyment. Children are stimulated to engage in tasks by teachers' personal encouragement and praise, and proximity. Children reported that they value teachers who are capable of showing concern, enthusiasm, interest, and warmth. These TPs were mentioned as being important for building strong and positive teacher-child relationships that impact children's enjoyment. For example:

When you receive a compliment [from the teacher] ... such as 'good interception or good catch', you also get more motivation and then you also think more [about the game]... like ... what would I do to do it right? [FG2, child 2].

Sometimes it is nice if you are a little sad or insecure and then ... and then you do something good and [teacher's name] gives you a compliment. Because then it does something good [good feeling] [FG1, child 4].

Children highlighted that teachers should not only ask about children's feelings, preferences, ideas, and interests, but also listen actively, acknowledge their perspectives, and respond to their PE needs. For example:

I asked the teacher to hang the rings lower, he only said 'no, they hang well', ... The teacher wouldn't listen to me to lower them ... I find that annoying [FG3, child 3].

The teachers always say to us: 'If you have ideas for the PE lessons, say so', but they never do anything with our ideas [FG3, child 3].

4.1.4. Instructions

The focus group sessions revealed that children want the teacher to provide understandable verbal and visual instructions. Children indicated that content and organizational information (who, what, where, when, why, and how) are necessary for them to start these activities with confidence and pleasure. For example:

Sometimes I don't understand every task, and then it becomes ... I find it more boring [FG2, child 5].

In addition to clear verbal instructions, children reported that they also like to see a demonstration of the task by the teacher with or without children. For example:

They [PE teachers] help us step by step ... They show us how for example to put your hands, how to jump first ... and how the final jump should look like [FG3, child 3].

4.1.5. Rules and expectations

Children noted that they perceive the PE environment as pleasant and positive if peers actively participate and behave as expected. Therefore, children value teachers who make clear what is expected of them and why, and what the consequences are for inappropriate behavior. For example:

During the instruction there is one rule; we must be quiet. Sometimes there are a few children who keep talking through it [the instruction]. He [the PE teacher] then waits a very long time before he continues. We have to make less noise and I actually quite agree with that [FG4, child 6].

Additionally, children reported that the teacher should monitor if children keep to the rules and agreements and behave appropriately. They indicated that they want teachers to respond fairly, consistently, directly, and consequently to inappropriate behavior

(e.g. arguing, interrupting, asking for negative attention, and not following directions), because this minimizes problems and contributes to enjoyable PE lessons and a positive learning climate. For example:

I like PE, but I don't like the fact that everyone is arguing sometimes, for example [about] who won, or that they are rude to each other and ... everyone fights, and a lot of PE time is wasted [FG1, child 3].

4.1.6. Physical activity time

Children stated that physical activity during PE positively contributes to their feelings of enjoyment. Situations that are experienced as a waste of PE time were described as having a negative impact on children's PE enjoyment. Children emphasized teachers' responsibility to ensure physical activity time, e.g. by limiting waiting time, instruction time, and elimination games. For example:

The teacher offers side activities, for example when you're tagged in a game, or you have to wait in line. So we don't have to stand still. I like that [FG2, child 4].

4.1.7. Grouping

Grouping strategies were mentioned as having an impact on children's feelings toward PE. Children value teachers consciously using a variety of grouping strategies. They indicated that groups could vary in size, e.g. pairs, small groups or large groups, and in composition, e.g. homogeneous groups based on gender or skill level or heterogeneous groups. They want teachers to group in a way that best suits the class and PE lesson objectives. For example:

I like it when the teacher [groups us] ... when the sporty children with the less sporty children are mixed a bit so that you have some sporty children and some less sporty children together ... or for example children who are equally good are placed together in one team [FG4, child 5].

Children stressed the importance of grouping with care, meaning that the teacher ensures that children do not feel rejected when groups are formed, and children feel comfortable in their group. They also highlighted teachers' responsibility in grouping. For example:

I want the teacher to group us. Because then you also get for example to play with other children and then you can make some new friends, but ... what I would say to ... to the teachers ... 'he doesn't get along with that [person], and he doesn't get along with that one [person]', so that the teacher can take that into account [FG2, child 6].

4.1.8. Learning process

It was indicated that teachers' individual feedback, help, and feedforward positively affect children's PE enjoyment. An emphasis on children's individual learning processes encourages them to engage in PE and continue practicing tasks. For example:

I would like to get some tips [from the teacher], because then I would understand what I'm doing well ... or what I can do to get even better [in the task] [FG4, child 2].

Children indicated that they find it motivating when the teacher recognizes, acknowledges, and respects children's efforts to master PE tasks. For example:

It is nice when the teacher sees that you are trying something that you can't do and that you are doing your best. It encourages me to keep practicing instead of giving up [FG3, child 2].

The teachers help if you don't dare to do something. And then you get help and if you really don't dare then you just move on to the next [task], they don't mind. It's not that you have to do something, but you have to try [FG2, child 4].

4.1.9. Learning together

Teachers' guidance in learning, particularly the social component, was reported as being an important attribute of children's PE enjoyment. Children expect teachers to encourage and guide them in physical activities to work together, learn from and with each other, and take social responsibility. For example:

When we played soccer, I had to come to [teacher's name] and he told me to pass more because otherwise I was in ball position too often ... And then I just ... passed and that worked. I think it's good because now the other kids had the ball too [FG2, child 1].

Usually he [the teacher] gives tips about working together more ... such as ... 'If you pass you probably reach the goal faster'. If we work together, games are more fun for everyone [FG4, child 3].

Children enjoy PE lessons in which everyone feels related, respected, and included. TPs that aim to create a sense of belonging are highly valued by children. For example:

It is good if we learn from each other during PE. The teacher can ensure that everyone is involved in games by using specific game rules, e.g. playing with an agreed number of passes or passing boy to girl and girl to boy [FG1, child 5].

I like it when we start and end a PE lesson, in which we work in small groups, together or when these PE lessons are alternated with PE lessons in which we work with the whole group [FG4, child 6].

4.1.10. Limited performance comparison

Teacher behaviors such as encouragement of intra-team and/or inter-team rivalry, comparing children's performances and stimulating children to perform better than others, were indicated as preventing children from enjoying PE. The children reported that these teacher behaviors contribute to PE lessons in which learning from mistakes is not common and children feel pressure to perform. For example:

Sometimes it's fun to do [competitive games] but ... if you lose ... some children are very glad that they have won and then they all cheer ... but it shouldn't be about ... it should be about having fun playing and not about winning [FG4, child 6].

He [teacher's name] has an unfair rule, I think, because if you climb to the top [rope climbing] you get chocolate or ... candy and some children are afraid of heights and that is very unfair [FG1, child 3].

4

4.2. Current use of child-identified TPs by PE teachers

Table 4.1 provides the mean score for each of the TPs in total as well as stratified by "type" of teacher, i.e. PE specialist or generalist. Overall, teachers used many of the child-identified TPs regularly during primary PE lessons. The TP "giving recognition to all children" was observed the most. Nonetheless, within three dimensions, i.e. explorative learning, learning process and learning together, child-identified TPs were observed rarely ($M < 1.5$). Other rarely observed TPs were the use of differentiation, the demonstration of tasks, rationale provision and consciously grouping. The use of cooperative learning showed the lowest mean score of all TPs ($M = 0.16$; $SD = .45$) and was never observed in generalists' PE lessons.

Significant differences in the occurrence of TPs in PE lessons between generalists and PE specialists were found. PE specialists provided children with opportunities to choose who to work with and to make meaningful choices more often than generalists. PE specialists provided more often challenging, and differentiated tasks, and they used equipment more often in a creative and appropriate way than generalists did. Additionally, offering physical or verbal help and new guidelines were not observed as regularly in generalists' PE lessons as in PE specialists' lessons.

Table 4.1. Descriptive statistics of observed teaching practices categorized in 10 dimensions that, according to children, contribute to children's PE enjoyment, stratified for generalists versus PE specialists

Observation criterion	PE lessons all teachers Mean (SD) N = 31	PE lessons generalists Mean (SD) N = 11	PE lessons PE specialists Mean (SD) N = 20	Generalists – PE specialists Mann-Whitney <i>p</i> (<i>U</i>)*	No. of Times discussed
The teacher...					
Dimension 1 Exploratory learning					39
gives children the opportunity to explore physical activities themselves (try, practice, adapt, initiate, problem-solve)	1.87 (1.18)	.91 (1.22)	2.40 (.75)	n.s. (40.5)	15
gives children the opportunity to choose who to work with in small groups in physical activities	1.48 (.89)	.73 (1.01)	1.90 (.45)	<.05 (36.5)	11
provides meaningful choices in physical activities	1.39 (.92)	.64 (.81)	1.80 (.70)	<.05 (35.0)	13
Dimension 2 Tasks					117
provides challenging, developmentally appropriate learning tasks	2.39 (.72)	1.73 (.65)	2.75 (.44)	<.05 (27.5)	55
provides variation between or within exercises	2.26 (.51)	2.00 (.45)	2.40 (.50)	n.s. (70.0)	29
applies differentiation	1.13 (.89)	.45 (.69)	1.50 (.76)	<.05 (36.0)	22
provides appropriate, safe, creative physical learning materials/equipment	2.32 (1.11)	1.09 (1.04)	3.00 (.00)	<.05 (10.0)	11
Dimension 3 Communication					93
is physically close to the children	2.26 (.93)	1.73 (1.01)	2.55 (.76)	n.s. (58.5)	9
encourages children	2.19 (.79)	1.91 (.83)	2.35 (.75)	n.s. (77.0)	20
gives recognition to all children	2.87 (.34)	2.73 (.47)	2.95 (.22)	n.s. (85.5)	21
provides general positive feedback and compliments to children	2.35 (.61)	2.18 (.60)	2.45 (.61)	n.s. (84.0)	9
asks the pupils questions about their interests, problems, values or wishes/acknowledges feelings and perspectives	1.94 (.96)	1.45 (1.13)	2.20 (.77)	n.s. (68.0)	22
is enthusiastic, eager, and open	2.39 (.80)	1.73 (.91)	2.75 (.44)	n.s. (42.5)	3
uses a non-controlling, warm verbal communication style (i.e. no orders, is approachable)	2.32 (.75)	1.91 (.83)	2.55 (.61)	n.s. (62.0)	9
Dimension 4 Instructions					21
gives clear verbal instructions	2.55 (.68)	2.09 (.83)	2.80 (.41)	n.s. (56.0)	3
gives clear instructions about content and organization	2.26 (.77)	1.91 (.94)	2.45 (.61)	n.s. (73.5)	5
demonstrates the tasks himself, with children and/or with visual material; is a model for the children before or during physical activities	1.32 (1.05)	.73 (.65)	1.65 (1.09)	n.s. (55.5)	13

Table 4.1. (Continued)

Observation criterion	PE lessons all teachers Mean (SD) N = 31	PE lessons generalists Mean (SD) N = 11	PE lessons PE specialists Mean (SD) N = 20	Generalists – PE specialists Mann-Whitney p (U)*	No. of Times discussed
The teacher...					
Dimension 5 Rules and expectations					39
gives clear (behavioral) rules and agreements	2.45 (.51)	2.45 (.52)	2.45 (.51)	n.s. (109.5)	5
offers the pupils a rationale for tasks/physical activities, rules and agreements, requests, expectations, goals	1.45 (.72)	1.09 (.70)	1.65 (.67)	n.s. (64.0)	7
Dimension 6 Physical activity time					27
monitors if the children comply with the instructions, rules, and agreements	2.58 (.67)	2.73 (.47)	2.50 (.76)	n.s. (97.0)	36
Dimension 7 Grouping					36
designs learning tasks with maximal learning time	2.58 (.72)	2.00 (.89)	2.90 (.31)	n.s. (39.0)	37
Dimension 8 Learning process					37
consciously forms groups for PE class and/or physical activities in PE	1.19 (.83)	1.18 (.98)	1.20 (.77)	n.s. (108.0)	56
Dimension 9 Learning together					17
offers physical and/or verbal help during physical activities/tasks	1.45 (.93)	.64 (.67)	1.90 (.72)	<.05 (25.5)	14
offers children (separate from instruction) new guidelines, tips, and advice during physical activities	1.39 (.92)	.64 (.81)	1.80 (.70)	<.05 (34.5)	25
emphasizes/recognizes effort and/or (individual) improvement (learning process)	1.00 (.63)	.64 (.67)	1.20 (.52)	n.s. (60.0)	77
Dimension 10 Limited performance comparison					30
uses instructional methods during physical activities to promote children's (social) learning processes	.94 (1.00)	.55 (.82)	1.15 (1.04)	n.s. (72.0)	8
starts and ends PE lessons with all children	2.65 (.49)	2.73 (.47)	2.60 (.50)	n.s. (96.0)	29
uses cooperative learning in a sense that children learn from each other	.16 (.45)	.00 (.00)	.25 (.55)	n.s. (88.0)	10
encourages working and playing together	1.06 (.81)	.64 (.67)	1.30 (.80)	n.s. (61.0)	34
Dimension 10 Limited performance comparison					17
emphasizes/recognizes inferior/superior performance and ability**	.19 (.40)	.36 (.51)	.10 (.31)	n.s. (81.0)	11
encourages inter-team and/or intra-team rivalry**	.61 (.56)	.82 (.60)	.50 (.51)	n.s. (80.0)	6
punishes mistakes**	.32 (.60)	.64 (.81)	.15 (.37)	n.s. (73.5)	

Note. * = Mann-Whitney tests using Bonferroni correction; ** = Items that are reverse-scored; Bold values represent the significant differences between generalists and PE specialists.

5. DISCUSSION

This study aimed to investigate primary school children's perspectives of enjoyable PE teaching practices and the extent to which they were reflected in daily practice. Our study revealed 32 child-identified TPs, which could be categorized into 10 dimensions that may have an impact on children's PE enjoyment. TPs related to PE enjoyment are associated with pedagogical strategies to motivate children to engage and to learn in PE. Many of these TPs were regularly observed to be used by primary PE teachers, whereas some TPs were rarely observed, indicating room for improvement. These TPs were mostly found within the explorative learning, learning process, learning together, and grouping dimensions. Substantial inter-teacher differences in TPs were observed between PE specialists and generalists.

The 10 dimensions and the child-identified TPs found in this study showed strong similarities with dimensions and teaching strategies from previous studies considering SDT (Curran & Standage, 2017; Haerens et al., 2013; Sun et al., 2017), AGT (Liu et al., 2017; Morgan & Hassan, 2014), the integration of SDT and AGT (Morgan, 2017; Weeldenburg et al., 2021) and MPE (Beni et al., 2019). Moreover, the child-identified TPs are related to social, cognitive, and motor learning challenges, consistent with the association between fun and learning in PE (Dismore & Bailey, 2011; Iannucci & Parker, 2022). For example, children mentioned the importance of being physically active together and learning from and with each other. This reflects the social component of PE. Previous studies also indicated children's need for social relations during PE (Domville et al., 2019; Quay & Peters, 2008) and the importance of social relationships in contributing to children's meaningful experiences in PE (Beni et al., 2017; Quay & Peters, 2008) and PE enjoyment (Domville et al., 2019). Therefore, teachers should emphasize the social component of PE in their teaching to promote children's PE enjoyment.

While including children's perspectives on TPs could be considered as highly valuable, it also comes with challenges. Some of the child-identified enjoyable TPs require a complex balancing act by PE teachers to satisfy children's needs. Children in this study preferred PE lessons with low ego-involvement, but at the same time they liked competitive games. Teachers are therefore challenged to provide competitive PE situations while ensuring that everyone, regardless of their skills, abilities, or goal orientation, has equal opportunities and enjoyable learning experiences (Aggerholm et al., 2018; Wintle, 2018). Teachers should avoid an explicit emphasis on rivalry and outperforming others, because this might lead to basic psychological needs frustration and feelings of boredom in children (García-González et al., 2019).

A couple of child-identified TPs were only rarely brought into practice during PE lessons. Teachers rarely used consciously grouping strategies. Teachers often formed groups by giving each child a number corresponding to one of the group numbers leading to randomized heterogeneous groups. Although this could be a conscious choice, we assume teachers used this strategy because it is a quick, time-saving way to group and get started. Teachers might not be aware of the importance children attach to PE grouping and how grouping affects their PE enjoyment (Iannucci & Parker, 2022). Children indicated that they want to be in groups in which they can learn from and with others and in which they feel comfortable. Therefore, teachers are encouraged to thoughtfully use various grouping strategies aligned with children's needs and lessons goals.

Other TPs that were rarely brought into practice were the use of cooperative learning, encouragement to work together and the use of instructional methods that promote children's social learning processes. This might be explained by teachers' lack of knowledge, skills and priority given to guide children in cooperative learning and taking social responsibility (Hortigüela-Alcalá et al., 2020; Quay & Peters, 2008). Knowledge about models-based approaches to PE, such as the Teaching Personal and Social Responsibility model (Pozo et al., 2018; Quay & Peters, 2008), Teaching Games for Understanding (Barba-Martín et al., 2020) and the Cooperative Learning model (Bores-García et al., 2021; Casey & Quennerstedt, 2020) might be helpful in order to encourage the use of these TPs more often.

Finally, TPs supporting children's individual learning processes were rarely observed. Primary PE teachers in the Netherlands often provide a variety of physical activities in parallel, in different areas of the gym. This was also the case in the observed lessons. This places a significant demand on the organizational and class management skills of teachers. We speculate that, as a result, teachers must often switch between areas, leaving little time to monitor children's individual learning process, or analyze the group and individual needs and act accordingly. Nonetheless, children indicated that they value teachers' personal attention and individual recognition of progress. The feeling of being seen and praised for individual progress contributes to children's self-confidence, their perceived basic psychological needs satisfaction, and their feeling of happiness (Leisterer & Jekauc, 2019; White et al., 2021).

This study further endorses the need for high quality PE teachers in primary schools (Fletcher & Mandigo, 2012). Compared to generalists, the PE specialists in our study demonstrated practices that promote children's exploratory behavior more often. It could be that generalists have a stronger need for control during PE than PE specialists, which prevents generalists from providing free choices to children. The

relationship between teachers' feelings and their motivating teaching styles in PE has been confirmed by previous research (Burel et al., 2021). We also found a significant difference in the extent to which generalists and PE specialists provide challenging learning tasks, apply the safe and creative use of equipment, and give individual help and feedback during PE. The most likely explanation is that PE specialists, with their PE teacher education course of four years (240 ECTS), are equipped with more PE-specific content and didactic knowledge, skills, and experiences than generalists, who have followed a shorter training course (40 ECTS) to become qualified to teach PE in primary school (Slingerland et al., 2019).

5.1. Strengths and limitations

A strength of this study is the use of a mixed methods design, including children's perspectives on enjoyable TPs in PE lessons with observations of PE lessons focusing on the extent to which these TPs were used in practice. Our study contributes to a comprehensive understanding of children's PE enjoyment and the TPs that, according to children, could enhance this. The observations revealed which child-identified teaching practices were rarely or regularly demonstrated by PE teachers. This exploratory study also provides insight into the current PE teaching differences between PE specialists and generalists. Insight into these differences can contribute to improving or adapting PE teacher education courses and equip pre-service teachers with the knowledge and skills necessary to enhance children's enjoyment in PE.

However, this study also has some weaknesses. Focus group sessions were only conducted with grade-7 children from four schools. Additionally, the number of PE lesson observations, including the variation in observed PE teachers, was somewhat limited. This may have impacted the generalizability of our study. The inter-rater reliability between observer one and observer two, and observer one and observer three was acceptable. Observing the same PE classes by all three observers, improving observation calibration and guidance for scoring the items, may enhance inter-rater reliability. Finally, our study has not considered variables that might have influenced teachers' behavior during observations, e.g. teachers' awareness of being filmed, the physical PE environment, and available teaching time.

6. CONCLUSION

This study showed that listening to children's perspectives contributes to a comprehensive understanding of children's enjoyment in primary PE and teaching practices related to this. The child-identified TPs in this study strongly corresponded

with teaching strategies mentioned in studies on PE motivation and meaningful PE experiences. This finding suggests that using multiple different perspectives helps to define teaching practices that foster children's PE enjoyment.

This study also showed that teachers did not regularly apply some of the child-identified enjoyable TPs, which is especially the case for generalists. Knowledge about TPs and dimensions related to children's PE enjoyment should be shared in teacher education and primary schools to encourage pre-service teachers and primary teachers to apply these TPs in their PE lessons. Further research into how teachers can improve their listening and responding to children's needs in practice is recommended.

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CHAPTER 5

REFLECTIVE PRACTICES AND TEACHING BARRIERS IN PHYSICAL EDUCATION

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1. ABSTRACT

Enjoyment is key in primary school physical education (PE), yet ensuring enjoyable PE experiences for all children is challenging. Reflection may help teachers improve lesson quality and foster PE enjoyment. This cross-sectional study explored Dutch primary school teachers' perspectives on enjoyable PE and reflective practices. An online questionnaire was completed by 173 teachers (70,5% PE specialists, 29,5% generalists) who teach at least one PE lesson per week. Teacher type differences were analyzed using Chi-square-tests, Mann-Whitney U-tests, and logistic regressions. Perspectives on reflective practices were similar among teacher types. Generalists reported more teacher- and policy-related barriers to providing enjoyable PE, while specialists cited child-related challenges. Most teachers reflected internally, with limited use of written reflection or feedback from children and colleagues. Specialists used professional networks and peer feedback more. Time constraints and low prioritization were key barriers to reflection. Schools should allocate time and promote reflection tools. Generalists could benefit from coaching and targeted professional development. For specialists, teacher education might foster reflective practices using video and child feedback to improve child outcomes like PE enjoyment. Tailored strategies are needed to strengthen reflection and improve PE quality to foster children's PE enjoyment.

2. INTRODUCTION

Sufficient physical activity (PA) and limited sedentary behavior (SB) are important for children's physical and mental health (Cliff et al., 2016; Weggemans et al., 2018; World Health Organization, 2022), as early PA behaviors predict lifelong activity patterns (Telama, 2009). Physical education (PE) in primary schools plays a key role (Hills et al., 2015) in fostering children's development of skills, knowledge, and attitudes that promote lifelong participation in PA. Central to achieving these outcomes is fostering children's enjoyment of PE, which increases when PE is delivered in a need-supportive environment. A need-supportive environment is considered one that satisfies children's basic psychological needs for autonomy, competence, and relatedness. Such environments enhance children's engagement, motivation, and learning in PE (Navarro-Patón et al., 2019), increases enjoyment of and motivation for PA (Ramer et al., 2021), and help reduce SB outside the school context (Adank et al., 2021).

Delivering high-quality primary school PE that is enjoyable for all children, however, is a challenging task, given the complexity of the PE environment. Teachers must respond to various factors, including differences among children in terms of skill levels, interests, characteristics, and learning needs. They must also account for external factors related to PE facilities and policy, such as the availability of facilities and equipment, the time allocated for PE lessons, institutional support, and opportunities for teachers' professional development (Abdulla et al., 2022; Jenkinson & Benson, 2010; Morgan & Hansen, 2008; Truelove et al., 2021). Addressing these challenges requires PE teachers to have professional, pedagogical and didactic competencies (Durden-Myers et al., 2018; Iannucci & Parker, 2022).

Reflection can help teachers develop and enhance these competencies. In the present study, reflection is defined as a systematic, cyclical process that involves evaluating past lessons, identifying areas for improvement, exploring alternative teaching practices, and implementing these strategies in future lessons (Korthagen & Nuijten, 2022; Korthagen & Vasalos, 2005; Maksimović & Jelena, 2018). PE lesson evaluations form a vital component of this reflection process, as teachers look back on their lessons by describing, explaining, and analyzing their teaching experiences (Korthagen & Vasalos, 2005). Child feedback can enrich these evaluations, providing teachers with valuable insights into children's perspectives, preferences, and needs for PE enjoyment (Golding & Adam, 2016; Mandouit, 2018; Rollett et al., 2021), while also fostering a stronger teacher-pupil relationship by ensuring children feel heard (Connelly et al., 2020; Rollett et al., 2021). Additionally, collaborative reflection with colleagues further supports professional learning and development by providing alternative points of view, shared experiences,

and constructive feedback that help identify and implement improved teaching practices (Bjørke & Casey, 2024; Morgan et al., 2019; Parker et al., 2021; Standal & Moe, 2013).

Previous PE-related research has shown that reflective strategies, such as self-evaluation questionnaires, written logbooks, video recordings, peer observations, and structured reflective discussions, can support (pre-service) teachers' reflective processes and enhance their teaching effectiveness. The structured use of these reflection strategies supports (pre-service) teachers' professional learning and development (Bjørke et al., 2023; Crawford et al., 2012; Dervent, 2015; Moon & Lee, 2022). It is therefore hypothesized that engaging in reflection enables PE teachers to identify areas for improvement and address them, ultimately improving teaching quality and fostering greater enjoyment of PE.

Despite its potential, reflection is not widely embedded in primary school PE practice. Teachers face barriers to engage in reflection, including a lack of perceived value, insufficient knowledge and skills, time constraints, and limited encouragement from school leadership (Armour & Yelling, 2007). Moreover, teachers rarely ask for feedback from their children (Iannucci & Parker, 2022), thereby underutilizing valuable sources of information for improving their teaching practice.

Given current PE goals, in which teachers play a leading role in ensuring PE enjoyment for every child, it is crucial to understand how teachers perceive the importance of creating enjoyable PE lessons and their perceived barriers to creating enjoyable PE lessons. Additionally, understanding the challenges teachers encounter in reflecting on their teaching is important, as reflection enables them to evaluate lesson quality and identify areas of improvement. These insights are prerequisites for supporting teachers' continuous professional development and designing effective strategies to enhance both their reflective practices and teaching competencies.

A better understanding of how primary school teachers reflect on their PE teaching can further inform such strategies, particularly in countries like the Netherlands, where primary school PE is taught by various 'types' of teachers, i.e. PE specialists, generalists, or a combination of both. Generalists complete a shorter training course to become qualified to provide PE at the primary level, while PE specialists follow a comprehensive PE teacher education program to teach PE across all educational levels (Slingerland et al., 2019). PE specialists often teach primary school PE full-time across multiple classes, whereas generalist teachers may deliver one or two PE lessons per week to their class, in addition to general classroom lessons. These different types of teachers may differ in the barriers they face in delivering enjoyable PE lessons and engaging in

reflective practices, as well as in their perspectives on and actual practices of teaching and reflection. For example, a study by Truelove et al. (2021) found that generalists reported barriers such as limited time, inadequate facilities and equipment, insufficient training, lack of knowledge, and low self-efficacy in delivering primary school PE. PE specialists did not report these barriers.

To the best of our knowledge, no study has yet explored the perspectives of primary school teachers on creating enjoyable PE lessons, their use of reflective practices, and the differences between PE specialists and generalists in this area. Therefore, the aim of this study was to explore primary school teachers' perspectives on providing enjoyable PE lessons, including the barriers they perceive and their use of reflection to enhance teaching practices. This study also examined potential differences between PE specialists and generalists to inform the development of tailored strategies that support reflective practices, enhance teaching quality and promote PE enjoyment among children.

3. METHODS

3.1. Participants

The current study used a cross-sectional design. Participants included both primary school generalists and PE specialists who teach at least one PE lesson per week. Dutch generalists have completed a four-year teacher education program (240 European Credit Transfer and Accumulation System (ECTS)) to become primary school teachers and have followed a 40-ECTS training course to become qualified to teach primary school PE. In contrast, Dutch PE specialists have completed a 240-ECTS PE teacher education program qualifying to teach PE at primary, secondary and tertiary levels (Slingerland et al., 2019).

Participants were recruited through professional associations for (PE) teachers, as well as national, regional, and local organizations that employ primary school (PE) teachers, via email and social media (LinkedIn). Recipients were encouraged to share the invitation with colleagues (generalists or PE specialists) teaching PE in primary schools. This approach aimed to ensure a nationally representative and diverse sample across regions and types of school. Recipients were informed about the study's purpose and methods and invited to complete an anonymous, one-time online questionnaire. A reminder was sent three weeks later. Ethical consent was obtained by the Ethics Committee of Fontys University of Applied Sciences (reference number FCEO 24-03 Adank). Written informed consent for data collection, processing and analysis, was obtained at the start of the questionnaire.

As an inclusion criterion for participation, teachers had to teach at least one lesson per week. Only complete questionnaires were included in the analyses.

3.2. Instrumentation

The questionnaire developed for this study consisted of three sections: i) demographics, ii) perspectives on providing enjoyable PE lessons, and iii) perspectives on reflective practices. Prior to these sections, participants were presented with a screening question to ensure they provided at least one PE lesson per week. The questionnaire was pilot tested with three PE teachers in April 2024. Based on their feedback, a few questions were revised to improve clarity. Data collection took place in May and June 2024. It took participants approximately 15 minutes to complete the questionnaire.

3.2.1. Demographics

Demographic data on the teachers were collected, including age, gender, years of experience in primary school PE teaching, and whether they were PE specialists or generalists (teacher type).

3.2.2. Perspectives on providing enjoyable PE lessons

To assess whether teachers value children's PE enjoyment and actively foster enjoyment during lessons, two single items on a 4-point Likert scale (ranging from 1 = 'agree' to 4 = 'disagree') were utilized. Additionally, a question was included to identify the key barriers teachers face in providing enjoyable PE lessons. Participants were asked to select up to five barriers from a provided list or choose the 'other' option to specify additional barriers. The listed options were based on barriers reported in previous research (Abdulla et al., 2022; Jenkinson & Benson, 2010; Morgan & Hansen, 2008; Truelove et al., 2021), and grouped into four categories: i) teacher-related factors, such as PE-specific knowledge and skills and self-confidence in teaching PE ($n = 7$), ii) child-related factors, such as children's interest and motivation ($n = 5$), iii) school facility factors, such as quality of the PE accommodation and available equipment ($n = 8$), and iv) school policy factors, such as PE scheduling and PE lesson preparation time ($n = 5$).

3.2.3. Perspectives on reflective practices

To assess teachers' perspectives on reflective practices and willingness for professional growth, we selected four constructs, each consisting of four items (see Appendix 5.1), from the validated Reflective Practice Questionnaire by Priddis and Rogers which initially includes eleven constructs, measured on a 6-point Likert scale (Priddis & Rogers, 2018). This questionnaire has been used in multiple studies across different contexts (e.g. education, nursing, psychology) and has demonstrated good validity and reliability (Fuertes-Camacho et al., 2021; Rogers et al., 2024). The selected constructs reflect key

aspects of reflection, including self-evaluation (construct 'reflection on action'), self-assessment (construct 'self-appraisal'), reflection with others (construct 'reflection with colleagues'), and the desire to improve one's teaching practices (construct 'desire for improvement'). In the current study, the scale reliability of these constructs, measured by Cronbach's alpha, ranged from fair to good, with values of .68, .80, .63, and .76, respectively. Additionally, to assess a construct examining teachers' openness to feedback from children for reflecting and improving their PE teaching, three single items (see Supplementary Material) were adapted from Choy's Reflective Thinking Questionnaire (Choy et al., 2019). All items were adjusted to the PE context and translated into Dutch. Responses were collected on a 4-point Likert scale (1 = 'agree' to 4 = 'disagree') to reduce and simplify interpretation for participants. In the current study, Cronbach's alpha for the construct 'feedback from children' was .80.

To gain a deeper understanding of how teachers currently engage in reflective practices, participants were asked about the frequency, methods and perceived barriers associated with their reflection on teaching PE. The frequency of engagement in reflection was measured using a 4-point Likert scale, ranging from '(almost) always (1)' to '(almost) never (4)'. To identify the reflective methods as well as applied lesson evaluation strategies, participants were asked to select one or more predefined strategies commonly recognized in prior research, such as "using a logbook" or "analyzing recorded PE lessons" (Dervent, 2015; Moon & Lee, 2022). They were also allowed to add their strategies.

To examine the reasons teachers do not engage in reflection, respondents selected one or more barriers from a list of commonly reported barriers, such as lack of time and insufficient support (Jaeger, 2013; Saric & Steh, 2017). Participants could also provide additional reasons in their own words.

3.3. Data analysis

Data were analyzed using SPSS Statistics (version 28; Armonk, NY: IBM Corp). Descriptive statistics were conducted for demographic variables, including age, gender, years of PE teaching experience, and teacher type (generalist or PE specialist). Additionally, descriptive analyses were performed to examine teachers' value of and frequency in consciously providing enjoyable PE lessons, frequency of reflective practice, methods used for evaluating PE lessons and reflecting on PE teaching, as well as perceived barriers to reflection. To compare generalists and PE specialists regarding reflection methods and perceived barriers to reflect, Chi-square tests were conducted.

For the perceived barriers to providing enjoyable PE lessons the proportion of selected barriers within each category was calculated for each participant, relative to their total

number of selected barriers, resulting in a score between 0 and 1 per category. The mean proportion score for each main category was calculated across all participants, reflecting the relative occurrence of each category. A score of 0 indicated no selection within this category, while a score of 1 indicated that all five selected barriers fell into this category. To assess overall differences in barrier selection across the four categories, a non-parametric Friedman test was used on mean proportion scores. Unadjusted non-parametric Mann-Whitney U tests were conducted to compare the mean proportion scores between generalists and PE specialists.

For constructs assessing perspectives on reflective practices, normality tests (Shapiro-Wilk-tests) were conducted to evaluate the distribution of construct scores. As the assumption of homogeneity was violated for several constructs, responses were dichotomized: “agree” and “somewhat agree” were recoded as 1, and “somewhat disagree” and “disagree” as 0. Construct sum scores were then calculated by summing the binary responses per construct, resulting in scores ranging from 0 to 4. These scores were further dichotomized: a score of 1 was assigned if all four items within a construct were rated as somewhat agree or agree (score = 4), and 0 otherwise. Binary logistic regression analyses were performed to examine whether teacher type (generalist versus PE specialist) predicted the odds of complete agreement within each construct. Gender and years of teaching experience were included as covariates in this model. For all statistical analyses, the statistical significance was determined at $p < 0.05$.

4. RESULTS

A total of 228 individuals accessed the online questionnaire. Of these, 24 closed the survey without answering any questions. Of the 204 responses received, 173 teachers (85%) fully completed the questionnaire. Among these 173 teachers, the average age was 35.6 years (± 9.78) and 51.4% was female. Approximately two-thirds of these participants were PE specialists (70.5%), while the remaining one-third were generalists (29.5%). The participants' experience in delivering PE lessons varied, with 43.4% having ten or more years of experience.

4.1. Providing enjoyable PE lessons

Of the 173 teachers who completed the questionnaire, almost all ($n = 167$ (96.0%)) totally agreed that enjoyment in PE lessons is important. However, fewer reported having a conscious focus on fostering children's PE enjoyment ($n = 135$ totally agreed (78.0%)). No significant differences were found between generalists and PE specialists on either of these measures. Regarding perceived barriers in providing enjoyable PE

lessons for every child, six PE specialists indicated that they do not experience any barriers. Among the teachers who perceived barriers ($n = 167$), a significant difference in the proportion of barriers selected across the four categories was found ($\chi^2(3) = 33.93, p < .001$). Teacher-related barriers were selected significantly less often than both facility-related (adjusted $p < .001$) and child-related barriers (adjusted $p < .001$). Child-related barriers were the most frequently selected ($M [SD]: .34 [\pm.33]$). This was followed by barriers related to school facilities ($M [SD]: .30 [\pm.32]$), school policies ($M [SD]: .22 [\pm.27]$) and teacher-related barriers ($M [SD]: .14 [\pm.24]$) (Table 5.1).

Results showed significant differences between PE specialists and generalists for three of the four barrier categories. Compared to PE specialists, generalists were more likely to select teacher-related barriers (Mann-Whitney $U = 1992.00; p < .001$), such as inadequate PE lesson preparation and a lack of content expertise, and school policy-related barriers (Mann-Whitney $U = 2326.50; p = .019$), like facilitation in lesson preparation time and prioritization of PE by management and colleagues. PE specialists were more likely to select child-related barriers, such as children's motivation and concentration, than generalists (Mann-Whitney $U = 4300.50; p < .001$). No significant difference was found between teacher types for school facilities barriers, with similar mean proportion values among generalists and PE specialists (Mann-Whitney $U = 3072.00; p = .682$).

Table 5.1. Perceived barriers to deliver enjoyable PE lessons, overall and by teacher type

	All teachers	Generalists	PE specialists	Generalist ↔ PE specialist	
Category	M ($\pm$ SD) N=167	M ($\pm$ SD) N=51	M ($\pm$ SD) N=116	U	p
Teacher-related barriers ^a	.14 ($\pm$.24)	.25 ($\pm$.30)	.09 ($\pm$.18)	1992.0	<.01*
Child-related barriers ^b	.34 ($\pm$.33)	.16 ($\pm$.26)	.41 ($\pm$.33)	1615.5	<.01*
School-related barriers: facilities ^c	.30 ($\pm$.32)	.29 ($\pm$.33)	.31 ($\pm$.31)	2844.0	.68
School-related barriers: policies ^d	.22 ($\pm$.27)	.29 ($\pm$.29)	.19 ($\pm$.26)	2326.5	.02

Note. Values represent the mean proportion scores for each main barrier category (range from 0 to 1), where 0 indicates that no barriers were selected in this category, and 1 indicates that all five selected options fell within this category. M = mean proportion score; SD = standard deviation; U = Mann-Whitney U statistic.

^a teacher's knowledge and skills, PE teaching experiences, negative PE experiences, confidence in PE teaching, motor skills, PE lessons preparation, personal interest in PE

^b children's attitudes toward PE activities, interest in PE, concentration in PE, motivation for PE, perception of the value of PA

^c location, accommodation, available equipment availability, budget, space for physical activity

^d schools' emphasis on PE, PE scheduling, PE lesson time, preparation time for PE, access to supportive resources, opportunities for professional development, teacher autonomy in designing PE, teacher autonomy in teaching styles.

4.2. Reflective practices

Teachers expressed high levels of agreement with the constructs “reflection on action”, “reflection with colleagues”, “self-appraisal” and “feedback from children” (Table 5.2), with mean scores ranging from 1.24 (SD = $\pm$.33) for “reflection on action” to 1.52 (SD = $\pm$.53) for “feedback from children”. In contrast, teachers showed relatively less agreement with the construct “desire for improvement” (mean (SD): 2.27 ($\pm$.68)). Across all constructs, teacher type did not significantly predict the odds of complete agreement on the constructs, when controlling for gender and years of PE teaching experience. The results of generalists and PE specialists on all constructs were comparable (see Table 5.3).

Overall, 71.7% reported frequently or consistently engaging in reflective practices. Teachers who did not consistently reflect mentioned a lack of time (62.2%), low prioritization (35.6%), and limited awareness (31.9%) as key reasons. No significant differences were found between generalists and PE specialists in either frequency of reflection or perceived barriers. In terms of reflection methods, most teachers reported engaging in internal reflection (92.5%) or informally sharing experiences with (PE) colleagues (71.1%). Methods such as written reflection (8.7%), peer discussions (42.2%), or participation in professional communities (24.9%) were less common. Lesson evaluations were also primarily internal (93.6%), with around half of teachers involving children (64.2%) or using peer feedback (50.3%). Evaluation strategies such as logbooks (9.8%), video analysis (4.0%), or child monitoring systems (21.4%) were less frequently used. PE specialists were significantly more likely than generalists to participate in professional communities ($\chi^2(1, N = 173) = 11.21, p < .001$), use peer feedback ($\chi^2(1, N = 167) = 6.51, p = .01$) and use child monitoring systems ($\chi^2(1, N = 167) = 5.77, p = .02$).

Table 5.2. Teachers’ perspectives on reflective practices, overall and by teacher type

	All teachers	Generalists	PE specialists
Construct	M ($\pm$ SD) N = 173	M ($\pm$ SD) N = 51	M ($\pm$ SD) N = 122
Reflection on action	1.24 ($\pm$.33)	1.25 ($\pm$.40)	1.24 ($\pm$.30)
Reflection with colleagues	1.43 ($\pm$.46)	1.42 ($\pm$.52)	1.43 ($\pm$.43)
Self-appraisal	1.53 ($\pm$.45)	1.47 ($\pm$.49)	1.56 ($\pm$.42)
Desire for improvement	2.27 ($\pm$.68)	2.47 ($\pm$.77)	2.18 ($\pm$.62)
Feedback from children	1.52 ($\pm$.53)	1.48 ($\pm$.60)	1.54 ($\pm$.50)

Note. Scoring on each construct: 1 (agree) to 4 (disagree). M = mean; SD = standard deviation.

Table 5.3. Binary logistic regression results: differences in perspectives on reflective practices between generalists and PE specialists

Construct	B	p	Exp(B)	95% CI for Exp(B)
Reflection on action	.35	.67	.67	.29 to 6.95
Reflection with colleagues	.23	.75	1.26	.31 to 5.07
Self-appraisal	-.57	.19	.56	.24 to 1.34
Desire for improvement	-.15	.72	.86	.37 to 1.97
Feedback from children	-.63	.32	.53	.16 to 1.83

Note: Model was corrected for gender and years of PE teaching experience. Outcome variables were coded as 0 = did not fully agree with one or more items within the construct, 1 = fully agreed on all items within the construct. B = regression coefficient; Exp(B) = odds ratio; 95% CI for Exp(B) = 95% confidence interval for the odds ratio.

5. DISCUSSION

This study explored primary school teachers' perspectives on providing enjoyable physical education lessons and their use of reflective practices to foster PE enjoyment of children. Additionally, it examined potential differences between PE specialists and generalists in these perspectives. Most teachers acknowledged the importance of children's PE enjoyment, but fewer actively focused on fostering enjoyment in their lessons. This discrepancy could be explained by teachers prioritizing skill development and performance over enjoyment, possibly due to a lack of clarity about what fosters PE enjoyment and how to incorporate it into lessons (Adank et al., 2023).

Consistent with other studies, generalists reported teacher-related and school policy-related barriers significantly more often than PE specialists as main barriers to deliver enjoyable PE lessons (Hyndman, 2017; Tsangaridou, 2005). These barriers are likely to be attributed to teachers' educational backgrounds and work responsibilities (Slingerland et al., 2019; Truelove et al., 2021). Generalists received a relatively brief and less specialized PE training compared to PE specialists (Slingerland et al., 2019; Truelove et al., 2021). Consequently, generalists may feel less confident and competent in providing enjoyable PE (Abdulla et al., 2022; Hyndman, 2017). In practice, generalists are predominantly responsible for classroom instruction, limiting their time for PE preparation. Moreover, by providing a PE lesson once a week their ability for continuous professional development on the job is limited. In contrast, PE specialists reported child-related factors, such as children's lack of motivation, concentration and interest, significantly more often than generalists, and identified these as their main barriers to deliver enjoyable PE lessons. This reveals a paradox: while PE specialists identify child-related barriers, they may fail to acknowledge their role and responsibility in fostering

a motivational and need-supportive PE learning environment. This is consistent with the attribution bias, commonly seen in cases of perceived failure (Rollett et al., 2021).

5.1. Reflective practices

In line with previous studies (Esser-Noethlichs et al., 2024; Maksimović & Jelena, 2018), most teachers valued reflective practices. However, a significant negative association was found between years of teaching experience and teachers' desire to improve their PE teaching. More experienced teachers might rely on routines, perceiving little need to change as they view their practices as sufficient (Rollett et al., 2021; Zhang et al., 2021). Although many teachers reported engaging in regular reflection, most engaged internally or by sharing experiences with colleagues, rather than through written reflections and reflective discussions with colleagues. This raises concerns about the depth and quality of reflection, as undocumented, internal reflection may be subject to cognitive biases and emotional influences. Areas of improvement might be overlooked limiting their professional development and, ultimately, PE enjoyment of children (Impedovo, 2021; Korthagen & Nuijten, 2022).

Teachers' undocumented, internal reflection could be explained by perceived time constraints. Reflection requires time and structured approaches (Korthagen & Nuijten, 2022; Moon & Lee, 2022; Rollett et al., 2021), yet demanding workloads may hinder its prioritization. Generalists have to manage a broad curriculum, and PE specialists usually teach consecutive classes (Hyndman, 2017; Slingerland, 2014), leaving limited time for reflection (Armour & Yelling, 2007). When primary schools fail to allocate time, space and resources for reflection, teachers may further be discouraged from engaging in reflective practices. Additionally, teachers may lack a conscious focus on reflective practices because they do not fully realize how reflection can enhance the quality of PE teaching or improve children's PE enjoyment. Teachers may lack knowledge or skills to collect meaningful feedback from children, colleagues or themselves, or they may believe they already understand their children's PE needs (Jaeger, 2013; Korthagen & Nuijten, 2022; Rollett et al., 2021). PE specialists were significantly more likely than generalists to engage in reflection through professional networks, which may be very useful for specialists who often work isolated without PE specific colleagues. These communities offer opportunities for collaborative learning (Moon & Lee, 2022).

5.2. Implications for primary school teachers

Effective and time-efficient strategies tailored to the primary PE context are needed to support teachers in engaging in high-quality reflection. Written, documented reflection including formats such as journals, logbooks and self-reflective notes, enables teachers to revisit and build on previous insights. Guided templates can enhance the depth of

reflection, while digital tools can facilitate documentation, accessibility and long-term use (Bolton & Delderfield, 2018; Hiemstra, 2001; Moon & Lee, 2022; Stevens & Cooper, 2023). In addition to self-reflection, teachers should be encouraged to frequently and systematically gather and use feedback from children. Combining teachers' self-reflection with input from children and colleagues enriches reflection and supports more responsive PE teaching (Bergmark, 2023; Crawford et al., 2012; Impedovo, 2021). To make this process feasible, schools should provide time and appropriate tools for reflection without increasing workload (Zhang et al., 2021). Schools should promote the use of digital reflection tools, given their potential to support the integration of various reflection methods and simplify the documentation and accessibility of reflective practices. While digital tools are increasingly used in secondary and higher education, they remain underutilized in primary PE as a result of context-inappropriateness (Prieto et al., 2020).

Moreover, tailored strategies seem relevant to improve reflective practices by PE specialists and generalists. Although PE specialists often focus on child-related challenges, reflect on their own teaching practices is needed to impact children's enjoyment and motivation in PE. Encouraging pre-service PE teachers in PE teacher education to engage in self-assessment and children's feedback could help them recognize their role in fostering enjoyable, need-supportive environments (Iannucci & Parker, 2022; Moon & Lee, 2022). Our findings suggest that more years of PE teaching experience are associated with a decreased desire to improve teaching. This further strengthens the need for reflective skills in pre-service education programs, as it promotes lifelong reflective practices, supports continuous professional development, and enhances the quality of PE lessons (Crawford et al., 2012; Dervent, 2015; Moon & Lee, 2022).

To ensure that generalists feel competent in providing enjoyable PE lessons, schools are encouraged to provide targeted professional development opportunities, such as PE-specific professional development days and coaching-on-the-job sessions tailored to each teachers' needs and areas of improvement by PE specialists. Collaborative reflection enhances teaching quality and improves teachers' confidence and perceived competence (Bergmark, 2023; Moon & Lee, 2022; Morgan et al., 2019). Finally, to encourage teachers to engage more frequently in high-quality reflection, its added value should be made more visible. Well-designed and implemented interventions, potentially shaped by school policy changes, are needed to demonstrate how changes in teachers' reflection practices influence child-related outcomes, such as enjoyment, engagement, and interest in PE.

5.3. Strengths and limitations

A strength of this study is its exploratory nature, which provides deeper insights into teachers' perspectives on providing enjoyable PE lessons and their reflective practices. Additionally, the specific comparison between PE specialists and generalist teachers provides valuable insights into the unique challenges and practices of each group. The generalizability of the study results is impacted by this differentiation, and the outcomes are particularly relevant for contexts in which PE lessons are taught by both types of teachers. The practical implications, such as tailored strategies for professional development and reflective practices, further highlight the study's contribution to the field.

However, the study has several limitations. The relatively small sample size, the skewed distribution between PE specialists and generalist teachers, although representative for the current Dutch situation (approximately 70% vs 30%) (Vrieswijk, 2024), and potential selection bias based on personal affection with the topic reflection or PE enjoyment warrant cautious interpretation of the findings. Additionally, the use of self-reported data may have led to over- or underestimation of reflection practices (Pajares, 1992). Lastly, while most constructs related to perspectives on reflective practices showed acceptable internal consistency, the reliability of the constructs 'self-appraisal' and 'reflection on action' suggests the need for cautious interpretation.

6. CONCLUSIONS

This study demonstrated that while most teachers recognize the importance of enjoyment in PE, fewer actively focus on fostering it during PE lessons. Generalists identified teacher- and school policy-related barriers as the main obstacles, whereas PE specialists more frequently highlighted child-related barriers. Both types of teachers frequently used reflective practices, but structured, written reflection and documentation were relatively rare. The main barriers to reflection included a lack of time, insufficient emphasis on reflection, and a lack of conscious focus.

To address these challenges, tailored strategies are recommended to promote reflection and continuous professional development, ultimately enhancing the quality of PE lessons and children's PE enjoyment. PE specialists should be supported in developing reflective practices focused on fostering enjoyment. Generalists may benefit from coaching and targeted professional development in PE-specific skills. Schools can support this by allocating time and promoting appropriate tools.

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8. APPENDIX 5.1

SUPPLEMENTARY MATERIAL

Questions assessing teachers' perspectives on reflective practices

	Cronbach's Alpha
Reflection on action	.675
After a PE lesson, I spend time thinking about what was said and done.	
After a PE lesson, I think about how things went during the interaction.	
After a PE lesson, I wonder about the children's experience of the PE lesson.	
After a PE lesson, I wonder about my own experience of the interaction.	
Reflection with colleagues	.804
I find that reflecting with colleagues about how I teach helps me to work out problems I might be having.	
When reflecting with colleagues about how I teach I become aware of things I had not previously considered.	
I gain new insights when reflecting with colleagues about how I teach.	
When reflecting with colleagues about how I teach I develop new perspectives.	
Self-appraisal	.633
I think about my weaknesses in teaching.	
I think about how I might improve my ability to teach.	
I think about my strengths for teaching.	
I critically evaluate the strategies and techniques I use when I teach.	
Desire for improvement	.756
I think I still have a lot of things to learn to improve my ability to teach.	
I desire more experience to improve my ability to teach.	
I would like to learn new skills to improve my ability to teach.	
I desire more knowledge to improve my ability to teach.	
Feedback from children	.795
I feel that children's feedback is important because it identifies my strengths and weaknesses.	
I think children's feedback is important as it will help me understand them better.	
I think it is important to consider children's feedback, as it will help me enhance my current teaching and perform better in the future.	



CHAPTER 6

PHYSICAL EDUCATION-SPECIFIC FEEDBACK AND REFLECTION TOOLS

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1. ABSTRACT

Enjoyment of physical education (PE) is essential for engaging primary school children in physical activities. However, delivering enjoyable PE lessons that meet the diverse needs of all children is challenging. Systematic reflective practice, where teachers use pupils' feedback to identify areas for improvement, explore new strategies, and reflect again, can address this, but remains underutilized in primary school PE. Technological tools could support reflective practices, but currently fail to meet PE teachers' specific needs. This paper explores the design considerations of feedback and reflection tools tailored to primary school PE settings.

Using a user-centered, iterative research-through-design approach, we developed a tangible feedback device for children and a digital reflection platform for teachers. Methods included lesson observations, focus groups, questionnaires, prototyping, and user-testing with PE teachers, pre-service PE teachers and children. Findings revealed preference for a portable, battery-powered feedback device for children, enabling anonymous use and data collection during PE lessons. Teachers favored a web-based platform for systematic reflection, guiding structured reflection, peer collaborating and lessons planning. This study provides design considerations for context-sensitive tools enhancing children's PE experiences and supporting teachers' professional development.

2. INTRODUCTION

Physical inactivity and sedentary lifestyles have become significant global health concerns (World Health Organization, 2022). Primary school physical education (PE) plays a vital role in fostering active lifestyles by providing enjoyable experiences that help children develop the skills, knowledge, and attitudes necessary for lifelong engagement in physical activity (Whitehead, 2020). However, delivering enjoyable and effective PE lessons for all children is challenging, due to the diverse needs, abilities, and interests among children, as well as the complexities of the PE context.

An effective way to help teachers recognize and respond to children's needs, while improving their practice, is through deep, critical reflection. This involves teachers (i) evaluating past lessons to assess their teaching strategies and impact on pupils' learning, (ii) identifying areas for improvement, (iii) exploring alternative teaching strategies, (iv) implementing these strategies in future lessons, and (v) reflecting again (Korthagen & Nuijten, 2022). Feedback from children is crucial in this process, especially during the initial phase, by helping teachers identify teaching aspects that need adjustment to better meet children's needs and interests (Rollett et al., 2021). Additionally, interactions with colleagues through critical questioning and collaborative discussions can support the exploration of new strategies to improve teaching (Murphy et al., 2021).

Despite recognizing the benefits, many teachers do not engage deeply in the full reflection cycle. Primary school PE teachers often reflect internally, without systematic and structured use of various reflection methods, such as self-reflection questionnaires, video feedback, logbooks and discussions. Furthermore, they rarely gather feedback from children or explore alternative strategies based on evaluations, independently or with others (Iannucci & Parker, 2022). Barriers to critical reflection include lack of time, inadequate reflective skills, and insufficient methods to integrate feedback from children into the reflection process (Jaeger, 2013; Korthagen & Nuijten, 2022).

Technology offers a promising solution to these challenges by making critical reflection more accessible and efficient. Digital tools such as video analysis, feedback platforms, e-portfolios, and online forums are increasingly applied in secondary and tertiary education and have been well-received by teachers (Prieto et al., 2020). Integrating such tools into a context-specific reflection toolkit could support primary school PE teachers in reflecting more critically and fostering their professional growth.

This study applied a user-centered, iterative, research-through-design approach to establish design considerations for primary school PE-specific feedback and reflection

tools. It involved collaboration with design researchers, primary school PE teachers, and children and included methods such as lesson observations, focus groups, reflective questionnaires, and prototyping and testing of a tangible feedback device and a digital mock-up reflection tool.

3. UNDERSTANDING NEEDS AND CHALLENGES IN THE PRIMARY SCHOOL PE-CONTEXT

To gain a deeper understanding of the primary school PE context and develop design recommendations for a reflection toolkit including a feedback tool, several methods were conducted from January 2022 to June 2023. All participating PE teachers gave verbal permission. For all children participating in our study children's willingness and written parental consent were obtained.

3.1. Observations

To understand the PE context and explore how and when primary school teachers evaluate their PE lessons with pupils, two researchers independently analyzed recordings (audio and video) of 24 PE lessons taught by 24 primary school teachers from 10 different primary schools in the south of the Netherlands. The children involved were aged 8-12 years. The findings revealed limited opportunities for feedback collection during the 50-minute lessons, with no time allocated afterward. Lessons were packed with activities, often noisy and involved constant movement, and objects such as balls. In line with previous studies (Iannucci & Parker, 2022) teachers rarely evaluated their lessons with pupils. When they did, it mainly involved brief questions about which activities they enjoyed most, with little to no further questioning.

3.2. Focus groups

A focus group consisting of seven primary school PE teachers (five male and two female) and one researcher explored their perspectives on fostering children's PE enjoyment and identified essential teaching practices for delivering enjoyable PE lessons. The results showed that all teachers recognized the importance of ensuring enjoyable PE lesson experiences for every child. However, they reported that they do not consistently prioritize this during lessons and expressed uncertainty about whether all children have enjoyable experiences. The identified teaching practices categorized into key dimensions that foster enjoyment were consistent with findings from prior research, including studies grounded on motivational theories (Beni et al., 2019; Morgan, 2017) and those involving children's perspectives (Adank et al., 2023).

A second focus group, involving 10 primary school PE teachers (6 male and 4 female), led by the same researcher explored the current use of reflective practices. While teachers acknowledged the value of reflection in enhancing teaching, they reported rarely engaging in structured, and systematic reflective practices. They often evaluate on their lessons mentally but rarely collect feedback from peers and pupils or engage in discussions with colleagues about their teaching practices. Although teachers expressed curiosity about children's PE experiences and their enjoyment needs, they expressed not knowing how to approach this and what specific questions to ask, which prevent them from gathering feedback.

At the end of the lesson, I sometimes ask pupils if they enjoyed today's PE class, why and which activity was most instructive [teacher 8].

I'm unsure how to ask for feedback or what questions to use [teacher 3].

I would like more objective insight into my pupils' PE experiences [teacher 7].

Teachers also cited time constraints and a lack of resources as barriers to critical reflection. Concerns were reported about gathering feedback from children during PE lessons; teachers emphasizing the need for minimally disruptive methods that encourage children to provide anonymous and honest responses.

3.3. Questionnaire

To assess teachers' reflective thinking and practices, the Reflective Thinking of Teachers Questionnaire (Choy et al., 2019), translated into Dutch, was administered to 10 primary school PE teachers (6 male, 4 female). This questionnaire contained 32 statements rated on a 5-point Likert Scale (5 'strongly agree', 1 'strongly disagree'), along with two open-ended questions the use of reflective practices and the challenges they encounter. The results aligned with those obtained from the focus groups. Teachers' levels of reflective thinking varied from intermediate to advanced. Although teachers frequently evaluate their lessons mentally and are open to feedback from pupils and colleagues, they do not engage in consistent, systematic reflective practices. Lack of time was identified as a significant barrier to critical reflection.

4. PROTOTYPING

The information gathered through observations, focus groups and questionnaire informed the prototyping of a feedback (see Figure 6.1) and reflection tool (see Figure

6.2). Findings emphasized the importance of collecting pupil feedback during PE lessons in a way that minimizes disruption. In response, the proposed feedback tool should be tangible, portable, battery-powered, shock-resistant and offline-operable. It must be child-friendly and support independent use by pupils in PE settings, allowing them to respond to feedback questions efficiently and with a minimal interruption to lesson flow. Feedback questions should focus specifically on teaching practices that enhance pupils' PE enjoyment, be limited in number, and designed to allow for quick, autonomous responses.

A web-based reflection platform is proposed, offering structured activities to guide teachers through reflection phases, ensuring an easy and time and place independently use. The platform should integrate with the tangible feedback device to import pupils' feedback data and to generate relevant feedback questions. The tool should have functionalities for adding, storing and archiving information and resources for structured organized reflection. In addition, the platform must feature an intuitive design with clearly understandable elements, minimizing time spent on navigation and tool use.

4.1. Prototyping and testing the tangible feedback device

4.1.1. Iteration 1

From initial paper sketches, a low-fidelity prototype was developed using an MDF casing (12x10.5x4 cm) with a 3.5-inch touch screen, sized for children to hold and read. Feedback questions were formulated, derived from literature, on children's PE enjoyment (Adank et al., 2023; Morgan, 2017). Informed by literature on obtaining children's feedback (Fargas-Malet et al., 2010; Punch, 2002; Rollett et al., 2021), the questions were designed to be short, clear, closed-ended, adapted to the language skills of 8- to 12-year-olds. The questions were answered by touching one of four smiley faces on a 4-point Likert scale (ranging from red to green).

Fifteen industrial design students, two experts in industrial design, and two PE teacher educators reviewed this prototype during a demo day. They found the tool's size appealing and the smileys recognizable. However, they suggested a more PE-related design, improved screen resolution, and increased interactivity.

4.1.2. Iteration 2

The second prototype used a smaller, high-resolution e-paper screen with separate press smiley buttons for improved control. The MDF casing was covered with faux leather inspired by sports balls. Usability, understandability, and likability were tested with 155 primary school children individually during PE lessons. In addition, their

PE teachers (N =2) were asked about their first experiences using the tool and their opinions on the feedback questions.

Children liked the look and feel of the prototype, but some struggled with pressing buttons, particularly those unfamiliar with game consoles. Most children understood the feedback questions, except for one negatively phrased item. It took children about three minutes to answer the feedback questions, with Grade-5 children needing more time than older children, likely due to their reading ability. Teachers appreciated the tool's ease of use and the privacy it ensured for children's feedback.

During a workshop at a national PE conference, 25 PE teachers reviewed and assessed the feedback questions, provided suggestions for improvement or additional questions, and indicated their preferences for feedback data representation. They responded positively to the feedback questions and expressed interest in the ability to zoom in on specific teaching dimensions with yes/no questions. Additionally, they preferred a clear, non-judgmental visualization of children's feedback data.

4.1.3. Iteration 3

The final prototype featured a larger 3.7-inch e-paper screen for improved readability. Answer buttons were positioned on the top, with yes/no buttons and the 4-point Likert scale buttons on opposite sides for clarity. The buttons required less pressure, improving usability. The casing (12x10x4.5cm) was updated for safety and ease of use, and the cover was redesigned to have a more PE-related look. The negatively phrased feedback question was rephrased positively, and one additional question was included. Ten industrial designers and two PE teacher educators reviewed the prototype, finding the design coherent with the PE context and intuitive to use.

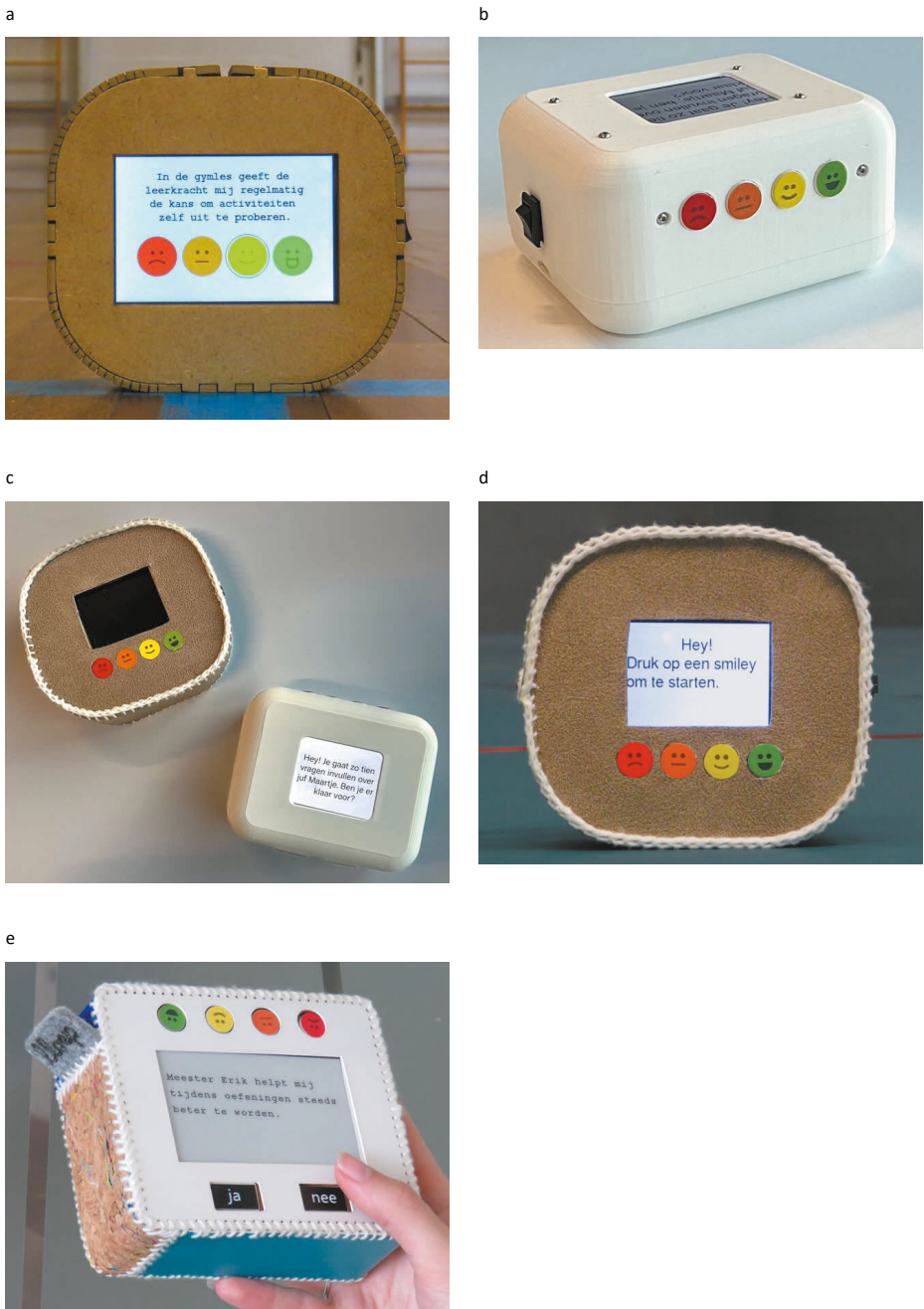


Figure 6.1: Iteration 1(a), 2 (b, c, d) and 3 (e) of the feedback tool prototype

4.2. Prototyping, testing and evaluating the digital reflection platform

A mock-up of a digital reflection tool was developed in Figma (www.figma.com), structured around Korthagen reflection cycle (Korthagen & Nuijten, 2022). Using Chat-GPT-generated data for graphs, it guided teachers through a four-step reflection process. The first page, "Measurement," displayed feedback from pupils (collected with the tangible feedback tool), peer-assessments and self-assessments. The second page, "Reflection," included evaluation questions to help teachers critically analyze their lessons and set goals for improvement. The third page, "Action Plan," outlined steps for learning new teaching strategies, collaborating with colleagues in an online community, and creating an action plan for implementing strategies in future lessons. The fourth page facilitated peer collaboration. Additional features include a personal dashboard to managing settings, viewing feedback, and accessing action plans, along with a secure login page and a tool configuration page for customizing feedback questions for the tangible feedback tool. All pages had a consistent layout with an intuitive left sidebar menu for navigation.

Usability was evaluated through two one-to-one semi-structured online interviews with PE teachers, a focus group with eight primary school PE teachers, and an interview with two pre-service PE teachers. Participants received a brief introduction and walkthrough of the Figma prototype. They were asked about their ability to complete a set of proposed activities and to identify any issues or suggestions for improvement. Additionally, participants discussed the tool's ease of use, clarity, intuitiveness and perceived usefulness based on the System Usability Scale (Brooke, 2013).

Reviewers generally expressed positive feedback regarding the tool, highlighting its facilitation for structured reflection, and enhancement of pedagogical knowledge, aiming to improve PE lessons and meet the diverse needs of children. The integration with the physical feedback tool, particularly its use of children's feedback as a starting point for reflection, was highly valued. Teachers appreciated the tool's flexibility, which allowed for selective engagement with content. The online community was perceived as a valuable resource for sharing experiences and strategies. The tool was also considered beneficial for demonstrating professional development efforts to others, such as the school board, and for pre-service PE teachers to track their progress and engage in constructive feedback discussions with supervisors.

The bar chart highlights areas of improvement, and the reflection questions helped me define the issue and create a plan to improve my teaching [Teacher 1].

The tool offers all the necessary options. It provides insights, solutions, and help set and achieve goals [Teacher 3].

However, several concerns and recommendations were raised, particularly regarding the time required for regular use. Most teachers preferred a closed, invitation-only online community, with the option to share documents (e.g. lessons plans). They suggested incorporating an information icon, via a brief animation or written text, to clarify the purpose and method of each of the reflection activities. Regarding the action plan, most teachers preferred a few concise questions to motivate them to consider actions for future lessons and how and when to evaluate these actions. Additionally, some teachers recommended a feature to set reminders within the platform for evaluating these actions. They also valued supplementary information, such as brief explanations, articles or links about teaching strategies that enhance children's PE enjoyment. Furthermore, they recommended an archive feature within the platform for storing lesson plans, evaluations and other valuable resources. Teachers also questioned whether school managers would support the platform costs and raised privacy concerns about sharing and storing sensitive data.

I was excited about the platform, but some activities need to be shorter to fit my schedule [Teacher 6]

I would like to create my own group to collaborate with [Teacher 5]

It should be easy and secure to share and store information [Teacher 4]

I should add suggestions for improvement, like links to helpful articles or websites [Teacher 5]



Figure 6.2: Architecture of the reflection tool mock-up based on Korthagen's reflection cycle

5. DISCUSSION

Using an iterative, research-through-design approach, we explored the development of a tangible feedback tool, and a digital reflection tool aimed at encouraging primary school PE teachers to collect feedback from pupils and reflect on their teaching practices. We collaborated with both children and teachers to gain insight into the needs related to feedback and reflection in PE settings and to develop and refine prototypes.

5.1. Feedback and reflection in a PE context

The feedback tool enabled children to provide feedback on teaching practices they perceived as essential for PE enjoyment. Children engaged both enthusiastically and seriously, demonstrating understanding of the questions and a sense of feeling heard. They were able to use the tool's intuitive, game-like interface autonomously and anonymously within a short timeframe during PE lessons. The tangible nature of the tool integrated seamlessly into the PE environment, minimizing distractions typically associated with mobile devices, while maintaining both privacy and visibility. Its mobility also empowered children to choose when and where to give feedback, enhancing their sense of agency and engagement.

Teachers acknowledged the value of integrating both the tangible feedback and digital reflection tools to understand children's needs and improve their teaching pedagogies accordingly. They showed strong commitment to ideating, exploring, and reviewing technological solution for supporting and facilitating teacher reflection. The digital reflection prototype was appreciated for its clear visualizations of feedback data, guided reflection questions, collaborative chat function, and access to pedagogical resources. These features enabled continuous access to feedback and facilitated structured reflection. Familiarity with digital platforms contributed to a smooth integration process. In a traditionally conservative PE context, this incremental, low-cost approach using familiar technologies enhances the likelihood of adoption (Norman & Verganti, 2014).

Based on the findings from the research process, a set of design principles and considerations was formulated to guide the development of both the tangible feedback and digital reflection tools. Four overarching design principles were established to guide the development of both the tangible feedback and digital reflection tools: (i) efficiency and practicality, (ii) ease of use and intuitive interaction, (iii) clarity and relevance, and (iv) safety and privacy. For each principle, specific design considerations were identified through engagement with children and teachers during the iterative design process.

For the tangible feedback tool, the principle of efficiency and practicality was addressed by ensuring that the tool was portable, battery-powered, and capable of operating offline, enabling seamless integration in the PE lessons.

The feedback process was streamlined through a limited set of questions to allow for quick completion, while data collection, storage, and transfer mechanisms were designed to be straightforward and robust. To meet the principle of ease of use and intuitive interaction, the tool was constructed using shock-resistant and sturdy materials, with a design that was both child-friendly and visually aligned with the PE environment. Its physical form allowed children to hold it comfortably with both hands and interact through familiar actions, such as pressing buttons, supporting independent and confident use. Regarding clarity and relevance, the feedback content focused specifically on teaching practices that contribute to children's enjoyment of PE. Questions were short, simple, positively phrased, and closed-ended, using Likert-scale response options to ensure comprehensibility and ease of interpretation by young users. Finally, under the principle of safety and privacy, the tool was designed to enable children to provide anonymous feedback in a secure manner. Data handling processes ensured information protection during both storage and transfer, reinforcing children's sense of trust and honesty in the feedback process.

For the digital reflection tool, the same four principles informed its design. In terms of efficiency and practicality, the tool was implemented as a web-based platform that supported quick and easy reflection activities. It enabled teachers to document reflections efficiently and add supplementary materials (such as recorded lessons, self-evaluations, peer feedback, and relevant articles) which could be stored and archived for ongoing professional development. To ensure ease of use and intuitive interaction, the tool allowed teachers to customize the feedback questions presented in the tangible tool and facilitated seamless connection for importing and exporting data between both tools. Additionally, it presented visualized feedback data in a clear, easily interpretable format and included features for collaborative reflection, promoting peer learning among teachers. The principle of clarity and relevance was operationalized through structured reflection phases that guided teachers from lesson evaluation to deeper pedagogical analysis. Reflection prompts helped structure this process, ensuring relevance to the specific context of PE teaching. Lastly, safety and privacy were ensured by incorporating robust digital safeguards to protect sensitive data and maintain user confidentiality throughout the reflection process.

Together, these principles and associated considerations form a framework for designing tools that are meaningful, contextually appropriate, and practically usable

in primary PE settings. They provide a foundation for future development of feedback and reflection tools aimed at enhancing teaching quality through teacher and pupil collaboration.

5.2. Challenges and limitations

Despite the positive reception of the toolkit, several challenges remain. For the tangible feedback tool, the cost of developing and maintaining the physical tool raises concerns regarding viability and feasibility. While shifting to a tablet or smartphone-based app could reduce these costs, it may compromise the physical interaction that fosters engagement and may introduce distractions. A careful balance between practicality and educational effectiveness is therefore required.

Further improvements of the toolkit are needed to ensure its capacity to promote more frequent and systematic reflection. School-related barriers, such as a lack of support for using child feedback and reflection, or personal beliefs (e.g., assuming teachers already understand children's needs), may hinder adoption (Avidov-Ungar & Eshet-Alkalai, 2011). Additionally, teacher-centred approaches may reduce motivation to engage in reflective practices. Mitigating these barriers is crucial for embedding reflection in daily teaching practices.

5.3. Future work and implications

This study focused on developing prototypes for feedback and reflection tools in PE. However, it did not assess the long-term impact on teachers' reflective practices or resulting changes in their teaching. The study involved small participant groups and short-term testing, limiting the generalizability of findings regarding the toolkit's effectiveness over time. Future research should investigate the long-term impact of the toolkit on teacher reflection and teaching quality and assess whether integrating feedback leads to improvements in teaching outcomes.

To embed reflective practice more deeply into professional development, PE teacher education should offer opportunities for pre-service teachers to practice feedback-based reflection. School leaders should also support teachers with time and resources to engage in reflective practices. In this study, co-designing and prototype testing with children and teachers ensured that the toolkit aligned with their needs. Future work should continue to emphasize this collaborative approach to design and encourage designers to immerse themselves in the PE context and collaborate closely with end-users. The toolkit and design considerations from this study can inspire future tools for both primary and secondary PE settings.

6. CONCLUSION

This study explored the development of a tangible feedback tool and a digital reflection tool aimed to support primary school PE teachers in gathering pupils' feedback and reflecting on their teaching. The toolkit supports a step-by-step, continuous feedback loop that empowers children to share their perspectives and assists PE teachers in improving their teaching practices. We collaborated with primary school children and PE teachers to understand the PE-specific needs. Our findings suggest that children are motivated to provide feedback when the process is clear, enjoyable, and anonymous, while teachers value tools that are intuitive and time-efficient. Our work offers actionable insights for future design of feedback and reflection tools tailored to specific education contexts, such as PE lessons in primary school.

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CHAPTER 7

GENERAL DISCUSSION

1. INTRODUCTION

The school environment, and specifically physical education (PE), is an important setting for promoting an active lifestyle among children. PE not only provides opportunities for physical activity (PA), but also fosters the development of skills, knowledge, and positive attitudes that support lifelong engagement in PA. Primary school teachers, both generalists and PE specialists, play a central role in shaping this environment.

This dissertation first examined children's PA and sedentary behavior (SB) in middle and late primary school and how these behavioral patterns evolved over time. It then explored how motor competence (MC), PA enjoyment, and basic psychological need (BPN) satisfaction in PE were related to children's PA and SB, thereby contributing to a more comprehensive understanding of the psychological and contextual determinants of PA patterns in childhood. Building on these findings, the overarching aim was to advance understanding of how PE teachers, both generalist teachers and PE specialists, can foster children's enjoyment in PE. Furthermore, the dissertation explored how teachers reflect on their PE lessons, particularly regarding strategies to enhance children's PE enjoyment, and how design based technological feedback and reflection tools can support this reflective process. Such tools were intended to improve teaching quality, better meet children's needs for PE enjoyment, contribute to teachers' professional development, and ultimately stimulate active lifestyles among children. To address this overarching aim, four sub-aims were formulated:

1. Examining the associations between primary school children's MC, enjoyment of PA, satisfaction of BPN in PE, and their daily patterns of PA and SB over time.
2. Exploring children's perspectives on teaching practices that foster PE enjoyment and the extent to which these practices are applied by primary school PE teachers, i.e., generalist teachers and PE specialists.
3. Exploring teachers' perspectives on enjoyable PE lessons and reflective practices, how teachers currently engage in reflection, and identifying the barriers they experience in both reflective practices and in delivering enjoyable PE lessons.
4. Identifying design considerations for technological feedback and reflection tools aimed at supporting PE teachers in effectively using reflective practices to improve their teaching and better meet children's needs for PE enjoyment.

This chapter begins by summarizing the key findings presented in the five preceding chapters. It then outlines the overall contributions of this dissertation. These findings and contributions are subsequently discussed in more depth. Methodological

considerations and limitations are addressed thereafter. Finally, recommendations for future research, practical implications, and a concise general conclusion are drawn.

2. SUMMARY OF THE MAIN FINDINGS

Chapter 2 presented a cross-sectional study exploring the associations between MC, PA, and SB among primary school children in grades 4 and 6 (N = 595; 291 boys; M age = 9.1 years; SD = 1.1). The results showed that overweight children had significantly lower levels of MC and engaged in less moderate-to-vigorous PA (MVPA) compared to their non-overweight peers. On average, children spent 62.7% of their waking hours on schooldays in SB (M = 480 minutes; SD = 66.6), 29.7% time in light PA (LPA) (M = 228 minutes; SD = 40.7), and 7.6% time in MVPA (M = 58 minutes; SD = 21.0). Mixed-model analyses revealed that lower MC scores were associated with more SB and less LPA and MVPA. Conversely, children with above-average MC showed the opposite pattern. The strength of the associations between MC and both SB and MVPA was greater among children whose MC scores were either substantially below or above the average. Age and gender also influenced activity patterns, with older children and girls being more sedentary and less physically active.

Chapter 3 reported a longitudinal study examining the associations between MC, PA enjoyment, SB, and MVPA over a two-year period (grade 6 to 8). The study also explored how perceived satisfaction of BPN in PE, i.e. autonomy, competence and relatedness, were related to PA enjoyment. At baseline, 371 children in grade 6 (M age = 10.1 years; SD = 0.5; 52.3% girls) participated. Gender-stratified analyses, adjusted for BMI and age, revealed that SB significantly increased over time for both boys and girls. Throughout the study period, boys consistently engaged in less SB and more MVPA than girls, although these gender differences narrowed over time. By grade 8, boys' MVPA had declined below the recommended 60 minutes per day, whereas girls' MVPA remained consistently below this threshold. MC and PA enjoyment were significant predictors of SB and MVPA, with gender-specific patterns. For boys, PA enjoyment predicted SB, and MC predicted MVPA. For girls, both MC and PA enjoyment predicted SB and MVPA. Gender differences were also found in the predictors of PA enjoyment. For boys, higher perceived competence in PE and lower levels of SB predicted greater PA enjoyment. Among girls, PA enjoyment was influenced by perceived competence and teacher-relatedness in PE, while PA enjoyment declined over time.

Together, the findings from Chapters 2 and 3 underscored the importance of promoting an active lifestyle among primary school children, given their high levels

of SB and insufficient engagement in MVPA. To support healthy activity patterns, it is essential to provide children with enjoyable experiences in physical activity, along with opportunities to develop their motor skills, both within and beyond the school context. In the school setting, PE offers a key opportunity to foster MC and to promote positive attitudes towards physical activity. By supporting children's basic psychological needs, i.e., autonomy, competence, and relatedness, PE can enhance their enjoyment of physical activity, particularly among girls. This increased enjoyment, subsequently may contribute to higher levels of MVPA and reduced SB. As such, PE plays a pivotal role in addressing the physical inactivity challenges observed among primary school children.

Building on these insights, **Chapter 4** explored which teaching practices (TPs) primary school children consider as important for enjoying PE and exploring the extent to which these practices are implemented by teachers. Twenty-four children aged 10 to 12 (50% boys) participated in focus groups. During these focus groups, children discussed their current PE experiences, described PE lessons they enjoyed, identified key teaching practices (TPs), and provided advice to PE teachers on fostering enjoyment in PE. This process resulted in 32 identified TPs, which were grouped into ten dimensions: exploratory learning, tasks, communication, instruction, rules and expectations, physical activity time, grouping, learning process, learning together and limited performance comparison. These child-identified TPs served as criteria to observe 31 PE lessons taught by 19 different PE teachers (11 generalists, 8 PE specialists), assessing the extent to which the TPs were applied. While many TPs were observed in practice, areas for improvement emerged, particularly in cooperative learning, encouraging children's social learning, emphasizing individual progression, and implementing more purposeful grouping. PE specialists tended to apply certain practices more frequently than generalists. Specifically, they provided more individualized guidance to support the learning process, offered greater opportunities for exploratory learning, and implemented challenging, differentiated tasks within physical activities. These findings highlight the importance of integrating children's perspectives to deepen and refine our conceptual understanding of enjoyment in PE. Observing lessons through the lens of child-identified criteria enables the identification of specific teaching areas that can be improved. This child-centered approach underscores the value of listening to children's voices to enhance PE teaching quality and foster enjoyment for all children.

Chapter 5 and 6 shifted the focus from children's perspectives to teachers' practices and professional development. **Chapter 5** presented a cross-sectional study on primary school teachers' views regarding children's enjoyment in PE, the barriers they face in fostering enjoyable PE experiences, and their perspectives on, and use of reflection to improve teaching. Differences between PE specialists and generalists in

this were also examined. A total of 173 teachers (70.5% PE specialists, 29.5% generalists) completed an online questionnaire. Most teachers valued providing enjoyable PE for all children. However, generalists more often reported teacher- and policy-related barriers, such as limited knowledge, skills, confidence, and PE lessons' preparation time. PE Specialists more frequently cited child-related challenges, including children's attitudes and motivation. Although teachers viewed reflection positively, most relied on informal, internal strategies, making little use of structured methods and feedback from children. Time constraints, limited knowledge of effective reflective methods and low prioritization were cited as key barriers. Coaching and targeted training may support generalist teachers, while PE specialists could benefit from further professional development in structured reflective practices, such as video analysis and the use of children's feedback, to enhance lesson quality and enjoyment.

Chapter 6 built on these findings by exploring design considerations of technological tools intended to support primary school PE teachers in structured reflection and integrating children's feedback to improve lesson quality. Through a user-centered, iterative research-through-design approach, design researchers collaborated with PE teachers and primary school children to develop, prototype, and test two complementary tools: a tangible feedback tool and a digital reflection tool. The design process was informed by PE lesson observations (N = 24), teacher focus groups (N = 17), and a teacher questionnaire (N = 10). The feedback tool was refined over through multiple design iterations. During this process, one prototype was tested by two teachers and 155 primary school children in the PE context, while other prototypes were reviewed by design researchers (N = 27) and PE specialists (N = 29). In parallel, a mock-up of a web-based reflection tool was developed and evaluated for usability by PE teachers in focus groups (N = 8) and by (pre-service) PE teachers via online interviews (N = 4). Both tool prototypes were positively evaluated, particularly for their integration of feedback and reflection, user-friendliness, and practical relevance. The study identified design considerations to guide the development of PE-specific tools aimed at enhancing children's enjoyment of PE, supporting teacher professional development, and improving the overall quality of PE lessons. Informed by insights from children and teachers during the iterative design process, these considerations highlighted key design challenges in PE as an active, time-pressured and socially visible learning environment, including tensions between immediacy of child feedback and reflective distance, and between child anonymity and teacher trust. These design considerations were categorized into four overarching principles: (i) efficiency and practicality, (ii) ease of use and intuitive interaction, (iii) clarity and relevance, and (iv) safety and privacy.

3. CONTRIBUTIONS

This dissertation provides several methodological, empirical, and artifactual contributions to research on PE and PA. Methodologically, it demonstrates the value of integrating mixed methods across studies (Vors & Bourcier, 2022), combining quantitative tracking of PA levels, MC, PA enjoyment, and BPN satisfaction in PE, with qualitative insights from children and teachers regarding PE enjoyment. This mixed-methods approach contributed to a better understanding of the interplay between individual and contextual factors across PE and other PA contexts. The longitudinal design used to explore associations between MC, PA enjoyment, BPN satisfaction in PE, and PA patterns strengthened the validity of findings, revealed gender specific patterns, and highlighted trans-contextual associations between children's satisfaction of BPN in PE and their PA levels beyond PE. A child-centered approach guided the development of a PE observation tool designed to evaluate teaching practices that foster enjoyment in PE and identify areas for improvement of PE teaching. Participatory and user-centered design methods ensured that children's voices informed the identification of enjoyable teaching practices and the co-design of feedback tool prototypes. This dissertation examined reflective practices among PE specialists and generalist teachers and emphasized the importance of an iterative, research-through-design approach in developing feedback and reflection tools tailored to primary PE contexts.

Empirically, this dissertation revealed strong associations between MC and both MVPA and SB. The strength of these associations increased as children's MC levels deviated from the mean, emphasizing the importance of considering individual differences in MC when developing strategies to reduce SB and promote PA. Persistent gender differences in MVPA and SB were identified, as well as associations between MC and PA enjoyment with both MVPA and SB, emphasizing the need for tailored strategies to foster active lifestyles. It also provided empirical support for the trans-contextual model (Hagger & Chatzisarantis, 2016) by demonstrating that BPN satisfaction in PE is associated with PA enjoyment beyond school. Furthermore, teaching practices that according to children foster their PE enjoyment were identified, aligning with the BPN support and mastery orientation constructs from Self-Determination Theory (Deci & Ryan, 2000) and Achievement Goal Theory (Ames & Archer, 1988) respectively. Differences in reflective practices between PE specialists and generalist teachers were demonstrated, and barriers and opportunities to enhance PE enjoyment were identified. Finally, this dissertation demonstrated how a user-centered approach can inform design considerations for the development of feedback and reflection tools tailored to PE contexts, showing their potential to support teachers' professional development and improve PE quality by better meet children's needs. The development of a tangible

feedback tool and a digital reflection tool represent an artifactual contribution of this dissertation, providing practical means to bridge research and practice in primary school PE, supporting teachers' professional development and improving lesson quality.

4. DISCUSSION

4.1. Enjoyment as a dynamic, contextual experience

Enjoyment in PA, particularly within PE, represents a central theme of this dissertation. Previous research has demonstrated that enjoyment is a key determinant of sustained engagement in PA, thereby contributing to the development of an active lifestyle (Eberline et al., 2018; Haas et al., 2021; Ramer et al., 2021). This dissertation provides empirical evidence supporting this association, showing that PA enjoyment is significantly associated with active lifestyle behaviors among children. For girls, higher enjoyment is associated with increased time spent in MVPA, while for both boys and girls, it is associated with reduced time spent in SB.

Traditionally, PA enjoyment has been conceptualized as a subjective experience of pleasure, interest, or fun derived from participation in physical activity or sport. From this perspective, enjoyment is considered as an intrinsic preference, i.e., a natural tendency to like or dislike certain activities. In this view, enjoyment is interpreted as a key indicator and manifestation of intrinsic motivation, as defined by the Self-Determination Theory (Bajamal et al., 2024; Hagger & Chatzisarantis, 2016; Standage et al., 2025). Individuals engage in PA for the inherent satisfaction or pleasure it provides. This aligns with the concept of hedonic enjoyment, referring to the immediate pleasure derived from the activity itself (Kawabata & Mallett, 2022).

However, findings from this dissertation, alongside broader literature, suggest that enjoyment is more complex (Kawabata & Mallett, 2022). It is not solely an individual disposition nor solely a product of the activity itself. Rather, PA enjoyment emerges from dynamic interactions between the individual and the surrounding environment in which the physical activity takes place (Bajamal et al., 2024; Carcamo-Oyarzun et al., 2025; Chang et al., 2016; Domville et al., 2019; Standage et al., 2025). PA enjoyment is shaped by environmental factors and by how these factors are perceived and experienced. This interactional view shifts the understanding of enjoyment from an individual trait toward a relational process. Enjoyment arises not only from what is done, but also from how, where and with whom the activity is undertaken (Bajamal et al., 2024; Domville et al., 2019; Standage et al., 2025).

Acknowledging this environmental influence expands our understanding of why children enjoy PA. Children's enjoyment may stem not only from immediate pleasure derived from the activity itself, defined as hedonic enjoyment, but also from personally meaningful outcomes such as skill mastery, self-growth, or alignment with their values, referred to as eudaimonic enjoyment (Kawabata & Mallett, 2022). In this sense, PA enjoyment reflects more internalized forms of extrinsic motivation, corresponding to identified or integrated regulation, where engaging in PA is valued for their contribution to personal development, even if the activity itself is not inherently pleasurable (Bajamal et al., 2024; Deci & Ryan, 2000; Kawabata & Mallett, 2022; Standage et al., 2025).

External factors within learning environments can shape children's motivation for PA (Carcamo-Oyarzun et al., 2025). Supporting children's basic psychological needs (BPN) for autonomy, competence and relatedness during PE fosters motivation and enjoyment in PE (Chang et al., 2016; Huhtiniemi et al., 2019). These principles align with a mastery-oriented PE climate as described in the Achievement Goal Theory (AGT) (Ames, 1992; Ommundsen & Kvalø, 2007), where emphasis on personal progress and effort, rather than normative comparison, further enhances motivation and enjoyment in PE (Chang et al., 2016; Jaitner et al., 2019; Ommundsen & Kvalø, 2007). This dissertation demonstrated that meeting BPN within PE can have effects beyond PE, influencing PA enjoyment in other contexts. Children who perceived feelings of competence and autonomy were more likely to report higher PA enjoyment. This finding supports the trans-contextual model of motivation (Hagger & Chatzisarantis, 2016), which posits that positive motivational experiences in PE can shape broader attitudes and behaviors toward lifelong PA (Huhtiniemi et al., 2019; Jaakkola et al., 2019; Navarro-Patón et al., 2019). From a socio-ecological perspective, this highlights the role of PE and PE teachers as crucial environmental factors for fostering enjoyment and promoting lifelong engagement in PA (Burns et al., 2023).

Responding to calls for clearer understanding of enjoyment in PE (Dudley et al., 2011), this dissertation highlights the need to disentangle the concept within this PE context and include children's voices in this process, rather than relying on theoretical assumptions. Drawing on principles of participatory design (Druin, 2002) children's perspectives, expressed in their own language during focus groups, were used to co-define the teaching practices that shaped the conceptualisation of PE enjoyment and informed the observation criteria. Primary school children were able to articulate practical teaching practices that enhance their enjoyment and are meaningful to them. They valued opportunities to explore independently and learn at their own pace, a variety of appropriately challenging physical activities, and clear instructions, rules, and expectations that are understood and respected by all.

They also appreciated a positive PE learning environment characterized by constructive, open communication with peers and teachers, purposeful grouping, collaboration, and a focus on individual progress. In essence, PE becomes enjoyable when it feels meaningful and supports optimal learning and development across motor, social, cognitive and affective domains, consistent with principles from SDT, AGT, and the Meaningful PE framework (Beni et al., 2019; Deci & Ryan, 2000; Jaakkola et al., 2015; Kokkonen et al., 2018; Pérez-González et al., 2019; Standage et al., 2025). Although these findings provide valuable insights into what children perceive as enjoyable PE, they should be interpreted within a developmental perspective. As children grow older, cognitive development and new experiences influence how they express and prioritise enjoyment, meaning that the identified teaching practices may differ across groups and change over time (Druin, 2002; Schepers et al., 2018).

Using child-identified teaching practices as observation criteria, observations of PE lessons revealed valuable insights into what works well and where improvements are possible to foster PE enjoyment. This approach not only validated children's perspectives in their PE context but also offered teachers a concrete framework for reflection on their practice. Integrating observation and reflection in this way strengthens the practical contribution of this dissertation and extends prior research that has relied solely on self-reports or theoretical assumptions about effective PE teaching. Furthermore, integrating children's perspectives on PE enjoyment into feedback and reflection tools enhances professional learning and supports the creation of meaningful and enjoyable PE environments. In doing so, this work advances both the theoretical understanding and the practical application of enjoyment in PE, contributing to improved teaching quality and lifelong engagement in PA.

4.2. Teachers' role in fostering enjoyment and active lifestyles through PE

PE is a key context for fostering enjoyment in physical activity, as it reaches all children. The PE learning environment is shaped by an interplay of policy, physical and social factors that together influence how children experience PE lessons (Abdulla et al., 2022; Chu et al., 2019). Teachers, as the central social factor, are responsible for creating an enjoyable and supportive climate that promotes positive experiences and lays the foundation for active lifestyles (Chu et al., 2019; Gråstén et al., 2019; Huhtiniemi et al., 2019). Policy factors, such as sufficient time for lesson preparation and delivery, and physical factors, such as adequate space, appropriate climatic conditions, and access to high quality, fixed and flexible equipment, enable teachers to provide enjoyable PE (Jenkinson & Benson, 2010).

In the Netherlands, primary school education is compulsory for children aged 4 to 12 years, and schools are legally required to provide at least two PE lessons per week (45 minutes each) for each class, taught by either a PE specialist or a generalist with additional certification to teach primary school PE (Rijksoverheid, 2023). A critical issue concerning PE quality is the need for competent PE teachers who can create and provide lessons that meet curricular PE aims, including fostering children's PE enjoyment, adapting to diverse needs, and encouraging active participation (Baumgartner, 2022; Domville et al., 2019; Schnitzius et al., 2021). Such competence involves pedagogical and didactic skills, as well as the ability to reflect on one's teaching to respond effectively to children's needs (Korthagen & Nuijten, 2022; Rollett et al., 2021; Standal & Moe, 2013). Delivering high-quality PE is increasingly complex given declining MC among Dutch children (Mombarg et al., 2023) and high levels of physical inactivity and sedentary behavior (Bull et al., 2020; RIVM, 2023).

Previous studies have primarily examined teachers' reflective capacity (Choy et al., 2019; Standal & Moe, 2013; Tsangaridou & Polemitou, 2015) or perceived barriers in teaching PE (Abdulla et al., 2022; Jenkinson & Benson, 2010). This dissertation extends that work by exploring both barriers that teachers experienced in delivering enjoyable PE lessons and those they faced when engaging in reflection. It explored the extent to which teachers used reflection, how and why they did so, and what factors facilitated or hindered this process. These insights contribute to a deeper understanding of how reflection can help teachers improve PE teaching, overcome barriers, and better align with children's needs for PE enjoyment.

Consistent with earlier finding (Maksimović & Jelena, 2018), this dissertation confirms that teachers generally hold positive attitudes toward reflection and feedback collection. Nevertheless, practical application of reflection remains limited among both generalists and PE specialists. Key barriers include a lack of time, low prioritization, uncertainty about how to engage children in feedback, and limited knowledge of how to initiate reflection. Opportunities to exchange ideas with colleagues in accessible and effective ways are also scarce. Reflection, when supported and initiated through children's feedback (Iannucci & Parker, 2022; Mandouit, 2018; Rollett et al., 2021), can help teachers identify and address barriers, and recognize both strengths and areas of improvement in their teaching. Yet, research indicates that children's feedback is rarely collected systematically in PE (Göbel et al., 2021; Iannucci & Parker, 2022). When gathered, it often remains superficial, for instance by asking which activity children liked most. Consequently, valuable insights into children's needs and experiences that could inform teachers' reflection and PE lessons remain largely underutilized.

4.2.1. Differences between generalist teachers and PE specialists

Findings revealed differences in perceived barriers to delivering enjoyable PE between generalists and PE specialist. Generalists reported more frequently personal barriers, such as limited experiences and self-confidence in PE teaching, insufficient preparation time, lack of subject knowledge and pedagogical skills, and policy-related barriers, including restricted preparation time, limited professional development opportunities, and limited autonomy in PE lesson planning. In contrast, PE specialists more often attributed challenges to child-related factors, such as low motivation, limited concentration, and lack of interest.

Differences were also found in the use of teaching practices that children identified as contributing to PE enjoyment. Generalists applied teaching practices concerning stimulating individual learning processes, offering varied and challenging tasks, and providing opportunities for exploratory learning less frequently than PE specialists. This may affect the level of enjoyment children experience during PE lessons. These findings align with previous studies showing that PE specialists tend to adopt more child-centered and need-supportive approaches (Breslin et al., 2012; Gerovac et al., 2025; Truelove, Bruijns, et al., 2021; Truelove, Johnson, et al., 2021).

These findings highlight the need for targeted and differentiated professional development opportunities for both PE specialists and generalist teachers. For generalist teachers, strategies aimed at increasing confidence, subject knowledge, and pedagogical competence in PE may help foster more enjoyable PE lessons. For PE specialists, enhancing awareness of teaching practices that contribute to children's PE enjoyment and emphasizing their role in shaping a positive, enjoyable PE environment may be a promising approach. Ultimately, it is essential not only to identify which teaching practices are applied less frequently, but also to understand the underlying reasons (Ahraz, 2025).

4.3. Technology to support PE teachers' reflection and pedagogical practice

To help teachers enhance their PE teaching, while ensuring enjoyable PE experiences for children, there needs to be attention to the potential of educational technologies to support systematic reflection and ongoing professional development. The integration of educational technology (EdTech) into PE is increasing, reflecting the growing and persistent presence of technology in today's educational practice (Martín-Rodríguez & Madrigal-Cerezo, 2025; Zhao et al., 2025). Within PE, technologies such as audiovisual resources, video analysis applications for performance feedback, and digital monitoring systems to track children's learning progress are frequently used to support instruction

(Saiz-González et al., 2025). Additionally, digital logs and online portfolios are employed to foster children's engagement and their sense of ownership over their learning (Jastrow et al., 2022; Martín-Rodríguez & Madrigal-Cerezo, 2025; Saiz-González et al., 2025). Beyond its instructional applications, EdTech also holds potential to support teachers' reflection and professional development (Krause et al., 2020). However, such applications, particularly in primary school PE, remain underexplored (Jastrow et al., 2022; Sargent & Calderón, 2021).

This dissertation showed that when technology is purposefully designed and aligned with the specific pedagogical and practical context of PE, teachers are more likely to value and accept technological tools that facilitate their reflection. This, in turn, supports improvements in their teaching practices that better meet with children's needs and enhance their PE enjoyment. This alignment between technological design and pedagogical goals reflects the importance of performance expectancy in the Unified Theory of Acceptance and Use of Technology (UTAUT), which posits that users are more likely to adopt technology when they perceive it as beneficial to their professional tasks (Noureddine et al., 2025; Taiwo & Downe, 2013).

This research employed a user-centered, iterative approach, resulting in a functional prototype of a feedback tool and a mock-up of a reflection tool. Both were perceived by PE teachers as useful, relevant, intuitive, and easy to integrate into their daily teaching practice. These characteristics correspond to effort expectancy in UTAUT (Noureddine et al., 2025; Taiwo & Downe, 2013) and perceived behavioral control in the Theory of Planned Behavior (Ajzen, 1991) emphasizing that technology must be easy to use and fit within the daily teaching practice. Although the reflection tool was presented only as a mock-up, teachers responded positively to its conceptual design, indicating its potential to support reflective practices. However, age- and competence-related differences in technology acceptance among teachers should be acknowledged. Previous research shows that age, technological experience, and perceived digital competence influence teachers' attitudes toward and intentions to use digital technologies (Antonietti et al., 2022; Scherer et al., 2019). Older and less technologically confident teachers reported lower acceptance and less frequent use of digital Human Computer Interaction (HCI) tools (Šabić, 2022). Such unequal adoption may widen the gap between more and less experienced teachers in their attitudes toward and their actual engagement in systematic reflection.

The user-centered, iterative approach played a crucial role in shaping the positive experiences of both teachers and children with the technological tools. From the start, design researchers collaborated closely with teachers and children, actively

involving them in the development of the feedback and reflection tools. PE lesson observations and focus group discussions provided a deeper understanding of the primary school PE context, children's PE experiences and needs, and the pedagogical goals and challenges faced by teachers. These contextual insights highlighted specific areas where technology could meaningfully enhance teaching practice, particularly in using feedback from children to inform teachers' reflection aimed at improving their teaching and fostering children's PE enjoyment. This understanding of the context was essential given the dynamic nature of PE lessons, where teachers must simultaneously ensure physical safety, respond to diverse interests, needs, and skill levels of children, and work within budgetary and facility constraints, making the acceptance and use of technological tools challenging (Ma, 2025; Weeldenburg, 2023).

These insights led to the formulation of design considerations and guided the iterative process of designing, prototyping and testing. This phase of understanding the PE context, ensured that technology was used to develop tools aligned with teachers' pedagogical aims and the specific needs of their PE context. This integration of technological, pedagogical and content knowledge is essential for effective educational innovation according to the Technological Pedagogical and Content Knowledge (TPACK) framework (Koh et al., 2010; Lee et al., 2025; Park et al., 2025).

Beyond supporting usability and technology acceptance, the design process also showed that enabling children to provide feedback is not only a technical challenge but also a social design challenge (Röhl et al., 2025; Rollett et al., 2021). Because this involves a tension where children evaluate their teachers' teaching, it introduces sensitivity and potential vulnerability for both children and teachers (Elbra-Ramsay, 2021; Rolett et al., 2021). Drawing on Human-Computer Interaction research on feedback in imbalanced feedback situations (Liu et al., 2022) and reflective informatics (Fleck & Fitzpatrick, 2010), the user-centered design approach explicitly accounted for these relational dynamics in feedback situations. The tools were designed to support honest child feedback while maintaining a positive teacher-child relationship. Anonymous feedback enabled children to express their experiences openly and autonomously (Rollett et al., 2021), whereas the reflection tool presented feedback through clear, non-judgmental visualizations that encouraged teachers to use children's feedback as a basis for reflection rather than interpreting it as a personal evaluation (Röhl et al., 2025).

Throughout the iterative process, teachers and children remained actively involved in prototyping and testing, providing ongoing feedback that refined the tools, particularly the feedback tool, by enhancing usability, relevance, intuitiveness and feasibility. These qualities are essential for technology acceptance and adoption, as they reflect effort

expectancy and perceived behavioral control, as emphasized in the UTAUT and Theory of Planned Behavior respectively (Ajzen, 1991; Ince et al., 2006; Nouredine et al., 2025; Pürgstaller et al., 2025; Taiwo & Downe, 2013). The research-through-design approach also supported teachers in exploring and shaping the possibilities of the tools within their PE context. Teachers began to recognize the potential of technology to support them in gathering meaningful feedback and reflecting on their lessons, which might contribute to improvements in teaching but also to their professional development. This recognition can positively influence teachers' attitudes toward technology, which is a key determinant of behavioral intention in the Theory of Planned Behavior (Ince et al., 2006; Pürgstaller et al., 2025).

Although the prototype feedback and reflection tools were positively received in a short-term, exploratory context, sustained use in everyday PE practice cannot be assumed. Initial positive attitudes toward technological innovations do not necessarily translate into long-term integration into teachers' routine practice, particularly given limited time for reflection and competing instructional demands. In addition, repeated use may lead to challenges such as habituation, response fatigue among pupils, and socially desirable responding. These factors suggest that long-term value depends not only on perceived usefulness and ease of use (UTAUT), but also on the extent to which such tools can be embedded within existing school routines and structures.

Taken together, this dissertation addressed key theoretical principles known to underlie technology acceptance. By ensuring that tools were pedagogically meaningful, contextually relevant, and easy to use, the approach supported the integration of technological, pedagogical, and content knowledge, central aspects to the TPACK framework (Koh et al., 2010; Lee et al., 2025; Park et al., 2025). It also aligned with UTAUT's emphasis on performance and effort expectancy (Nouredine et al., 2025; Taiwo & Downe, 2013), and the focus on attitude and ability in the Theory of Planned Behavior (Ajzen, 1991; Ince et al., 2006; Pürgstaller et al., 2025). This work demonstrates that, although the combination of reflection, design, and physical education may appear somewhat unusual and unexpected, it represents a promising approach for creating technological innovations that are educational relevant, valued by teachers, and therefore more likely to be adapted in practice. Such innovations have the potential to enhance the quality of primary school PE and fostering children's enjoyment of physical activity.

4.4. Gender-specific patterns of PA and SB: practical implications for PE

This dissertation revealed gender differences in patterns of PA and SB during the late primary school years during the late primary school years, as well as in the predictive

value of MC and PA enjoyment for these patterns. In addition, the results demonstrated that the predictive role of different aspects of BPN satisfaction in PE on children's PA enjoyment varied between boys and girls. These insights are relevant for developing effective strategies to promote positive changes in children's PA and SB patterns (Atkin et al., 2025; Chen et al., 2023; Kretschmer et al., 2023). Furthermore, declines in PA behaviors accelerate during transition to secondary school, reinforcing the need for early interventions (Remmers et al., 2020; van Sluijs et al., 2021).

Our findings showed that girls in grade 6 engaged in MVPA for an average of 48 minutes per day, which is below the recommended 60 minutes. This low level of MVPA remained stable throughout the late primary school years, contrasting with findings from previous studies that reported further declines in girls' PA levels across this period (Atkin et al., 2025; Farooq et al., 2020; Schwarzfischer et al., 2019). Among boys, an undesirable decline in MVPA was observed, decreasing from above the recommended level to below it by the end of primary school. These results highlight the importance of early interventions aimed to make PA a structural component of children's daily routines, particularly for girls (Carrasco-Uribarren et al., 2023; Guo et al., 2025).

Although SB increased with age in both groups, the influencing factors also differed by gender. For boys, MC predicted SB, while PA enjoyment predicted MVPA. In contrast, for girls, both MC and PA enjoyment predicted both SB and MVPA. These findings suggest the potential value of gender-specific intervention strategies. In boys, enhancing MC and PA enjoyment may be key to influencing SB and MVPA, respectively, whereas in girls, strengthening MC and PA enjoyment may be crucial for improving both behavioral patterns.

This dissertation also emphasizes the role of PE teachers in fostering an enjoyable PE environment (Prado-Botana et al., 2023). These findings suggest that teachers should respond to children's experiences within the class, recognizing that similar classroom experiences may not lead to the same outcomes for every child. The feedback and reflection tools developed in this dissertation were intentionally designed from a child-centered perspective, allowing patterns in anonymized child feedback to emerge without predefined subgroup classifications. When interpreting feedback patterns, teachers may consider that some patterns are associated with child characteristics, such as gender, age, or motor competence, and use this information to guide further investigation or adaptations. This perspective can support teachers in identifying adaptations that enhance enjoyable PE experiences at the class level. From the perspectives of the trans-contextual model, it is plausible that such an approach may

also influence PA behaviors in other contexts beyond PE (Polet et al., 2021; Prado-Botana et al., 2023).

5. METHODOLOGICAL CONSIDERATIONS

Although the studies presented in this dissertation were grounded thoughtful methodological choices and demonstrated notable strengths, several overarching considerations must also be acknowledged. These are outlined below.

5.1. Instruments

The studies assessing children's PA levels, SB, MC, PA enjoyment, and perceived satisfaction of BPN during PE, all used validated instruments. The use of standardized instruments enhanced the objectivity, reliability and comparability of the collected data. Accelerometry provides an objective indicator of PA and SB, reducing the subjectivity and misreporting associated with self-reported logbooks (Fiedler et al., 2021). Although a combination of objective and subjective measurements of PA might give a more comprehensive view (Burchartz et al., 2021; Marasso et al., 2021). MC was assessed using the validated Athletic Skills Track, which provides standardized, time-based performance metrics (Hoeboer et al., 2018). PA enjoyment and children's perceived satisfaction of BPN were measured with validated questionnaires (Moore et al., 2009; van Aart et al., 2015).

However, these instruments also come with limitations. Regarding accelerometry, no statistical corrections were made for contextual factors such as seasonality, weather conditions, or day-to-day variations, all of which may influence children's PA levels and SB (Turrise et al., 2021). Moreover, the studies did not account for potential compensatory behavior, such as differences between school days and weekend days, or between school days with and without PE lessons, although previous studies demonstrated that such compensation occurs (Beck et al., 2022; Nigg et al., 2022). In addition, children's participation in organized sports or other activities beyond the school context was not considered, even though this may influence their daily PA patterns. These considerations limit the generalizability of the findings, as PA and SB levels may differ during winter months, on weekend days, or under varying environmental conditions (Harrison et al., 2017; Turrise et al., 2021). Furthermore, limited attention was given to LPA, a category that may offer valuable additional insights into children's everyday activity behavior (Füzéki et al., 2017; Gråstén et al., 2021).

Although motor competence was measured using the validated and standardized Athletic Skills Track, this instrument also has its constraints. The track focuses on stability and locomotor skills, excluding control and manipulative skills. As a result, the AST captures only a part of the broader construct of motor competence (Barnett et al., 2016; Logan et al., 2018; Rudd et al., 2016).

The questionnaires used to assess PA enjoyment and the perceived satisfaction of basic psychological needs, the PACES and the CARR questionnaire respectively, also have limitations. PACES scores were consistently high, raising questions about its discriminative capacity among children with different PA experiences (Chen et al., 2021). Additionally, the CARR did not demonstrate equally strong reliability across all constructs, which may have affected the precision with which autonomy, competence, and relatedness were measured (Martela & Ryan, 2024; van Aart et al., 2015).

More generally, the operationalization of complex constructs such as enjoyment, motor competence, and PA remains a methodological challenge. These constructs are context-dependent and may be interpreted differently by children, teachers, and researchers, which can influence both measurement and interpretation.

5.2. Research population

A second methodological consideration concerns potential bias related to the study population. Children, teachers, and schools were recruited through existing collaborations between teacher education institutes and primary schools, primarily in the south of the Netherlands. Participating schools were in neighborhoods with medium to high socioeconomic status and represented traditional forms of primary school education, for example, no Montessori or project-based primary schools were included. This may limit the generalizability of the findings to other regions and school contexts (Tipton & Olsen, 2022).

Voluntary participation may also have introduced selection bias. Children and teachers who choose to participate in research may be more motivated and may have a stronger affinity for studies on PA, PE, and reflective practice than those who do not participate (Showalter & Mullet, 2017). As a result, the extent to which the findings can be generalized to other regions, school types, and populations may be limited.

Regarding the feedback tool, testing was conducted with children in grades 4 and 6. It therefore remains unclear whether the tool, in its current form, is suitable for younger or older children. Adjustments to the content, format, number of questions, or

response categories may be necessary to ensure usability for primary school children across a broader age range.

5.3. Prototyping

Although the design, prototyping, and initial testing of the feedback and reflection tools provided valuable insights into their perceived usability, the final version of the feedback tool was tested only once on a small scale in its physical form, and the reflection tool was evaluated solely as a mock-up. Consequently, neither tool has been tested on a large-scale or over a longer period in an authentic PE context. Such testing is necessary to determine their practical usability, the support and experiences they offer teachers, and their long-term applicability. According to the Affordance Theory, this is a crucial limitation (Wegerif & Major, 2023; Xue & Han, 2023). The theory states that the effectiveness of a technological tool depends not only on its design, but primarily on how users perceive and use the tool's available features in the PE context. Without long-term practical implementation, it remains unclear whether teachers, who may differ in age, gender, teaching experience, technological experience, perceived technology competence, and type (PE specialist of generalist) perceive digital HCI tools as useful, user-friendly, understandable, accessible, and valuable in supporting them to enhance their teaching (Antonietti et al., 2022; Šabić et al., 2022). This underscores the importance of future longitudinal implementation research to develop a deeper understanding of how its practical use evolves over time and how these experiences can inform the improvement of such feedback and reflection tools for long-term sustainability and meaningful integration in primary school PE.

5.4. Integration of qualitative and quantitative methods

In several studies included in this dissertation (Chapters 4, 5, and 6), exploratory and participatory research methods were employed to obtain practice-oriented insights into the experiences, perceptions, and needs of children and teachers in primary school PE. Although these studies relied on relatively small samples, thereby limiting the generalizability of the findings, this methodological approach (Chand, 2025) offered important advantages. Focus groups with children and teachers provided nuanced insights into the teaching practices they perceive as contributing to children's enjoyment and engagement in PE. Furthermore, interviews focusing on teachers' reflective practices and their involvement in the development of feedback and reflection tools offered a deeper understanding of the PE teaching context, including its complexity, the challenges teachers face, and the types of support they consider meaningful.

This emphasis on exploratory and participatory methods (Amiel & Reeves, 2008; Cumbo & Selwyn, 2022) was essential for capturing the complexity of primary PE, which is

crucial for developing strategies that align with everyday PE teaching practice. Attention to teachers' reflections provided insight into how they interpret pupils' needs, evaluate their own pedagogical approaches, and apply these insights in their teaching. Such understanding offers an important foundation for the development of context-specific and sustainable innovations (Kahts-Kramer & Wood, 2023).

A key recommendation for future research is to integrate objective measurements, such as accelerometry or systematic observations, with qualitative methods. Combining objective behavioral data with pupils' and teachers' subjective perspectives, would offer a more comprehensive understanding of when, where, and how enjoyment is experienced, PA occurs, and motor skills are further developed, as well as the mechanisms that drive these experiences. This integrative approach would provide crucial information on the how, what, where, when, and why of children's physical activity and sedentary behavior, thereby enabling policymakers, practitioners, and designers to develop more effective, responsive, and evidence-informed strategies for stimulating an active lifestyle and fostering enjoyment in primary school PE.

6. RECOMMENDATIONS FOR PRACTICE AND FUTURE RESEARCH

6.1. Recommendations for practice

This dissertation demonstrated teaching practices that children consider essential for enjoying PE. Applying these child-identified teaching practices fosters a child-centered approach to PE that can enhance children's enjoyment, increase MVPA and reduce SB. Many of these practices align with core pedagogical principles such as differentiation, variation, positive communication, exploration, and collaboration. Together, these principles support the development of motor, social and regulatory skills, as well as relevant knowledge and attitudes. Motor skill development within an enjoyable PE environment is particularly important, as higher MC is positively associated with MVPA and negatively associated with SB.

To create an enjoyable PE environment, teachers should identify which teaching practices their pupils value most and how these practices are currently implemented. Addressing gaps between children's perceived importance and actual practice provides actionable insights for pedagogical improvement. Adopting a child-centered approach can simultaneously enhance enjoyment and skill development, contributing to more active lifestyles among children.

6.1.1. Acknowledge the potential gender-specific differences in environmental needs and respond to this accordingly

Girls aged 8 to 12 years engage significantly less in MVPA compared to boys. To reduce this gap, it is important to develop PA-stimulating strategies that are responsive to girls' needs. Given that MC and enjoyment have impact on PA in girls, PE teachers should be attentive to girls' experiences and consider how these can be supported from a young age. PE teachers play a key role by offering lessons that foster enjoyment and motor competence. Teaching practices such as positive communication, constructive feedback, and attention to children's individual learning processes may be particularly relevant for girls, as these practices enhance not only PA enjoyment but also strengthen girls' perceived relatedness with the teacher and competence. Rather than assuming that all girls have the same needs, teachers can use ongoing child feedback and reflection to identify patterns within their own classes and determine whether adaptations are needed to better support girls' experiences. Beyond PE, it is valuable to explore what girls need in other settings, in and outside the school context, to engage in PA with enjoyment and create safe, inviting environments that reflect these needs.

Since MC is associated with MVPA declines in later years of primary school among boys, it is particularly important to address motor skill development during primary school years through targeted PE. By acknowledging that environmental needs may differ between groups of children, including boys and girls (Prado-Botana et al., 2023), and by using child feedback alongside teachers' professional judgement to guide context-specific adaptations, school programs, sports clubs, and community initiatives may better support sustainable increases in PA among children.

6.1.2. Ensure PE policies are aligned with the needs of teachers responsible for PE

Time constraints and low priority limit teachers' reflecting on lessons, and feedback from children and colleagues is rarely used. Structured reflection can help teachers improve PE lessons and better meet children's needs. Therefore, schools should provide sufficient time and accessible, practical and time-efficient resources for reflection. Investing in a culture where teachers are encouraged to evaluate with children and collaborate with colleagues to improve teaching is essential.

Generalists often face policy- and teacher-related challenges, such as limited preparation time, lower confidence, and limited PE knowledge when teaching PE, while PE specialists more often perceive child-related barriers like low motivation and poor concentration. Because these teachers differ in their perceived barriers, it is crucial to identify and address their specific support needs. For generalists, schools are recommended to provide feasible timetables, adequate resources, and training supported by in-service

learning, peer coaching, and collaboration with PE specialists. For specialists, promoting structured reflection and peer collaboration to develop strategies to better engage students and foster enjoyment is recommended. Aligning PE policy and practice requires examining staff composition and differentiating support based on teachers' needs. Policies ensuring adequate PE scheduling, access to expertise, and professional learning opportunities can reduce barriers and enhance teaching quality.

6.1.3. Embedding and strengthening technology supported reflection and feedback informed practice in PE teacher education

PE teacher education programs should ensure that pre-service teachers develop a clear understanding of their responsibility to create enjoyable PE learning environments and of their influential role in shaping children's SB and PA patterns. These programs should teach pre-service teachers how to implement teaching practices that effectively enhance children's enjoyment and how to use these practices as criteria for observation and assessment during internships, enabling pre-service teachers and teacher educators to identify specific areas for professional growth.

Programs should also ensure that pre-service teachers understand the nature and importance of reflective practice, including how children's feedback can deepen and refine their reflections. To support this process, pre-service teachers should be introduced to methods and technological tools that facilitate systematic reflection, such as video-supported reflection tools and digital feedback and reflection platforms, which can enhance their reflective practices during internships and throughout the curriculum.

Embedding structured opportunities for reflection, feedback collection, and the use of technology-supported tools throughout the curriculum can strengthen ongoing professional development. Introducing these elements early in the program fosters a mindset of continuous learning. A feedback-informed, reflective approach can enhance PE teaching quality, increase teachers' responsiveness to children's needs, and promote positive PE experiences that encourage lifelong active lifestyles.

6.1.4. Fostering openness to technology and strengthening collaboration between education and design

When applied thoughtfully and in context-sensitive ways, technological applications can enrich PE and help primary school teachers address pedagogical challenges. To ensure successful implementation, educational technology designers should explore the specific context of primary school PE early in the design process and involve both

teachers and children throughout development and testing, so that solutions align with users' needs and are perceived as supportive.

In addition, primary schools should foster a collaborative culture in which teachers routinely discuss their support needs and share effective practices. By identifying pedagogical needs and aligning them with appropriate technological applications, school can reduce resistance to technological innovation and create opportunities to strengthen professional development and PE teaching.

PE teacher education institutes also play a role. By collaborating with primary schools and technology designers, they can bridge practice, knowledge and research. Integrating technology into their curricula helps pre-service teachers develop design thinking competencies and become familiar with the use of technological possibilities, better preparing them for dynamic, technology rich educational environments.

6.1.5. Invest in facilities that enable teachers to provide enjoyable PE lessons

Primary school teachers, both generalists and PE specialists, consistently report that facility-related barriers make it difficult to provide enjoyable, high-quality PE lessons. To address these challenges, schools and municipalities should consider the location, design, spatial capacity and equipment of gymnasiums when constructing new facilities or upgrading existing ones. Collaboration with PE specialists can help identify specific facility-related barriers such as limited space, poor acoustics, or inadequate equipment and inform solutions. Sufficient budget is also essential to ensure relevant and sustainable improvements, including the provision of appropriate fixed and movable equipment, enabling teachers to provide enjoyable PE.

6.1.6. Providing children with enjoyable environments that promote active lifestyles

It is recommended that schools and educators use the findings of this dissertation to inform not only PE, but also classroom teaching and practices in extracurricular settings such as sports clubs. Although classroom and sport-club contexts each have their own specific context demands, both classroom teachers and sport coaches can benefit from the child-identified teaching practices that enhance PE enjoyment, as they share responsibility for providing engaging and enjoyable learning and training experiences for children.

The rationale also applies to the use of reflective practices, including systematically incorporating child feedback in both classrooms and in sport club contexts. Evaluating lessons and training sessions with children enables teachers and coaches to better

understand their pupils' needs, thereby promoting more effective, responsive and enjoyable learning environments.

The importance of promoting an active lifestyle which is characterized by limited prolonged SB and sufficient engagement in moderate-to-vigorous PA has also been demonstrated. Since children spend most of their time at school, schools play a crucial role in fostering such lifestyles. This goes beyond providing weekly PE lessons. Schools are encouraged to create more dynamic learning environments in which periods of SB and PA are regularly alternated, using context-specific strategies tailored to their own setting.

6.2. Recommendations for future research

6.2.1. Conducting longitudinal implementation research and long-term impact of feedback and reflection tools

Although this dissertation examined a mock-up prototype of a reflection tool to assess its perceived usability and potential among primary school teachers, the tool was not implemented in physical form in daily PE practice. Moreover, the prototype feedback tool was used only once by teachers and children, rather than across a long period. Therefore, longitudinal studies are recommended to investigate the long-term effectiveness and impact of the toolkit's use on teachers' reflective practices. Such research should determine whether ongoing reflection with integrated feedback leads to PE lessons that better align with children's needs for PE enjoyment, improvements in PE teaching, and greater encouragement of teachers' ongoing professional development. In addition, future studies should examine the implementation conditions that enable sustained use in practice, including the optimal frequency of use, integration into existing professional development structures such as professional learning communities, and the use of adaptive feedback cycles. Attention should also be given to potential barriers to long-term use, including habituation, response fatigue, social desirability effects, and limited time for reflection.

6.2.2. Understanding children's gender- and context-specific needs and opportunities for an active lifestyle

Boys and girls differ in how their PA and SB evolve over time, and similar factors can influence these behaviors differently for gender. The same applies to PA enjoyment, as factors can shape boys' and girls' PA enjoyment in distinct ways. Such differences highlight the need for research that provides deeper insight into how PA, SB, and their key determinants can be positively shaped for both boys and girls. Further research should identify gender-specific and context-specific needs and opportunities that can strengthen children's motor competence, PA enjoyment, engagement in PA, and

reduction of SB. This requires examining the daily contexts in which children develop, including schools, sports clubs, neighborhoods and the home environment and evaluating which strategies are effective for boys and for girls, how effectiveness varies across contexts, and how these effects change over time. Gathering such evidence is crucial for developing tailored, context-specific interventions that sustainably promote PA and reduce SB throughout childhood.

6.2.3. Deepen insights into teacher differences in primary school PE

As generalists and PE specialists differ in their use of teaching practices that foster children's PE enjoyment, future research should examine whether these differences occur nationally and across diverse school contexts. Follow-up studies should identify where and why differences emerge, as understanding these underlying factors is essential for designing targeted professional development. Research should also examine how teacher education and in-school support can help both types of teachers implement practices that enhance children's PE enjoyment.

6.2.4. Validating observation criteria for teaching practices fostering PE enjoyment

The child-identified teaching practices contributing to PE enjoyment identified in this dissertation align closely with established theoretical frameworks. This closeness suggests that these identified practices are valuable indicators for evaluating PE teaching, identifying areas for improvement, and enhancing the quality of PE in ways that support children's enjoyment. However, the observation instrument developed based on these practices and categorized into several dimensions, has not yet been validated. A validation study is therefore a logical next step, as well as research examining, for example, the relative weighting of the instrument's dimensions, as some dimensions may be considered more important than others by teachers and children. Future research could also investigate potential gender differences given evidence that girls' need for teacher relatedness is more strongly associated with PA enjoyment than it is for boys.

7. GENERAL CONCLUSION

This dissertation demonstrates that primary school PE has substantial potential to foster children's active lifestyles, characterized by sufficient PA and limited SB throughout the day. Children's experiences within PE can positively influence children's enjoyment of PA, which in turn supports favorable PA patterns. Furthermore, PE lessons provide opportunities to develop motor competence, another critical factor associated with healthier PA patterns.

By unravelling what PE enjoyment means from children's perspectives, this dissertation provides pedagogical practices that both generalists and PE specialists can adopt to align more closely with children's needs for enjoyment. It also shows that the use of technology can enrich PE. Technological tools for feedback and reflection provide the opportunity for teachers to gather meaningful feedback from children and refine their teaching systematically. Thereby encouraging teachers for ongoing professional development, support them to improve their PE lessons and overcome the barriers they face in reflection and teaching PE. Taken together, the findings of this dissertation advance understanding of how PE teachers can foster children's enjoyment in PE and demonstrate how reflective practices—supported by well-designed technological tools—can help teachers improve lesson quality and better meet children's needs. The design considerations identified in this dissertation emphasize the importance of collaboration between designers, teachers, and children to ensure that technological tools are contextually relevant, needs-driven, and useful in practice. To be successful, it is essential to utilize a user-centered, context-specific research-through-design approach.

Based on this dissertation, primary schools and teacher education programs are encouraged to invest in the professional development of in-service and pre-service teachers in the context of PE. Such investment should not only prioritize creating time and providing supportive resources for structured reflection and offering training opportunities tailored to teachers' needs, but also promote a professional culture in which gathering feedback from children on teaching and engaging in constructive dialogue with colleagues about how to improve practice are regarded as essential components of high-quality teaching. Moreover, schools and educational institutions should embrace the integration of technology and pedagogy as an approach to improving PE quality. By doing so, they can help ensure that PE fulfills its potential as a cornerstone for lifelong engagement in physical activity.

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CHAPTER 8

SUMMARIES

1. SUMMARY

Primary school physical education (PE) is widely recognized as a key setting for promoting an active lifestyle among children. PE aims to provide enjoyable physical activity (PA) experiences through which children develop skills, knowledge, and attitudes that support lifelong engagement in PA. Primary school teachers, both generalists and PE specialists, play a central role in creating these experiences. However, meeting the diverse needs of children within the dynamic and complex PE context remains challenging. Understanding why enjoyment in PE matters, and how teachers can foster enjoyable PA experiences, is therefore essential.

Previous research has identified motor competence (MC) and PA enjoyment as key individual factors related to children's PA and sedentary behavior (SB). However, limited insight exists into how these relationships develop over time as how PE teaching practices may contribute to them. Moreover, teachers require insight into how children experience PE lessons to adapt and improve their teaching and to provide engaging and supportive learning environments that foster active lifestyles.

Reflective practices may play an important role in this process. Through reflection, informed by feedback from children and colleagues, teachers can gain insight into their teaching, refine their teaching strategies, and better align their PE lessons with children's needs. Technological tools may support this process by facilitating the collection of children's feedback and structured reflection. However, little is known about how such tools should be designed to be meaningful, acceptable, and useable in the dynamic context of primary school PE, or about the barriers teachers experience in delivering enjoyable PE lessons and engaging in reflective practices.

This dissertation contributes to a deeper understanding of enjoyable PA experiences in primary school PE and the role of teachers in creating these experiences by:

1. Examining the association between primary school children's MC, enjoyment of PA, satisfaction of basic psychological needs (BPN) in PE, and their daily patterns of PA and SB over time.
2. Exploring children's perspectives on teaching practices that foster PE enjoyment and the extent to which these practices are applied by primary school PE teachers, i.e., generalist teachers and PE specialists.
3. Exploring teachers' perspectives on enjoyable PE lessons and reflective practices, how teachers currently engage in reflection, and identifying the barriers they experience in both reflective practices and in delivering enjoyable PE lessons.

4. Identifying design considerations for technological feedback and reflection tools aimed at supporting PE teachers in effectively using reflective practices to improve their teaching and better meet children's needs for PE enjoyment.

Chapter 2 presented a cross-sectional study examining associations between MC, PA, and SB among primary school children. **Chapter 3** reported on a two-year longitudinal study examining associations between MC, PA enjoyment, SB, and moderate-to-vigorous PA (MVPA), as well as the role of children's perceived satisfaction of BPN in PE. MC was negatively associated with SB and positively associated with MVPA, with stronger associations observed among children with MC levels below or above the average. Over time, SB increased and was predicted by PA enjoyment in boys and by both PA enjoyment and MC in girls. Boys' MVPA declined and was predicted by MC, while girls' MVPA remained consistently low and was predicted by both PA enjoyment and MC. Competence predicted PA enjoyment for all children, with relatedness additionally relevant for girls, highlighting PE as a key setting for fostering enjoyment and active lifestyles.

Building on these findings, **Chapter 4** explored children's perspectives on enjoyable PE lessons. Thirty-two teaching practices were identified through several focus groups. These practices were clustered into 10 dimensions that children considered essential for PE enjoyment. PE lesson observations revealed that although teachers applied several of these practices, opportunities for improvement remained, particularly in fostering cooperative learning and supporting children's learning processes.

Chapter 5 and 6 focused on teachers' reflective practices as an essential element of professional development. **Chapter 5** examined teachers' use of feedback and reflection and identified several barriers to reflective practice and to delivering enjoyable PE. Generalist teachers primarily reported barriers such as limited knowledge and preparation time, whereas specialists emphasized child-related challenges. Across both groups, reflection was largely informal and rarely supported by structured feedback from children.

Chapter 6 adopted a user-centered design approach to explore how technology can support teachers' reflective practices. Through an iterative process of development, prototyping, testing and evaluation of a tangible feedback tool and a digital reflection tool, four overarching design principles were identified: efficiency, ease of use, clarity and safety. The prototyped tools were positively evaluated for their usability and practical relevance, demonstrating their potential to meaningfully integrate children's feedback into teachers' professional development.

Overall, this dissertation highlighted the importance of aligning PE teaching practices with children's perspectives and supporting teachers through structured reflection. Technology offered promising opportunities to enhance PE quality and promote enjoyable PA experiences. **Chapter 7** summarized and discussed the main findings of this thesis. It also outlined considerations and implications for research and practice.

2. SUMMARY IN DUTCH

Bewegingsonderwijs op de basisschool wordt beschouwd als een belangrijke context voor het bevorderen van een actieve leefstijl bij kinderen. Het doel van het bewegingsonderwijs is om kinderen plezierige ervaringen te bieden waarin zij vaardigheden, kennis en attitudes ontwikkelen die een leven lang bewegen ondersteunen. Basisschoolleerkrachten, zowel groepsleerkrachten als vakleerkrachten bewegingsonderwijs, spelen een centrale rol in het creëren van dergelijke ervaringen. Tegelijkertijd vormt dit een uitdagende taak, gezien de diverse bekwaamheden en behoeften van kinderen binnen de dynamische en complexe context van het bewegingsonderwijs. Voor leerkrachten is het daarom niet alleen essentieel om het belang van plezier in het bewegingsonderwijs te erkennen, maar ook om te weten hoe zij plezierige ervaringen voor ieder kind kunnen faciliteren.

Eerder onderzoek heeft aangetoond dat motorische vaardigheid en beweegplezier belangrijke individuele factoren zijn die samenhangen met het beweeg- en zitgedrag van kinderen. Er is echter nog beperkt inzicht in hoe deze relaties zich in de loop van de tijd ontwikkelen en welke rol het bewegingsonderwijs hierin kan spelen. Daarnaast is het van belang dat leerkrachten inzicht krijgen in hoe kinderen de huidige gymlessen ervaren. Dit stelt hen in staat hun onderwijspraktijk beter af te stemmen op de behoeften van leerlingen, zodat een leeromgeving ontstaat waarin leerlingen optimaal worden ondersteund en het bevorderen van een actieve leefstijl centraal staat.

Reflectie kan een belangrijke rol spelen in dit proces. Door te reflecteren op hun onderwijspraktijk, onder andere door feedback van leerlingen en collega's te verzamelen en te benutten, kunnen leerkrachten meer inzicht krijgen in hun eigen lesgeven, hun pedagogisch-, methodisch- en didactisch handelen verfijnen en het bewegingsonderwijs beter afstemmen op de behoeften van leerlingen.

Technologische hulpmiddelen kunnen dit reflectieproces ondersteunen door het verzamelen en analyseren van feedback van leerlingen te faciliteren en gestructureerde reflectie te bevorderen. Er is echter nog weinig bekend over hoe dergelijke hulpmiddelen ontworpen moeten worden om binnen de dynamische context van het bewegingsonderwijs in het basisonderwijs als betekenisvol, acceptabel en bruikbaar te worden ervaren. Daarnaast is er beperkt inzicht in de belemmeringen die leerkrachten ervaren bij het bieden van plezierige ervaringen in het bewegingsonderwijs en bij het toepassen van reflectie in hun onderwijspraktijk.

Dit proefschrift draagt bij aan een dieper begrip van plezierbeleving in het bewegingsonderwijs op de basisschool en de rol die leerkrachten spelen in het faciliteren van plezierige ervaringen. De studies in dit proefschrift richten zich daarbij op de volgende subdoelen:

1. Het onderzoeken van de relatie tussen motorische vaardigheid, beweegplezier, de ervaren vervulling van psychologische basisbehoeften in het bewegingsonderwijs, en de ontwikkeling van dagelijkse patronen van fysieke activiteit en sedentair gedrag van basisschoolkinderen.
2. Het verkennen van de perspectieven van kinderen op leerkrachthandelingen die de plezierbeleving in het bewegingsonderwijs bevorderen, evenals de mate waarin deze handelingen door groepsleerkrachten en vakleerkrachten worden toegepast.
3. Het verkennen van de perspectieven van leerkrachten op het belang van plezier in het bewegingsonderwijs en van reflectie op het eigen handelen, hoe leerkrachten momenteel reflecteren op hun handelen, en het identificeren van belemmeringen die zij ervaren bij zowel reflectie als bij het verzorgen van plezierige ervaringen in het bewegingsonderwijs.
4. Het identificeren van ontwerpoverwegingen voor technologische feedback- en reflectietools die leerkrachten ondersteunen bij het effectief toepassen van reflectie, met als doel hun lesgeven te verbeteren en beter aan te sluiten bij de behoeften van leerlingen met betrekking tot plezier in het bewegingsonderwijs.

Hoofdstuk 2 presenteerde een cross-sectionele studie naar de relatie tussen motorische vaardigheid, fysieke activiteit en zitgedrag onder basisschoolkinderen.

Hoofdstuk 3 beschreef een tweejarige longitudinale studie naar de relatie tussen motorische vaardigheid, beweegplezier, zitgedrag en matige-tot-zware fysieke activiteit, evenals de rol van de tevredenheid van psychologische basisbehoeften tijdens het bewegingsonderwijs. De resultaten toonden aan dat motorische vaardigheid negatief samenhangt met zitgedrag en positief met matig-tot-zware fysieke activiteit, waarbij deze relaties sterker waren naarmate de motorische vaardigheid verder onder of boven het gemiddelde lag. Zitgedrag nam toe met de leeftijd en werd bij jongens voorspeld door beweegplezier en bij meisjes door zowel beweegplezier als motorische vaardigheid. De matig-tot-zware fysieke activiteit van jongens nam in de tijd af en werd voorspeld door motorische vaardigheid, terwijl deze bij meisjes consistent laag bleef en werd voorspeld door zowel beweegplezier als motorische vaardigheid. Ervaren competentie tijdens het bewegingsonderwijs voorspelde het beweegplezier bij alle kinderen, terwijl ervaren betrokkenheid daarnaast uitsluitend bij meisjes een significante voorspeller was. Op basis van deze bevindingen werd geconcludeerd dat het bewegingsonderwijs een

belangrijke context vormt voor het bevorderen van beweegplezier en het stimuleren van een actieve leefstijl.

Voortbouwend op deze bevindingen richtte **hoofdstuk 4** zich op de perspectieven van kinderen op plezier in het bewegingsonderwijs. Op basis van focusgroepen werden tweeëndertig leerkrachthandelingen geïdentificeerd, onderverdeeld in tien dimensies, die volgens kinderen essentieel zijn voor plezier in het bewegingsonderwijs. Observaties tijdens gymlessen toonden aan dat, hoewel leerkrachten verschillende van deze handelingen toepasten, er nog mogelijkheden tot verbetering waren, met name op het gebied van coöperatief leren en ondersteunen van het leerproces van leerlingen.

Hoofdstuk 5 en 6 beschreven studies naar reflectie van leerkrachten als een essentieel onderdeel van professionele ontwikkeling. **Hoofdstuk 5** onderzocht het gebruik van feedback en reflectie door leerkrachten en identificeerde verschillende belemmeringen voor het toepassen van reflectie en het bevorderen van plezierige ervaringen in het bewegingsonderwijs. Groepsleerkrachten rapporteerden met name belemmeringen zoals beperkte kennis en voorbereidingstijd, terwijl vakleerkrachten bewegingsonderwijs vooral leerling-gerelateerde uitdagingen benoemden. In beide groepen vond reflectie voornamelijk informeel plaats en werd deze zelden ondersteund door gestructureerde feedback van leerlingen.

Hoofdstuk 6 paste een gebruikersgerichte ontwerpbenadering toe om te onderzoeken hoe technologie leerkrachten effectief kan ondersteunen bij reflectie. Door een iteratief proces van ontwikkelen, prototypen, testen en evalueren van een fysieke feedbacktool en een digitale reflectietool werden vier overkoepelende ontwerpprincipes vastgesteld: efficiëntie, gebruiksgemak, duidelijkheid en veiligheid. De prototypen werden positief beoordeeld wat betreft bruikbaarheid en praktische relevantie, wat hun potentieel illustreerde om leerling-feedback zinvol te integreren in de professionele ontwikkeling van leerkrachten. Dit proefschrift benadrukt het belang van het afstemmen van het bewegingsonderwijs op de behoeften van leerlingen en van het ondersteunen van leerkrachten bij gestructureerde, planmatige reflectie. Technologie biedt veelbelovende mogelijkheden om de kwaliteit van het bewegingsonderwijs te verbeteren en plezierige leerervaringen tijdens de lessen te bevorderen. In **hoofdstuk 7** werden de belangrijkste bevindingen uit dit proefschrift samengebracht en bediscussieerd. Tevens werden implicaties voor zowel onderzoek als praktijk toegelicht.



CHAPTER 9

CLOSING PAGES

1. ABOUT THE AUTHOR

Anoek Adank was born on 2 June 1980 in Breda, the Netherlands. In 2002, she completed her bachelor's degree in Physical Education (PE) at Fontys School of Sport Studies in Tilburg. Driven by a strong interest in human behavior and development, she continued her academic journey at Tilburg University, where she began studying psychology. In 2003, she combined her study psychology with working as a PE teacher at a secondary school. One year later, she started working as a lecturer at Fontys School of Sport Studies, contributing to the education of future PE teachers. In 2005, she obtained her Bachelor of Psychology, with specializations in child and adolescent psychology and neuropsychology. One year later, in 2006, she completed her master's degree in Psychology and Mental Health at Tilburg University. As part of this program, she undertook a traineeship at a residential youth care institution, further strengthening her practical expertise. After completing her master's degree, she continued her work at Fontys School of Sport Studies, where she focuses on the development, coordination, and delivery of curricula for future physical education teachers. In addition, she supervises students throughout their studies. From 2007 to 2009 she was also involved in the research group, contributing to the project Basisschool in Beweging [Primary Schools in Motion]. Within this project, she collaborated with municipalities, municipal health services (GGD), and PE teachers to develop an approach to support schools in promoting children's physical activity throughout the school day. Since 2018, she is part of research group Move to Be at Fontys School of Sport Studies, where her doctoral research forms an integral part of her work. In addition, she collaborates with colleagues and external partners on various projects aimed at promoting physical activity in and around the school, as well as creating optimal PE learning environments. After completing her doctoral study, she aims to continue her work in educating and inspiring future PE teachers, while collaborating with schools and community partners to create supportive environments that foster active lifestyles for all children.



2. LIST OF PUBLICATIONS

2.1. Peer-reviewed international publications

- Adank, A., Bartelink, N., Vos, S., & Van Kann, D. (2026). "Look at yourself": Teachers' reflective practices toward enjoyment in primary school physical education. *Journal of School Health*, 96(1), e70092. <https://doi.org/10.1111/Josh.70092>
- Adank, A., Bloemraad, R., Van Kann, D., & Vos, S. (2025). Reflective practice in primary physical education: Developing context-specific tools and design considerations to support physical education teachers. In T. Ahram, W. Karwowski, & D. Etinger (Eds.), *Human Systems Engineering and Design (IHSED2025): Future Trends and Applications* (Vol. 198). AHFE International. <https://doi.org/10.54941/ahfe1006789>
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2.2. National publications

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- De Vries, E., Adank, A., Leenhouts, J., Timmermans A. C. (2025). *Peil.Sport & Bewegen 2023/2024. Verdiepende studie*. Groningen: GION Onderwijs/Onderzoek.
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- Adank, A. M. (2022, 13 oktober). De gymles als bouwsteen voor een leven lang bewegen. *Sport-knowhowXL*. <https://www.sportknowhowxl.nl/nieuws/de-gymles-als-bouwsteen-voor-een-leven-lang-bewegen>
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- Adank, A.M. (2010). School en ouders: Invloed op het beweeggedrag is een gezamenlijke klus! *Lichamelijke opvoeding*, 11, 10-13.

2.3. International conference contributions

- Adank, A.M. (2025 september). Reflective Practice in Primary Physical Education: Developing Context-Specific Tools and Design Considerations to support PE teachers [presentatie]. Human Systems Engineering and Design Conference, Pula, Kroatië.

2.4. National conference contributions

- Adank, A.M. (2026, 18 maart). *Plezier in bewegingsonderwijs: van belang naar wat werkt in de praktijk* [presentatie]. Inspiratiedag Beweegrijke Basisscholen, Eindhoven, Nederland.
- Adank, A.M. (2025, 20 november). *Plezier in de gymles: wat jij doet maakt het verschil!* [presentatie]. THOMAS Oriëntatie dag, Tilburg, Nederland.
- Adank, A.M. (2024, 27 maart). *Training voor de verdiepende studie* [presentatie]. Peil. Sport en Beweging verdiepende studie, Utrecht, Nederland.
- Adank, A.M. (2023, 23 november). *Dit is wat ik leuk vind! Het bevorderen van plezier in de gymlessen op de basisschool* [presentatie]. Dag van het Sportonderzoek, Groningen, Nederland.
- Adank, A.M. (2023, 28 maart). *Buddy Feedbacktool* [presentatie]. Fontys YES event, Tilburg, Nederland.
- Adank, A.M. (2022, 23 november). *De Buddy in de SALTO-studie* [presentatie]. Dag voor Lichamelijke Opvoeding, Zwolle, Nederland.
- Adank, A.M. (2022, 2 oktober). *Een leven lang bewegen begint bij de basis(school)* [presentatie]. Fontys Share, Eindhoven, Nederland.
- Adank, A.M. (2020, 12 november). Een longitudinaal onderzoek naar beweeg- en zitpatronen van kinderen en de rol van de gymles: draait het allemaal om beweegplezier? [online presentatie]. Dag van het Sportonderzoek, Eindhoven, Nederland.
- Adank, A.M. (2017, 9 november). *Kinderen minder laten zitten, is dat de remedie tegen de afname van motorische vaardigheden?* [presentatie]. Dag van het Sportonderzoek, Den Haag, Nederland.

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