JYU DISSERTATIONS 664

Mikko Huhtiniemi

Students' Motivational and Affective Experiences in Physical Education and during School-Based Fitness Testing, and the Development of Motor Competence and Health-Related Fitness

UNIVERSITY OF JYVÄSKYLÄ
FACULTY OF SPORT AND HEALTH SCIENCES

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ABSTRACT

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Students' Motivational and Affective Experiences in Physical Education and during School-Based Fitness Testing, and the Development of Motor Competence and Health-Related Fitness
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The purpose of this dissertation research was to examine students' motivational and affective experiences in physical education, and particularly during school-based fitness testing sessions. In addition, it was investigated if elements of motor competence and health-related fitness can be developed through a school-based intervention program. This dissertation entity includes four original articles (studies I-IV) and a summary section, where some unpublished results are also presented. Three different datasets were collected from different parts of Finland to answer the research questions. In total, 1472 Finnish 5th and 8th grade students (aged 11 and 14) participated in the studies.

Different theoretical frameworks, concepts, research designs, and methodologies were utilized in the substudies. Generally, study I showed that students' need satisfaction and autonomous motivation are factors that facilitate enjoyment in PE context. The findings of study II revealed that students perceived lower levels of enjoyment and cognitive anxiety, and higher levels of somatic anxiety in fitness testing classes than in general PE. Perceptions of worry were approximately at the same level in general PE and during fitness testing classes. Results indicate that students do not have inflated negative expectations of fitness testing or increased fear of performing poorly in test situations. In study III, the findings showed that task-involving motivational climate and perceived competence were directly associated with enjoyment, regardless of testing content or students' actual performance. Finally, in study IV the results showed that the intervention program was effective in increasing students' motor competence and health-related fitness.

The findings not only provide new insights for international research concerning school-based fitness testing and physical performance development but also inform the development of the physical education curriculum, teaching practice, and the newly introduced national Move! – fitness monitoring system.

Keywords: physical education, fitness testing, affects, motivation, physical performance, adolescents, school

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Huhtiniemi, Mikko
Oppilaiden motivaatio- ja tunnekokemukset koululiikunnassa ja koulun kuntotestitilanteissa sekä oppilaiden motoristen taitojen ja kunnon kehittäminen
Jyväskylä: Jyväskylän yliopisto, 2023, 115 sivua + alkuperäiset artikkelit.
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Tämän väitöskirjakokonaisuuden tarkoituksena oli tutkia oppilaiden motivaatio- ja tunnekokemuksia koululiikunnassa, ja erityisesti kuntotestitilanteiden aikana. Lisäksi tutkittiin, voidaanko oppilaiden motorisia taitoja ja fyysistä kuntoa kehittää kouluissa toteutettavalla interventiolla. Väitöskirjakokonaisuuteen sisältyy neljä alkuperäistä tutkimusartikkelia (osatutkimukset I-IV) sekä yhteenveto-osio, jossa myös esitetään joitakin aikaisemmin julkaisemattomia tuloksia. Tutkimuksessa kerättiin kolme erillistä aineistoa eri puolilta Suomea. Yhteensä 1472 viidennen ja kahdeksannen luokan oppilasta (ikä 11–14) osallistui osatutkimuksiin.

Väitöskirjan osatutkimuksissa hyödynnettiin useita erilaisia teoreettisia viitekehyksiä, konsepteja, tutkimusasetelmia ja menetelmiä. Ensimmäisen osatutkimuksen tulokset osoittivat yleisesti, että oppilaiden psykologisten perustarpeiden tyydyttyminen ja autonominen motivaatio ovat yhteydessä viihtymiseen koululiikunnassa. Toisen osatutkimuksen tulokset osoittivat, että oppilaat kokivat alhaisempaa viihtymistä ja kognitiivista ahdistuneisuutta, ja korkeampaa somaattista ahdistuneisuutta kuntotestitunneilla verrattuna yleiseen koululiikuntaan. Huolestuneisuuden kokemukset olivat samalla tasolla kuntotestitunneilla ja yleisesti koululiikunnassa. Tulokset viittaavat siihen, ettei oppilailla ole erityisiä negatiivisia odotuksia kuntotestitunneista tai lisääntynyttä pelkoa huonosta suoriutumisesta testitilanteissa. Kolmannen osatutkimuksen tulokset osoittivat, että tehtäväsuuntautunut motivaatioilmasto ja koettu liikunnallinen pätevyys olivat suoraan yhteydessä viihtymiseen kuntotestitunneilla, riippumatta testisisällöistä tai oppilaiden mittaustuloksista. Neljännen osatutkimuksen tulokset osoittivat, että oppilaiden motorisia taitoja ja fyysistä kuntoa pystyttiin tehokkaasti kehittämään viiden kuukauden mittaisen interventio-ohjelman avulla.

Väitöskirjakokonaisuuden tulokset tarjoavat lisätietoa koulun kuntotestaukseen ja fyysisen toimintakyvyn kehittämiseen liittyvään kansainväliseen tutkimukseen. Lisäksi tuloksia voidaan hyödyntää koululiikunnan opetussuunnitelmien, käytännön opetuksen sekä fyysisen toimintakyvyn seurantajärjestelmä Move!:n kehittämisessä.

Asiasanat: koululiikunta, kuntotestaus, affektit, motivaatio, fyysinen suorituskyky, nuoret, koulu

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Jyväskylä 24.5.2023

Mikko Huhtiniemi

ORIGINAL PUBLICATIONS AND AUTHOR CONTRIBUTION

This dissertation is based on the following original peer-reviewed scientific publications. The articles are referred to in the text by their Roman numerals. In addition, the dissertation includes previously unpublished results.

I Huhtiniemi, M., Sääkslahti, A., Watt, A., & Jaakkola, T. (2019). Associations among basic psychological needs, motivation, and enjoyment within Finnish physical education students. Journal of Sports Science and Medicine, 18(2), 239-247. https://www.jssm.org/volume18/iss2/cap/jssm-18-239.pdf

II Huhtiniemi, M., Salin, K., Lahti, J., Sääkslahti, A., Tolvanen, A., Watt, A., & Jaakkola, T. (2021). Finnish students’ enjoyment and anxiety levels during fitness testing classes. Physical Education and Sport Pedagogy, 26(1), 1-15. https://doi.org/10.1080/17408989.2020.1793926

III Huhtiniemi, M., Sääkslahti, A., Tolvanen, A., Watt, A., & Jaakkola, T. (2022). The relationships among motivational climate, perceived competence, physical performance, and affects during physical education fitness testing lessons. European Physical Education Review, 28(3), 594-612. https://doi.org/10.1177/1356336X211063568

IV Huhtiniemi, M., Sääkslahti, A., Tolvanen, A., Lubans, D. R., & Jaakkola, T. (2023). A scalable school-based intervention to increase early adolescents’ motor competence and health-related fitness. Scandinavian Journal of Medicine & Science in Sports, Early view, 1-12. https://doi.org/10.1111/sms.14410

Mikko Huhtiniemi was responsible of the overall planning of the dissertation. As the first author of the original publications, considering the comments from the co-authors, he drafted the study questions and designs for the publications, conducted data preparation for statistical analysis, performed statistical analysis with help from a statistician, and took main responsibility of writing the manuscripts. The author was also responsible of all data collections.

FIGURES

TABLES

ABBREVIATIONS

AGT	Achievement goal theory
CRF	Cardiorespiratory fitness
HRF	Health-related fitness
MC	Motor competence
MF	Muscular fitness
MVPA	Moderate-to-vigorous physical activity
PA	Physical activity
PC	Perceived competence
PE	Physical education
SDT	Self-determination theory
TEO	Theory of expanded, extended, and enhanced opportunities

CONTENTS

1 INTRODUCTION

Global physical activity (PA) recommendations set by health experts indicate that school-aged children and adolescents should engage in moderate-to-vigorous physical activity (MVPA) for at least 60 minutes daily (Bull et al., 2020). Although it is widely acknowledged that PA has positive effects on health, the vast majority of adolescents do not meet the current PA guidelines (Guthold et al., 2019; Hallal et al., 2012). The issue of low PA has also raised concerns in Finland. A recent nationally representative accelerometer-based study shows that only 34%, 17%, and 9% of those aged 11, 13, and 15 years, respectively, reached the guideline of at least 60 minutes of MVPA per day (Husu et al., 2023).

Concurrently, negative trends have been documented in young people's health-related fitness (HRF) (Huotari et al., 2022; Fühner et al., 2021; Tomkinson & Olds, 2007) and motor competence (MC) (Jaakkola et al., 2022; Huotari et al., 2018). These findings are alarming, as lowered physical performance in adolescence has been shown to negatively influence several health outcomes, such as body weight (Chagas et al., 2021; Katzmarzyk et al., 2015), metabolic health (Raghuveer et al., 2020; Smith et al., 2014), bone health (Gómez-Bruton et al., 2017), and cardiovascular health (Mintjens et al., 2018). Furthermore, decreased physical performance has been linked to negative development in academic performance (Santana et al., 2016) and mental health (Kandola et al., 2019; Biddle & Asare, 2011).

School physical education (PE) can be a prominent platform for enhancing students' PA engagement, HRF, and MC because it effectively reaches the entire age cohort of youth (García-Hermoso et al., 2020; Neil-Sztramko et al., 2021). In addition, PE offers an ideal context for developing students' perceptions, attitudes, and affects toward physical fitness, MC, and PA because it is implemented by teaching professionals (Sallis et al., 2012). It has been suggested that positive experiences in PE lessons are crucial to evoking students' intentions to be physically active later in their lives (McKenzie, 2007). In fact, enjoyment in PE has been associated with leisure-time PA (Bengoechea et al., 2010). Hence, establishing positive experiences can be seen as one of the most important goals of PE (Chen, 2013).

One commonly implemented curriculum element of school PE is fitness testing (O'Keeffe et al., 2020). It is also a practice that has generated much debate among researchers and practitioners (Cale & Harris, 2009; Jaakkola et al., 2013; Naughton, Carlson, & Greene, 2006; Rice, 2007; Silverman et al., 2008; Simonton, Mercier, & Garn, 2019). Arguments in favor of fitness testing include, for example, that it may have the potential to increase students' awareness of their physical fitness status and their willingness to maintain or increase their PA levels (Harris & Cale, 2006). It has also been suggested that fitness testing may have other positive effects, such as enhanced levels of motivation (Jaakkola et al., 2013). On the other hand, contrasting arguments against fitness testing have also been raised, saying that it can have a negative impact on students' affects, interest in PE, and willingness to be physically active (Lodewyk & Muir, 2017; Cale & Harris, 2009; Rice, 2007). Despite the attention paid by researchers, practitioners, and public health organizations to fitness testing (e.g., Cohen et al., 2015), the majority of the arguments are based on speculative opinions, whereas empirical evidence concerning students' perceptions of fitness testing is limited.

In the Finnish national core curriculum for PE, one of the main purposes of the subject is to support students' physical, social, and psychological well-being (Finnish National Agency for Education, 2014). The core curriculum also highlights the role of reinforcing students' need for autonomy, competence, and relatedness, as well as their intrinsic motivation toward PE and PA. In terms of content and aims, the development of fundamental movement skills, as well as HRF, are among the cornerstones of the subject. From this perspective, the aims of this thesis are deeply connected to the national curricular aspects of PE and therefore provide pertinent information for future development.

In the fall of 2016, following an eight-year development period (Jaakkola et al., 2012), a compulsory nationwide fitness testing system was initiated in Finnish schools. The system called *Move!* is a monitoring and feedback system for MC and HRF targeted at all Finnish 5th and 8th grade students. The system and the data are utilized in schools, particularly in school PE, but also in health care, and in data-informed decision-making at different political and societal levels. Therefore, the Move! system can be seen as a widely influential pedagogical innovation enhancing Finnish students' physical performance, health, and comprehensive well-being. As the system is still relatively new, there are only a limited number of studies connected to the system (e.g., Joensuu, 2021; Pirnes, 2022). The current thesis is the first study to investigate students' perceptions of the Move! testing situations.

Testing students' MC and HRF and providing feedback on the students' physical status is the starting point for the individual development of physical performance. To enhance and guide students' physical development, teachers and schools should be provided with evidence-based implementation models designed to increase PA, fitness, and MC. This is also highlighted by a recent Delphi study, which identified 10 top priorities in fitness research (Lang et al., 2022). One of the key priorities recognized was the need to study and implement feasible and scalable school-based intervention programs to improve and promote fitness among children and adolescents. In the current dissertation, one such program is presented, making it a timely contribution in terms of both practice and research.

In this thesis, different theoretical models and concepts are utilized to study students' motivational and affective experiences in PE and in fitness testing situations, and the development of students' physical performance. In the PE context, the self-determination theory (SDT; Ryan & Deci, 2017) and the concept of motivational sequence (Vallerand, 1997) are utilized to understand the relationships between basic psychological needs, motivational regulations, and enjoyment among students (study I). The hierarchical model of motivation (Vallerand, 1997; see also Goetz et al., 2006) is also utilized when considering the situational context of fitness testing alongside the more general context of PE (study II). Furthermore, the achievement goal theory (AGT; Nicholls, 1989; Ames, 1992) and the concepts of HRF, MC, and perceived physical competence were considered when studying the antecedents of students' affective responses during two fitness testing classes with different content (study III). Finally, the theory of expanded, extended, and enhanced opportunities (TEO; Beets et al., 2016) was utilized in the development of a five-month school-based intervention program targeting the MC and HRF of adolescent students (study IV).

In conclusion, this dissertation is based on four original articles and a summary section. Additionally, some previously unpublished results are presented. Together, they contribute to international research on students' motivational and affective experiences in PE and fitness testing, as well as to research on the development of adolescents' physical performance, especially in the school context. The insights from this thesis can hopefully be utilized in practice, for example, in the development of the Finnish PE curriculum and the Move! system, in pre- and in-service teacher education programs, and in the implementation of PA and fitness development programs in schools.

2 REVIEW OF THE LITERATURE

2.1 Physical education and fitness monitoring in Finnish schools

As this dissertation explores students' experiences of school PE, specifically fitness testing situations, it is vital to understand the context of Finnish schools and PE. Therefore, this section provides an overview of the Finnish school system, particularly from the perspective of PE. In addition, the national fitness and MC monitoring system Move! is described.

2.1.1 Finnish school and physical education

Education is one of the cornerstones of Finnish society. The Finnish school system consists of six main parts (Table 1), from early childhood to tertiary and adult education (Ministry of Education and Culture, 2022). In Finland, education from pre-primary to higher education is free of charge, highly trusted, and equitable (Välimaa, 2021). Generally, the Finnish school has been recognized as a success story, although recently, some concerns regarding the quality and quantity of education have been raised (OECD, 2022; Ahonen, 2020; OECD, 2019; Sahlgren, 2015). According to Sahlberg (2011), the success of the Finnish school system is based on multiple factors, including the requirement of a master's degree qualification for all teachers; the availability of high-quality, equal public schools for everyone regardless of socioeconomic status (less than 2% of Finnish children attend private or state schools [Ministry of Education and Culture, 2022]); small school and class sizes (average school size is 236 students [Nyyssölä & Kumpulainen, 2020], average class size is 19 students [OECD, 2012]); and teachers' ability and willingness for continuous professional development. Teaching, as a profession, is today—and has for several decades been—highly respected, as the recent national review of Finnish educational development highlights (Kalenius, 2023).

Compulsory education in Finland typically starts in the year a child turns seven and ends when one reaches the age of 18 or completes an upper secondary qualification. The current dissertation focuses on the comprehensive school level. This is typically further divided into primary (grades 1–6) and lower secondary (grades 7–9) school levels. At the primary level, all study subjects are usually taught by generalist class teachers with varying amounts of training in PE. However, at the lower secondary level, specialized subject teachers (e.g., PE and health education) are in charge of teaching. In total, there are 2120 comprehensive schools in Finland (Vipunen, 2023), which are almost exclusively maintained by local municipalities.

In Finland, the latest major school reform was carried out in 1972, when the comprehensive basic education, "the Finnish basic school," was formed and began gradual implementation. At the same time, in 1979, Finland became the first country in the world to set a master's degree as a requirement for all teachers (Ahonen, 2020). The educational renewals during the past five decades, including decisions regarding the lesson frame (i.e., the amount of teaching in each subject) and the actual curriculum changes, have been made roughly every 10 years. The Finnish National Agency for Education is responsible for drawing up the national core curriculum, whereas the lesson frame is decided in a political process by parliament.

PE has a long history in Finland. It started as early as 1843 in the form of gymnastics, but as a compulsory subject, it has been taught since 1882. During the past 140 years, PE in Finland has transformed from a narrow selection of particular sports to a holistic concept of well-being (Ilmanen & Voutilainen, 1982). Throughout its history, PE has been an important part of schools. At the moment, it is the third biggest subject after Finnish language and mathematics (Act 793/2018). In the most recent lesson frame reform that effectively started in 2016, the amount of PE was slightly increased, with two additional weekly lessons during the nine-year comprehensive education (Finnish National Agency for Education, 2014). One of the reasons for this addition was the introduction of the Move! monitoring system. After this addition, the average amount of PE during the nine-year comprehensive education has been 100 minutes per week.

TABLE 1 Finnish educational system and amount of PE in primary and lower secondary education. Adapted and modified from the Ministry of Education and Culture (2022). ISCED stands for the International Standard Classification of Education (Unesco, 2012).

ISCED	Duration in years	Educations and degrees	
8		**Doctoral degrees** Universities	
7	2	**Master's degrees** Universities	**Master's degrees** Universities of applied sciences
6	3	**Bachelor's degrees** Universities	**Bachelor's degrees** Universities of applied sciences
4 & 3	3	**Matriculation examination** General upper secondary schools	**Vocational qualifications** Vocational institutes
2 & 1	9	**Primary and lower secondary education** Comprehensive schools *Amount of compulsory PE: 100 min/week (on average).* *Move! measurements during 5^{th} and 8^{th} grade.*	
0	1	**Pre-primary education**	
0	0–6	**Early childhood education and care**	

In the PE curriculum at the comprehensive school level, the main purpose of the subject is to influence students' overall wellness and flourishing by supporting their physical, social, and psychological well-being and a positive attitude toward one's own body (Finnish National Agency for Education, 2014). In total, the PE curriculum describes 13 objectives targeting physical, social, and psychological content areas (Table 2). It is worth mentioning that the specific contents of PE are not dictated in the curriculum, as Finnish teachers have a lot of autonomy when choosing PE activities and methods as long as they follow the learning objectives set in the core curriculum.

TABLE 2 Overview of the aims for physical education in the national core curriculum. Table represents shortened versions of the objectives in grades 7-9. Adapted and modified from the Finnish core curriculum for basic education (The Finnish Agency for Education, 2014).

Physical goals	Social goals	Psychological goals
1. Practicing while giving one's best effort. 2. Skills in making observations and finding solutions; perceptual-motor skills 3. Fundamental movement skills (balance and locomotor skills) 4. Fundamental movement skills (object control skills) 5. Physical fitness (strength, speed, endurance, and flexibility) 6. Swimming and water rescue skills 7. Safe and appropriate actions during physical education lessons	8. Working together with everyone and taking others into account 9. Following the principle of fair play and taking responsibility for shared learning situations	10. Encouraging the student to take responsibility for his or her actions and to support the students' skills in working independently 11. Students' positive experiences of their own body, self-efficacy, and social relatedness 12. Understanding the significance of a physically active lifestyle 13. Information on possibilities for recreational physical activities
"Students are guided in adopting a physically active lifestyle and educated through physical activities"		

Students' assessment in PE is based on the objectives divided into physical, social, and psychological key content areas. In total, there are 13 objectives in the curriculum, of which 10 are considered while giving summative assessments or grades. It is worth noting that the PE curriculum clearly forbids the use of physical fitness test results (i.e., level of fitness) in students' grading. In PE, and more generally in the core curriculum, both formative and summative assessments are used, although the emphasis is on the former. In everyday practice, teachers give formative assessments, that is, feedback, to students in relation to their individual development (assessment for/of learning; see, e.g., Wiliam, 2011; Schellekens, 2021). Summative assessment is based on national criteria and is given at the end of the semester. In addition, students are strongly guided toward self-evaluation (Finnish National Agency for Education, 2014).

It should be mentioned that alongside PE, health education is a separate subject in Finland. This allows more opportunities to teach the cognitive elements and importance of PA and health. Since 2004, health education has been compulsory for grades 7–9, with 45 minutes of teaching every week. In grades 1–6, the content related to health education is taught in a subject group of environment and nature studies (Finnish National Agency for Education, 2004, 2014. In practice, it is common for the same teacher to be responsible for teaching both PE and health education.

2.1.2 Move! – a national monitoring system for physical fitness and motor competence

Move! is a national monitoring and feedback system for physical performance targeted at all Finnish 5th and 8th grade students. The main purpose of the Move! system is to provide systematic feedback to students and their parents on their physical performance, and to collect annual nationwide data on physical performance from the age cohorts of students at 5th and 8th grades (11–15 years old). More specifically, the physical performance in the Move! system has been operationalized to include components of HRF and MC, which are ideally needed during adolescence and later in adulthood.

It is good to acknowledge that Move! is not meant to test the sports performance of students. It is aimed at evaluating whether their MC and HRF are of the level needed for normal daily living. These daily physical tasks were defined during the Move! development process (Jaakkola et al., 2012), and they include walking or cycling to school, carrying one's own schoolbag, and moving efficiently in different environments and surfaces.

The Move! battery includes eight different tests that aim to capture students' MC and HRF through feasible, cost- and time-effective procedures in PE. For example, no additional equipment or special facilities are required. Tests in the Move! include the 20 m shuttle run, five-leaps, throwing–catching combination, curl-up, push-up, and mobility and flexibility tests. The test items and the key elements of the assessments are presented in Table 3. Piloting procedures, psychometric properties, and the formulation of the Move! measurements are described in detail in the final process report (Jaakkola et al., 2012).

TABLE 3 Test items in the Move! battery.

Test concept	Test item	Key elements of the assessment
Cardiorespiratory fitness	20m shuttle run test	Cardiorespiratory fitness, locomotor skills
Motor competence	Continuous five-leaps	Strength of the lower body, speed, dynamic balance skills, locomotor skills
	Throwing-catching combination	Object control skills, upper body strength, and perceptual-motor skills
Muscular fitness	Curl-up	Strength and endurance of abdominal muscles
	Push-up	Strength and endurance of the upper body muscles
Mobility and flexibility	Squat	Mobility of the pelvis area and lower limbs
	Lower back extension	Range of motion of the lower back and hip area joints
	Shoulder stretch (left and right)	Mobility of upper limbs and shoulder area

The Move! process in schools is described in Figure 1. In the beginning of the school year—August through September—PE teachers administer the Move! assessments during routine PE classes. The Move! measurements are carried out by PE teachers because they have the pedagogical and didactical expertise to arrange the measurements in a way that makes the testing situation safe and enjoyable, which contributes to students' motivation for PA. However, it should be emphasized that PE in grades 1–6 is typically taught by class teachers with varying amounts of PE training and experience (Salin et al., 2022b). Teachers may choose to conduct the measures as part of PE lessons or in other parts of the school day, for example, during dedicated movement days. Since the measurements are defined as part of the Finnish core curriculum (Finnish National Agency for Education, 2014), they should be implemented for all 5th and

8^{th} students in general education. Adapted versions are also available for students with special needs (Asunta & Lindeman, 2021).

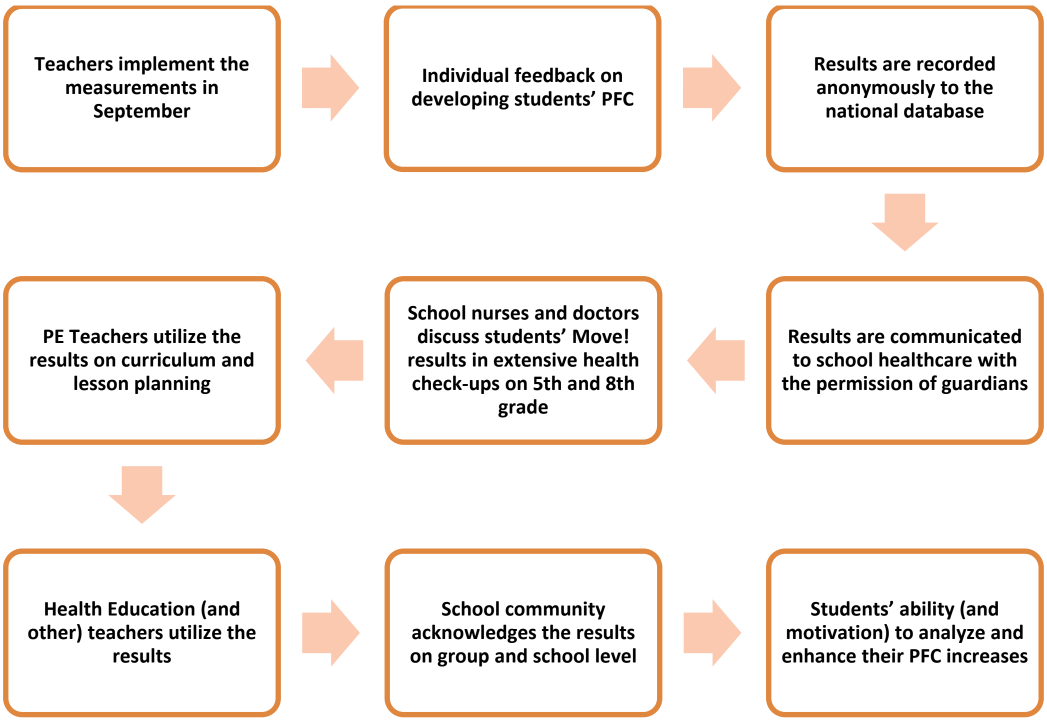

FIGURE 1 The process of the Move! system from schools' perspective.

The Move! test results are used extensively. In schools, PE teachers give immediate feedback to students during and after test sessions. In addition, teachers can utilize Move! data when designing PE programs and lessons, particularly when planning how to differentiate teaching. Students' results are sent home, and parents are encouraged to discuss the results and their implications with their children. Students and their parents are also directed to the Move! web pages, where they are provided with more information about the tests along with guidance on how to develop different elements of physical performance. These contents are available in Finnish and Swedish, the two official languages of Finland, on the Move! web pages (https://oph.fi/move). In addition, the results are transferred to school health care with the consent of the guardians. With their permission, the results are utilized in extensive health check-ups during the 5^{th} and 8^{th} grades, where school nurses and doctors consider students' physical fitness and MC information along with other health data. Finally, PE teachers or other school staff members enter the students' results into the national database through the internet. Through the database, it is possible to follow students' physical performance trends over time. The data can also be used in political decision-making at national and local levels, for example, when promoting PA.

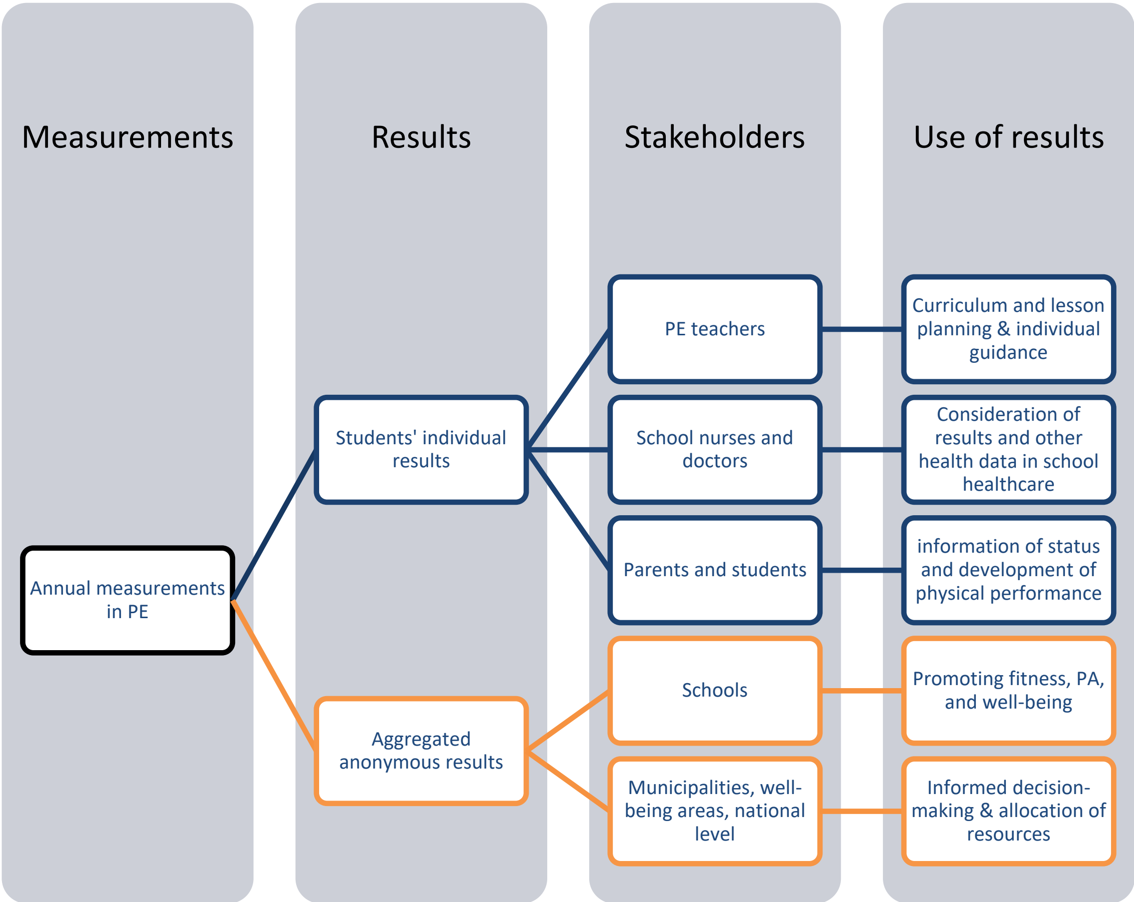

FIGURE 2 The use of Move! information.

Guiding students to adopt a physically active lifestyle is one of the central aims of Finnish school PE. As described above, the aims and activities of the Move! system also align with broader curriculum aims. Motivation is one crucial element influencing the adoption and maintenance of a physically active lifestyle.

2.2 Motivation

Motivation can be described as the driving force of all human actions, providing both energy and direction for different behaviors in achievement situations (Roberts, 2012). Throughout history, many different motivational theories have been developed to understand and predict changes in behavior, learning, and performance (Ryan & Deci, 2017). During the past decades, motivation has been predominantly considered a social–cognitive process where both individual and social factors have crucial roles in determining one's motivation and subsequent behavioral, cognitive, and affective outcomes (Roberts, 2012; Ryan & Deci, 2017). In this dissertation, the social and individual factors of motivation are considered mainly through two prominent social–cognitive theories: achievement goal theory (Nicholls, 1989) and self-determination theory (Deci & Ryan, 1985a; Ryan & Deci, 2017). Additionally, the hierarchical model of intrinsic and extrinsic motivation (Vallerand, 1997) and the competence motivation theory (Harter, 1978) are given consideration.

2.2.1 Achievement goal theory

Achievement goal theory (AGT; Nicholls, 1989) is one of the most widely applied motivational theories in PE and PA settings. The theory was developed to understand how people perceive their success and competence in achievement situations. In essence, the theory consists of two central elements: goal orientations, referring to the perception of one's competence toward an activity, and motivational climate, referring to the perception of the social environment. In this dissertation, only the construct of motivational climate was used.

AGT outlines that individuals may have different goals and aspirations when engaging in activities (Nicholls, 1989). Whereas one person might focus on outperforming others in performance situations such as fitness testing, another might strive for the successful completion of the task and focus on self-improvement. These two motivational goal orientations are specifically called task and ego orientations (Nicholls, 1989). According to the AGT, task and ego goal orientations are orthogonal (Nicholls, 1989). This means that one might perceive a low or high level of ego involvement and simultaneously a low or high level of task involvement while engaging in activities. The theory proposes that goal perspectives are differentially related to affective, cognitive, and behavioral outcomes (Nicholls, 1989). More specifically, task-involving goal perspectives are believed to lead to more adaptive outcomes, regardless of the level of perceived competence. On the other hand, ego-involving goal perspectives lead to more maladaptive outcomes when combined with low perceptions of competence. Previous empirical research has confirmed these propositions in many domains, including sports (Duda & Whitehead, 1998; Jaakkola & Digelidis, 2007) and PE (Liukkonen et al., 2010).

In PA and achievement situations, for example, during PE and fitness testing classes, students' perceptions of the social environment have a significant influence on their motivational and affective experiences (Deci et al., 1994; Ames, 1992; Duda, 1996; Nicholls, 1989). One representation of the social environment that is believed to influence individual motivational processes and subsequent outcomes, such as affect, is the concept of motivational climate (Ames, 1992; Ames & Archer, 1988). The two main elements of motivational climate are task- and ego-involving climates (Ames, 1992). Task-involving climate is characterized by elements such as trying one's best, focusing on learning and self-improvement, showing effort, and working in cooperation with others. Ego-involving climate, on the other hand, is characterized by elements such as social or normative comparison and competition between students, concentrating on outcomes rather than on learning processes (Ames, 1992). Students' motivational climates can be instigated through the actions of both teachers and significant others (Nicholls, 1989).

Previous studies in PE have demonstrated that students' perceived task-involving motivational climate is positively associated with a range of adaptive outcomes, such as perceived competence, enjoyment, and satisfaction with PE classes (Johnson et al., 2017; Gråstén & Watt, 2017; Sevil et al., 2016; Baena-Extremera et al., 2015; Cox et al., 2008). In contrast, students' perceived ego-involving climate has been found to be related to maladaptive outcomes, such as boredom, anxiety, and feelings of less enjoyment (Baena-Extremera et al., 2015; Carpenter & Morgan, 1999; Ommundsen & Kvalø, 2007; Papaioannou & Kouli, 1999). Past studies have also shown that task-involving motivational climate has been found to be positively associated with enjoyment of the PE context (Jaakkola et al., 2017; Jaakkola et al., 2015; Digelidis et al., 2003). In contrast, associations between ego-involving motivational climate and enjoyment have been found to be nonexistent or negative (Digelidis et al., 2003; Liukkonen et al., 2010). Moreover, Harwood et al. (2015) showed in their systematic review that task-involving climate has consistently been associated with a wide range of positive outcomes, such as perceived competence, self-esteem, and intrinsic motivation, whereas ego-involving climate has been associated with negative outcomes, such as amotivation, negative affect, and diminished feelings of autonomy. Despite extensive research attention given to motivational climate, there is a lack of research on motivational climate conducted specifically in PE fitness testing situations.

2.2.2 Self-determination theory

One of the most widely used theoretical frameworks for understanding and explaining human motivation and behavior is self-determination theory (SDT) (Deci & Ryan, 1985a; Ryan & Deci, 2017). At its core, the theory concentrates on basic psychological needs and motivation as a qualitative rather than quantitative construct (Ryan & Deci, 2017; Deci & Ryan, 2000). The theory also highlights social and cultural factors facilitating or threatening one's sense of volition and initiative, well-being, and quality of actions. SDT has received a growing amount of research attention in recent decades (Ryan et al., 2022). This is also illustrated by recent systematic reviews and meta-analyses in multiple different domains, such as education (Bureau et al., 2022; Howard et al., 2021), health (Ntoumanis et al., 2021; Gillison et al., 2019; Ng et al., 2012), sports (Mossman et al., 2022; Chu & Zhang., 2019), PA (Teixeira et al., 2018; 2012; Quested et al., 2017; Owen et al., 2014), and PE (White et al., 2021; Vasconcellos et al., 2020; Chatzisarantis et al., 2003).

SDT comprises six overlapping mini-theories (Ryan et al., 2022; Vansteenkiste, Ryan, & Soenens, 2020), each covering a certain aspect of the wider umbrella theory. The mini-theories have developed gradually over the last four decades as empirical findings have accumulated (Ryan et al., 2022). The first mini-theory, cognitive evaluation theory (Deci & Ryan, 1980; 1985a), concerns the social and individual aspects of intrinsic motivation. The second mini-theory, organismic integration theory (Ryan & Connell, 1989), was formulated to cover different forms of extrinsic motivation and their related internalization process.

The third mini-theory, causality orientation theory (Deci & Ryan, 1985b), examines aspects related to motivational orientations: autonomy, controlled, and impersonal orientation. According to Ryan et al. (2022), SDT evolved into a broader theory of wellness through the introduction of the fourth mini-theory: basic psychological needs theory (Ryan, 1995). The basic psychological needs theory highlights the crucial meaning of the innate needs for autonomy, competence, and relatedness for well-being and overall human flourishing. The fifth mini-theory, goal contents theory (Kasser & Ryan, 1993; 1996; Deci & Ryan, 2017), focuses on different intrinsic and extrinsic aspirations and life goals, and how they afford psychological need satisfaction and wellness. Finally, the sixth mini-theory, relationship motivation theory (Ryan & Deci, 2017), covers the motivational aspects of close social relationships. A recent meta-review of meta-analytical findings demonstrates strong support for theoretical postulations in SDT mini-theories in various domains (Ryan et al., 2022).

Basic psychological needs

According to SDT, people have three basic psychological needs: autonomy, competence, and relatedness, which are defined as essential psychological nutrients for growth, integrity, and well-being (Ryan & Deci, 2017). When these needs are satisfied, people flourish and can sustain their psychological wellness, interest, and development. On the contrary, when these needs are thwarted or frustrated, wellness decreases (Ryan & Deci, 2017; Vansteenkiste et al., 2020). The need for autonomy is defined as a sense of feeling volitional, congruent, and integrated (De Charms, 1968). It is most evidently shown when one's behaviors are self-endorsed and aligned with one's interests and values (Ryan & Deci, 2017). The need for competence can be described as a feeling of effectiveness and mastery when operating in different life contexts and tasks (Ryan & Deci, 2017; White, 1959). The need for relatedness is defined as feeling close, cared for, and connected to the significant individuals in one's life (Ryan & Deci, 2017). The satisfaction of these needs acts as a motivator and source of energy for particular behaviors, such as PA (Ryan & Deci, 2017). For example, students are likely to be more autonomously motivated to participate in activities if school PE helps them to meet or satisfy these needs by increasing their perceptions of efficacy in specific activities (competence), increasing their opportunities to develop interest or value in activities (autonomy), and supporting and encouraging their relationships with their teachers and peers (relatedness) (Ryan & Deci, 2017; Ahmadi et al., 2023). It is noteworthy that for full functioning and well-being, the satisfaction of all three needs is required. Ryan and Deci (2017) illustrated this metaphorically by saying that well-being is like a three-legged stool; remove one support and the stool will fall.

The combination of both need satisfaction and need frustration has been examined in SDT research (Vansteenkiste et al., 2020; Chen et al., 2015; Ryan et al., 2016; Warburton et al., 2020), as it has been demonstrated that both have differentiated effects on various outcomes in educational settings and in school

PE (De Meyer et al., 2014; Haerens et al., 2013, 2015; Sun et al., 2017; Wang et al., 2016). However, in this thesis, only the role of need satisfaction was considered.

Generally, previous meta-analytic evidence has clearly shown that autonomy, competence, and relatedness satisfaction are essential for one's wellness (Ryan et al., 2022). Research in various domains—and specifically in educational and physical domains—has also provided an abundance of evidence concerning the associations between psychological need satisfaction and a multitude of behavioral, cognitive, and affective variables (e.g., Ryan et al., 2022; Vasconcellos et al., 2020). More specifically, needs for autonomy, competence, and relatedness have been positively linked with engagement in PA during PE and leisure time (Cox et al., 2008; Gråstén & Watt, 2017; Chatzisarantis & Hagger, 2009; Lonsdale et al., 2009; Taylor et al., 2010), autonomous motivation toward PE (Haerens et al., 2015, 2017; Vasconcellos et al., 2020), and enjoyment in PE context (Ommundsen & Kvalø, 2007; Leptokaridou et al., 2015; Cox et al., 2008; Cox et al., 2009). Additionally, a systematic review by White et al. (2021) indicated that need satisfaction was associated with increased participation and positive affect in PE. Vasconcellos et al. (2020) conducted a systematic review and meta-analysis in the PE context, which showed that autonomy, competence, and relatedness satisfaction were strongly linked with autonomous motivation.

Previous findings related to gender differences in perceived need satisfaction have been inconsistent. For example, some have found no gender differences in relatedness satisfaction (Mouratidis et al., 2015; Xiang et al., 2017), while some have reported higher levels (Ntoumanis et al., 2009; Ullrich-French & Cox, 2014) and lower levels of relatedness need satisfaction (Gråstén & Watt, 2017) among boys than girls. Furthermore, boys have been found to report higher levels of competence (Wang & Chen, 2022; Mouratidis et al., 2015; Ullrich-French & Cox, 2014) and autonomy need satisfaction (Mouratidis et al., 2015; Soini, 2006) than girls in the PE context.

Motivational regulations

SDT proposes that the satisfaction of innate psychological needs underpins one's motivation in given situations (Ryan & Deci, 2017). However, in SDT, it is also argued that the quality of motivation can vary. According to Ryan and Deci (2017), human behavior can be intrinsically motivated, extrinsically motivated, or amotivated. Intrinsically motivated behavior is present, for example, when a student engages in physical activities and tasks out of pure interest and enjoyment (Deci & Ryan, 1980; 1985a; Ryan & Deci, 2017). Extrinsically motivated behaviors, on the contrary, originate from more instrumental factors, such as punishments, rewards, or peer approval (Deci & Ryan, 2000). Different forms of these more external motives can be divided into four types of extrinsic regulations that are autonomous or controlling to varying degrees.

The more internalized the extrinsic motivation, the more autonomously motivated one will be when engaging in an activity (Ryan & Connell, 1989). Conversely, if internalization is forestalled, behavioral regulation will be more controlled (Ryan & Connell, 1989). Starting from the more controlled perspective, the four types of extrinsic motivation are *external regulation*, where activities are performed for external prompts or factors (e.g., to gain rewards or to get a good grade); *introjected regulation*, where activities are performed through internal pressures or self-set contingencies (e.g., feeling of guilt); *identified regulation*, which reflects behavior that is personally important and valued; and *integrated regulation*, where activities assimilate with personal goals, attitudes, and values (Ryan & Deci, 2017; Ryan & Connell, 1989). In addition, there is a state of amotivation, where the individual has no intention or tendency to engage in certain behaviors or activities without a purpose (Ryan & Deci, 2017). The dynamics of these different motivational types are illustrated in Figure 3.

Amotivation	**Controlled extrinsic motivation**		**Autonomous extrinsic motivation**		**Intrinsic motivation**
	External regulation	Introjected regulation	Identified regulation	Integrated regulation	
*lack of value *nonrelevance	*external rewards or punishments	*focus on approval from self and others	*personal importance *valuing of activity *goals self-endorsement	*congruence	*interest *enjoyment *inherent satisfaction
Impersonal	External	Somewhat external	Somewhat internal	Internal	Internal

FIGURE 3 Motivational regulations based on the Self-Determination theory. Adapted and modified from Ryan, Deci, Vansteenkiste & Soenens (2021).

Previous systematic reviews and meta-analytic evidence have confirmed that more autonomous forms of motivation are linked to adaptive behavioral, cognitive, and affective outcomes, whereas controlling forms of motivation and amotivation to more maladaptive outcomes (Ryan et al., 2022). For example, systematic reviews in PA and PE contexts have shown that autonomous motivation is positively linked to increased PA and the intention to be physically active (Vasconcellos et al., 2020; Owen et al., 2014; Chatzisarantis et al., 2003). Conversely, controlled motivation has been linked to decreased PA levels and the intention to be physically active (Van den Berghe et al., 2014; Ntoumanis & Standage, 2009). Autonomous motivation has also been associated with positive affective experiences, such as enjoyment (Sánchez-Oliva et al., 2014; Gråstén et al., 2012; Yli-Piipari et al., 2012; Cox et al., 2008), whereas controlled motivation has been linked with negative affective experiences, such as boredom, unhappiness, and anxiety (Ntoumanis & Standage, 2009; Cox et al., 2011).

A recent meta-review of meta-analytic findings by Ryan et al. (2022) indicated that gender has not emerged as a significant moderator in SDT-based studies. However, previous research in the PE context has indicated some gender differences in findings related to motivational regulations. For example, in a meta-analysis by Vasconcellos et al. (2020), gender moderated the effects between introjected regulations and amotivation, as well as between introjected regulation and adaptive outcomes in PE. They stated that only a small number of studies included in the meta-analysis analyzed the data between boys and girls separately. Therefore, they called for future studies to provide separate data on boys and girls to allow for investigations of possible gender differences (Vasconcellos et al., 2020).

2.2.3 Hierarchical model of motivation

Vallerand's (1997) hierarchical model of intrinsic and extrinsic motivation is a motivational theory that has been extensively used in PA and PE contexts. The model complements the SDT and proposes that the motivational process and subsequent psychological outcomes, such as enjoyment or anxiety, occur at three levels: global (personality), contextual (life domain), and situational (state). A fitness testing class is an example of a situational level in which motivational and affective perceptions arise from the immediate experiences of involvement in the situation. While the situational level is highly specific, the contextual level represents a more generalized perspective of certain life domains, such as education or sports. One example of a contextual level is PE (Jaakkola et al., 2013). Although not investigated in this dissertation, the model also describes a global level, which is the most holistic and generalized perspective in the hierarchy, and refers to personal tendency in perceiving motivation and subsequent consequences toward life in general. According to the model, perceptions on a certain level of generality affect perceptions on another level of generality. More specifically, the theory suggests reciprocal effects (i.e., top-down and bottom-up effects) between levels next to each other in the hierarchy.

The hierarchical model of motivation (Vallerand & Lalande, 2011) also describes a sequential model and direction of different motivational constructs and resulting outcomes. In essence, the model describes a pathway from social factors (e.g., motivational climate) to basic psychological needs (needs for competence, autonomy, relatedness) to intrinsic motivation, and finally to cognitive, affective, and behavioral contextual consequences (Deci & Ryan, 2017; Vallerand & Lalande, 2011). In this vein, the model can be seen as a bridge between the constructs of the AGT and the SDT.

Vallerand's (1997) hierarchical model has been incorporated into multiple studies that have investigated students' motivational and affective perceptions in different contexts, such as sports (Kowal & Fortier, 2000) and PE (Fernandez-Rio et al., 2022; Fin et al., 2019; Gråstén & Watt, 2017; Jaakkola et al., 2008). Additionally, the concept of different generality levels has been previously utilized when studying enjoyment (Goetz et al., 2006) and anxiety (Zeidner, 1998; Zeidner & Matthews, 2005) in educational contexts. For example, Goetz et al.

(2006) found evidence of the top-down effects of adjacent levels concerning enjoyment constructs in educational settings in a longitudinal study among German students (mean age = 13.8 years). Taken together, it can be used as a framework to study students' affective perceptions in general PE and fitness testing situations.

TABLE 4 Motivational sequence (adapted from Vallerand, 1997)

	Social factors	Mediators	Type of motivation	Consequences
Global level	Global factors	Autonomy	Intrinsic motivation	Affect
		Competence	Extrinsic motivation	Cognition
		Relatedness	Amotivation	Behavior
Contextual level	Contextual factors	Autonomy	Intrinsic motivation	Affect
		Competence	Extrinsic motivation	Cognition
		Relatedness	Amotivation	Behavior
Situational level	Situational factors	Autonomy	Intrinsic motivation	Affect
		Competence	Extrinsic motivation	Cognition
		Relatedness	Amotivation	Behavior

2.2.4 Competence motivation theory

Perceived physical competence can be described as one's own assessment of one's ability to accomplish different tasks in a given domain, such as school, sports, or PA (Fox, 1997). According to Harter's (1978) competence motivation theory, perceptions of one's abilities are formed cumulatively when interacting with the environment. Individuals with high perceived competence (PC) are more persistent in their chosen activities than those with low PC (Harter, 1978). The development of PC occurs concurrently with the development of MC, as children's cognitive capacities to understand their physical abilities develop (Stodden et al., 2008; Harter, 1978).

PC has been recognized as one of the strongest cognitive antecedents of PA engagement in childhood and adolescence (Bai et al., 2015; Babic et al., 2014; Seabra et al., 2013). Additionally, PC has been found to be negatively associated with sedentary behavior among youth (Bai et al., 2015). Moreover, a systematic review and meta-analysis by De Meester et al. (2020) indicated that perceived MC and actual MC are positively associated although the strength of the relationship was found to be low to moderate. Recent longitudinal evidence has also indicated that the development of perceived MC is reciprocally linked with the development of HRF (Gråstén et al., 2022).

In previous studies, higher perceived physical competence has been linked with increased enjoyment of PE lessons (Carroll & Loumidis, 2001; Fairclough, 2003), and lower anxiety, specifically in test situations (Putwain & Symes, 2012). However, there is a dearth of research conducted in a PE fitness testing context that has investigated the relationships between PC and affective outcomes. A rare study was carried out by Lodewyk and Muir (2017) in which they showed that self-efficacy—a central construct of social–cognitive theory (Bandura, 1986) and closely related to PC—was negatively associated with state anxiety and social physique anxiety. In terms of gender, Babic et al. (2014) concluded in a systematic review that sex has been found to moderate the association between PA and physical self-concept.

2.3 Affects

In school PE, as in all life situations, students regularly face both positive and negative affective experiences while engaging in different activities. Two regularly studied positive and negative concepts in school PE are enjoyment and anxiety. In this dissertation, these concepts are distinctively defined yet organized under the umbrella term of affects.

2.3.1 Enjoyment

One example of positive affect is enjoyment, which can be characterized as a multidimensional construct closely related to enthusiasm, excitement, and perceptions of competence (Hashim et al., 2008). According to Scanlan and Simons (1992), enjoyment can be verbalized through terms such as "happiness," "liking," "pleasure," and "fun"; therefore, it is seen to represent these more generalized feelings rather than specific emotions such as excitement. Enjoyment can also be seen as a hierarchically structured concept (Goetz et al., 2006), meaning that one might perceive enjoyment differently, for example, in school PE from specific situations such as in fitness testing.

Previous studies among children and young people have reported enjoyment to be a predictor of PA (Eberline et al., 2018; Gao, 2008), and enjoyment in PA has been shown to positively influence sustained participation in PA settings (Cairney et al., 2012). Enjoyment has also been highlighted as an influential affective outcome for adolescents in a PE context, and evidence demonstrating enjoyment of PE is linked to PA outside of PE (Burns et al., 2017). Evidence suggests that enjoyment of PE has been consistently associated with PA engagement during school PE (Hashim et al., 2008; Dishman et al., 2005) and leisure time (Bengoechea et al., 2010; Hashim et al., 2008; Wallhead & Buckworth, 2004). Moreover, in a review of PA correlates for secondary school students in PE (Zhou & Wang, 2019), enjoyment was found to have a consistent positive association with MVPA time in PE. In a study examining the psychosocial correlates of PA in middle school girls, those with a higher enjoyment of PE had greater odds of participating in structured PA (Barr-Anderson et al., 2007).

Although past studies of enjoyment in fitness testing classes are limited, there is a substantial body of research focused on PE demonstrating consistently high levels of enjoyment among elementary (Carroll & Loumidis, 2001; Huhtiniemi et al., 2019; Jaakkola et al., 2019) and secondary school students (Soini, 2006; Gråstén, 2014). Moreover, previous investigations have revealed differences in PE enjoyment among gender groups. Several studies in Finland and elsewhere have demonstrated higher PE enjoyment levels among boys than girls (Yli-Piipari et al., 2021; Cairney et al., 2012; Carroll & Loumidis, 2001).

2.3.2 Anxiety

The most common negative affect studied in PE is anxiety. Barkoukis (2007) proposed that negative perceptions, such as anxiety, may result from aspects such as social evaluation, peer comparison, and low competence in the PE context. According to Barkoukis (2007), anxiety in PE classes can be explained through somatic symptoms and cognitive symptoms, which can be further divided into worry and information processing symptoms. More specifically, somatic anxiety refers to perceptions of physical symptoms (e.g., "Having shortness of breath"), cognitive processes refer to symptoms related to information processing during the activity (e.g., "I find it difficult to focus on the task presented"), and worry refers to negative expectations related to the activity and the consequences of possible failures (e.g., "I'm afraid of making mistakes while performing the exercises") (Barkoukis et al., 2008). Naturally, many psychosocial factors may trigger responses toward these distinctive manifestations. Factors such as different content areas in PE, class atmosphere, or teachers' interpersonal style may increase or decrease perceptions of anxiety among students (Barkoukis, 2007).

Previous meta-analytic findings have shown that higher levels of PA and sports participation have significant effects on reducing anxiety among children and adolescents (Ahn & Fedewa, 2011; Eime et al., 2013). In a review of reviews, Biddle and Asare (2011) similarly concluded that PA has the potential to decrease anxiety. However, a recent umbrella review of systematic reviews and meta-analyses concludes that there is still little research concerning the links between PA and anxiety among youth (Dale et al., 2019). In addition to PA, different components of fitness have been associated with anxiety. For example, in a recent systematic review of the relationships between physical fitness and mental health (Cadenas-Sanchez et al., 2021), both cardiorespiratory fitness and muscular fitness were negatively associated with adolescents' anxiety.

Studies in PE and educational settings have shown that motivational variables are associated with anxiety. More specifically, controlled forms of motivation have been associated with increased anxiety (Black & Deci, 2000; Cox et al., 2013; Niemiec & Ryan, 2009). Studies have also shown that anxiety is unrelated or negatively linked with task-involving motivational climate (Liukkonen et al., 2010; Papaioannou & Kouli 1999; Cecchini et al., 2001) and positively linked with ego-involving motivational climate (Liukkonen et al., 2010). Cox et al. (2011) also demonstrated that social physique anxiety in PE may lead to diminished PE participation and effort. From a broader educational perspective, a plethora of studies have focused on test anxiety (Von der Embse et al., 2018; Zeidner & Matthews, 2005; Zeidner, 1998; Hembree, 1988), demonstrating negative associations between anxiety and a range of behavioral and affective outcomes. Von der Embse et al. (2018) showed in a meta-analytic review that test anxiety has been negatively related with academic performance outcomes such as grade point average. In terms of gender, previous studies in the broad test anxiety field have clearly indicated that girls report higher anxiety levels than boys (Putwain et al., 2009; Putwain, 2007; Putwain & Daly, 2014; Zeidner & Schleyer, 1999). In the PE context, Danthony et al. (2020, 2019) have reported similar findings.

2.4 Physical performance

2.4.1 Motor competence

In the literature, MC has been used as a global term to describe goal-directed human movement that reflects various other similar terms, such as motor proficiency, fundamental movement/motor skills, motor ability, and motor coordination (Robinson et al., 2015). MC can also be described through the widely used specification of fundamental movement skills by Donnelly and colleagues (2017). These include locomotor (e.g., running and leaping), stability (e.g., dynamic and static balance), and object control (e.g., throwing and catching) skills.

Although MC development is linked to the natural maturation process of children (Vandendriessche et al., 2012; Vandorpe et al., 2012), it has been shown that systematic training and practice are needed for optimal MC progression (Stodden et al., 2008; Barnett et al., 2016; Donnelly et al., 2017). The proficient level and progression of MC builds the foundation for different physical activities and motor behaviors across the life course (Stodden et al., 2018; Hulteen et al., 2018). Previous systematic reviews have found evidence of a link between MC and PA during childhood and adolescence (Robinson et al., 2015; Logan et al., 2015; Holfelder & Schott, 2014; Lubans et al., 2010). However, a recent review of longitudinal evidence by Barnett et al. (2022) concluded that the evidence is nonexistent for the pathway from PA to MC and uncertain for the pathway from MC to PA.

Previous studies and systematic reviews have shown that MC has been consistently linked to several important health-related factors, such as higher cardiorespiratory and muscular fitness (Kolunsarka et al., 2021; Cattuzzo et al., 2016; Barnett et al., 2016), higher PA engagement in organized settings (Holfelder & Schott, 2014), and healthy body weight (Chagas et al., 2021). Moreover, longitudinal evidence based on a systematic review has shown that MC is inversely associated with weight status among children and adolescents (Barnett et al., 2021). In terms of gender differences, a previous systematic review and meta-analysis by Barnett et al. (2016) indicated that boys scored better in object control competence and motor coordination tasks than girls. However, they stated that the covariate effect of sex is uncertain because sex appears to associate differently with various elements of MC (Barnett et al., 2016).

2.4.2 Health-related fitness

HRF can be defined as a multidimensional construct comprising cardiorespiratory fitness (CRF), musculoskeletal fitness (MF), flexibility, and body composition (Caspersen et al., 1985; Ortega et al., 2008). In this dissertation, the focus is on CRF and MF, whereas flexibility and body composition receive only minor attention.

CRF can be seen as the capacity of the body's circulatory and respiratory systems to supply oxygen to skeletal muscles during PA (Caspersen et al., 1985; Ross et al., 2016). The enhancement of CRF may be explained by systematic PA leading to structural and functional adaptations and further to a better oxygen transport system (Raghuveer et al., 2020). MF can be divided into muscle endurance and muscle strength, which are both commonly used in fitness testing among adolescents. Muscle endurance relates to a muscle's ability to perform without fatigue, while muscle strength relates to a muscle's ability to exert force (Ortega et al., 2008; Smith et al., 2014; Marques et al., 2021).

HRF also includes flexibility, which can be defined as the intrinsic property of body tissues that determines the range of motion achievable without injuries at a joint or group of joints (Holt et al., 1996), and body composition, which refers to the body's relative portions of bone, fat, and muscle tissue (Wang et al., 1992). Some have argued that body composition should not be seen as a component of HRF because it is not a performance measure and because it is commonly considered as an outcome of HRF and other variables (Britton et al., 2020). Similarly, the role of flexibility as a core component of fitness has been criticized (Nuzzo et al., 2020).

Evidence has shown that components of HRF, especially CRF and MF, act as important indicators of current and future health (Raghuveer et al., 2020; Ruiz et al., 2009; Ortega et al., 2008). For example, CRF in youth has been found to predict future cardiometabolic health (Lang et al., 2018) and premature cardiovascular disease (Högström et al., 2014). Evidence indicates that CRF is, even as independently from PA, a predictive measure of health outcomes among children (Raghuveer et al., 2020; Ross et al., 2016; Ekelund et al., 2007). In terms of MF, systematic review and meta-analysis by García-Hermoso et al. (2019) indicated that MF in childhood and adolescence is negatively associated with adiposity and cardiometabolic parameters, and positively with bone health in later life. In addition, increasing muscle mass is recognized as an independent marker of metabolic health in children (Cossio-Bolaños et al., 2019).

HRF has been linked with PA engagement (Dencker & Andersen, 2011) and has been found to be the strongest predictor for later PA participation during the transition from primary to secondary school (Britton et al., 2020). Previous systematic reviews considering cross-sectional and longitudinal evidence have demonstrated that HRF is also positively associated with MC among children and adolescents (Barnett et al., 2022; Cattuzzo et al., 2016; Utesch et al., 2019).

2.5 Students' experiences with school-based testing of fitness and motor competence

One commonly applied yet controversial element of school PE is fitness testing (e.g., Simonton et al., 2019; Jaakkola et al., 2013; Cale & Harris, 2009; Silverman et al., 2008; Rice 2007). According to SHAPE (2017), the fundamental aim of fitness testing is to provide students with the necessary knowledge and skills to achieve and maintain a health-enhancing level of PA and fitness (SHAPE, 2017). The aim of the Finnish Move! testing system is also aligned with this statement (Finnish National Agency for Education, 2014). Many teachers consider that by using a variety of different tests, they can provide students with feedback regarding their fitness status and increase students' willingness to become or remain physically active (Harris & Cale, 2006). However, research on students' positive and negative experiences with fitness testing has been scarce. In particular, there is a lack of empirical studies. Nevertheless, arguments in favor of and against school-based fitness testing have been raised.

Previous empirical findings show that fitness testing has been found to be a positive and enjoyable experience and a useful tool to motivate students toward lifelong PA if delivered in an affirming and supportive manner (O'Keeffe et al., 2021; Ashley & Kawabata, 2023). For example, Jaakkola et al. (2013) showed that Finnish students (aged 11–15) reported higher levels of autonomous motivation during fitness testing classes than in the general PE program. However, higher levels of amotivation were simultaneously reported. They also found that students' fitness levels were positively associated with PC, which in turn, was positively associated with intrinsic motivation during fitness testing. Moreover, in a study by O'Keeffe et al. (2021), 13-year-old students from Ireland reported positive attitudes toward and experiences with student-centered HRF testing. Goudas et al. (1994) showed that those students (aged 11–15) who had a high task orientation and low ego orientation had the highest levels of enjoyment regardless of their results in a 20 m shuttle run test. In another study, Garn and Sun (2009) investigated the effects of achievement and social goals on middle school students' (aged 11–15) preparation effort and test performance on the Progressive Aerobic Cardiovascular Endurance Run (PACER). They found that mastery-, performance-, and friendship-approach goals positively influenced either preparation effort or performance and concluded that teachers are advised to increase the achievement and social goals of their students by creating mastery and socially inviting environments for adaptive fitness testing outcomes.

However, several researchers have stated that fitness testing may lead to negative experiences and cause students to be less interested and involved in PE or general PA (e.g., Rice, 2007; Naughton et al. 2006; Corbin, 2002). Recently, Yager et al. (2021) showed that students aged 15 and older may experience a decline in self-esteem due to fitness testing. For example, Lodewyk and Muir (2017) demonstrated that grade 9 girls (aged 14–15) perceived higher levels of state anxiety and social physique anxiety in fitness testing classes than in soccer lessons. Furthermore, Hopple and Graham (1995) reported in their qualitative study that grade 4 and 5 students (aged 10–11) had difficulties understanding the purpose of the 1-mile-run test and that they generally had negative perceptions regarding the test. Additionally, in a study by Luke and Sinclair (1991), Canadian grade 11 boys and girls (aged 16–17) experienced fitness testing unfavorably and reported it as contributing to negative attitudes in the PE context.

Although previous studies have provided valuable insights into students' experiences related to fitness testing, additional investigations are needed for a more detailed picture. For example, previous studies conducted on fitness testing in a PE context have mainly pertained to individual cognitive attributes, such as goal orientations or motivational regulations. In addition, many of the arguments are based on speculative grounds whereas empirical results are scarce. As the prevalence of fitness testing as part of PE curricula worldwide has remained high (Ortega et al., 2023; O'Keeffe et al., 2020; Morrow et al., 2009), additional investigations of students' motivational and affective experiences in fitness testing situations are warranted.

2.6 School-based interventions targeting physical performance

It is reported that the vast majority of adolescents do not meet the current guidelines for PA (Guthold et al., 2020). Concurrently, negative trends have been documented in young people's HRF (Huotari et al., 2022; Fühner et al., 2021; Tomkinson, 2007) and MC (Jaakkola et al., 2022; Huotari et al., 2018). A wide range of actions in multiple domains have been explored to reverse the negative course. School has been identified as one of the most compelling contexts for promoting MC and HRF, as it effectively reaches the entire age cohort of children and adolescents (García-Hermoso et al., 2020; Neil-Sztramko et al., 2021). In addition to the effective reach of the population, schools also have professional teachers and other staff members who can contribute to PA promotion (Sallis et al., 2012) and who can support engagement in PA, regardless of the students' background or socioeconomic status (Love et al., 2019).

Previous studies have demonstrated the potential of school-based interventions to improve students' MC. For example, a systematic review and meta-analysis by Morgan et al. (2013) found that school-based programs delivered by PE professionals can significantly improve children's and adolescents' (aged 5–18 years) fundamental movement skill proficiency (standardized mean difference [SMD] = 1.42, 95% CI = 0.68–2.16). In addition, in a meta-analysis including 56 trials and over 48,000 participants (aged 3–18 years), quality-based PE interventions were positively related to increases in fundamental motor skills (pooled effect size: Hedges g = 0.38; 95% CI = 0.27–0.49) (García-Hermoso et al., 2020).

Previous findings have also shown the positive effects of school-based interventions on young people's HRF. For example, based on a review and meta-analysis study, Villa-González et al. (2023) concluded that school-based activities that include strength exercises may enhance MF among primary school students (aged <13 years). In another review and meta-analytic study (Cox et al., 2020), school-based interventions that targeted MF in adolescent boys (aged 10–12 years) showed small-to-moderate effects. Moreover, Hartwig et al. (2021) showed that PA interventions can modestly improve CRF among 4–18-year-old students based on a pooled analysis of 20 controlled trials (overall effect: 0.47 mL/kg/ min [95% CI 0.33 to 0.61]).

One key factor to consider when evaluating school-based PA interventions is the potential scalability of the programs. From a public health perspective, scaling up effective programs is of utmost importance (Lane et al., 2021). To be scalable, interventions should show effectiveness, have the potential for extended reach, show high acceptability by target groups and settings, and have acceptable delivery costs (Milat et al., 2013; Milat et al., 2016). For any intervention program, the aspects of scalability should be considered prior to first-hand implementation. In the current dissertation, and specifically in the intervention program design, multiple aspects of scaling up were considered. For example, the program was aligned with the school day structure and curriculum, and no additional resources were required.

In summary, previous findings have clearly demonstrated the possibility of school-based interventions in promoting adolescents' MC and HRF. However, more evidence-based programs are needed to reverse the negative trends in PA and physical performance. This argument is further evidenced by a recent Delphi study, which utilized 46 experts in the field to recognize priorities for physical fitness research (Lang et al., 2022). One of the prioritized actions was school-based intervention programs that are effective, feasible, and scalable to wider use.

2.6.1 The theory of expanded, extended, and enhanced opportunities

The theory of expanded, extended, and enhanced opportunities (TEO) (Beets et al., 2016) is a framework for understanding adolescents' PA behaviors. The theory describes a taxonomy to help researchers identify appropriate targets for PA interventions in different contexts. The three elements of TEO include: a) the expansion of opportunities to be active (e.g., breaks during academic lessons), b) the extension of an existing PA opportunity (e.g., a long recess devoted to activity), and c) the enhancement of existing PA opportunities (e.g., increasing the intensity of PE lessons).

The *expansion of opportunities* refers to the introduction of an entirely new PA opportunity. The new opportunity serves to broaden preexisting PA opportunities and correspondingly increase the time to be physically active. Examples of expansion from the literature include the introduction of PA breaks into a classroom environment (Barr-Anderson et al., 2011), the integration of PA into other learning areas such as language and mathematics (Webster et al., 2015), the introduction of before- or afterschool PA opportunities (Garnett et al., 2017), the provision of activity equipment within a classroom (Wendel et al., 2016; Benden et al., 2014), and encouraging active traveling to and from school (McDonald et al., 2015).

The *extension of opportunities* is defined as allocating additional time to an existing PA opportunity (Beets et al., 2016). This can be achieved by adding more time to a scheduled opportunity, such as extending a 20 min recess session to 40 min per day or by adding another opportunity of the same type, such as scheduling PE for three days per week instead of one day per week or providing additional recess breaks per day (Sallis et al., 1997; Brusseau & Kulinna, 2015).

An *enhancement of opportunities* is defined as the modification of an existing PA opportunity to increase the amount of PA accumulated during that opportunity (Beets et al., 2016). Examples include enhancing the quality of a PE lesson (McKenzie et al., 1997) or afterschool programs to maximize the amount of PA that occurs above normal school day practice (Beets et al., 2016; 2015) or enhancing the school building and near environment to make it more physically active (Ickes et al., 2013). Enhancements can involve training teachers to deliver more active lessons, changing curricula to introduce a greater variety of physical activities, acquiring play equipment, or using playground markings to increase youth PA (Lonsdale et al., 2013; Ickes et al., 2013).

The TEO framework has been successfully applied in previous intervention studies targeting PA (e.g., Killian et al., 2022; Brazendale et al., 2020; Jones et al., 2020). In this dissertation, TEO was used as a framework when designing, choosing, and reporting the intervention activities of substudy IV, as it provides a practical and systematic way to understand the program components.

TABLE 5 Practical taxonomy of the theory of expanded, extended, and enhanced opportunities (Beets et al., 2016) to help researchers identify and describe appropriate targets for PA interventions in different contexts.

Theoretical concept	Definition	Examples
Expansion	Substituting low active or sedentary time with more active activities.	- Replacing seatwork in general education classrooms with active learning activities. - Giving students the chance to exercise before or after school.
Extension	Increasing the time currently used for physical activities.	- Providing additional PE lessons per week. - Adding or lengthening active recess sessions
Enhancement	Redesigning the current PA opportunities to increase the amount of PA accumulated weekly	- Designing activities with minimum amount of wait time during PE lessons - Providing equipment for students during recess. - Creating choices among different activity opportunities

2.7 Theoretical underpinnings and rationale of the study

In this thesis, different theoretical models and concepts are utilized to understand students' psychological and affective experiences in PE and in fitness testing situations, and the status and development of students' physical performance. In the PE context, the SDT (Ryan & Deci, 2017) and the concept of motivational sequence (Vallerand, 1997) are utilized to understand the relationships between basic psychological needs, motivational regulations, and enjoyment among adolescent students (study I). When considering the situational context of fitness testing alongside the more general context of PE, the hierarchical model of motivation (Vallerand, 1997; see also Goetz et al., 2006) is utilized, as students' motivational and affective experiences on a general contextual level (PE) might differ from specific situations (fitness testing) (study II). In addition to exploring the differences in students' perceptions between PE and fitness testing situations, it is also important to consider the antecedents of those experiences during specific fitness testing classes. In this dissertation, the AGT (Nicholls, 1989; Ames, 1992) and the concepts of HRF, MC, and perceived physical competence were considered direct or indirect predictors of students' affective responses during fitness testing classes (study III).

This dissertation also explores the development of MC and HRF through a five-month school-based intervention program (study IV). The design of the intervention program is aligned with the TEO (Beets et al., 2016). The three activity components of the intervention can be categorized according to the TEO taxonomy: a) the expansion of opportunities to be active (e.g., breaks during academic lessons), b) the extension of an existing PA opportunity (e.g., a long recess devoted to activity), and c) the enhancement of existing PA opportunities (e.g., increasing the intensity of PE lessons).

The rationale of the current study

Previous studies in the PE context have provided evidence regarding the relationships between basic psychological needs, motivational regulations, and enjoyment (e.g., Leptokaridou et al., 2015; Cox et al., 2008; Ommundsen & Kvalø, 2007). However, no studies have utilized all basic psychological needs and motivational regulations when investigating the enjoyment of PE. For example, in a study conducted by Gråstén and Watt (2017), the variables of motivational climate, basic psychological needs, intrinsic motivation, and affective, cognitive, and behavioral outcomes were examined, but other than intrinsic regulation, no other regulations were included. Therefore, to fill the gaps in the literature, study I utilized the whole motivational process proposed in the SDT (Ryan & Deci, 2017) when explaining students' enjoyment of PE.

A review of the literature reveals that previous studies related to students' affective perceptions in PE fitness testing situations are limited and varied (e.g., Lodewyk & Muir, 2017; Jaakkola et al., 2013; Hopple & Graham, 1995; Luke & Sinclair, 1991). Notably, no studies have examined how students' perceptions of enjoyment and anxiety differ between contextual PE and situational fitness testing classes. Moreover, there is limited evidence about the psychological and cognitive factors predicting affective experiences in PE fitness testing situations. Another aspect that has not been studied is the concurrent mediational roles of perceived physical competence and actual physical performance (Stodden et al., 2008) when predicting students' affective experiences during fitness testing classes. Therefore, studies II and III in this dissertation address previous gaps in the literature and provide further understanding of students' motivational and affective perceptions in the school fitness testing context.

As previously mentioned, the testing of fitness and MC should always lead to the systematic development of these elements. Previous meta-analytic evidence indicates that school-based interventions have the potential to improve young people's HRF (Villa-González et al., 2023; Hartwig et al., 2021) and MC (García-Hermoso et al., 2020; Morgan et al., 2013). However, there is a need for additional programs targeting these attributes in the school context, which are also feasible and scalable to the wider user (Lang et al., 2022). For this purpose, study IV of this dissertation presents the effects of a multicomponent five-month intervention program that was executed during PE lessons, academic lessons, and recess time.

3 PURPOSE AND AIMS OF THE THESIS

The purpose of this thesis was to examine students' motivational and affective experiences in PE, particularly during school-based fitness testing sessions. Additionally, the thesis aimed to explore whether MC and HRF can be developed through a five-month scalable intervention program. The detailed aims of the original studies are as follows:

I To analyze the associations between basic psychological need satisfaction, motivational regulations, and enjoyment among Finnish PE students.

II To investigate whether students' perceptions of anxiety and enjoyment differed among PE in general and two distinct fitness testing classes. In addition, the measurement invariance over time and between 5^{th} and 8^{th} grade student groups was determined.

III To study the associations among task- and ego-involving motivational climates, perceived physical competence, physical performance, enjoyment, and anxiety during two PE fitness testing classes with different content.

IV To assess the effectiveness of a scalable five-month multicomponent school-based quasi-experimental intervention program on adolescents' MC and HRF.

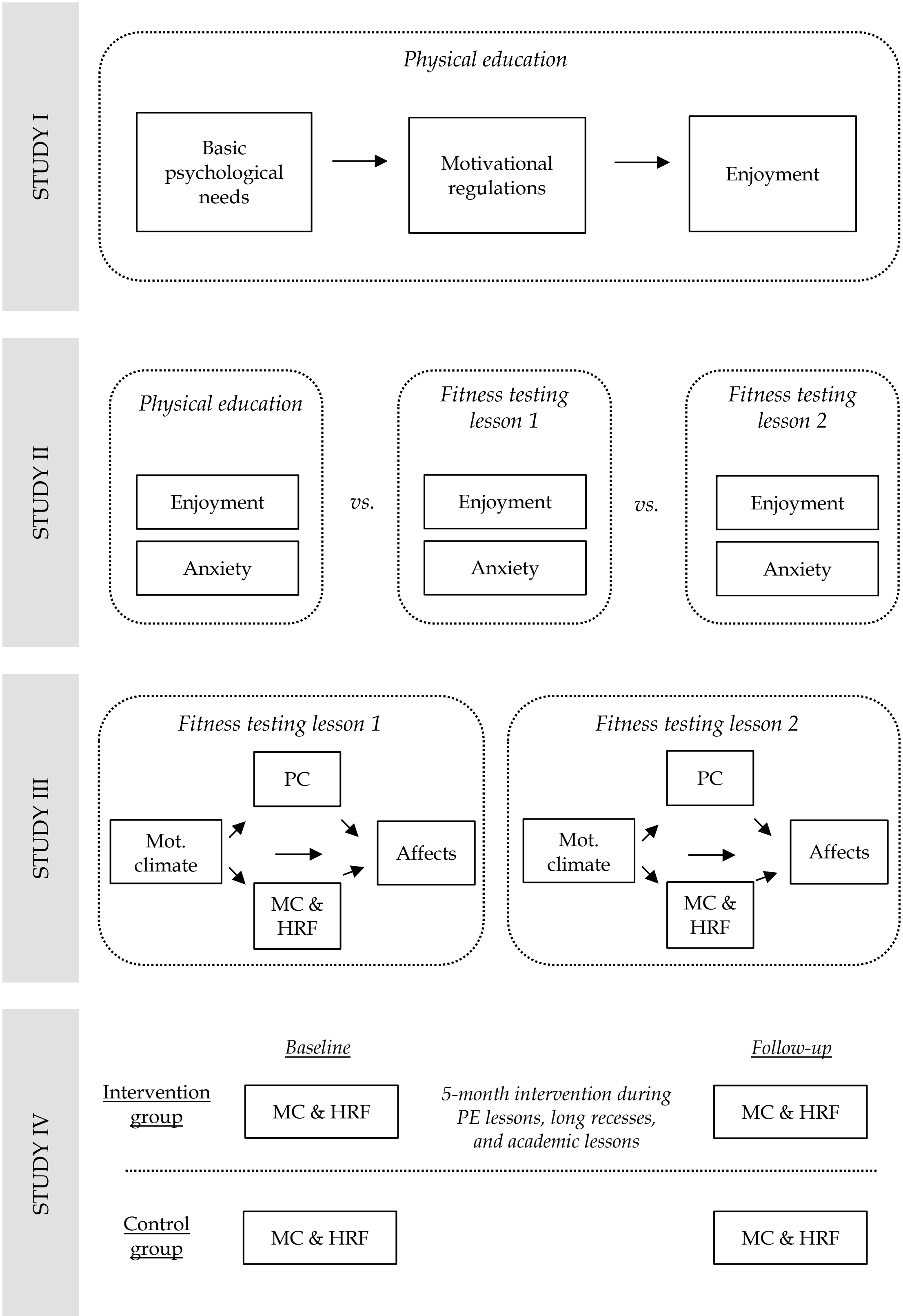

FIGURE 4 Operational framework of the study.

4 MATERIALS AND METHODS

This research was connected to a larger study, "Associations between Move! - Monitoring and feedback system for physical functioning capacity and Finnish students' physical performance, physical activity engagement, and motivation in physical education," funded by the Finnish Ministry of Education and Culture, and led by Professor Timo Jaakkola from the University of Jyväskylä. In addition to students' perspectives, that research project investigated teachers' and school nurses' experiences related to the Move! system, and more broadly, the development of students' physical performance and PA (Salin et al., 2022a; Salin et al., 2022b; Salin et al., 2021). In this dissertation, only the students' perspectives were considered. The author of this dissertation was responsible for the data collection of the larger research project in addition to the data collection of this dissertation.

4.1 Participants and data collections

Different datasets were utilized in the four studies in this thesis. In addition to the data used in the original articles, piloting data was collected.

In study I, a cross-sectional sample was used. Participants in the study were 5th grade (130 boys and 130 girls, mean age 11.86 years, SD=0.28) and 8th grade (109 boys and 133 girls, mean age 14.93 years, SD=0.37) students from Central and Southern Finland. Data was collected via questionnaire prior to regular PE classes. The researcher administered the questionnaire, and the students had an opportunity to ask if they had trouble understanding some of the questions.

Studies II and III utilized the same dataset collected from different parts of Finland. The studies used a short-term longitudinal design with three data collections a few weeks apart. In total, participants were 645 Finnish 5th and 8thgrade students recruited from 36 classes and 12 schools in the Southern, Western, and Central regions of Finland. Invitations to participate were sent to schools, and those willing to participate were recruited for the study. Schools represented both urban and rural areas and followed the national core curriculum with no optional study lines (e.g., sports or math emphasis). Teachers in the 8th grade were all specialized in PE, whereas the 5th grade teachers were generalist class teachers with basic training in PE. The sample of 5th grade students included 164 boys and 164 girls with an average age of 11.2 years (SD = 0.36), and the sample of 8th grade students included 150 boys and 167 girls with an average age of 14.2 years (SD = 0.35). The sample was comprised of students who were engaged in the regular school program and followed the national curriculum. All the students were eligible to participate, yet the sample did not include any students with disabilities or special education needs.

Study IV utilized a quasi-experimental intervention design with pre- and post-tests, and one intervention group and control group. Participants were 325 Finnish 5th grade students (baseline mean age = 11.26, SD = 0.33) from Central Finland. The participants represented five schools and 16 classes. At the beginning of the study, schools were randomly allocated to the intervention and control groups. The intervention group consisted of 157 students (78 boys and 78 girls; one student did not want to share information about gender) from two schools and seven classes. The control group consisted of 168 students (81 boys and 83 girls; four students did not want to share information about gender) from three schools and nine classes. The study schools represented typical Finnish elementary schools, and they shared many similar attributes. All schools were similar in size, had similar indoor and outdoor facilities for PA, followed the same national curriculum, had teachers with similar (master's level) education and teaching experience, and had similar student populations (e.g., ethnicity mostly white and drawn from similar neighborhoods).

4.2 Study ethics

In all parts of the study—during recruitment, data collection, analysis, and reporting—the researcher and research assistants followed the practices of good scientific behavior. The principles of the Declaration of Helsinki (World Medical Association, 2021) guided the activities in all the studies of this dissertation. Because the research involved children and adolescents, special attention was given to ethical processes and the United Nations Convention of the Rights of the Child. Ethical questions were also considered, following the advice of the National Advisory Board on Research Ethics. Prior to the beginning of the studies included in this dissertation, the ethics committee of the University of Jyväskylä, Finland, approved the study protocols.

In all substudies, the research aims, methods, and participant requirements and rights were carefully described to students and their guardians. Participation was completely voluntary. Students had the right to withdraw their participation at any time without facing any consequences or questioning. Written active consent was obtained from the students' legal guardians prior to their child's participation in the study. Additionally, the students' assents were confirmed before the data collection.

4.3 Measures

The different instruments used in this thesis are described below. It should be emphasized that certain scales were used at different levels of generality, specifically in PE and during fitness testing classes. Table 6 summarizes the measures in substudies I–IV.

TABLE 6 Overview of the main measures used in different substudies.

Measure	Study	Origin of the measure
Motivational climate in PE	II, III	Soini et al., 2014
Motivational climate in fitness testing classes	II, III	Soini et al., 2014
Basic psychological needs in PE	I	Vlachopoulos et al., 2011a
Basic psychological needs in fitness testing classes	II, III	Vlachopoulos et al., 2011a
Motivational regulations in PE	I	Vlachopoulos et al., 2011b
Motivational regulations in fitness testing classes	II, III	Vlachopoulos et al., 2011b
Enjoyment in PE	I, II, III	Scanlan et al., 2016
Enjoyment in fitness testing classes	II, III	Scanlan et al., 2016
Anxiety in PE	II, III	Barkoukis et al., 2005
Anxiety in fitness testing classes	II, III	Barkoukis et al., 2005
Cardiorespiratory fitness	III, IV	Léger 1982; Léger 1988
Muscular fitness	III, IV	Jaakkola et al., 2012
Flexibility and mobility	II	Jaakkola et al., 2012
Body composition (BMI)	IV	
Motor competence	III, IV	Jaakkola et al., 2012
Perceived physical competence	III	Fox and Corbin, 1989

4.3.1 Motivational climate

The motivational climate during fitness testing classes was measured using the Finnish version of the Motivational Climate in Physical Education Scale (MCPES; Soini et al., 2014). The scale items were modified to reflect the situational fitness testing class. The scale includes four dimensions: autonomy climate (5 items; e.g., "Students are given the opportunity to affect the way classes are run"), relatedness climate (4 items; e.g., "Our class has a good sense of unity"), task-involving climate (5 items; e.g. "Learning new things makes me want to learn more"), and ego-involving climate (4 items; e.g. "During the fitness testing class students compete with each other in their performance"). Items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). In the questionnaire, the following item stem was used: "During the fitness testing class...” The Finnish version of the MCPES has been found to produce valid and reliable scores when used with adolescent students (aged 14–15) during PE classes (Soini et al., 2014).

4.3.2 Basic psychological needs

The Finnish version of the Basic Psychological Needs in Physical Education scale (BPN-PE; Vlachopoulos et al., 2011) was used to measure the extent of the participants’ fulfillment of the needs for autonomy, competence, and relatedness in PE. The scale includes 12 items that tap into the satisfaction of autonomy (4 items; e.g., “PE class is taught the way I like it to be taught”), competence (4 items; e.g., “I am able to do well even in the PE classes considered difficult by most kids in my class”), and relatedness (4 items; e.g., “I feel like I have a close bond with the other kids in my class.” Items were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Evidence for the validity and reliability of the BPN-PE scale has been demonstrated among Greek elementary school (aged 11–12), middle school (aged 13–15), and high school (aged 16–18) students in the PE context (Vlachopoulos et al., 2011a). As the scale had not been previously used in the Finnish language, it was translated using the back-translation procedure, as suggested by Brislin (1986).

4.3.3 Motivational regulations

To measure the motivation for PE participation, the Finnish version of the Revised Perceived Locus of Causality Scale (PLOC-R; Vlachopoulos et al., 2011b) was used. The scale uses the following stem: “I take part in PE…” and comprises 19 items, which measure students’ amotivation (4 items; e.g., “But I really don’t know why”), external regulation (3 items; e.g., “So that the teacher won’t yell at me”), introjected regulation (4 items; e.g., “Because it would bother me if I didn’t”), identified regulation (4 items; e.g., “Because it is important to me to try in PE”), and intrinsic regulation (4 items; e.g., “Because PE is fun”). Items were rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Vlachopoulos et al. (2011) have demonstrated initial evidence for the validity and reliability of the instrument among elementary (aged 11–12), middle (aged 13–15), and high school (aged 16–18) students in the PE context. The scale was translated using a back-translation procedure, as suggested by Brislin (1986), because it has not been previously used in the Finnish language.

4.3.4 Motor competence

The students’ MC was measured using two test items obtained from the Move! battery: the five-leap test and the throwing-catching-combination test (Jaakkola et al., 2012).

The students’ *locomotor skills* were measured using the five-leap test (Nupponen et al., 1999 Jaakkola et al., 2012). The five-leap test consists of five consecutive jumps with a joined foot position at the start. Following the first jump with two legs, one takes four strides, starting with the preferred leg, and continues using the other leg. After the strides, the landing is performed with both legs in a parallel position. The score is measured from the front edge of the participant's feet at the starting position to the rear edge of the feet at the final position (cm). Participants were given two practice rounds, and two actual trials. Previous studies have reported satisfactory test–retest reliability (ICC = 0.85) among 13-year-old adolescents (Nupponen et al., 1999). Jaakkola et al. (2012) reported intraclass correlations (girls 0.54 [p = 0.045]; boys 0.96 [0.000]), which supported the reliability of the five-leap test among 15-year-old adolescents.

Students' *object control skills* were measured using the recently developed throwing–catching combination test (Jaakkola et al., 2012). In the throwing–catching combination test, one throws a tennis ball to a specified target area on the wall (sized 1.5 × 1.5 m and situated 90 cm above the floor level) from a given distance (7 m for 5th grade girls, 8 m for 8th grade girls and 5th grade boys, and 10 m for 8th grade boys) and catches the ball after one bounce from the floor. Both tests have been proven to produce reliable and valid scores among adolescents (Jaakkola et al., 2012). The test has shown acceptable test–retest reliability (ICC = 0.692, p = 0.000) among adolescents (Jaakkola et al., 2012).

4.3.5 Health-related fitness

Students' *cardiorespiratory fitness* was measured using the 20 m shuttle run test (Jaakkola et al., 2012; Léger et al., 1988; Léger et al., 1982), also known as PACER (Plowman & Meredith, 2013). In the test protocol, participants are asked to run laps back and forth between two parallel lines 20 m apart. An audio recording paces the participants, starting at a speed of 8.0 km/h with an incremental increase of 1.0 km/h after the first minute and 0.5 km/h every minute thereafter. Participants continue until they are no longer able to maintain the pace set by the audiotape for two consecutive laps, at which point their score is recorded. The score was the number of shuttles completed (Jaakkola et al., 2012). The 20 m shuttle run test is a widely used field-based measurement of CRF and motor skills that has been utilized in many previous studies (Tomkinson et al., 2017). Moreover, previous studies have indicated a strong test–retest reliability and moderate-to-strong validity for the 20 m shuttle run test as a measurement of CRF and VO^2max.

Muscular fitness was measured using push-up and curl-up tests (Plowman & Meredith, 2013). In the push-up test, participants were asked to keep a straight line from the toes to hips and hips to shoulders, lower their body so that the elbows were bent to 90 degrees, and push back up to the start position, which was considered one repetition. In the start position (up), the palms and toes (boys) or the palms and knees (girls) touched the floor. The test score was the correctly completed repetitions in 60 seconds. In the curl-up test, participants were lying on their backs on the gym mat, with knees bent at about 100 degrees. The heels were attached to the floor, and the feet were slightly apart. Hands were kept next to the body and head on the floor. The curl-ups were performed by activating the abdominal muscles so that the upper body rose from the floor and the fingers slipped between the marked area on the floor. Participants were asked to follow the pace of the audio tape, and breaks were not allowed. The score was the number of repetitions (max 75 reps). These MF tests have shown adequate reliability and validity in a sample of Finnish adolescents (Jaakkola et al., 2012).

Flexibility was measured using three static positions: squat, lower back extension, and left and right shoulder stretch (Jaakkola et al., 2012). Scoring was dichotomous (successful or unsuccessful). *In the squat*, students stand in an upright position with arms raised and squat to at least 90 degrees knee angle. The performance is successful if their backs are extended, knees are behind the toe line, hip angle is above 45°, heels stay on the ground, and feet and knees are shoulder-width apart. *In the lower back extension*, the students sit on the floor with both legs extended and try to straighten their lower back while maintaining the position. *In the shoulder stretch*, students stand in an upright position and attempt to put their fingers together behind their backs by flexing the other arm from above (elbow up) and the other one from below (elbow down). Both sides were tested (Jaakkola et al., 2012). Flexibility measures were part of the testing protocol in substudies II and III. However, scores were not used in the analysis.

The students' *body mass index* (BMI) was calculated using a weight (kg) and height (m) formula (kg/m2) (Nuttall, 2015). The height was measured to the nearest 0.1 cm using portable measuring equipment. Body weight was measured to the nearest 0.1 kg using calibrated scales for children in light clothing and bare feet. Both measurements were conducted by the researchers.

4.3.6 Perceived physical competence

To analyze students' perceived competence toward PA, the Finnish version of the sports competence dimension in the Physical Self-Perception Profile (PSPP; Fox & Corbin, 1989) was used. The scale comprised five items that were each rated on a five-point Osgood scale, from 1 = I'm among the best when it comes to athletic ability to 5 = I'm not among the best when it comes to athletic ability. The individual item stem of the scale is as follows: "What am I like?" The Finnish version of the perceived competence scale has been found to produce valid and reliable scores when used among adolescent students (aged 11–17) (Gråstén et al., 2022).

4.3.7 Enjoyment

The Finnish version of the enjoyment subscale from the Sport Commitment Questionnaire -2 (SCQ-2; Scanlan et al., 2016) was used to measure the enjoyment of PE. The scale comprises five items (e.g., "Physical education is fun") rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The respondents were asked to think about their overall PE experiences. The validity and reliability of the enjoyment scale have been previously reported when used with Finnish 13-year-old students during PE classes (Kalaja, 2012).

Enjoyment during fitness testing classes was measured using the same SCQ-2 enjoyment subscale, as described earlier, with the exception of different situational specific wordings of items (e.g., “This fitness testing class was fun” versus “Physical education is fun”). These revisions were made to emphasize the change from contextual PE to fitness testing situations.

4.3.8 Anxiety

The Finnish version of the Physical Education State Anxiety Scale (PESAS; Barkoukis et al., 2005) was used to measure anxiety in PE. The scale assesses three dimensions of anxiety: somatic anxiety (6 items; e.g. “I have a sense of pressure on my chest”), cognitive processes (6 items; e.g. “I find it difficult to focus on the task presented”), and worry (6 items; e.g. “I'm afraid of making mistakes while performing the exercises”). Each dimension is rated on a five-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The Finnish version of the PESAS has been shown to produce valid and reliable scores when used with adolescent students (aged 11–12) in the PE context (Liukkonen et al., 2010).

Anxiety during the fitness testing class was measured using the PESAS scale, apart from using a different stem (“During this fitness testing class…”), emphasizing the change from contextual PE to a fitness testing situation. These revisions were made to emphasize the change from contextual PE to a fitness testing situation.

4.4 Intervention activities and measures

The intervention program in study IV was designed to increase students' HRF and MC through weekly guided activities. The chosen activities or intervention components were aligned with the TEO (Beets et al., 2016). The intervention program was active for five months, beginning in October and ending in March. In total, after excluding the usual holiday breaks, the program activities ran for 18 active weeks, with 65 minutes of structured content weekly.

The research team was responsible for implementing the program. Fifth-year master's degree students from the local university's PE teaching education program instructed on the activities after completing a training session. All games, tasks, and exercises chosen for the program were relatively easy to instruct and required no special equipment or facilities. To enable students with high and low fitness and skill levels to participate at the optimal level, the activities included a lot of variation and optionality.

The intervention had three major components linked to the TEO (Beets et al., 2016), and all contained different activities, games, and tasks that systematically developed different elements of HRF and MC. The first component was *PE lesson activation:* a weekly 20-minute unit that was implemented at the beginning of students' regular 90-minute physical education (PE) lesson. Two trained researchers instructed on the component. The second component was *recess activation*: a weekly 20-minute recess activity implemented once a week during students' regular recess time. The effective time for physical activities was maximized, as the students were instructed for the session at the end of the preceding lesson. Again, two trained researchers instructed on the activities. The third component was *academic lesson activation*: daily five-minute activity breaks organized during regular lessons. The research team was responsible for designing the activities and the detailed instruction notes. The students' own teachers followed the written instructions and education given by the research team and instructed the activities during lessons. A more detailed description of the intervention activities can be found in the original article (substudy IV).

Baseline measures were performed in September for the intervention and control groups. Two weeks after the baseline measures, the predesigned intervention program commenced. The program was aligned with the normal yearly schedule of the schools. One week after the end of the intervention program, in April, follow-up measurements were conducted for both groups. All measurements were administered by the members of the research group for both the intervention and control groups at baseline and follow-up. Tests were performed in an indoor hall during a 90-minute class in the following order: 1) throwing–catching combination test, 2) five-leap test, 3) curl-up test, 4) push-up test, and 5) 20 m shuttle run test. The students' heights and weights were also recorded. Moreover, a questionnaire was administered during a regular school class to record the students' background information and other data.

In addition to the measures reported in substudy IV, accelerometer data was collected from the intervention and control group students. The students wore accelerometers for seven days before and after other measurements. However, this PA data was not used in the analysis but will be published separately.

4.5 Statistical approaches

A brief overview of the statistical methods used in the different studies of the thesis is provided in this section. For further information, please refer to the original articles. In all studies, preliminary and basic analyses (e.g., normal distributions, means, outliers) were performed with SPSS software (IBM, 2016) and all further analyses with Mplus software (Muthén & Muthén, 2017).

In study I, confirmatory factor analysis (CFA) and Cronbach's alpha coefficients were used to examine the construct validity and reliability of the scales. Analyses of the relationships among the study variables involved the determination of Pearson's correlation coefficients and the use of structural equation modeling. Multigroup structural equation modeling (SEM) was used to analyze whether the associations between the study variables varied between boys and girls in different age groups. The mean- and variance-adjusted weighted least squares estimation method (WLSMV) was applied in the analysis. Squared multiple correlations were used to calculate the proportion of explained variance of the dependent variables. The equality of the coefficients between the models was compared using the χ^2 difference test (WLSMV difference testing).

In study II, statistical analyses were performed using Mplus (Muthén & Muthén, 2017) and implementing the robust full-information maximum-likelihood (MLR) estimation method. A series of multigroup confirmatory factor analyses (CFA) were conducted to test the measurement invariance across groups (5th and 8th grade) and over time (general PE, fitness testing class 1, fitness testing class 2). Measurement invariance is a precondition for investigating latent mean differences among the study variables, and it involves incorporating increasingly stringent steps to constrain different model parameters (Kline, 2015). In essence, it provides evidence of the degree to which the scale or measure functions in a similar way over time and across groups. After evaluating the measurement invariance, the mean differences in the latent constructs were investigated. With repeated measures, the mean of a latent variable is usually set to 0 in one group or time point (as a reference) and freely estimated in other groups or time points (Muthén & Muthén, 2017). However, in this study, a model constraint was applied, setting the sum of item intercepts over time and across groups to 0 in order to estimate the latent means on the same scale as the original items (1–5). Therefore, the interpretation of the mean levels, as well as the mean differences, was more convenient. The statistical significance of the mean differences was determined using z-tests.

TABLE 7 Levels of measurement invariance.

Level of measurement invariance	Specification	Meaning
Configural invariance	No constraints	Specific items that load on each of the respective factors are the same for each group or occasion
Metric or weak factorial invariance	Factor loadings are set equal across groups or over-time	Enables meaningful comparisons of factor variances and covariances between groups or over time
Scalar or strong factorial invariance	Factor loadings and intercepts are set equal across groups or over-time	Enables comparison of latent factor means between groups or over time
Error or strict invariance	Factor loadings, intercepts and residual variances of observed variables are set equal across groups or over-time	Enables comparison of observed scores between groups or over time

As study II concentrated on enjoyment and anxiety variables, some additional analyses were conducted for other motivational variables for the purposes of this thesis summary. A series of repeated measures ANOVA procedures were used to determine whether the mean levels of the motivational variables differed between the three time points (PE in general vs. fitness testing class 1 vs. fitness testing class 2). Greenhouse–Geisser correction was used in the case of significant Mauchly's test for sphericity. Bonferroni adjustment was used in the post hoc analysis.

In study III, direct and indirect associations between latent study variables were investigated using structural equation modeling (SEM). Two separate models were created to study the two fitness testing classes with different contents. A robust full-information MLR procedure was implemented to estimate the model parameters and account for the possible non-normality of observations (Muthén & Muthén, 2017). Models were estimated using the TYPE=COMPLEX approach (Muthén & Muthén, 2017) which corrects standard error distortions caused by students being clustered in classes. To conduct mediation analyses in Mplus, the MODEL INDIRECT command was used (Muthén & Muthén, 2017). Bootstrapping was also applied to create confidence intervals for the indirect effects and to test the statistical significance of the mediation analyses (Hayes, 2013).

In study IV, latent change score analysis in the structural equation modeling framework was used to examine the effects of the intervention in the 20 m shuttle run, five-leaps, curl-up, push-up, and throwing–catching-combination tests, along with the body mass index. A multigroup approach was used to test the differences between groups. The Wald test (Muthén & Muthén, 2017) was used to test the difference between intervention and control groups and between boys and girls. Latent change score modeling combines features from cross-lagged regression modeling and latent growth curves (Ferrer & McArdle, 2003; McArdle & Prindle, 2008; McArdle, 2009). In latent change models, the change between T0 and T1 is represented as a latent variable with a mean (i.e., average change), a variance (i.e., individual differences in change), and a covariation of the change with the initial factor and possible other factors in the model (McArdle, 2009). This means that the model can estimate latent means and latent intraindividual mean changes (e.g., between pretest and posttest) but also interindividual differences in these variables (Könen & Karbach, 2021).

As structural equation modeling procedures were applied in all studies, the evaluation of model fit indices was a common practice in all studies. In general, the model fit was evaluated using multiple indicators, as suggested by Ntoumanis and Myers (2016). More specifically, the chi-square goodness-of-fit statistics ($\chi 2$), the comparative fit index (CFI), the Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) were used. To interpret these indices, previously recommended guidelines were followed. For CFI and TLI, cut-off values close to 0.95, for RMSEA values lower than 0.06, and for SRMR values lower than 0.08 were considered good (Hu & Bentler, 1999).

5 OVERVIEW OF THE RESULTS

This chapter provides an overview of the findings from studies I–IV. In addition, some unpublished additional results are presented, which were not presented in substudies I–IV. First, the students' motivational and affective responses at the contextual PE level are explored. Next, the results relating to students' affective experiences in both PE in general and situational fitness testing situations are considered. Finally, the findings of the school-based intervention program targeting the improvement of students' MC and HRF are presented.

5.1 Need satisfaction, motivational regulations, and enjoyment in physical education

In study I, the primary aim was to test the SDT-based motivational model in the PE context by analyzing the associations between basic psychological needs satisfaction (competence, autonomy, and relatedness), motivational regulations (intrinsic regulation, identified regulation, introjected regulation, external regulation, and amotivation), and enjoyment in PE among 5th and 8th grade Finnish students. Descriptive results are illustrated in Figures 5 and 6.

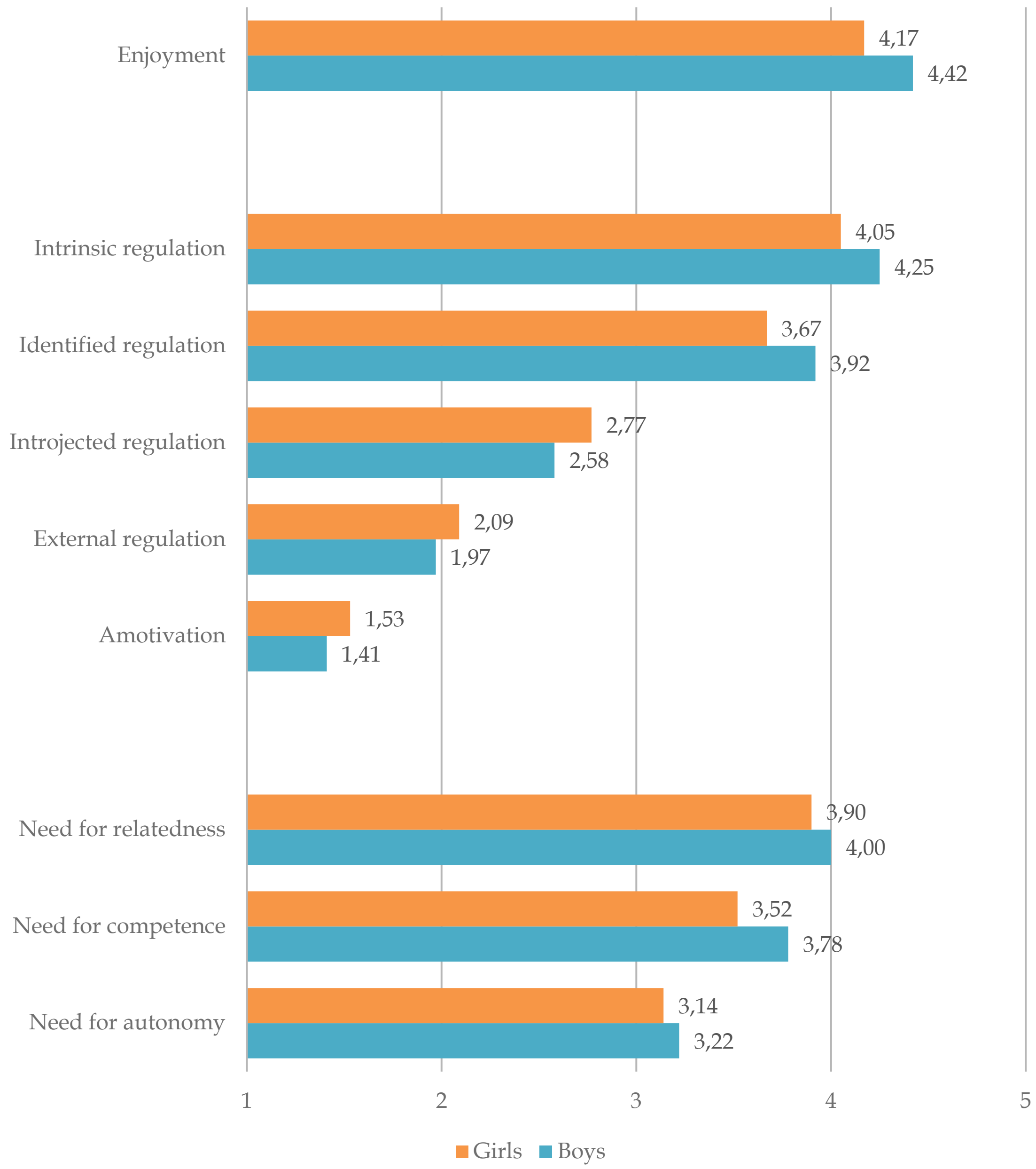

FIGURE 5 Mean values of basic psychological needs, motivational regulations, and enjoyment among 5th grade boys and girls.

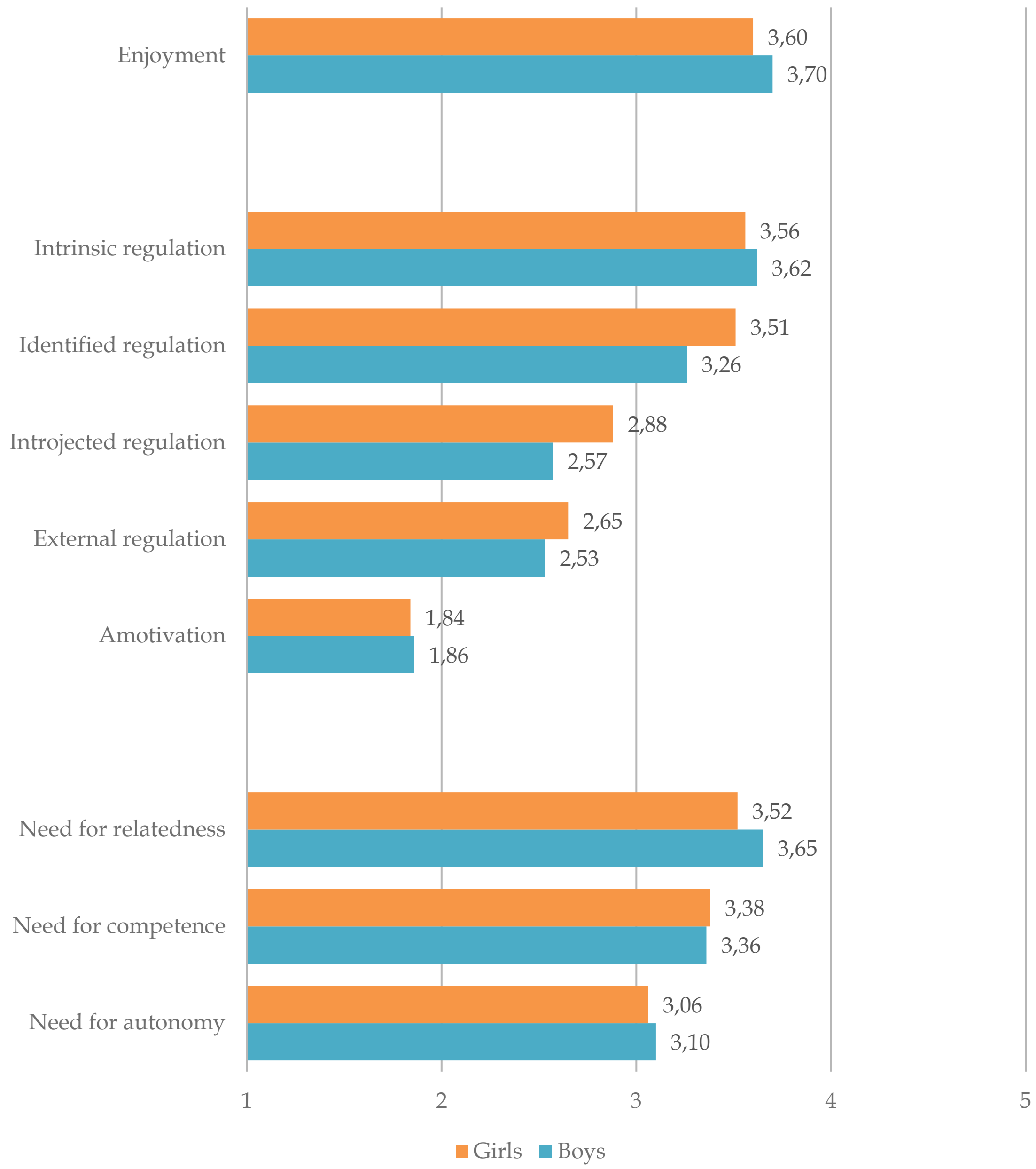

FIGURE 6 Mean values of basic psychological needs, motivational regulations, and enjoyment among 8th grade boys and girls.

To investigate the associations between the study variables, multigroup structural equation modeling was applied. Final models had a good fit to the data for 5th grade students [$\chi2$ (48) = 48.35, p = 0.46; CFI = 1.00; TLI = 1.00; RMSEA = 0.01] and for 8th grade students [$\chi2$ (49) = 52.21, p = 0.35; CFI = 0.99; TLI = 0.99; RMSEA = 0.02]. There were both direct and indirect statistically significant paths for boys and girls in the model of 5th grade students. For both boys and girls, there was a direct positive path from the need for autonomy to enjoyment. In the boys' group, an indirect positive path was found from the need for autonomy to enjoyment via intrinsic regulation, and in the girls' group, an indirect positive path was found from the need for relatedness to enjoyment via intrinsic regulation. The SEM also revealed additional paths between basic psychological needs and motivational regulations. To begin with, a positive path from the need for autonomy to identified regulation was found for both gender groups. Additionally, boys demonstrated a negative path from the need for autonomy to amotivation and to external regulation. Regarding the girls' group, negative paths from the need for relatedness to amotivation and to external regulation were found. An additional negative path was identified from introjected regulation to enjoyment in the boys' group.

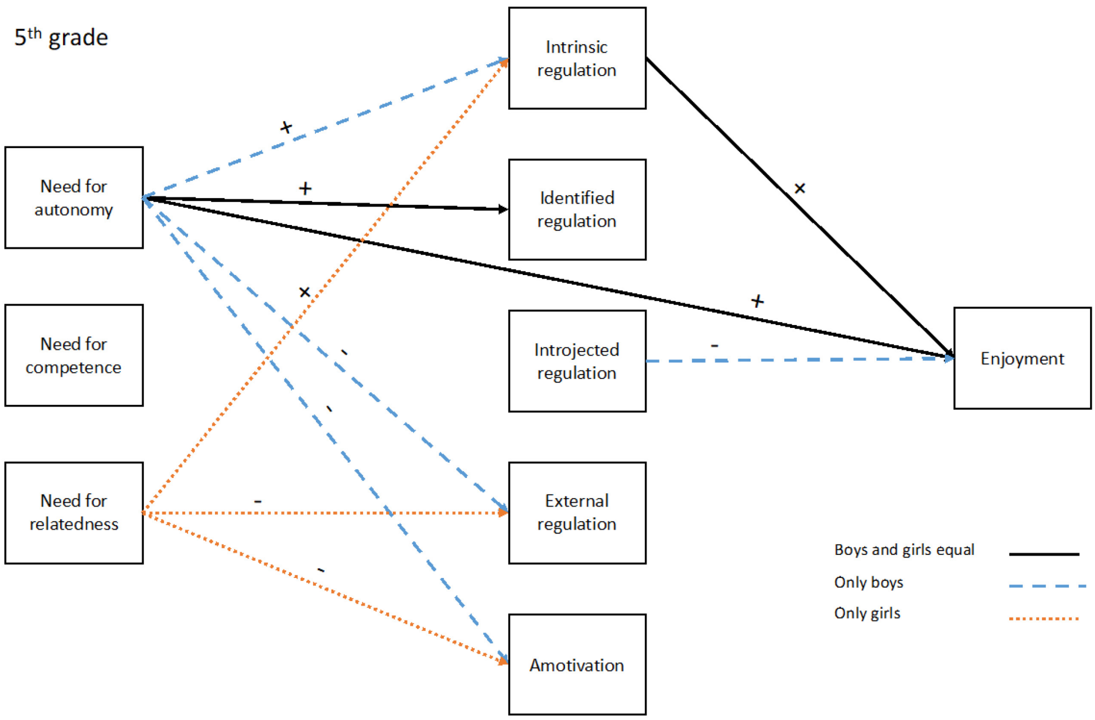

FIGURE 7 Need satisfaction, motivational regulations, and enjoyment among 5th grade students. Simplified results of the multigroup structural equation model (path model).

For the 8th grade students, both direct and indirect statistically significant paths emerged for boys and girls. In the boys' group, there was a direct positive path from the need for competence to enjoyment and from introjected regulation to enjoyment. In addition, a negative indirect path from the need for autonomy to enjoyment via external regulation was found for boys. In the girls' group, the results revealed a negative indirect path from the need for autonomy to enjoyment via amotivation. Several paths were found between needs and regulations. The need for autonomy was negatively linked to external regulation among boys and girls. In addition, the need for autonomy was positively linked to intrinsic regulation among girls. For boys, there was a positive path from the need for competence to intrinsic regulation, and a negative path from the need for competence to amotivation.

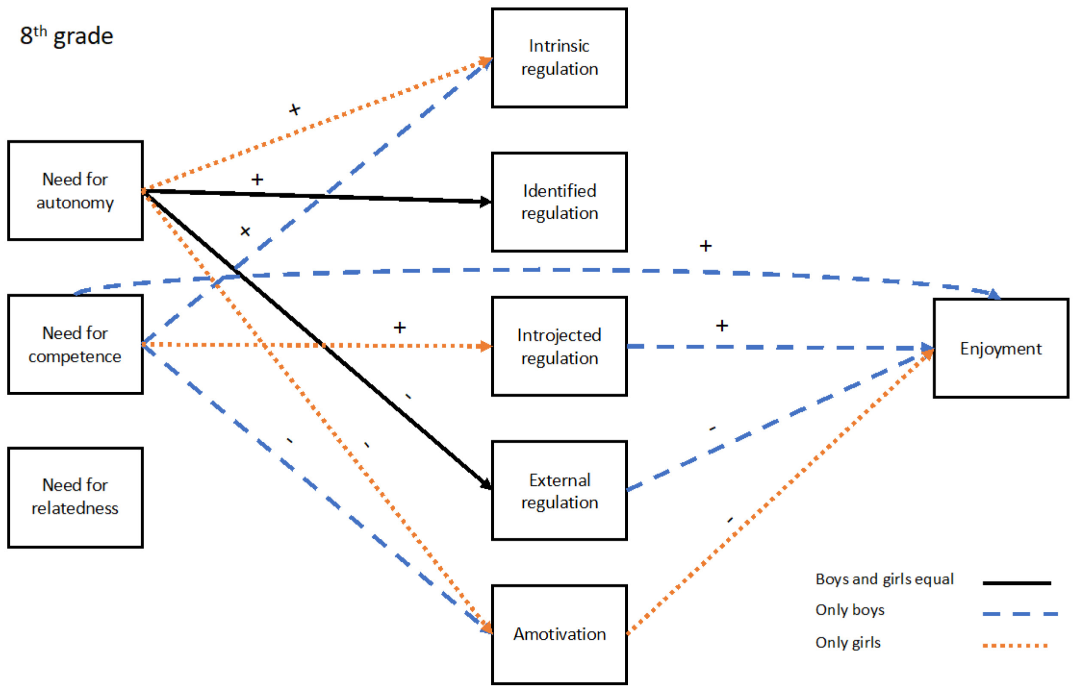

FIGURE 8 Need satisfaction, motivational regulations, and enjoyment among 8th grade students. Simplified results of the multigroup structural equation model (path model).

5.2 Students' perceptions of PE, and fitness testing classes

Study II examined whether students' perceptions of enjoyment, somatic anxiety, cognitive processes, and worry differed among PE in general and two fitness testing classes with distinct content (class 1: CRF; class 2: MC and MF). The additional aim of the study was to investigate the measurement invariance of anxiety and enjoyment scales over three time points [contextual PE (T0), situational fitness testing class 1 (T1), and 2 (T2)] and across groups (5th grade and 8th grade students).

Measurement invariance

The analysis process commenced by establishing configural baseline models (model 1; see Table 8) for the three subscales of anxiety and enjoyment. Based on Hu and Bentler's (1999) model fit criteria, all models demonstrated a good fit. The sequential models and different levels of invariance were tested in two parts. First, the invariance of factor loadings (metric or weak factorial invariance) was investigated, and then the equality of item intercepts (scalar or strong factorial invariance) and, finally, equalities of item residuals (error or strict invariance) over time separately between the two groups (models M2–M4) were tested. This was followed by applying the same parameter constraints over time and across both groups (models M5–M7). Please refer to the original article for fit indices of all nested models of the enjoyment and anxiety subscales.

TABLE 8 Models used in the analysis to determine measurement invariance of cognitive processes, somatic anxiety, worry, and enjoyment over time and across grade-level.

	Specification
Model 1	Configural – all parameters are freely estimated across measurement time and across school classes
Model 2	Factor loadings are set equal across measurement time separately in both school classes
Model 3	Factor loadings and intercepts are set equal across measurement time separately in both school classes
Model 4	Factor loadings, intercepts and residual variances of observed variables are set equal across measurement time separately in both school classes
Model 5	Factor loadings, intercepts and residual variances of observed variables are set equal across measurement time and factor loadings are set equal between school classes
Model 6	Factor loadings, intercepts and residual variances of observed variables are set equal across measurement time and factor loadings and intercepts are set equal between school classes
Model 7	Factor loadings, intercepts and residual variances of observed variables are set equal across measurement time and school classes

For enjoyment, the results indicated that all levels of measurement invariance (i.e., weak, strong, and strict factorial invariance) held over time and across groups. This is shown by the small changes in model fit (ΔRMSEA ≤.004) when comparing more constrained models to the more freely estimated models. Similarly, for cognitive processes, somatic anxiety, and worry, all levels of measurement invariance were supported based on the small changes in model fit. The values for ΔRMSEA were ≤.014, ≤.006, and ≤.005, respectively. In other words, the results indicated that enjoyment and all three anxiety subscales possessed full factorial invariance between different settings and across age groups. It should be acknowledged that full measurement invariance is rarely achieved in most empirical studies (Van de Schoot et al., 2015). This demonstrates that 5th and 8th grade students perceived the enjoyment and anxiety scales in a similar way when answering questions concerning PE in general (contextual) and when answering questions after fitness testing classes (situational). These findings indicate that comparisons between the study variables in different settings and age groups are plausible.

Mean differences

The results of the main analyses investigating the mean differences of latent constructs showed that, for 5th grade students, enjoyment was significantly lower in fitness testing classes (T1 and T2) than in PE in general (T0). However, there were no statistically significant differences in worry among the three time points. The level of cognitive processes was significantly lower and the level of somatic anxiety higher in fitness testing classes than in PE in general. The results also showed that somatic anxiety was higher in the first fitness testing class (T1) than in the second fitness testing class (T2).

For 8th grade students, the results indicated that levels of enjoyment were significantly lower in fitness testing classes (T1 and T2) than in PE in general (T0). According to the results for cognitive processes, there was a statistically significant difference between PE in general (T0) and the first fitness testing class (T1: aerobic endurance) but not between PE in general (T0) and the second fitness testing class (T2: skill and strength) or between the two fitness testing classes (T1 vs. T2). The level of somatic anxiety was significantly higher in the first fitness testing class (T1) and in the second fitness testing class (T2) compared to PE in general (T0). In addition, somatic anxiety was significantly higher in T1 than in T2. Finally, there was a statistically significant but weak difference between the levels of worry on T0 and T1. The levels of worry did not differ between T0 and T2 or between T1 and T2.

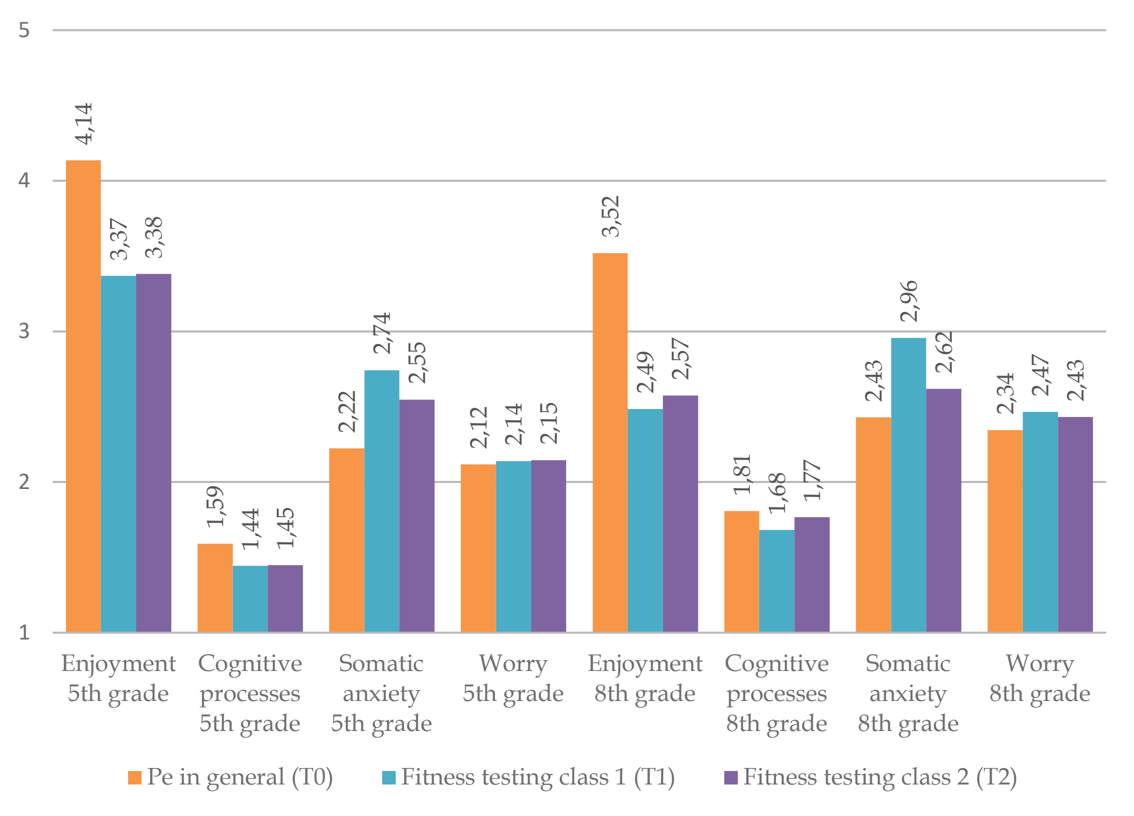

FIGURE 9 Mean levels of enjoyment, somatic anxiety, cognitive processes, and worry in PE, and in fitness testing classes 1 and 2 separately among 5th and 8th grade students.

Differences between 5th and 8th grade students in study variables were also analyzed at each measurement point. Results indicated that levels of enjoyment were significantly higher among 5th grade students at all three time points than 8th grade students. Furthermore, the mean levels of cognitive processes and worry were lower among 5th grade students than 8th grade students at all time points. For somatic anxiety, there was a statistically significant difference at T0 and T1, showing lower mean scores for 5th grade students, but no significant difference at T2 was found.

Additional results

In addition to enjoyment and anxiety utilized and reported in study II, other variables were considered during the data collection. These variables include dimensions of motivational climate (autonomy climate, relatedness climate, task-involving climate, and ego-involving climate), basic psychological need satisfaction (need for autonomy, competence, and relatedness), and motivational regulations (amotivation, external regulation, introjected regulation, identified regulation, and intrinsic regulation).

A series of repeated measures ANOVA procedures were used to determine if the mean levels of the variables differed between the three time points (PE in general vs. fitness testing class 1 vs. fitness testing class 2). Greenhouse–Geisser correction was used in the case of significant Mauchly's test for sphericity. Bonferroni adjustment was used in the post hoc analysis. The results for 5th and 8th grade students' within-subjects effects and pairwise comparisons are summarized in Tables 9 and 10. Additionally, the descriptive results are illustrated in Figures 10–15 separately for 5th and 8th grade students.

The results showed that among 5th grade students, autonomy climate, in particular, but also relatedness climate and task climate, were lower during both fitness testing classes than PE in general. Similarly, the needs for autonomy, competence, and relatedness were lower in both fitness testing classes than in PE in general. The need for autonomy was also higher in the first fitness testing class than in the second. Moreover, amotivation was higher and identified regulation and intrinsic motivation lower in the two fitness testing classes compared to PE in general.

TABLE 9 Results of repeated measures ANOVA among 5th grade students.

	Within-subjects effect			**pairwise comparisons**[b]		
	F (df, error)	p	ηp^2	T0 vs. T1	T0 vs. T2	T1 vs. T2
Autonomy climate	154.4 (1.78, 450.17)$^{g\text{-}g}$	**<.001**	.379	**.858***	**.898***	.040
Relatedness climate	14.5 (1.77, 448.22)$^{g\text{-}g}$	**<.001**	.054	**.236***	**.240***	.004
Task-climate	14.0 (2, 506)	**<.001**	.052	**.168***	**.216***	.048
Ego-climate	1.7 (1.88, 474.39)$^{g\text{-}g}$	.175	.007			
Need for autonomy	23.6 (1.84, 376.33)$^{g\text{-}g}$	**<.001**	.103	**.249***	**.403***	**.154***
Need for competence	16.2 (1.87, 382.42)$^{g\text{-}g}$	**<.001**	.073	**.271***	**.291***	.021
Need for relatedness	7.3 (1.92, 393.98)$^{g\text{-}g}$	**<.001**	.035	**.130***	**.182***	.052
Amotivation	28.5 (1.78, 452.90)$^{g\text{-}g}$	**<.001**	.100	**-.315***	**-.316***	-.001
External regulation	1.3 (1.84, 469.72)$^{g\text{-}g}$	.280	.005			
Introjected regulation	1.8 (1.94, 494.90)$^{g\text{-}g}$	.162	.007			
Identified regulation	14.7 (1.89, 481.37)$^{g\text{-}g}$	**<.001**	.055	**.217***	**.271***	.055
Intrinsic regulation	36.7 (1.81, 461.43)$^{g\text{-}g}$	**<.001**	.126	**.373***	**.474***	.101

Note. g-g = Greenhouse-Geisser correction, df = degrees of freedom, ηp^2 = partial eta squared, b = Bonferroni adjustment, T0 = PE in general, T1 = Fitness testing class 1, T2 = Fitness testing class 2.

*$p < 0.05$

Among 8th grade students, the results revealed mostly a similar pattern of findings than among 5th graders. Autonomy climate and task climate were higher and ego-climate lower during PE in general than in both fitness testing classes. The relatedness climate was lower during the second testing class compared with PE in general. In addition, the relatedness climate was higher in the first fitness testing class than in the second one. The need for autonomy and competence was also ranked lower in both fitness testing situations than in PE in general. There were higher values for relatedness need in general PE than in fitness testing class 2. Finally, amotivation was lower, and introjected, identified, and intrinsic regulations were higher in PE in general than in fitness testing classes 1 and 2.

TABLE 10 Results of repeated measures ANOVA among 8th grade students.

	Within-subjects effect			**pairwise comparisons[b]**		
	F (df, error)	p	ηp^2	T0 vs. T1	T0 vs. T2	T1 vs. T2
Autonomy climate	104.5 (1.65, 362.08)g-g	**<.001**	.323	**.873***	**.759***	-.114
Relatedness climate	7.0 (1.88, 411.19)g-g	**.001**	.031	.056	**.225***	**.169***
Task-climate	25.2 (1.94, 425.59)g-g	**<.001**	.103	**.309***	**.337***	.027
Ego-climate	5.8 (1.87, 409.15)g-g	**.004**	.026	**-.185***	**-.153***	.032
Need for autonomy	18.7 (1.92, 322.06)g-g	**<.001**	.100	**.348***	**.396***	.049
Need for competence	20.4 (2, 336)	**<.001**	.108	**.281***	**.407***	.126
Need for relatedness	11.1 (2, 336)	**<.001**	.062	.114	**.259***	**.145***
Amotivation	80.9 (1.90, 418.98)g-g	**<.001**	.269	**-.631***	**-.609***	.023
External regulation	1.1 (1.88, 413.08)g-g	.329	.005			
Introjected regulation	5.2 (1.95, 427.87)g-g	**.006**	.023	**.145***	**.148***	.003
Identified regulation	27.2 (2, 440)	**<.001**	.110	**.363***	**.345***	-.018
Intrinsic regulation	105.2 (1.80, 396.04)g-g	**<.001**	.324	**.777***	**.773***	-.005

Note. g-g = Greenhouse-Geisser correction, df = degrees of freedom, ηp^2 = partial eta squared, b = Bonferroni adjustment, T0 = PE in general, T1 = Fitness testing class 1, T2 = Fitness testing class 2.

*p < 0.05

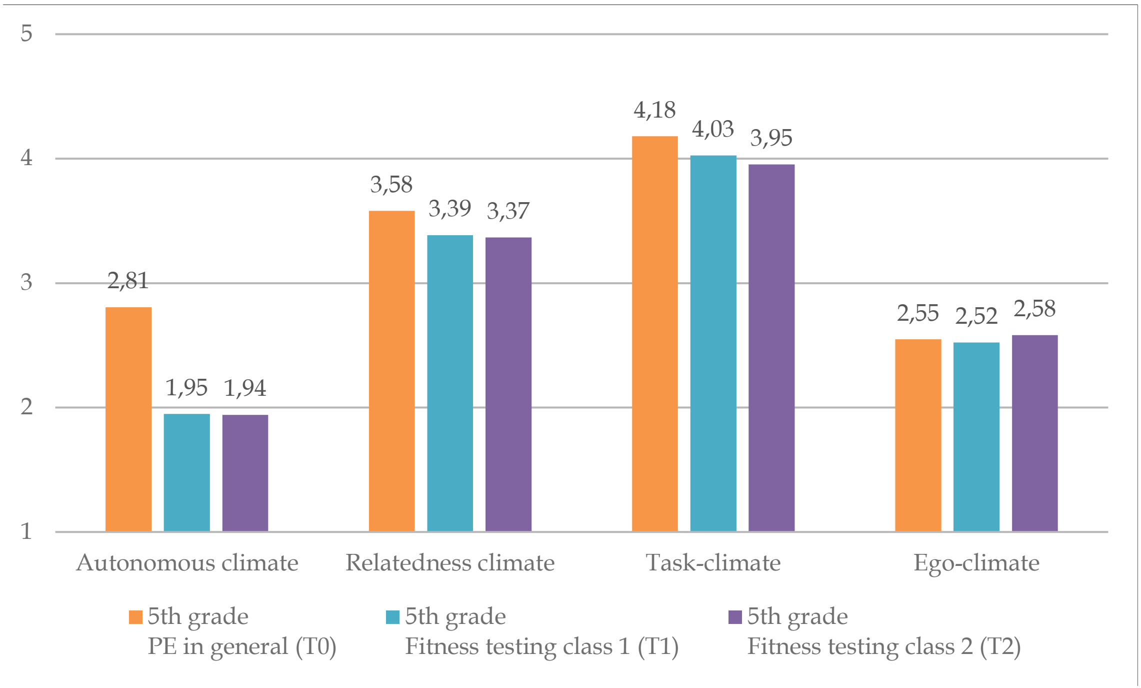

FIGURE 10 Mean levels of autonomy climate, relatedness climate, task-climate, and ego-climate in PE, and in fitness testing classes 1 and 2 among 5th grade students.

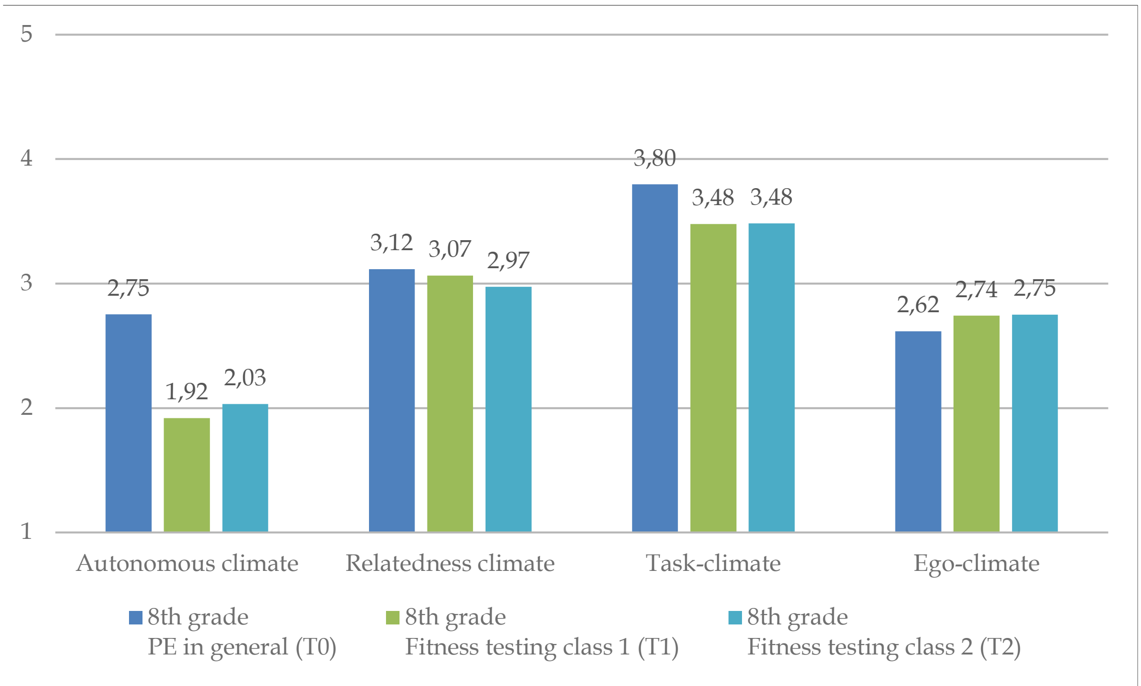

FIGURE 11 Mean levels of autonomy climate, relatedness climate, task-climate, and ego-climate in PE, and in fitness testing classes 1 and 2 among 8th grade students.

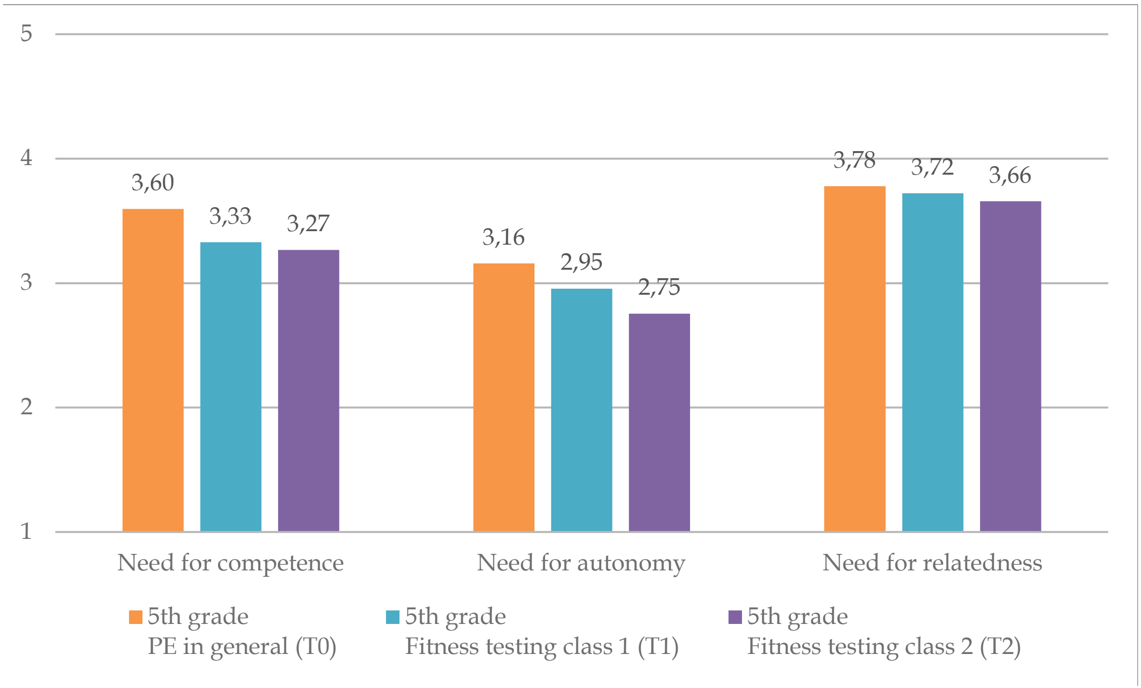

FIGURE 12 Mean levels of competence, autonomy, and relatedness need satisfactions in PE, and in fitness testing classes 1 and 2 among 5th grade students.

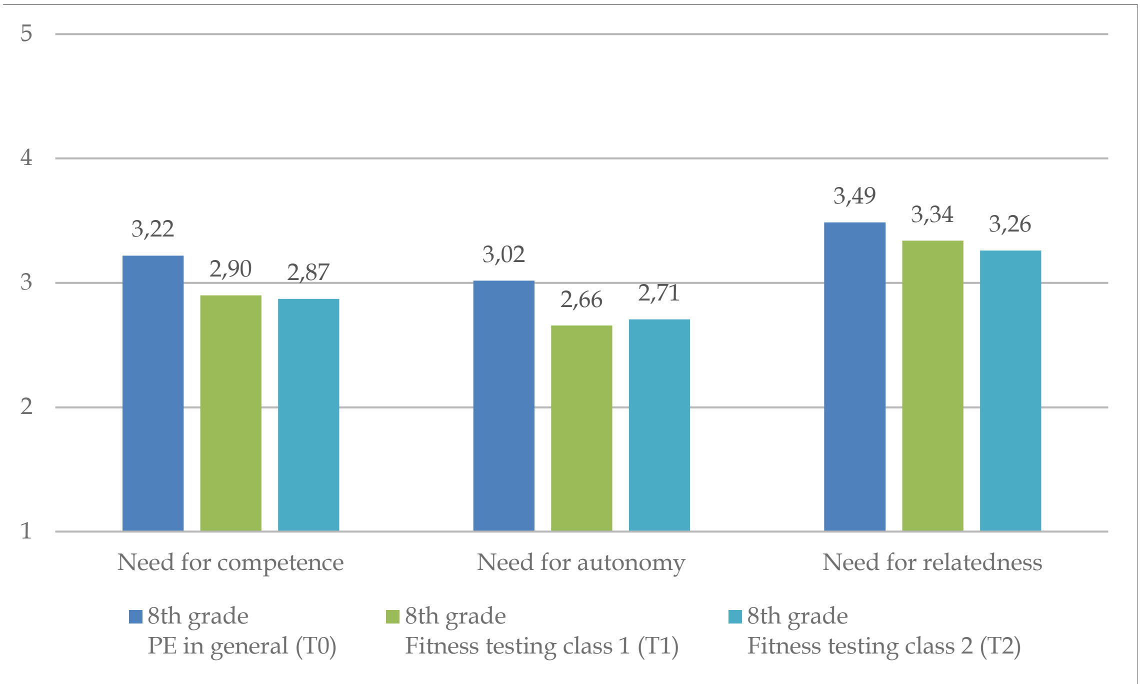

FIGURE 13 Mean levels of competence, autonomy, and relatedness need satisfactions in PE, and in fitness testing classes 1 and 2 among 8th grade students.

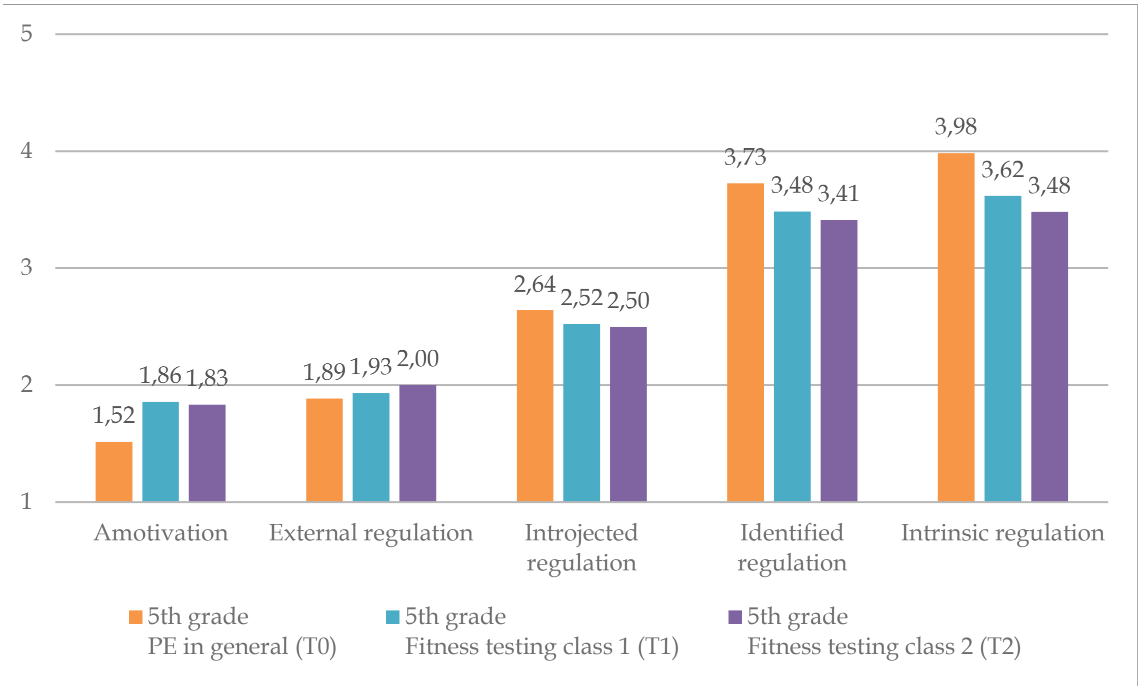

FIGURE 14 Mean levels of amotivation, external regulation, introjected regulation, identified regulation, and intrinsic regulation in PE, and in fitness testing classes 1 and 2 among 5th grade students.

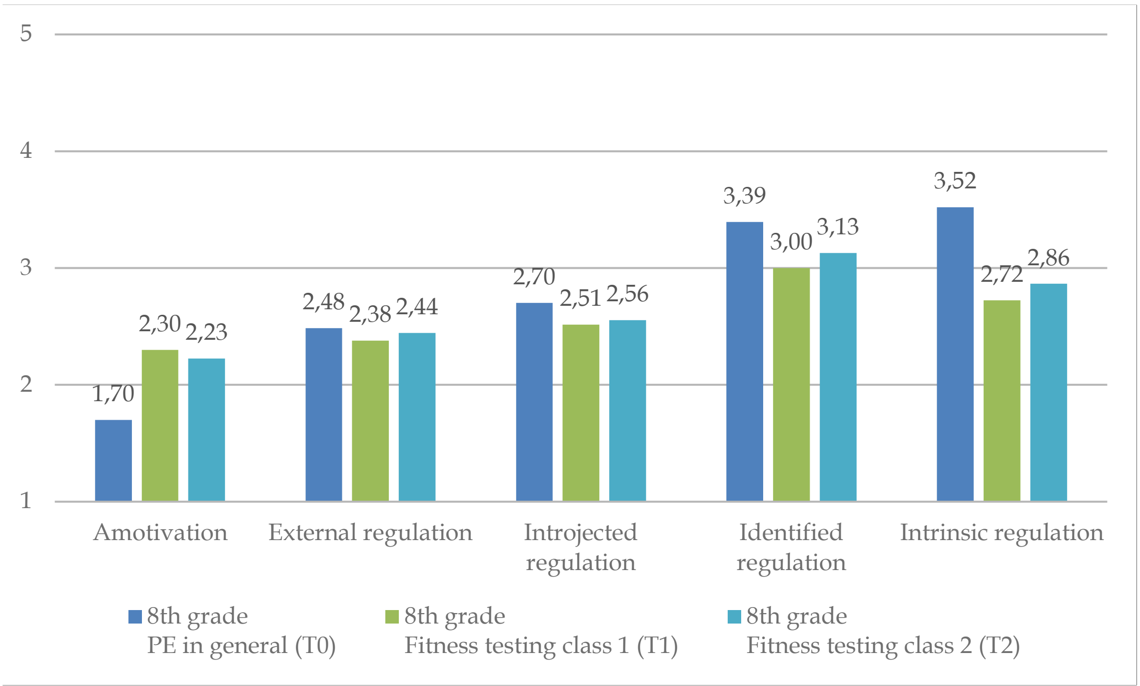

FIGURE 15 Mean levels of amotivation, external regulation, introjected regulation, identified regulation, and intrinsic regulation in PE, and in fitness testing classes 1 and 2 among 8th grade students.

5.3 Factors influencing students' affective perceptions during fitness testing classes

Study III investigated how social factors (motivational climate) and individual cognitive and physical factors (perceived physical competence and actual physical performance) influence students' affective responses during fitness testing classes. Separate baseline models (measurement models) were created for the two fitness testing classes with different contents. Class one included a 20 m shuttle run test and a test of flexibility, and class two included curl-up, push-up, five-leaps, and catching–throwing combination tests. The fit indices for the baseline models were appropriate, allowing for investigations of the structural models. A good fit for the data was confirmed for the final model of fitness testing class 1 ($\chi 2$ (638) = 1160.8, p < 0.000, CFI = 0.95, TLI = 0.95, RMSEA = 0.036, 90% CI [0.032, 0.039], SRMR = 0.057), and fitness testing class 2 ($\chi 2$ (738) = 1412.5, p < 0.000, CFI = 0.93, TLI = 0.92, RMSEA = 0.037, 90% CI [0.035, 0.040], SRMR = 0.066)]. Statistically significant relationships between study variables are shown in Figures 16 and 17. In addition, Table 11 presents the significant indirect effects among the study variables.

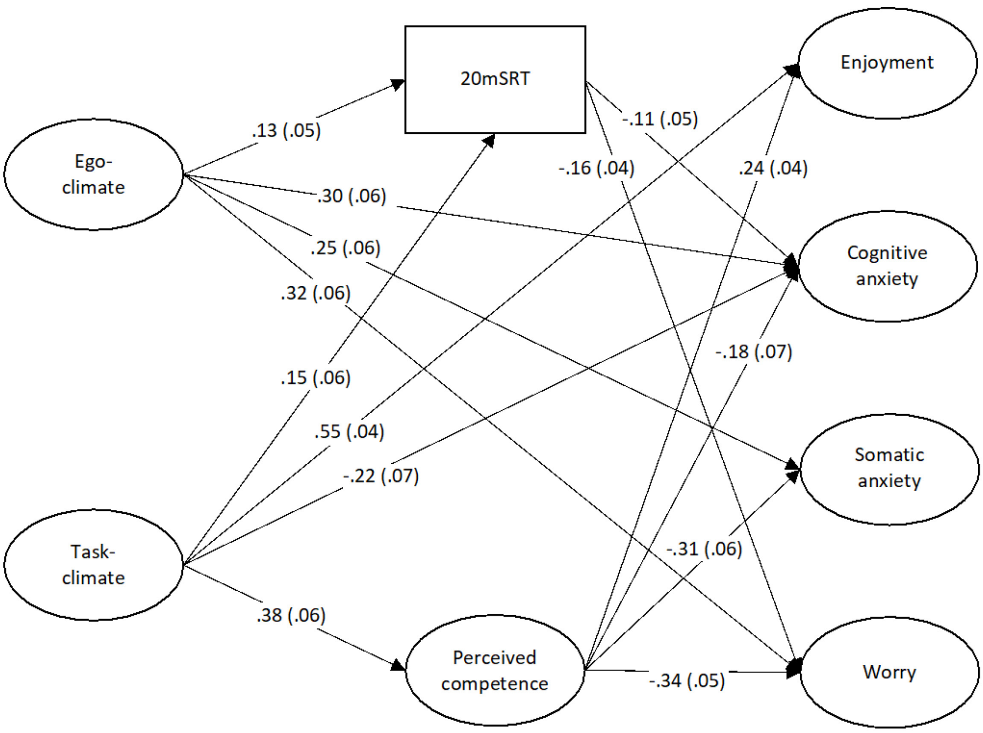

FIGURE 16 The standardized parameter estimates of the structural equation model for fitness testing class 1.

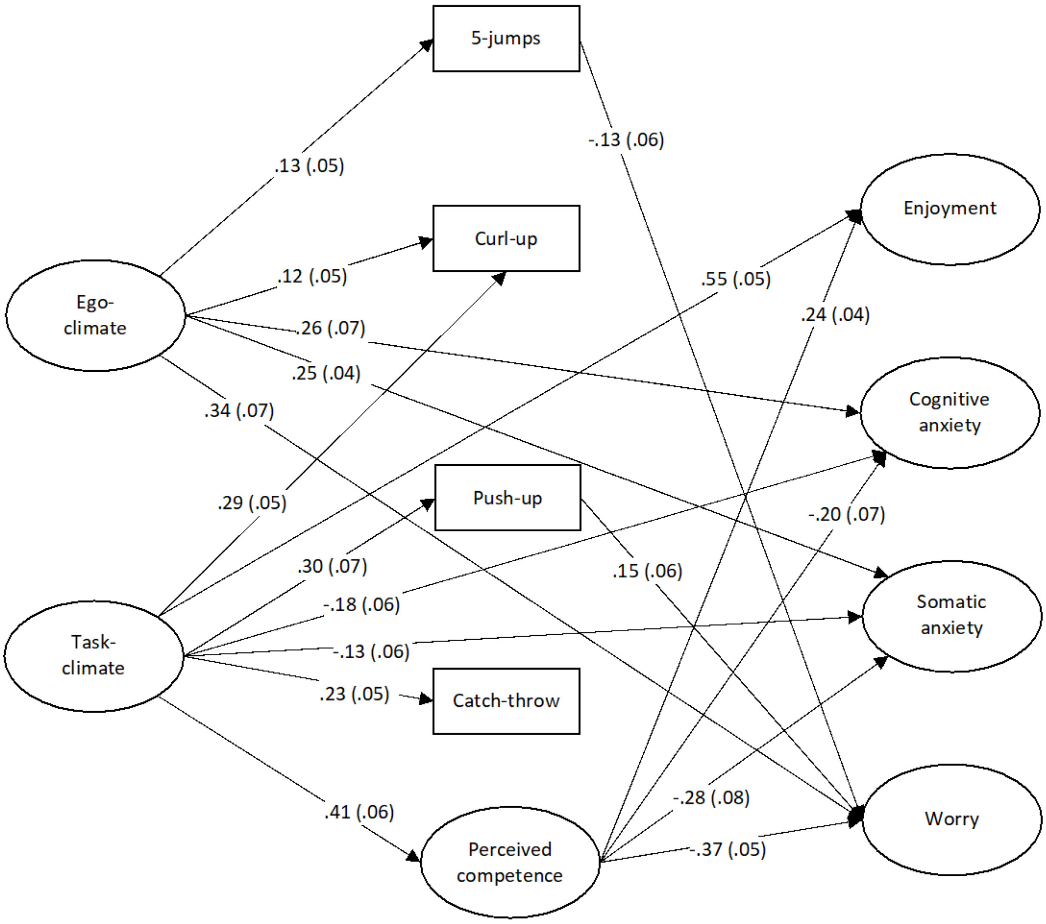

FIGURE 17 The standardized parameter estimates of the structural equation model for fitness testing class 2.

The results showed that for both fitness testing classes, enjoyment was directly and positively associated with PC and task-involving climate. In addition, all three anxiety subscales—cognitive processes, somatic anxiety, and worry—were negatively associated with PC in both models. In other words, a higher task-involving climate and perceived physical competence resulted in higher levels of enjoyment and decreased levels of anxiety. Moreover, ego-involving climate was positively associated with anxiety subscales, meaning that higher levels of ego-climate were linked to higher levels of anxiety. The results also showed that an ego-involving climate had no effect on students' enjoyment. In the first fitness testing class, higher results in the 20 m shuttle run test led to small decreases in cognitive anxiety and worry. In the second fitness testing class, higher push-up results increased worry, whereas higher five-leaps results decreased worry.

Investigations of the indirect effects revealed that in both models, task-involving climate was positively linked to enjoyment via PC. In addition, task-involving climate was linked to all three anxiety subscales via PC. A higher task climate and higher PC resulted in lower values of cognitive processes, somatic anxiety, and worry. In the first fitness testing class, results also revealed an indirect link from task- and ego-climate to worry via a 20 m shuttle run test. In the second testing class, an indirect link was found between task climate and worry via PC and push-up.

TABLE 11 Standardized indirect effects between the study variables in fitness testing classes 1 and 2. For clarity, only significant ($p<0.05$) effects are shown.

Specific indirect effects	**Estimate [95% CI]**	**p**
Fitness testing class 1		
Task-climate → PC → enjoyment	.087 [.055, .119]	.000
Task-climate → PC → cognitive processes	-.060 [-.101, -.020]	.014
Task-climate → PC → somatic anxiety	-.110 [-.152, -.068]	.000
Task-climate → PC → worry	-.124 [-.165, -.083]	.000
Task-climate → 20mSRT → worry	-.017 [-.030, -.003]	.040
Ego-climate → 20mSRT → worry	-.018 [-.031, -.004]	.035
Fitness testing class 2		
Task-climate → PC → enjoyment	.086 [.048, .123]	.000
Task-climate → PC → cognitive anxiety	-.067 [-.112, -.022]	.014
Task-climate → PC → somatic anxiety	-.094 [-.142, -.046]	.001
Task-climate → PC → worry	-.133 [-.186, -.079]	.000
Task-climate → push-up → worry	.038 [.014, .063]	.010

5.4 Developing students' motor competence and health-related fitness through a school-based intervention

In study IV, the aim was to assess the effectiveness of a five-month multicomponent school-based intervention on adolescents' MC and HRF. A latent change score model was established to study the effects of the intervention. All five fitness and MC test variables, 20 m shuttle run, five-leaps, curl-up, push-up, and throwing–catching combination tests, along with the body mass index, were used in the final model. The model demonstrated a good fit to the data [$\chi^2(6) = 8.54$, $p < 0.201$, CFI = 0.999, TLI = 0.993, RMSEA = 0.036, 90% CI [0.000, 0.087], SRMR = 0.02]. The results revealed that the group condition had a statistically significant positive effect on the latent change in the 20 m shuttle run ($\beta = 0.269$, p = 0.000, 95% CI [0.141, 0.397]; adjusted mean difference = 5.0 laps), curl-up (β = 0.353, p = 0.001, 95% CI [0.154, 0.552]; adjusted mean difference = 7.8 repetitions), push-up (β = 0.442, p = 0.000, 95% CI [0.267, 0.617]; adjusted mean difference = 6.5 repetitions) and throwing–catching combination tests (β = 0.195, p = 0.019, 95% CI [0.033, 0.356]; adjusted mean difference = 1.1 repetitions), but not on five-leaps (β = 0.060, p = 0.402, 95% CI [-0.080, 0.199]; adjusted mean difference = 0.01 m) or body mass index (β = -0.066, p = 0.580, 95%CI [-0.302, 0.169]; adjusted mean difference = 0.18 kg / m^2). The mean levels of different physical performance test items in both study conditions are presented in Figure 18.

Based on the two-group test [$\chi^2(6) = 43.63$, $p < 0.001$], there was an overall intervention effect, indicating that students in the intervention group developed significantly better than students in the control group when considering all MC and HRF variables simultaneously. The effect of gender was also investigated, and based on the Wald test results, the change between pre- and post-tests was similar between boys and girls in both the control and intervention groups ($\chi^2(5) = 8.62$, $p = 0.125$).

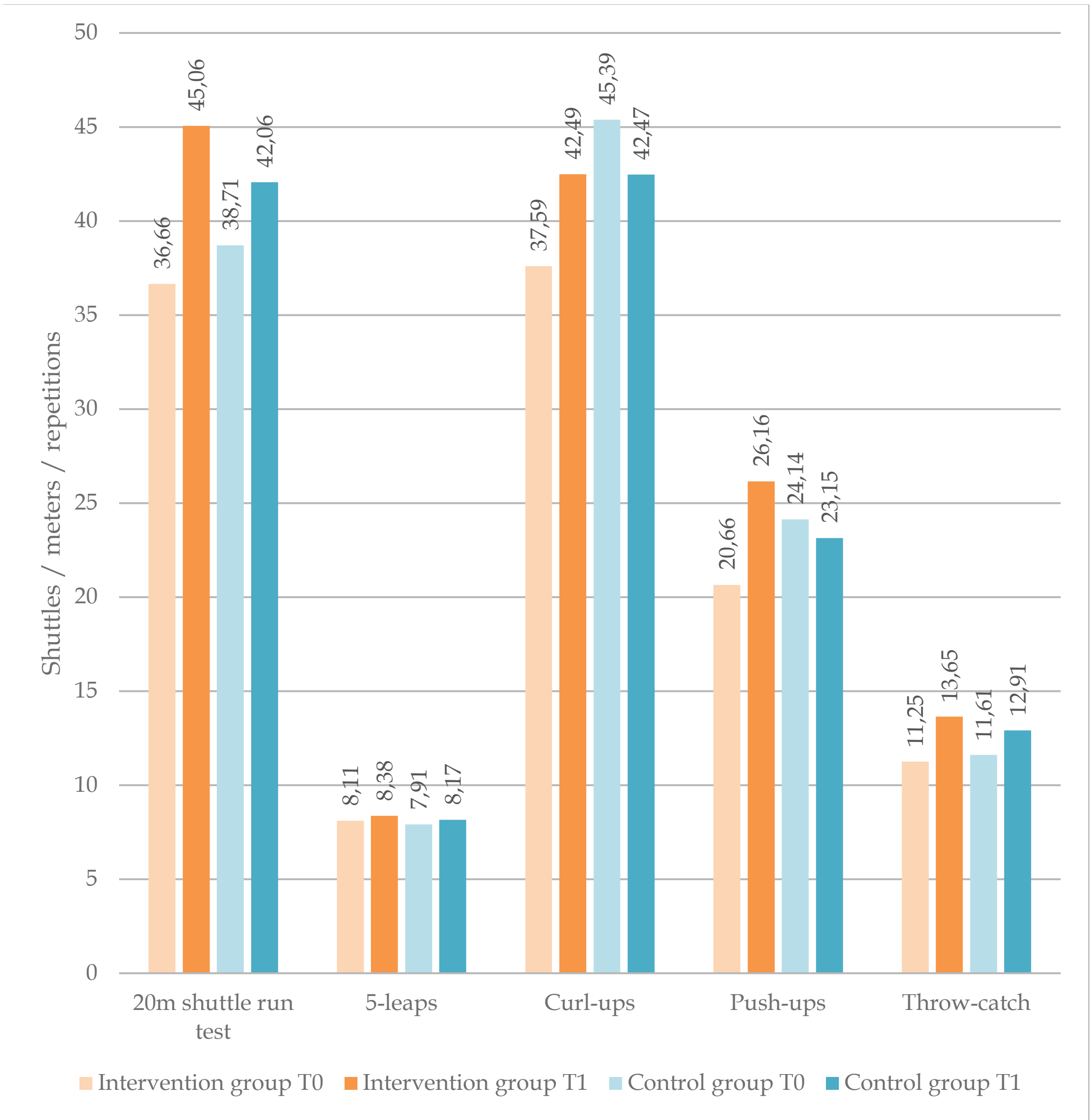

FIGURE 18 Mean values of 20m shuttle run test, five-leaps, curl-ups, push-ups, and throwing-catching combination test in intervention and control groups at baseline (T0) and follow-up (T1).

6 DISCUSSION

Low levels of PA (Guthold et al., 2020), together with decreasing trends in physical performance (Huotari et al., 2022; Jaakkola et al., 2022), have raised concerns among researchers and public health organizations (Bull et al., 2020). It seems evident that a multitude of actions are needed in various societal contexts, including schools. In light of these negative changes, Finland recently introduced a nationwide fitness monitoring system, Move!, meaning that all Finnish 5th and 8th graders take part in HRF and MC measurements during their PE lessons. As the system aims to improve students' willingness to be physically active, it is essential to explore the motivational and affective experiences of fitness testing situations. In addition to Finland, the international research community seeks new insights, as there has been a long-lasting debate concerning the use of school-based fitness testing. It is also clear that mere testing is not enough to achieve the underlying aim of promoting PA and physical performance. Specific actions and utilizing fitness test results are hence needed. Intervention programs, such as the one tested during this dissertation, provide evidence-based examples that illuminate the path toward increased physical performance and, further, to increased health and well-being.

6.1 Main findings

In study I, the aim was to analyze the associations between basic psychological need satisfactions, motivational regulations, and enjoyment among Finnish PE students. The results indicated that among 5th grade students, autonomy was directly associated with enjoyment. In addition, there was an indirect path from autonomy to enjoyment via intrinsic regulation in the boys' group and an indirect path from relatedness to enjoyment via intrinsic regulation in the girls' group. Among 8th grade students, the need for competence was directly associated with enjoyment for the boys. Results also revealed negative associations from autonomy to enjoyment via amotivation for the girls' group, and via external regulation for the boys' group. For both grades, the results revealed additional, gender-specific associations. Taken together, the results highlighted the importance of students' need for satisfaction and autonomous motivation as factors that could facilitate enjoyable experiences in PE classes.

In study II, the aim was to investigate whether students' perceptions of anxiety and enjoyment differed among PE in general and two distinct fitness testing classes. In addition, the measurement invariance over time and between 5th and 8th grades were determined. The results indicated that students' perceptions of enjoyment were lower in fitness testing classes compared to PE in general, albeit still moderately high. Additionally, students perceived lower levels of cognitive anxiety and higher levels of somatic anxiety in fitness testing classes than in general PE. However, the results showed that there were no statistically significant differences in worry among the three time points among 5th grade students. For 8th grade students, the level of worry was higher in the first fitness testing class compared with PE in general, albeit the difference was weak. It is noteworthy that students might not significantly dislike fitness testing per se but instead have significantly more positive affects toward PE in general.

In study III, the aim was to investigate the associations among task- and ego-involving motivational climates, perceived physical competence, physical performance, enjoyment, and anxiety during two PE fitness testing classes with different contents. The results indicated that during fitness testing classes, task-involving climate and PC increased students' enjoyment and decreased their anxiety levels. Moreover, students' perceived ego-involving climate was found to increase their anxiety levels. In addition, students' actual physical performance as a mediator between the perception of motivational climate and further affects, or as a direct predictor of affects, was limited.

In study IV, the aim was to assess the effectiveness of a scalable five-month multicomponent (activities in PE lessons, recesses, and academic lessons) school-based quasi-experimental intervention program on adolescents' MC and HRF. The results showed that the five-month school-based intervention program was effective in increasing students' physical performance. More specifically, students allocated to the intervention group developed significantly better than students in the control group in 20 m shuttle run test, push-up, curl-up, and throwing–catching combination test scores. This indicates that the intervention program appeared to be effective in increasing students' CRF, MF, and object control skills. The intervention effect was found to be similar for boys and girls.

6.2 Motivation and affects in physical education and fitness testing situations

6.2.1 Motivation and affects in physical education

In study I, the findings supported notions derived from the SDT, whereby basic psychological needs for autonomy, competence, and relatedness are seen as important antecedents for optimal motivation and well-being (Ryan & Deci, 2017; Bureau et al., 2022). The fulfillment of these psychological needs has a positive impact on affective consequences, such as enjoyment. This effect is also influenced by the type of motivation, where autonomous motivation leads to more favorable outcomes and controlled motivation leads to less favorable ones. In essence, the findings support the propositions of SDT (Ryan et al., 2022; Ryan & Deci, 2017) and the suggestion of the motivational sequence of the hierarchical model of extrinsic and intrinsic motivation (Vallerand, 1997). Need satisfaction is linked to autonomous motivation and further to positive affective experiences.

The results of study I indicate that satisfaction of students' needs for autonomy, competence, or relatedness was positively associated with more autonomous forms of motivation and enjoyment in school PE. These findings concur with the results of previous empirical studies in the PE context (Vlachopoulos et al., 2011a; Standage & Gillison, 2007). Additionally, the results revealed negative associations among need satisfaction, more controlling forms of motivation, and enjoyment. These findings are also in line with previous studies in the PE context from different cultures (e.g., Leptokaridou et al., 2015; Ommundsen & Kvalø, 2007).

Although the results were generally representative of the SDT, few differences between boys and girls were found among 5th and 8th grade students. For example, among 5th grade students, the results showed that motivational regulations were linked with autonomy in the boys' group and with relatedness in the girls' group. This implies that in the PE environment, students' autonomous motivation and subsequent positive experiences are formed, at least to some degree, differently between boys and girls. Previous research has shown that actions such as supporting personal agency, creating learning situations that include opportunities for choices, and using non-controlling language (Ahmadi et al., 2023; Reeve & Halusic, 2009; Ryan & Deci, 2017) are important in enhancing autonomous motivation and positive affect in PE. Furthermore, autonomous motivation and positive affect are especially promoted by fostering a sense of relatedness and a safe social environment (Ahmadi et al., 2023; Ryan & Deci, 2017).

Among 8th grade boys, the needs for competence and autonomy were linked with autonomous and controlled forms of motivation, whereas for 8th grade girls, the need for autonomy showed a clearer connection to these outcomes. This, together with the finding that among boys, competence is directly associated with enjoyment, indicates that for the 8th grade boys, the role of competence need satisfaction was more clearly visible than in the girls group. Considering these together, supporting both autonomy and competence need satisfaction is crucial for the optimal motivational and affective experiences of 8th grade students. Again, the findings were aligned with previous studies in the PE context (e.g., Taylor et al., 2010; Fairclough, 2003; Caroll & Loumidis, 2001).

The results of study I are especially relevant for teachers planning and conducting PE lessons for children and adolescents. A recent Delphi method–based recommendation for teachers' motivational behaviors (Ahmadi et al., 2023) suggests that the most effective actions to support autonomy are allowing students input and choice, teaching in students' preferred ways, and providing rationales. For competence support, the most effective actions are to provide optimal challenges, give specific feedback, and praise improvement or effort. To support relatedness, the most efficient actions are to show unconditional positive regard, ask about students' progress, welfare, and feelings, and express affection. In conclusion, practitioners should concentrate on fulfilling students' psychological needs to enhance autonomous motivation and enjoyment of PE. The importance of this is further highlighted by the fact that autonomous motivation and enjoyment of the PE context predict future PA and well-being (Vasconcellos et al., 2020; Eberline et al., 2018; Gao, 2008). Moreover, research has demonstrated that levels of PE enjoyment decline during adolescence (Yli-Piipari et al., 2013; Cairney et al., 2012), which is a further incentive for practitioners to promote actions that facilitate positive experiences in PE.

6.2.2 Contextual and situational experiences

Results of study II showed that both 5th and 8th grade students perceived lower levels of enjoyment in fitness testing classes than in general PE. As such, it indicates that fitness testing as a content area in PE might generate less feelings of pleasure, fun, and liking (Scanlan et al., 2016) than PE in general among adolescent students. However, it is noteworthy that, on average, students still perceived moderate levels (5th grade = 3.37–3.38 and 8th grade = 2.49–2.57) of enjoyment during the two fitness testing classes. In line with previous studies (Carroll & Loumidis, 2001; Soini, 2006; Gråstén, 2014; Jaakkola et al., 2019; Huhtiniemi et al., 2019), levels of enjoyment toward PE in general were relatively high, indicating that students may not specifically dislike fitness testing but have significantly more positive feelings toward PE in general. Nonetheless, deflated levels of enjoyment in fitness testing situations might cause students to be less engaged in fitness testing or fitness development in PE.

Interestingly, there were no differences in enjoyment levels between the two fitness testing classes although the classes consisted of different types of tests. The first fitness testing class included a 20 m shuttle run test that can be perceived as strenuous and unpleasant because it requires working at near-maximal aerobic capacity (Silverman et al., 2008). In contrast, the second fitness testing class included more skill-related measures and muscular strength measures. For example, the throwing–catching combination (Jaakkola et al., 2012), in which one repeatedly throws a tennis ball to the wall and catches it after a bounce, could easily be perceived as a fun activity that students might want to do during recess or free time. Yet, despite the content of the testing classes clearly differing, perceived enjoyment remained relatively stable between different test situations for both 5th and 8th grade students. This pattern might exist because the two fitness testing classes share similar elements related to pedagogical aspects, such as teachers' teaching style and the chosen didactic approach. For example, it is likely that teachers used the same kinds of teaching techniques while giving instructions or feedback during both fitness testing classes, which is indicative of the style of teaching rather than the content of the fitness testing as being more influential in mediating the students' experiences of enjoyment.

For both 5th and 8th grade students, levels of cognitive processes were lower in fitness testing classes than in general PE. As the cognitive processes dimension refers to symptoms related to information processing and cognitive reactions during the activity (Barkoukis et al., 2008; Barkoukis et al., 2005; Schwarzer, 1986), it might be that these reactions are typically present during general PE classes where there might be multiple ways to complete a certain activity rather than in fitness testing classes where the activities performed are very precise. This could mean that in fitness testing situations, students are asked to follow procedures strictly without any creative solutions. Additionally, lower levels of the cognitive processes dimension might be an outcome of the more structured and teacher-oriented approach during fitness testing classes, where students have fewer opportunities to make choices or be creative. Furthermore, the lack of difference in cognitive processes between the two fitness testing classes may also be due to the highly structured and teacher-oriented lessons.

Somatic anxiety, in contrast to cognitive processes, was higher in both fitness testing classes than in general PE for 5th and 8th grade students. This was not entirely surprising, as fitness testing situations and physical tests encourage students to perform near their maximal physical capacity. In addition, as somatic anxiety has been shown to have a curvilinear relationship with performance (i.e., moderate levels lead to optimum performance) (Craft et al., 2003), it is logical that elevated levels of somatic anxiety occurred in performance-related fitness testing situations rather than in general PE. Moreover, the results showed higher somatic anxiety in the first fitness testing class than in the second testing class. This is likely explained through the content of the classes: the first testing class included shuttle run tests, whereas the second testing class was comprised of more skill- and MF-related tests. It is more likely that students report elevated somatic anxiety levels after the shuttle run test, as somatic anxiety captures phenomena such as shortness of breath, discomfort while breathing, or dizziness (Barkoukis et al., 2005). It should be mentioned that somatic anxiety symptoms are related to the body's normal reactions to physical exertion.

Levels of worry among 5th and 8th grade students were approximately the same in general PE and during fitness classes, except for the slightly higher value for 8th grade students in the first testing class. Overall, and contrary to previous findings (e.g., Hopple & Graham, 1995; Luke & Sinclair, 1991), the pattern of worry level indicates that students do not necessarily have inflated negative expectations of fitness testing activities or that their fear of getting low results or performing poorly (Barkoukis, 2007) is not increased. Earlier studies have shown that worry is a negative predictor of performance in PA contexts such as sports and school PE (Barkoukis et al., 2005; Woodman & Hardy, 2003). In considering this pattern, it could be seen as a positive outcome that fitness testing provokes no more worry than general PE. Additionally, levels of worry did not differ between the two fitness testing classes in either of the grade-level groups, indicating that different test batteries did not seem to provoke increased achievement pressures.

Fifth-grade students perceived lower levels of worry, both in general PE and in fitness testing situations compared with 8th grade students. Again, this might be an age-related issue, as 8th grade students are at, or close to, puberty, which could amplify their anxiety levels during PA, especially when undertaken with peers (Wigfield et al., 2005; Eccles & Roeser, 2011). Another explanation for 8th grade students' higher level of worry could stem from the PE assessment or numeric grading, which is usually introduced to Finnish students from grade 7 onwards (Finnish National Board of Education, 2014). However, it should be noted that the current PE curriculum in Finland, which includes the new national fitness monitoring system, clearly forbids the use of fitness test results as a basis for grading in PE (Finnish National Board of Education, 2014; Salin & Huhtiniemi, 2018).

Brief notion of the additional results related to motivational variables

In addition to enjoyment and anxiety, which are reported in study II, other motivational variables were briefly explored in this thesis. More specifically, the investigation targeted the mean levels of the four motivational climate dimensions, three psychological needs, and five regulatory styles of motivation.

Inspection of the mean values indicated that the autonomy climate in PE was higher in general PE than during fitness testing classes. The mean levels of the needs for autonomy, competence, and relatedness were all slightly higher in PE compared to fitness testing situations. In addition, the pattern of motivational regulations showed that autonomous motivation was lower in fitness testing situations than generally in PE. Moreover, amotivation was higher during the fitness testing classes. External regulation, however, was on the same level during PE and fitness testing classes. Taking these together, it might be that fitness testing situations have certain constraints or elements that make it harder to facilitate psychological needs and autonomous motivation compared with other PE lessons. These constraints might include time pressure, predefined tasks, normative reference values, peer comparison, and teachers' varying knowledge and skills concerning the tests. The lower mean levels of autonomy climate and autonomous forms of motivational regulations are reasonable, as fitness testing classes are typically highly structured (Jaakkola et al., 2012) and students are not able to choose the tasks performed during the lessons. Previously, Jaakkola et al. (2013) reported that Finnish adolescents' students (aged 11–15) experienced higher intrinsic motivation but also higher amotivation during fitness testing classes than in general PE.

It should be noted that these variables were not the primary interest of the substudies in this thesis; therefore, more detailed analyses are needed to make any conclusions concerning them. For example, the invariance of motivational variables should be tested prior to mean-level comparisons (Kline, 2015). Nevertheless, considering both motivational (additional results) and affective results (substudy II), it seems that fitness testing classes, as pedagogical learning situations, require special attention from teachers to make them motivating and positive experiences for students.

6.2.3 Pathways to positive and negative affects during fitness testing situations

In study III, one of the most significant findings was that task-involving climate and PC are directly associated with enjoyment in both fitness testing classes. Besides the direct associations, an indirect effect was observed from task-involving climate to enjoyment via PC. These findings support the theoretical assumptions of AGT (Nicholls, 1989; Ames, 1992), whereby a task-involving motivational climate is believed to promote positive changes in behavioral, cognitive, and affective outcomes.

The results also showed that the patterns of associations were similar in both fitness testing classes between motivational climates and anxiety subscales. More specifically, students' task-involving climate was either directly or indirectly, via PC, associated with lower levels of cognitive anxiety, somatic anxiety, and worry. Furthermore, an ego-involving climate was associated with higher levels of cognitive anxiety, somatic anxiety, and worry. These findings reflect both the theoretical assumptions of the AGT (Ames, 1992; Nicholls, 1989) and previous findings in PE contexts in which an ego-involving climate has been shown to have maladaptive associations, and a task-involving climate adaptive associations, with affective experiences (Carpenter & Morgan, 1999; Ommundsen & Kvalø, 2007; Papaioannou & Kouli, 1999).

Overall, these findings highlight the importance of emphasizing task-involving motivational climate while conducting fitness testing. This can be accomplished, for example, by implementing elements from the TARGET model (Epstein, 1989). The TARGET refers to the following: task (design of tasks), authority (location of decision-making), recognition (distribution of rewards), grouping (ways and frequency of grouping), evaluation (standards for performance), and time (pace of learning). Students are more likely to perceive a task-involving climate when tasks are optimally challenging, participants can make choices and show leadership, recognition is provided privately, activities are done in mixed-ability groupings, personal improvement is emphasized, and time requirements are adjusted to personal needs (Epstein, 1989). A meta-analysis of motivational climate interventions in PE concluded that TARGET strategies promoting task-involving conditions have small-to-moderate treatment effects for affective, behavioral, and cognitive outcomes (Braithwaite et al., 2011).

When interpreting the results, it is important to consider the differences and similarities between the two fitness testing classes. In the first fitness testing class, students took part in a 20 m shuttle run test in which they were required to work at near-maximal aerobic capacity, which some might understandably perceive as unpleasant (Silverman et al., 2008). In contrast, in the second fitness testing class, the measures were more related to skill and strength. For example, the throwing–catching combination test (Jaakkola et al., 2012) in which students repeatedly throw a tennis ball at the wall could be perceived as a fun and playful activity and something many would like to do during recess or free time. Despite the apparent differences in the content of the classes, the students' perceptions were generally quite similar. It may be that aspects related to teachers' actions, such as their teaching style or didactic approach, and not the specific content of testing, have a more pronounced effect on students' affects (O'Keeffe et al., 2020).

Interestingly, students' actual physical performance was not directly associated with enjoyment, indicating that whether students are performing at high or low levels based on actual test scores does not seem to affect their feelings of satisfaction and enjoyment. This result concurs with previous findings (Simonton et al., 2019; Goudas et al,. 1994) that have also shown the limited effect of test performance on motivational and affective outcomes. Moreover, the mediational role of actual physical performance between motivational climates and affects was limited, although some small indirect effects were found. Students' PC, however, mediated the relationships between task-involving climate and enjoyment and between task-involving climate and anxiety in both fitness testing classes. Taken together, the role of PC seems to be more evident than the role of actual performance in terms of affective experiences in fitness testing situations. This finding highlights the importance of fostering actions that promote success for all students with low or high actual physical performance levels (De Meester et al., 2016).

6.3 Development of physical performance through a school-based intervention program

In study IV, students in the intervention group developed significantly better overall physical performance (i.e., when considering all tests simultaneously) than students in the control group. More specifically, the intervention effect was shown in the 20 m shuttle run, push-up, curl-up, and throwing–catching combination tests. The overall positive findings of the intervention are in line with previous review studies (e.g., Villa-González et al., 2023; Hartwig et al., 2021; Cox et al., 2020; García-Hermoso et al., 2020), which have demonstrated that school-based interventions can improve both physical fitness and MC among children and adolescents.

In the current intervention, the effects were achieved with relatively small actions conducted during PE classes, long recesses, and academic lessons. In total, the program activities consisted of 18 active weeks, with 65 minutes of structured content weekly. It is noteworthy that professionally instructed activities in schools are targeted at all students, including those who are inactive or who perceive themselves as poor movers and not just those who are already physically active. Unfortunately, it is not uncommon for school-based PA interventions to be ineffective among those who need them the most (Lonsdale et al., 2021). Moreover, Hartwig et al. (2021) showed, based on a pooled analysis from 20 trials, that students with lower levels of baseline PA benefitted less from school-based PA interventions. This finding, highlighting organized and guided activities, is especially important for decision makers who decide what kinds of elements are included in future PA programs. Recent analysis of systematic reviews (Neil-Sztramko et al., 2021) indicated that school-based interventions have shown limited effects on PA, whereas our study suggests that they may improve MC and HRF.

One key finding of the five-month study was the positive development of cardiorespiratory fitness in intervention group students (+8.4 laps) compared with the control group students (+3.4 laps). In the intervention program, the time allocated to enhancing the activity of students was relatively short, roughly an hour per week, and only a part of the activities specifically developed CRF. Hence, positive development in CRF achieved with relatively low effort is especially important, as researchers and societies have been increasingly worried about declining trends in youth cardiorespiratory fitness levels (Tomkinson et al., 2019). Our finding is mostly in line with, or succeeding, the results of previous intervention programs that have analyzed the effects of vigorous, high-intensity PA programs on the development of CRF. For example, Lubans et al. (2021) reported similar development (+4.1 laps) on a 20 m shuttle run test at a six-month follow-up for adolescent students. However, Wassenaar et al. (2021) found that vigorous PA intervention did not improve students' CRF following a 10-month program. Martínez-Vizcaíno et al. (2022) reported positive development only for girls (+3.4 laps) but not for boys in an academic year–long high-intensity PA intervention. Positive development of youths' CRF is called for, as it has been linked with overall health (Raghuveer et al., 2020; Lang et al., 2018; Ortega et al., 2008; Ruiz et al., 2009). Moreover, a systematic review and meta-analysis by Álvarez-Bueno et al. (2020) indicated that cardiorespiratory fitness is positively associated with academic achievement.

Another key finding of the study was that the MF of the intervention group students developed significantly better than that of the control group. Results in both push-up (difference = 6.5 repetitions) and curl-up tests (difference = 7.8 repetitions) improved more in the intervention group than in the control group, which was expected as the performed exercises and tasks in the program systematically and progressively developed MF attributes. Compared to similar studies, the effect of the intervention on MF was substantial. For example, in a cluster-randomized controlled trial among adolescents by Kennedy et al (2018) push-up test results improved by 2.0 repetitions at a six-month follow-up. In general, the findings are in line with previous studies, as shown by recent reviews of school-based interventions targeting MF (Cox et al., 2020; Villa-González et al., 2023). In the control group, the push-up test results declined from the baseline to the posttest. A corresponding declining trend in push-ups has been documented among similarly aged Finnish students in a nationally representative sample (Jaakkola et al., 2019). Taking these together, it is encouraging that a relatively short and easily executable intervention improved students' upper-body strength and endurance, as well as their abdominal strength and endurance. This positive finding is further amplified by the fact that MF has been associated with the overall health status of youth (García-Hermoso et al., 2019; Smith et al., 2014; Ortega et al., 2008; Ruiz et al., 2009).

Intervention effects on MC measures were mixed, as students in the intervention group developed significantly better in throwing–catching combination tests (difference = 1.1), but no differences were found in five-leaps. As previously described, the throwing–catching combination test measures students' object control skill proficiency. The increase in object control skills is an important positive finding, as object control skills have been shown to be clear predictors of adolescent PA engagement (Robinson et al., 2015). It is also notable that both girls' and boys' object control skills developed positively in the current study, which is especially important, as previous findings (Barnett et al., 2016) have indicated that girls perform more poorly in object control skills than boys. There might be several reasons for the lack of intervention effect in the five-leap test. As a performance, it requires both physical and skill-related qualities, especially explosive strength (Ramírez-Campillo et al., 2013), dynamic balance, and rhythmical skills (McGinnis, 2005). These multiple requirements might make it more difficult for students to develop leaping distance. Moreover, it could also be that the intervention activities were not specific enough for this kind of multifaceted leaping performance to develop, even though the program consisted of several activities aimed at enhancing locomotor skills. In future studies and intervention programs, it might be reasonable to increase the specificity of the guidance, especially in skill-related activities.

The equitable access of all students in PA promotion programs should be driven not only because of the clear health benefits but also because improving students' physical performance and their PA engagement might help their academic achievement (Donnelly et al., 2016). Hence, it should be in schools' interest to promote PA and fitness programs, especially when program goals are corroborating wider curricular aims. Nevertheless, the feasibility, scalability, and effectiveness of school-based physical fitness and MC interventions are important aspects to consider (Milat et al., 2013; Milat et al., 2016). All activities and tasks included in the current intervention were designed to be easy to perform by students and easy to be instructed by practitioners. In addition, no additional equipment or special sports venues were needed. Therefore, the intervention can be widely adapted to different schools, and the program activities can be implemented by regular school staff members, such as general classroom teachers. From a cost perspective, the PE and lesson brake components were delivered during regular school hours and therefore required no additional staff or funding. The only component in this intervention that would require extra funding is the guided recess activity. However, some schools in Finland currently use teaching assistants or older students as recess activators (Haapala et al., 2014). As such, this intervention component would be delivered at no additional cost. With the help of the structured program, these recess activators might be able to increase students' PA as well as their physical performance during school hours.

In conclusion, positive development in the current intervention program was achieved with relatively small effort – approximately 65 minutes of structured, professionally guided activities were performed weekly. Moreover, activities represented already established elements of the Finnish school week structure; therefore, only a small amount of additional time for PA was required. The intervention had three components (PE lessons, recess activation, and breaks during academic lessons) that, as the TEO described (Beets et al., 2016), enhance, expand, and extend the opportunities for PA and fitness development. It is noteworthy that structured and professionally guided activities confirm that the intensity level needed when developing physical performance is sufficiently high. Additionally, the researchers who conducted the activities had expertise in sports pedagogy and were therefore capable of differentiating the tasks for students with varying levels of physical performance.

6.4 Limitations

The studies (I–IV) in the thesis have several strengths but also limitations that should be acknowledged while interpreting the results.

In study I, the study design was cross-sectional and therefore not suitable for conclusions concerning causal links between the study variables. In addition, the representativeness of the results is limited because the sample of students was conveniently and not randomly selected.

In study II, first, the study sample was not randomly selected, which limits the representativeness of the results. Second, as students were asked to complete the three questionnaires in a relatively short timeframe, a fatigue or question-order effect (Pustejovsky & Spillane, 2009) could influence their responses. However, the invariance analysis showed that the students perceived and understood the scales in a similar way at each time point. This indicates that the mean levels between the groups or over time can be compared with confidence. Third, although the study protocol was carefully presented to the teachers, there is no way of knowing how well they followed the written instructions, as there were no observations or recordings of the classes available. Therefore, adding an objective measure, such as video or voice recording, to assess teachers' actions during the classes would have increased the reliability of the study. However, adding an external person or device to the situation might significantly affect students' behavior, physical performance, and cognitive perceptions.

In study III, although the student cohort represented 12 schools from different geographical locations, the sample was not randomly selected, which limited the generalizability of the results. Another possible limitation related to the sample was the simultaneous use of both 5th and 8th grade students in the two models. Previous research has demonstrated that students' maturation level and developmental phase could affect their motivational and affective experiences during fitness testing situations (Garn & Sun, 2009; Nicholls, 1989; Wigfield et al., 2005). Based on this behavior, 5th and 8th grade students' experiences of fitness testing situations might differ. However, the sample was analyzed together, as preliminary analyses showed similar patterns of associations among study variables for both grade-level groups. This also allowed for a more parsimonious way to model the research data. The third limitation of the study was that the teachers' actions during the classes were not monitored in any way by external means, such as observations or recordings. Although these external monitoring measures could have been useful in terms of reliability, they could also have been harmful, as they might have affected the students' perceptions or behavior during the class.

In study IV, the first limitation was the lack of random allocation of schools. The second limitation is the lack of retention measures that would have provided information regarding the long-term effects of the program. Therefore, the representativeness of the results should be carefully considered. In addition, it should be acknowledged that the MC measures in this study were product-oriented, meaning that the qualitative aspects of motor skills (process-oriented measures) were not considered while interpreting the results. Finally, a further limitation was that the students' biological maturation status was not measured in the study. However, the participants' BMI scores based on height and weight measurements were used in the analysis.

7 CONCLUSIONS AND FUTURE PERSPECTIVES

7.1 Conclusions

The findings of studies I–IV can be briefly concluded as follows:

- In study I, the results supported SDT propositions in the PE context by showing that innate psychological needs for autonomy, competence, and relatedness act as antecedents for optimal motivation and well-being. The satisfaction of these needs positively impacts affective outcomes, such as enjoyment. The type of motivation also has a clear influence, as autonomous motivation leads to more beneficial outcomes and controlled motivation to less beneficial outcomes.

- In study II, the findings demonstrated that students' perceptions of enjoyment and anxiety toward fitness testing classes differ from their perceptions toward PE in general. More explicitly, enjoyment was lower in fitness testing classes than in PE in general. Students also perceived lower levels of cognitive anxiety and higher levels of somatic anxiety in fitness testing classes than in general PE. However, levels of worry among students were approximately at the same level in general PE and during fitness testing classes. In conclusion, the findings indicate that students do not have inflated negative expectations of fitness testing or increased fear of performing poorly in test situations.

- In study III, findings showed that task-involving climate and PC were directly associated with enjoyment, regardless of testing content or students' actual performance. Students' PC appeared to have a greater influence on their affective experiences in fitness testing classes than their actual performance. This shows that students' affective impressions are not determined by test results, which is particularly important for low-performing individuals. To increase enjoyment and minimize anxiety during PE fitness testing classes, measures fostering a task-involving motivational climate, such as stressing effort and personal growth, are advocated.

- In study IV, the five-month school-based, easy-to-administer, cost-effective intervention program showed preliminary effectiveness in increasing students' physical performance. The program appeared to be effective in increasing students' CRF, MF, and object control skills, with similar effects for boys and girls. The results show that promoting physical fitness and motor competence among early adolescent students is possible through guided activities during school days.

7.2 Practical implications

In study I, the focus was on general PE experiences related to SDT constructs. The results of this study have several practical implications, especially for PE teachers. When formulating these implications, the results pertaining to each age group and both genders should be considered. Among 5th grade boys, the need for autonomy can be supported by creating opportunities for choice and emphasizing a sense of agency or ownership in the learning situation. It also involves using non-controlling language in instructions and feedback (Reeve & Halusic, 2009). Studies have shown that teachers' provision of autonomy support leads to positive consequences (e.g., Ulstad et al., 2016) and should therefore be enforced in PE teacher education and in-service training. Among 5th grade girls, and in addition to fostering the need for autonomy, the need for relatedness can be enhanced when students' feel the context as trustworthy and feel the approval and appreciation of important people around them (Ryan & Deci, 2017). In educational settings, as well as in PE, this involves teachers and peers showing interest, affection, and care, and demonstrating satisfaction and appreciation of the time spent together in learning situations (Haerens et al., 2013; Cox et al., 2008; Ryan & Deci, 2017). Previous studies have shown that students who perceive a sense of relatedness with their teachers are more positively engaged in PE (e.g., Shen et al., 2012). For 8th grade boys, the need for competence can be supported by providing learning goals that are optimally challenging and by providing structure, stating clear expectations of learning goals, giving detailed instructions, and offering guidance when performing activities. The provision of feedback to enhance the need for competence and perceived control has also been proven effective (Jang et al., 2010).

In studies II and III, attention was directed to students' affective and motivational experiences in PE fitness testing situations. Findings indicated that there were differences in 5th and 8th grade students' perceptions of enjoyment and anxiety between fitness testing classes and PE in general. Therefore, informing practitioners about the results might help them while they are planning and conducting fitness testing sessions for children of different ages. Some of the reasons underpinning affective experiences during fitness testing were also studied. From a practical perspective, strategies promoting task-involving motivational climate and students' perception of competence are recommended to increase enjoyment and decrease anxiety during PE fitness testing classes. Research has demonstrated that incorporating elements from the TARGET model, such as personal development, learning, and cooperation (Barkoukis et al., 2008), is beneficial in terms of the task-involving motivational climate. Previous intervention studies have shown that PE enjoyment is positively associated with higher perceptions of a task-involving climate and the basic psychological needs of autonomy, competence, and relatedness (Cox et al., 2008; Ommundsen & Kvalø, 2007). Prior investigations have also shown that task-involving climate is associated with lower levels of anxiety in PE (Papaioannou & Kouli, 1999; Cecchini et al., 2001) and that state anxiety is negatively linked to enjoyment in the PE context (Yli-Piipari et al., 2009). Therefore, adopting strategies that promote a task-involving climate and need fulfillment are recommended to increase enjoyment and reduce anxiety in PE but also in fitness testing classes.

The substudies of this dissertation highlight several specific practical implications. When considering these implications together, efforts should be directed toward promoting students' autonomous motivation, basic psychological need satisfaction, and task-involving motivational climate. If successful, this may lead to increased enjoyment, decreased anxiety, and, subsequently, higher PA levels, better physical performance, and increased overall health and well-being. This reasoning leads to the following question: What are the best practices available to promote these concepts, which are preferably empirically tested and truly useful from the practitioners' perspective?

Several frameworks, taxonomies, and theories [e.g., SDT (Ryan & Deci, 2017; Ahmadi et al., 2023), AGT (Nicholls, 1989), TARGET model (Epstein, 1989] have presented a great variety of recommended actions. However, Lubans et al. (2017) stated that it is difficult for practitioners to know which evidence-based strategies they should be using. This is because information related to these strategies is often presented in scholarly publications, making it unknown or inaccessible for many practitioners. For this reason, Lubans et al. (2017) consolidated evidence-based recommendations from different disciplines into a practical set of guiding principles that are easy for practitioners to put into action. Notably, the principles are designed with PA promotion in mind; therefore, these principles should also be considered in PA intervention research. As a result, the supportive, active, autonomous, fair, and enjoyable (SAAFE) framework was introduced to support the planning and delivery of positive PA experiences for school-aged adolescents (Lubans et al., 2017). The SAAFE framework employs elements of the SDT (Ryan & Deci, 2017), AGT (Nicholls, 1989), competence motivation theory (Harter, 1978), and TARGET framework (Epstein, 1989). The key principles and recommended actions of the SAAFE framework (Lubans et al., 2017) are presented in Table 12.

TABLE 12 Principles and recommendations of the SAAFE framework. Adapted from Lubans et al. (2017).

Principle	Recommendations
Support *Teachers and students facilitate a supportive environment*	• Provide individual skill specific feedback • Support needs for autonomy, competence, and relatedness • Praise effort and improvement • Acknowledge and reward good sportspersonship • Show empathy toward students who are frustrated or challenged
Active *Lessons with high level of PA and minimal transition time*	• Optimize session structure and activities (e.g., small-sided games) • Include an active warm-up • Ensure sufficient high-intensity (e.g., use 'bursts' of activity, avoid elimination games) • Complete student registration while students are active • Set up activities while students are active to reduce transition time • Minimize instructions • Maximize equipment available
Autonomous *Lessons involve opportunities for choice and graded tasks*	• Provide students with opportunities for choice • Include elements of free play • Involve students in design and modification of activities • Provide rationales for all activities • Avoid controlling language
Fair *All students have opportunities to experience success*	• Make sure students are evenly matched in activities • Modify activities to maximize students' opportunities for success • Encourage self-comparison rather than peer-comparison • De-emphasize competition (e.g. implement point system that rewards team values and not winning) • Regularly change teams/partners to ensure everyone experiences success
Enjoyable *Lessons are fun and enjoyable with a variety of activities*	• Use activities in which students can exhibit choice, feel competent, and also interact with others • Start and conclude sessions with an enjoyable activity • Use a variety of tasks/activities • Do not use exercise as punishment • Use self-selected and motivational music while exercising

7.3 Future research

Future studies could evaluate the SDT-based motivational sequence, including social factors, based on a longitudinal design. It would also be interesting to see the effects of modifying teachers' pedagogical approaches; therefore, more intervention studies are needed in the future. In addition, the school PE motivational model could be assessed in specific situations during PE lessons, for example, during different phases in the delivery of the content or in relation to a variety of sports or physical activities.

In the future, it would be interesting to see intervention studies aiming to change students' affective experiences during fitness testing classes and to test whether changes at the situational level have an effect at the contextual level, or vice versa. These bottom-up or top-down effects have been previously studied in sports contexts targeting motivational constructs (e.g., Kowal & Fortier, 2000) but not in the PE fitness testing context. It would also be interesting to study whether different subgroups of students (e.g., based on gender, ethnicity, or special needs) perceive enjoyment and anxiety differently during fitness testing classes. Additionally, as previous research has shown that PE may affect PA participation during leisure time (Hagger et al., 2003), it would be valuable to investigate how enjoyment and anxiety in school fitness testing classes impact students' willingness for fitness development and PA outside school.

Future research should consider examining possible group differences concerning the associations between motivational constructs and affects in fitness testing classes. These subgroups might be based on gender, ethnicity, special needs, level of perceived or actual competence, or fitness level. This would be beneficial for teachers who often work with heterogeneous groups of students while conducting testing in PE. In addition, intervention studies are needed to better understand how positive affective experiences can be fortified and negative affects minimized, specifically in fitness testing classes. Together with subgroup analyses, this information could contribute to an increase in both positive testing experiences and willingness to maintain PA and fitness levels. In addition to students' perceptions, future studies could also emphasize an examination of the pedagogical modalities used by teachers to better understand the specifics of their fitness testing implementation practices. Finally, longitudinal studies are needed to investigate the long-term behavioral, cognitive, and affective effects of regular PE-based fitness testing.

In the future, developing students' physical performance and PA in the school context should receive more attention, as suggested by a large expert panel of researchers in the field (Lang et al., 2022). For example, interventions that occur during school transitions (e.g., from primary to secondary school) could provide new insights into students' PA development. Additionally, programs that cross contextual borders (e.g., schools, leisure time, sports clubs) could be further examined. Longer intervention programs and longer follow-up periods are needed to understand the long-term effects of various programs. The effectiveness of intervention programs should also be determined with larger samples that represent randomly selected real-life schools. In addition, different requirements for scaling up the programs should be considered to achieve a meaningful effect on a population level (Milat et al., 2016).

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ORIGINAL PAPERS

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ASSOCIATIONS AMONG BASIC PSYCHOLOGICAL NEEDS, MOTIVATION AND ENJOYMENT WITHIN FINNISH PHYSICAL EDUCATION STUDENTS

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Research article

Associations among Basic Psychological Needs, Motivation and Enjoyment within Finnish Physical Education Students

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Abstract
The purpose of this study was to analyse the associations between basic psychological needs, motivational regulations and enjoyment within Finnish physical education (PE) students. The participants of the study were 260 Grade 5 students (M_{age}=11.86, SD=0.28) and 242 Grade 8 students (M_{age}=14.93, SD=0.37) who completed a questionnaire prior to their regular PE classes. This cross-sectional study incorporated a multigroup structural equation modelling (SEM, path model) separately for Grade 5 and 8 students, using gender as a grouping value. Results indicated that among Grade 5 students autonomy was directly associated with enjoyment. In addition, there was an indirect path from autonomy to enjoyment via intrinsic regulation in the boys group, and an indirect path from relatedness to enjoyment via intrinsic regulation in the girls group. Among Grade 8 students, need for competence was directly associated with enjoyment for the boys. Results also revealed negative associations from autonomy to enjoyment via amotivation for the girls group, and via external regulation for the boys group. For both Grades 5 and 8 SEM revealed additional, gender specific associations. The results of this study highlight the importance of students' need satisfaction and autonomous motivation as factors that could facilitate enjoyable experiences in PE classes.

Key words: psychological needs, motivation, enjoyment, physical education.

Introduction

Physical activity (PA) recommendations set by health experts indicate that school-aged children and adolescents should engage in moderate-to-vigorous PA for at least 60 minutes daily (World Health Organization, 2012). Although it is widely acknowledged that PA has positive effects on health, a substantial number of children fail to meet the recommendations (Hallal et al., 2012). For example, in Finland 49% of primary school and 18% of junior high school students achieve the national recommendations for PA (Tammelin et al., 2016). A notable decline in PA occurs when adolescents transit from childhood to adulthood (e.g. Currie et al., 2008). Across this age period, school physical education (PE) offers an ideal platform for enhancing PA engagement because it effectively reaches the entire age cohort. A key element underpinning PA engagement is enjoyment (Hashim et al., 2008; Wallhead and Buckworth, 2004). Therefore, more studies are needed to understand the factors associated with PE enjoyment.

In this study, in order to examine enjoyment in PE, we utilize the Self-Determination Theory (SDT) as a broad framework to understand and explain human motivation and behaviour (Deci and Ryan, 1985; 2000; Ryan and Deci, 2017). Recent meta-analyses by Owen et al. (2014) and Ng et al. (2012) have shown that SDT has proven to be a valuable tool for studies in the PA context, and more specifically, it has been used in order to study enjoyment in PE settings (e.g. Leptokaridou et al., 2015; Gråsten et al., 2017). According to the SDT, humans have three fundamental psychological needs that are autonomy, competence and relatedness which, when satisfied, lead to well-being and when thwarted, lead to ill-being (Ryan and Deci, 2017). Autonomy is described as a feeling of personal agency and ability to make your own decisions in different activities. Competence can be seen as a feeling of effectiveness when interacting with the environment and engaging in optimally challenging tasks. Relatedness is described as a sense of belonging and connectedness with the important people around you. Fulfilment of these needs guide and provide energy when engaging in certain behaviour, such as PA (Ryan and Deci, 2017). Previous studies have revealed that fulfilment of students' psychological needs have a positive impact on enjoyment in PE context. More specifically, enjoyment has been linked with the perception of autonomy (Ommundsen and Kvalo, 2007), competence (Leptokaridou et al., 2015) and social relatedness (Cox et al., 2008; 2009).

According to Ryan and Deci (2017) human behaviour can be intrinsically motivated, extrinsically motivated or amotivated. Intrinsically motivated behaviour is present when engaging in activity for itself out of pure interest and enjoyment (Ryan and Deci, 2017). An example of this intrinsically regulated behaviour is a student who performs physical activities or tasks without any external rewards. On the other hand, as Deci and Ryan (2000) have argued, some motives are more instrumental. Therefore, a student could be doing the activity to get a good grade. Different forms of these more external motives can be divided into four different types of extrinsic regulations, which fall along a continuum of internalization. The more internalized the extrinsic motivation, the more autonomous one will be when engaging in activity. Consequently, if the internalization is forestalled, the motivation will be more controlled. There are two forms of controlled motivation: external regulation, where activities are performed for external prompts or factors (e.g., to gain rewards or to get a good grade), and introjected regulation, where activities are performed through internal pressure or self-set contingencies (e.g., feeling of guilt). Similarly, there are two forms of autonomous motivation: identified regulation,

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which reflects behaviour that is personally important and valued, and integrated regulation, where activities assimilate with personal goals, attitudes and values. *Integrated regulation is not included in this study because it is a type of motivation which is usually not encountered with children, as they may be too young to have achieved a sense of integration within self (Vallerand and Losier, 1999).*

In addition, there is a state of amotivation, where the individual has no intentions or tendency for certain behaviour or engage in activities without a purpose (Ryan and Deci, 2017). Previous research has shown that these different types of motivational regulations have been associated with affective consequences, such as enjoyment. Studies completed in the PE context have indicated that enjoyment has been positively associated with autonomous forms of motivation and negatively with controlling forms of motivation (Gråsten et al., 2012; Yli-Piipari et al., 2012; Cox et al., 2008).

Enjoyment, when considered as a representation of positive affect, can be described as a multidimensional construct related to excitement, enthusiasm and perceptions of competence (Hashim et al., 2008). In this study, enjoyment was operationalized as a positive affective response that reflects more generalized feelings of fun, liking and pleasure. This construct is more general than a specific emotion (e.g. excitement) but more specific than global positive affect (Scanlan and Simons, 1992). Previous studies have shown that enjoyment in PE has found to be related with PA engagement both in school PE (Hashim et al., 2008; Dishman et al., 2005) and during leisure-time (Sallis et al. 1999; Wallhead and Buckworth, 2004; Hashim et al., 2008).

There is a strong body of research showing associations among basic psychological needs, motivational regulations and enjoyment in the PE context (e.g. Leptokaridou et al., 2015; Cox et al., 2008; Ommundsen and Kvalo, 2007). However, it is a shortcoming that there are no studies which have included all basic psychological needs and motivational regulations when investigating enjoyment in PE. For example, in a study conducted by Gråsten and Watt (2017) the variables of motivational climate, basic psychological needs, intrinsic motivation and affective, cognitive and behavioural outcomes were examined, but other than intrinsic regulation no other regulations were included. Ryan and Deci (Ryan and Deci, 2017) proposed, however, that to understand human motivation the whole motivational process (i.e., basic psychological needs, motivational regulations), needs to be involved in the analysis when investigating possible cognitive, affective or behavioural outcomes produced by motivation. Therefore, to fill the gaps in the literature, we utilized the whole motivational process proposed in the SDT (Ryan and Deci, 2017) when explaining students' enjoyment in PE. Additionally, previous studies have shown that motivational experiences related to PE vary within different age groups (Ntoumanis et al., 2009; Yli-Piipari et al., 2012). Therefore, we will investigate associations among study variables separately by using student samples from Grade 5 and Grade 8. The primary aim of this study was to test the SDT based motivational model in the PE context by analyzing the associations between basic psychological needs (competence, autonomy and relatedness), motivational regulations (intrinsic regulation, identified regulation, introjected regulation, external regulation and amotivation) and enjoyment in PE within Grade 5 and 8 Finnish students. Because previous research has demonstrated differences between boys and girls regarding enjoyment in PE (Carroll and Loumidis, 2001), psychological needs (Carroll and Loumidis, 2001; Fairclough, 2003) and motivational regulations (Yli-Piipari, 2011), we used gender as a grouping variable in the analysis and investigated whether the boys and the girls motivational experiences vary within different age groups.

Methods

Participants and procedures

Participants of the study were Grade 5 (130 boys and 130 girls, mean age 11.86 years, SD = 0.28) and Grade 8 (109 boys and 133 girls, mean age 14.93 years, SD = 0.37) students from Central and Southern Finland. Data was collected by a member of the research team prior to regular PE classes. Parents were informed about the study in advance and their written consent for the participation of their child was required. Study protocols were explained to the students, reinforcing that participation was voluntary and that their responses were kept confidential. Students had an opportunity to ask if they had trouble understanding some of the questions. Prior to the study, research protocols were approved by the ethics committee of the local University.

Measurements

Basic Psychological Needs: The Finnish version of the Basic Psychological Needs in Physical Education scale (BPN-PE) (Vlachopoulos et al., 2011) was used to measure the extent of participants' fulfillment of the needs for autonomy, competence and relatedness in PE. The scale includes 12 items which tap into the satisfaction of autonomy (4 items; e.g., "PE class is taught the way I like it to be taught"), competence (4 items; e.g., "I am able to do well even in the PE lessons considered difficult by most kids in my class") and relatedness (4 items; e.g., "I feel like I have a close bond with the other kids in my class". Items were rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Initial evidence for the validity and reliability of the BPN-PE scale has been demonstrated among Greek elementary ($\chi 2$ = 140.47, df = 51, CFI = 0.972, RMSEA = 0.046), middle ($\chi 2$ = 278.24, df = 51, CFI = 0.948, RMSEA = 0.072) and high school ($\chi 2$ = 183.01, df = 51, CFI = 0.977, RMSEA = 0.055) students in the PE context (Vlachopoulos et al., 2011).

Motivational regulations: To measure motivation for PE participation, the Finnish version of the Revised Perceived Locus of Causality Scale (PLOC-R) (Vlachopoulos et al., 2011) was used. The scale uses the following stem: "I take part in PE…" and comprises 19 items which measure students amotivation (4 items; e.g., "But I really don't know why"), external regulation (3 items; e.g., "So that the teacher won't yell at me"), introjected regulation (4 items; e.g., "Because it would bother me if I didn't"), identified regulation (4 items; e.g., "Because it is important to me to try in PE") and intrinsic regulation (4 items; e.g., "Because PE is fun"). Items were rated on a 5-

point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Vlachopoulos et al. (2011) have demonstrated initial evidence for the validity and reliability of the instrument among elementary ($\chi2$ = 277.2, df = 142, CFI = 0.94, RMSEA = 0.048), middle ($\chi2$ = 432.1, df = 142, CFI = 0.93, RMSEA = 0.066) and high school ($\chi2$ = 386.4, df = 142, CFI = 0.94, RMSEA = 0.063) students in PE context.

Enjoyment: Enjoyment in PE was measured with the Finnish version of the Enjoyment subscale from the Sport Commitment Questionnaire -2 (Scanlan et al., 1993; 2016). The Scale comprises five items (e.g., I enjoy PE classes) which are rated on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). Individual stem of "In my PE classes…" was used to reflect the PE context. The Finnish version of the Sport Enjoyment scale have been found to be a valid and reliable tool when used with 13-year-old students ($\chi2$ = 0.74, df = 2, CFI = 1.00, TLI = 1.00) during PE classes (Kalaja et al., 2010).

Translation and validation of the scales: Basic Psychological Needs in Physical Education scale (BPN-PE; Vlachopoulos et al., 2011) and Revised Perceived Locus of Causality Scale (PLOC-R; (Vlachopoulos et al., 2011) have not been previously used in the Finnish language. Scales were translated using back-translation procedure suggested by Brislin (1986). Firstly, all items were translated by a bilingual researcher from English to Finnish, then another bilingual researcher back-translated the items to English. After that, the original and the back-translated versions were compared. Items that were shown to have a number of possible meanings in Finnish were discussed by the panel of experts in order to redraft them to be as accurate as possible in meaning, compared to the original English version.

Analyses

Before major statistical analyses were completed, normality of data, outliers and missing values were examined. Because study variables were not normally distributed, we used the mean and variance adjusted weighted least squares estimation method (WLSMV) as suggested by Muthén and Muthén (2012) in further analyses. No significant outliers were detected based on the standardized values (± 3.00) (Tabachnick and Fidell, 2012). Missing completely at random test (MCAR; Little and Rubin, 2002) indicated that missing values were missing completely at random ($\chi2$ = 1608.6, df = 1574, p = 0.266). Descriptive statistics were used to summarize the data. Confirmatory factor analysis (CFA) and Cronbach's alpha coefficients were used to examine the construct validity and reliability of the scales. Analyses of the relationships among study variables involved the determination of Pearson's correlation coefficients and the use of structural equation modeling. As recommended by Bentler (1995), a multigroup structural equation modeling (SEM) was used to analyze whether the associations between the study variables varied between boys and girls in different age groups. To determine the appropriateness of CFA and SEM models, the Chi-square test ($\chi2$), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), and the Root Mean Square Error of Approximation (RMSEA) scores were calculated (Muthén and Muthén, 2012). The TLI and CFI indices varies from 0 to 1 and fit indices greater than 0.90 are indicative of acceptable model fit. In addition, an RMSEA score of lower than 0.10 is indicative of a representative model. Finally, the normed chi-square index ($\chi2$/df) representing parsimonious fit should be below the marginal maximum of 3.00 (Kline, 2011). Statistical analyses were conducted using the Mplus 7.11 program (Muthén and Muthén, 2012).

Results

Validity and reliability of the scales

Confirmatory factor analyses (CFA) were conducted in order to examine how well the three-factor structure of the BPN-PE, five-factor structure of the PLOC-R and one-factor structure of enjoyment in PE fitted to the data. Factors were allowed to correlate and no correlated residuals were permitted. The goodness-of-fit indices are shown in Table 1. The results indicated that all three measurements fitted the data well. A reliability analyses using Cronbach's alpha coefficients were conducted for dimensions in BPN-PE, PLOC-R and Enjoyment in PE. Results indicated that the coefficients were satisfactory among all variables and the alpha-values ranged 0.63 to 0.95.

Descriptive statistics and correlations

Descriptive statistics showed that both Grade 5 and 8 students scored high on autonomy, competence and relatedness (see Table 2). There were also high scores with enjoyment and autonomous forms of motivation; intrinsic and identified regulation. Low scores were found on amotivation and external regulation among both Grade 5 and 8 students. The associations among study variables showed that among Grade 5 students enjoyment correlated positively with autonomy, competence and relatedness. There was also a positive correlation between enjoyment and intrinsic regulation and identified regulation. A negative correlation

Table 1. Confirmatory factor analyses for BPN-PE, PLOC-R and the Enjoyment Scale.

		Chi-square test (CMIN)	Chi-square test (p-value)	Degrees of freedom (df)	CMIN/df	Tucker-Lewis Index (TLI)	Comparative Fit Index (CFI)	Root Mean Square Error of Approximation (RMSEA)
5th grade	BPN-PE	66.14	0.034	47	1.40	0.99	1.00	0.04
	PLOC-R	265.13	0.000	129	2.06	0.94	0.95	0.07
	Enjoyment	18.79	0.002	5	3.76	1.00	1.00	0.10
8th grade	BPN-PE	106.58	0.000	48	2.22	0.98	0.99	0.07
	PLOC-R	389.43	0.000	136	2.86	0.95	0.96	0.09
	Enjoyment	11.15	0.049	5	2.23	1.00	1.00	0.07

Table 2. Means, Standard deviations and Cronbach's Alphas for all variables.

	Grade 5 (N=260)			Grade 8 (N=238)		
	α	M	SD	α	M	SD
1. Autonomy	0.75	3.16	0.86	0.82	3.09	0.87
2. Competence	0.86	3.64	0.85	0.88	3.38	0.90
3. Relatedness	0.74	3.94	0.72	0.81	3.58	0.85
4. Amotivation	0.63	1.47	0.61	0.80	1.87	0.92
5. External regulation	0.64	2.02	0.99	0.68	2.59	1.07
6. Introjected regulation	0.67	2.68	0.97	0.76	2.73	1.03
7. Identified regulation	0.70	3.79	0.84	0.84	3.40	1.03
8. Intrinsic regulation	0.73	4.14	0.73	0.89	3.59	1.10
9. Enjoyment	0.91	4.30	0.81	0.95	3.64	1.14

α = Cronbach's Alpha, M=mean, SD= standard deviation

Table 3. Descriptive statistics and correlations among study variables for Grade 5 students.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	M (boys)	SD (boys)	M (girls)	SD (girls)
1. Autonomy	–	.40***	.45***	-.19*	-.14	.19	.26***	.41***	.52***	3.22	0.84	3.14	0.86
2. Competence	.47***	–	.51***	-.28***	-.15	.09	.32***	.39***	.38***	3.78	0.76	3.52	0.89
3. Relatedness	.44***	.38***	–	-.34***	-.23**	-.09	.27**	.44***	.47***	4.00	0.69	3.90	0.75
4. Amotivation	-.28***	-.12	-.17	–	.59***	.19*	-.02	-.32***	-.35***	1.41	0.61	1.53	0.63
5. External regulation	-.28**	-.23**	-.32***	.40***	–	.45***	.16	-.39***	-.32***	1.97	1.00	2.09	1.00
6. Introjected regulation	-.03	-.05	.07	.36***	.46***	–	.43***	-.06	-.02	2.58	0.93	2.77	1.01
7. Identified regulation	.26**	.28**	.21*	-.07	.15*	.19*	–	.17	.26**	3.92	0.80	3.67	0.88
8. Intrinsic regulation	.46***	.28***	.28***	-.30***	-.26**	-.02	.35***	–	.70***	4.25	0.71	4.05	0.72
9. Enjoyment	.55***	.31***	.43***	-.38***	-.39***	-.19*	.31***	.69***	–	4.42	0.72	4.17	0.83

* p < 0.05, ** p < 0.01**, *** p < *.001***, M=mean, SD= standard deviation. Lower side = Grade 5 boys (n=130), Upper side = Grade 5 girls (n=130).

Table 4. Descriptive statistics and correlations among study variables for Grade 8 students.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	M (boys)	SD (boys)	M (girls)	SD (girls)
1. Autonomy	-	.52***	.57***	-.50***	-.36***	.21*	.56***	.65***	.73***	3.10	0.80	3.06	0.91
2. Competence	.66***	-	.57***	-.31***	-.32***	.21*	.56***	.60***	.61***	3.36	0.85	3.38	0.89
3. Relatedness	.51***	.61***	-	-.26**	-.28**	.17	.54***	.55***	.58***	3.65	0.79	3.52	0.87
4. Amotivation	-.42***	-.42***	-.37***	-	.52***	.03	-.43***	-.57***	-.62***	1.86	0.91	1.84	0.89
5. External regulation	-.48***	-.42***	-.37***	.58***	-	.18*	-.30**	-.43***	-.49***	2.53	1.05	2.65	1.07
6. Introjected regulation	.25**	.15	.10	-.02	.16	-	.46***	.12	.19*	2.57	0.97	2.88	1.07
7. Identified regulation	.71***	.56***	.58***	-.39***	-.37***	.40***	-	.70***	.69***	3.26	0.99	3.51	1.01
8. Intrinsic regulation	.58***	.60***	.50***	-.43***	-.38***	.28**	.67***	-	.80***	3.62	1.01	3.56	1.11
9. Enjoyment	.70***	.70***	.58***	-.51***	-.52***	.22*	.62***	.67***	-	3.70	1.06	3.60	1.16

* p < 0.05, ** p < 0.01**, *** p < *.001***, M=mean, SD= standard deviation. Lower side = Grade 5 boys (n=130), Upper side = Grade 5 girls (n=133).

was found between enjoyment and amotivation, introjected regulation and external regulation. Among Grade 8 students there were positive correlations between enjoyment and autonomy, competence and relatedness. Amotivation and external regulation correlated negatively with enjoyment, and intrinsic, identified and introjected regulations positively with enjoyment. Correlations among study variables are presented in Tables 3 and 4.

Structural equation modeling (SEM)

Before conducting the SEM analyzes, we used descriptive statistics to evaluate the data and results revealed that all scales were not normally distributed. Therefore, as suggested by Muthen and Muthen (2012), we applied the mean and variance adjusted weighted least squares estimation method (WLSMV). Also, squared multiple correlations (R^2) were used to calculate the proportion of explained variance of dependent variables. The equality of the coefficients between these two models was compared by using the χ^2 difference test (WLSMV difference testing).

We started by creating separate models for Grade 5 boys and girls, and for Grade 8 boys and girls. After analyzing the models and modification indices we determined which parameters should be fixed and which should be estimated freely in each group. These initial models (a so-called configural model; Horn and McArdle, 1992) revealed that data was a good fit for the Grade 5 students [$\chi2$ (40) = 43.60, p = 0.32; CFI = 0.996; TLI = 0.993; RMSEA = 0.026], and the Grade 8 students [$\chi2$ (40) = 57.05, p = 0.04; CFI = 0.963; TLI = 0.933; RMSEA = 0.060]. We proceeded by individually examining the equality of the correlations and paths for both subgroups. Finally, the $\chi2$ difference test result indicated that these paths were equal for the boys and the girls [Grade 5: $\chi2$ (8) = 6.93, p = 0.54; Grade 8: $\chi2$ (10) = 6.68, p = 0.76]. With these equality constraints the final models had a good fit to the data for Grade 5 students [$\chi2$ (48) = 48.35, p = 0.46; CFI = 1.00; TLI = 1.00; RMSEA = 0.01] and for Grade 8 students [$\chi2$ (49) = 52.21, p = 0.35; CFI = 0.99; TLI = 0.99; RMSEA = 0.02].

There were both direct and indirect statistically significant paths for boys and girls in the model of Grade 5 students. For both boys and girls, there was a direct positive path from autonomy to enjoyment. In the boys group, an indirect positive path was found from autonomy to enjoyment via intrinsic regulation, and for the girls group an indirect positive path was found from relatedness to enjoyment via intrinsic regulation. The SEM also revealed additional paths between basic psychological needs and motivational regulations. To begin with, a positive path from autonomy to identified regulation was found for both genders. Additionally, boys demonstrated a negative path from autonomy to amotivation, and to external regulation. Regarding the girls group, negative paths from relatedness to amotivation and to external regulation were found. An additional negative path was identified from introjected regulation to enjoyment in the boys group. The model also revealed some additional correlations among basic psychological needs, and among motivational regulations. For both boys and girls, statistically significant correlations were found among all the three psychological needs. Results related to motivational regulations showed both boys and girls demonstrated statistically significant correlations between following variables: amotivation and external regulation; amotivation and introjected regulation; external regulation and introjected regulation; introjected regulation and identified regulation; and finally between external regulation and identified regulation. In the boys group, a positive correlation was found between identified regulation and intrinsic regulation, and a negative between amotivation and intrinsic regulation. In addition, girls demonstrated a negative correlation between external regulation and intrinsic regulation. Squared multiple correlations showed that significant variables explained enjoyment, 83% for boys and 82% for girls. The final model for Grade 5 is presented in Figure 1.

In the Grade 8 model results revealed both direct and indirect statistically significant paths for both genders. A direct positive path was found from competence to enjoyment, but only in the boys group. Data for the boys also demonstrated a negative indirect path from autonomy to enjoyment via external regulation. Another negative indirect path was found in the girls group from autonomy to enjoyment via amotivation. The SEM also revealed additional direct paths between the needs and the regulations. A negative path was found from autonomy to external regulation for both boys and girls. In the girls group, there was a positive path from autonomy to intrinsic regulation. In the boys group, a positive path from competence to intrinsic regulation, and a negative path from competence to amotivation were found. There was one more additional path in the boys group from introjected regulation to enjoyment. In addition, the model revealed correlations among basic psychological needs, and among motivational regulations. More specifically, correlations were found among autonomy, competence and relatedness for both genders. Concerning the regulations, both genders showed correlations between amotivation and external regulation, and between introjected regulation and identified regulation. In addition, the boys group demonstrated correlations between intrinsic, identified and introjected regulation, and girls between external and introjected regulations. Squared multiple correlations showed that significant variables explained enjoyment, 82% for boys and 92% for girls. The final model for Grade 8 is presented in Figure 2.

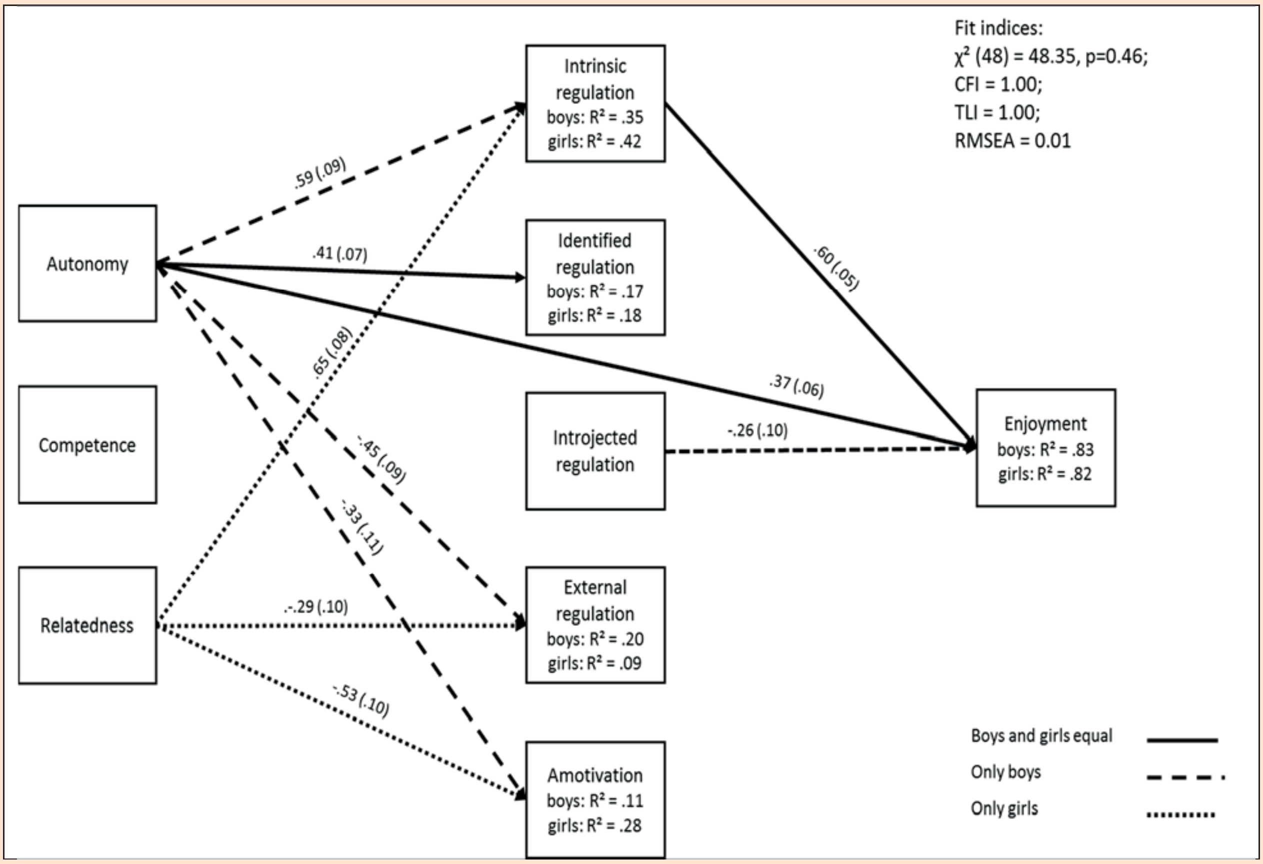

Figure 1. **Multigroup Structural Equation model for Grade 5.**

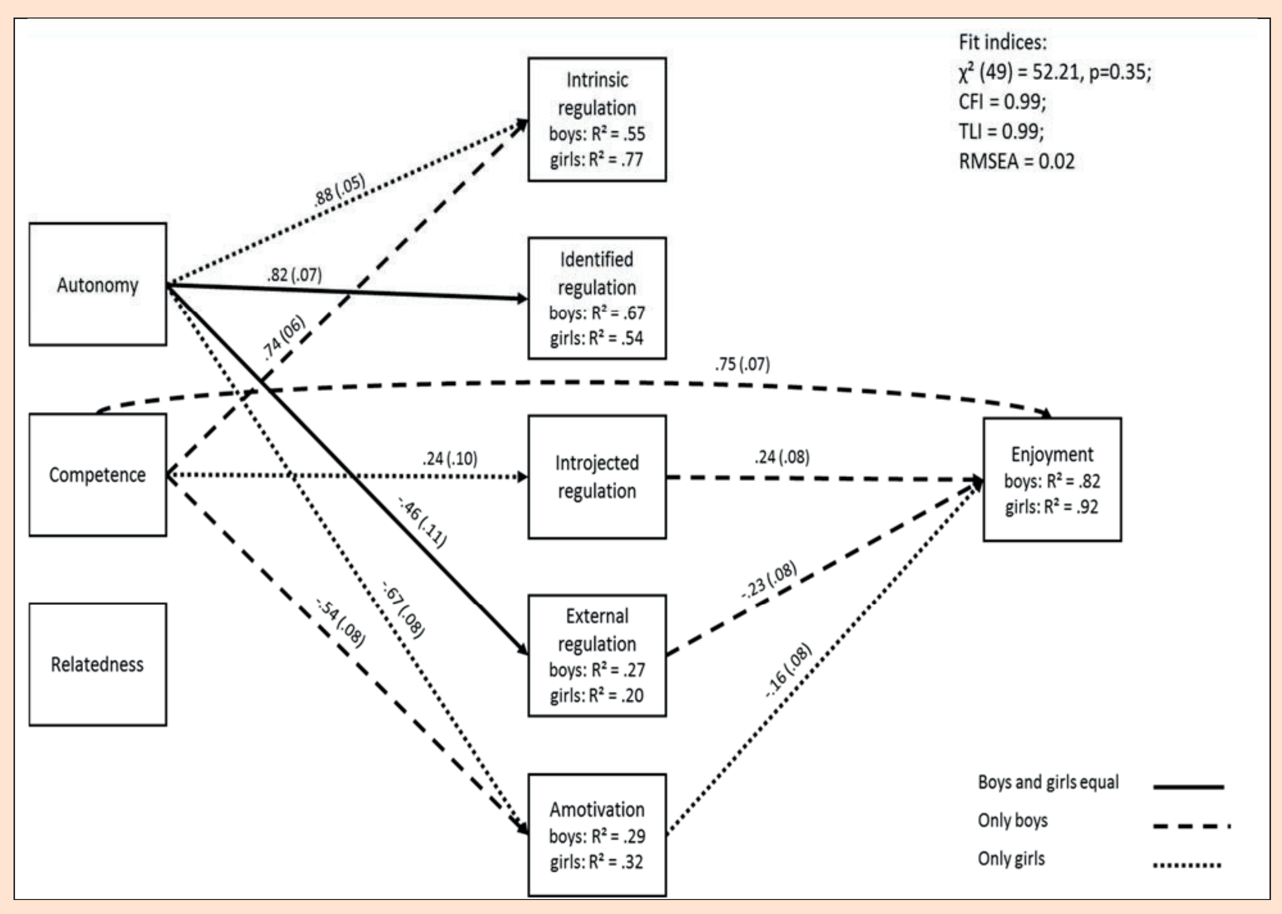

Figure 2. Multigroup Structural Equation model for Grade 8.

Discussion

The aim of this study was to investigate associations between basic psychological needs, motivational regulations and enjoyment in school PE context. To broaden the existing research, the entire motivational process as framed within the SDT was utilized as a theoretical foundation to investigate enjoyment in PE.

Generally, the results of this study are in line with the theoretical assumptions described in the SDT (Ryan and Deci, 2017) where it is argued that needs satisfaction would directly and indirectly promote PE enjoyment, and in contrast, needs frustration would lead to decreased enjoyment. More specifically, although statistically significant associations among basic psychological needs, motivational regulations and PE enjoyment varied in different age and gender groups, the results of our study indicate that satisfaction of students' needs for autonomy, competence or relatedness were only positively associated with more autonomous forms of motivation and enjoyment in school PE. These results are in line with previous empirical studies related to the PE context. Vlachopoulos et al. (2011), for example, showed positive links from the variables of needs for autonomy and competence to subjective vitality in PE among a sample of Greek students. Additionally, Standage and Gillison (2007) provided evidence that needs for autonomy and competence had positive indirect effects on self-esteem and health related quality of life. Also as expected, results of this study revealed only negative associations between needs satisfaction, more controlling forms of motivation and enjoyment. Similar results have been documented in several other studies in different cultures (e.g. Leptokaridou et al., 2015; Ommundsen and Kvalo, 2007). In the following section, the findings from the current study are discussed in detail separately for Grade 5 and Grade 8 students.

Among Grade 5 students, the model indicated that the need for autonomy was directly associated with PE enjoyment. The need for autonomy was also linked to enjoyment via intrinsic motivation, but only in the boys group. These findings demonstrate, that for boys who are just reaching puberty, the provision of opportunities to make choices and supporting feelings of personal agency in their learning situations are important elements in enhancing autonomous motivation and positive affect in PE. Similar results have been demonstrated in a previous study conducted by Leptokaridou et al. (2015), who showed that need for autonomy positively predicted enjoyment among Greek Grade 5 and 6 students. Additionally, the results of this study revealed an indirect path from the need for relatedness to PE enjoyment via intrinsic motivation in the girls group. This means that the role of important others and the sense of relatedness is especially important for the Grade 5 girls' positive affect in PE. The results concerning Grade 5 students are intriguing regarding the role of competence need satisfaction. Ryan and Deci (2017) have argued that satisfaction of all three psychological needs are needed for enhancing intrinsic motivation and well-being in general.

It is therefore interesting, that in the current sample of Grade 5 students the role of need for competence was not identified as a significant contributor towards PE enjoyment or autonomous motivation. This is somewhat contradictory to previous results. For example, Cairney et al. (2012) found that higher levels of perceived competence were associated with higher levels of PE enjoyment among Canadian Grade 4 students. Results also indicated that autonomy for the boys, and relatedness for the girls were negatively associated with external regulation and amotivation, which are usually seen less desirable in terms of optimal motivation (Ryan and Deci, 2017). In other words, this indicates that boys who feel that their aunomy need is satisfied and girls who perceive their relatedness need is satisfied might have less negative motivational experiences in PE.

Findings for the Grade 8 sample showed that there was a direct positive link between the need for competence and enjoyment, but the effect was evident only in the boys group. This finding is consistent with previous studies, that have linked the need for competence with intrinsic motivation (e.g. Taylor et al., 2010; Fairclough, 2003; Caroll and Loumidis, 2001) and points out that when students feel they can perform and excel in given situations, have clearly set goals, and are engaged in optimally challenging tasks they perceive the environment as more enjoyable. Although the Grade 5 model indicated that the role of need for competence was less meaningful in that younger age group, the model for Grade 8 students showed that competence was a significant contributor towards enjoyment in PE, especially for boys. One reason for this might be that the role of competence is more evident when students get older and their self-perceptions towards physical activity develop (Nicholls, 1989). From practical perspective, it would be rational for teachers conducting PE lessons to emphasize elements that enhance competence need satisfaction, especially with secondary school students. Additionally, the results indicated two indirect paths from basic psychological needs to enjoyment. More specifically, autonomy was negatively linked to enjoyment via external regulation for boys, and via amotivation for girls. These findings are also consistent with the SDT (Ryan and Deci, 2017) where it is argued that when the need for autonomy is not satisfied, it will lead to amotivation and external regulation, and subsequently decreased enjoyment. Specifically related to the boys was a positive connection between introjected regulation and enjoyment, which is somewhat peculiar as introjected regulation means that the motivation is resulting from an internal pressure (Ryan and Deci, 2017). This could be explained possibly through the reasoning that although students feel obligated to take part in compulsory school PE, the lesson content (e.g. football, skating) may nevertheless lead to enjoyable experiences. Interestingly, the need for relatedness was not associated with PE enjoyment or motivational regulations among Grade 8 students, although it is detailed in SDT (Ryan and Deci, 2017) that all the three basic needs are needed for optimal well-being. One reason for this could be that in order to experience the PE lesson as fun and pleasurable, the students' sense of agency, and perceived competence are more important factors than belonging within a safe group.

Results of this study have several practical implications especially for PE teachers. When formulating these implications, the results pertaining to each age group and both genders should be considered. Among Grade 5 boys, the need for autonomy can be supported by creating opportunities for choice and emphasizing a sense of agency or ownership in the learning situation. Also, it includes using non-controlling language and feedback (Reeve and Halusic, 2009). Studies have shown that teachers' provision of autonomy support leads to positive consequences (e.g. Ulstad et al., 2016) and should therefore be enforced in PE teacher education and in-service training. Among Grade 5 girls, and in addition to fostering the need for autonomy, the need for relatedness can be enhanced when students' feel the context as trustworthy and feel the approval and appreciation of important others around them (Ryan and Deci, 2017). In educational settings, as well as in PE, this includes teacher and peers showing interest, affection and caring, and demonstrating satisfaction and appreciation of the time spent together in learning situations (Haerens et al., 2013; Cox and Williams, 2008; Ryan and Deci, 2017). Previous studies have shown that students who perceive a sense of relatedness with their teachers are more positively engaged in PE (e.g. Shen et al., 2012). For Grade 8 boys, the need for competence can be supported by providing learning goals that are optimally challenging, and also by providing structure, stating clear expectations of learning goals, giving detailed instructions, and offering guidance when performing activities. The provision of feedback in order to enhance need for competence and perceived control has also been proven effective (Jang et al., 2010).

The results must be interpreted relative to the limitations of the study. Specifically, the study design was cross-sectional and therefore not suitable for conclusions concerning causal links between the study variables. Also, the representativeness of the results is limited because the sample of students were conveniently, and not randomly selected. Future studies could evaluate the SDT based motivational sequence, including social factors, based on a longitudinal design. It would also be interesting to see the effects of modifying the teachers' pedagogical approaches and therefore intervention studies are needed in the future. In addition, the school PE motivational model could be assessed in specific situations during PE lessons, for example during different phases in the delivery of the content or in relation to a variety of sports or physical activities.

Conclusion

In this study, enjoyment in PE among Grade 5 and 8 boys and girls was investigated through the lens of self-determination theory. Overall, the findings support notions derived from the SDT whereby basic psychological needs for autonomy, competence and relatedness are seen as important antecedents for optimal motivation and well-being. Fulfilment of these psychological needs has a positive impact for affective consequences, such as enjoyment. This effect is also influenced by type of motivation, where autonomous motivation leads to more favorable outcomes and controlled motivation to less favorable. Although the results were generally representative of the SDT, some important gender-specific differences were found among both age groups. Results of this study are especially relevant for teachers planning and conducting PE lessons for pre-adolescent and adolescent age groups. In conclusion, practitioners should concentrate on fulfilling students' psychological needs in order to enhance enjoyment in PE.

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Key points

- This study investigated enjoyment in PE among Grade 5 and Grade 8 boys and girls from the view-point of the self-determination theory (SDT).
- Generally, the findings are in line with the theoretical assumptions described in the SDT where it is argued that needs satisfaction would directly, and indirectly via autonomous motivation, promote PE enjoyment.
- Findings indicated some differences among boys and girls in both age-groups regarding the links between different psychological needs, motivational regulations and enjoyment. Results are especially interesting for teachers planning and conducting PE lessons for these age-groups.

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II

FINNISH STUDENTS' ENJOYMENT AND ANXIETY LEVELS DURING FITNESS TESTING CLASSES

by

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Finnish students' enjoyment and anxiety levels during fitness testing classes

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ABSTRACT

Background: Fitness testing is a commonly applied learning and teaching practice implemented in both secondary and elementary school physical education (PE). Many teachers believe that by using a variety of different tests, they are able to provide students with feedback regarding their fitness status, and furthermore, increase students' willingness to be physically active later in their lives. However, empirical evidence concerning students' affective responses during fitness testing classes is limited.
Purpose: The primary aim of the study was to investigate whether students' perceptions of enjoyment and anxiety differed between two different types of fitness testing classes and PE in general. In addition, the measurement invariances over time and between Grade 5 (aged 11–12) and Grade 8 (aged 14–15) groups were determined.
Method: A total sample of 645 Finnish Grade 5 ($N = 328$, 50% boys, mean age = 11.2, SD = 0.36) and Grade 8 students ($N = 317$, 47% boys, mean age = 14.2, SD = 0.35) participated in the study. Series of multi-group confirmatory factor analyses were conducted to test the level of measurement invariance between general PE and fitness testing classes, and between age groups. Strict factorial invariance was supported for both enjoyment and anxiety scales allowing for latent mean comparisons. Latent mean differences were studied using *z*-tests.
Results: Grade 5 students perceived significantly lower levels of enjoyment and cognitive processes and a higher level of somatic anxiety in fitness testing classes compared to general PE. Additionally, for Grade 8 students, levels of enjoyment and cognitive processes were significantly lower and somatic anxiety and worry higher in fitness testing classes than in general PE. Furthermore, enjoyment was significantly higher, and cognitive processes, somatic anxiety and worry lower among Grade 5 students compared with Grade 8 students in both contextual PE and during fitness testing class.
Conclusion: Results of this study indicate that students' perceptions of enjoyment were lower in fitness testing classes compared to PE in general. Additionally, students perceived lower levels of cognitive anxiety and higher levels of somatic anxiety in fitness testing classes than in general PE. It is noteworthy that students might not significantly dislike fitness testing per se but instead have significantly more positive affects towards PE in general. Generally, practitioners conducting fitness testing lessons are

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encouraged to embrace different strategies such as fostering basic psychological needs or promoting mastery climate to facilitate enjoyment and diminish anxiety.

Introduction

Physical education (PE) offers an ideal context for developing students' perceptions and attitudes towards physical fitness, physical performance and physical activity because it reaches the whole age cohort and is implemented by teaching professionals (Sallis et al. 2012). One commonly applied, yet controversial element in school PE is fitness testing (e.g. Simonton, Mercier, and Garn 2019; Jaakkola et al. 2013; Cale and Harris 2009; Silverman, Keating, and Phillips 2008; Rice 2007). According to SHAPE (2017), the fundamental aim of fitness testing is to provide students with necessary knowledge and skills for achieving and maintaining a health-enhancing level of physical activity and fitness. Many teachers consider that by using a variety of different tests they can provide students with feedback regarding their fitness status, and furthermore, increase students' willingness to become or remain physically active (Harris and Cale 2006). Fitness testing has been found to be a positive and enjoyable experience and a useful tool to motivate students towards lifelong physical activity if delivered in an affirming and supportive manner. For example, Jaakkola et al. (2013) found that students had higher perceptions of autonomous motivation in fitness testing sessions than their regular PE classes. Additionally, Goudas, Biddle, and Fox (1994) showed that students with high task orientation and low ego orientation had the highest levels of enjoyment regardless of their results in a 20-m shuttle run test. However, several researchers have reported that fitness testing may lead to negative experiences and cause students to be less interested and involved in PE or general physical activity (e.g. Rice 2007; Naughton, Carlson, and Greene 2006; Corbin 2002). For example, Lodewyk and Muir (2017) demonstrated that Grade 9 girls perceived higher levels of state anxiety and social physique anxiety in fitness testing lessons than in soccer lessons. Furthermore, Hopple and Graham (1995) reported in their qualitative study that Grade 4 and 5 students from the United States had difficulties understanding the purpose of the 1-mile-run test and that they generally had negative perceptions regarding the test. Additionally, in a study by Luke and Sinclair (1991), Canadian Grade 11 boys and girls experienced fitness testing unfavorably and reported it contributing to negative attitudes in PE context. Despite previous research attention, additional investigations on students' affective experiences of fitness testing are needed.

School PE, and fitness testing as part of it, are both examples of contexts where students' positive and negative affective experiences are clearly demonstrated. One example of positive affect is enjoyment which can be characterized as a multidimensional construct closely related to enthusiasm, excitement and perceptions of competence (Hashim, Grove, and Whipp 2008). According to Scanlan and Simons (1992), enjoyment can be verbalized through terms such as 'happiness,' 'liking,' 'pleasure' and 'fun,' and it is therefore seen to represent these more generalized feelings rather than specific emotions such as excitement. Additionally, according to Goetz et al. (2006), enjoyment can be seen as a hierarchically structured concept. This means that one might perceive enjoyment differently in general life than in a specific context such as in PE. Although past studies of enjoyment in fitness testing classes are limited, there is a substantial body of research focused on PE demonstrating consistently high levels of enjoyment among elementary (Carroll and Loumidis 2001; Huhtiniemi et al. 2019) and secondary school students (Soini 2006; Gråsten 2014). Furthermore, enjoyment in PE has been consistently associated with physical activity engagement during school PE (Hashim, Grove, and Whipp 2008; Dishman et al. 2005) and leisure time (Bengoechea et al. 2010; Hashim, Grove, and Whipp 2008; Wallhead and Buckworth 2004).

Although the majority of students find PE enjoyable (Soini 2006), some have reported negative experiences in PE. Barkoukis (2007) proposed that these negative perceptions may rise from many different factors such as social evaluation, peer comparison or low competence in PE context. The most common negative affect studied in PE is anxiety. More specifically, Barkoukis reported that anxiety in PE classes can be explained through cognitive symptoms (e.g. having negative thoughts), somatic symptoms (e.g. having shortness of breath) and information processing symptoms (e.g. attention disruption). Naturally, many psychosocial factors may trigger responses towards these distinctive manifestations. Factors such as different content areas in PE, class atmosphere, or teachers' interpersonal style may increase or decrease perceptions of anxiety among students. For example, a mastery-oriented motivational climate has been associated with lower anxiety in PE classes (Papaioannou and Kouli 1999; Cecchini et al. 2001). Furthermore, Cox et al. (2011) have demonstrated that social physique anxiety in PE may lead to diminished PE participation and effort. From a broader perspective, there is a plethora of studies focused on test-anxiety in the educational context (Hembree 1988; Zeidner 1998; Von der Embse et al. 2018) demonstrating that test-anxiety associates negatively to a range of behavioral and affective outcomes.

In order to examine how students' affective perceptions vary between fitness testing situations and general PE, we used the concept of different generality levels, previously utilized when studying enjoyment (Goetz et al. 2006) and anxiety (e.g. Zeidner 1998) in educational contexts. One model that has been regularly applied in the context of sport and physical activity is Vallerand's (1997) hierarchical model of intrinsic and extrinsic motivation where it is proposed that motivation and subsequent psychological outcomes such as enjoyment or anxiety occur at three levels, namely global (personality), contextual (life domain) and situational (state). Fitness testing class is an example of a situational level where motivational and affective perceptions arise from the immediate experiences of involvement in a given situation. While the situational level is highly specific, the contextual level represents a more generalized perspective of certain life domains such as education or sport. One example of a contextual level is PE (Jaakkola et al. 2013). The Vallerand's (1997) hierarchical model has been incorporated in multiple studies analyzing students' perceptions in different contexts such as sport (Kowal and Fortier 2000) and PE (Jaakkola et al. 2008). Thus it can be used as a framework to study students' affective perceptions in general PE and in fitness testing situations.

Previous research findings regarding students' affective perceptions in PE fitness testing situations are limited and variable (e.g. Lodewyk and Muir 2017; Jaakkola et al. 2013; Hopple and Graham 1995; Luke and Sinclair 1991). More specifically, a review of the literature reveals that there are no studies examining how students' perceptions of enjoyment and anxiety differ between contextual PE and situational fitness testing class. This knowledge would be useful for PE practitioners and PE teacher educators, and for future intervention development. Therefore, to contribute to the body of knowledge on this topic, the primary aim of this study was to investigate whether students' perceptions of enjoyment and anxiety differed between two different types of fitness testing classes and PE in general. More specifically, the aim was to examine whether students' perceptions of enjoyment, somatic anxiety, cognitive processes and worry differed among PE in general and two fitness testing classes with distinctive content foci (class 1: aerobic endurance, class 2: skills and muscular strength). Furthermore, as the enjoyment and anxiety scales of this study (SCQ-2: Scanlan et al. 2016 and PESAS: Barkoukis et al. 2005) have not been used in fitness testing situations, the additional aim of this study was to investigate the measurement invariance of anxiety and enjoyment scales over time (contextual PE vs. situational fitness testing class 1 and 2) and across groups (Grade 5 and Grade 8 students).

Methods

Participants of the study were 645 Finnish Grade 5 and 8 students recruited from 36 classes and 12 schools in the Southern, Western, and Central regions of Finland. Invitations to participate were sent to schools in different regions and those willing to participate were recruited for the study. Schools represented both urban and rural areas, and followed the national core curriculum with no optional study lines (e.g. sport or math emphasis). Teachers in Grade 8 were all specialized in PE whereas in Grade 5 teachers were generalist class teachers with basic training in PE. The sample of Grade 5 students included

164 boys and 164 girls with an average age of 11.2 years (SD = .36) and the sample of Grade 8 students included 150 boys and 167 girls with an average age of 14.2 years (SD = .35). Students with disabilities or special education needs did not participate in the study. Therefore, the sample comprised students who were engaged in the regular school program and following the national curriculum.

Procedure

Before commencing the data collection, the ethics committee of the local university approved the study protocol. Informed consent forms from both students and their guardians were obtained prior to the study. Participation was voluntary and students had the opportunity to withdraw from the study at any time. The first questionnaire, assessing contextual perceptions of PE, was administered in September before a regular PE class (T0). Students were asked to think about their general experiences of PE. The second questionnaire was completed two weeks later immediately after conclusion of the first fitness testing lesson (T1). This time, students were specifically asked to reflect upon their perceptions of the fitness testing lesson. Finally, the third questionnaire was completed one week later, immediately after the second fitness testing lesson (T2). Again, students were asked to consider their perceptions of the lesson they just concluded. During the questionnaires, students were allowed to ask for guidance if they did not comprehend some of the questions. Questionnaires were administered by trained PE teachers briefed regarding the research who followed written step-by-step instructions during the procedure. To further corroborate the reliability, a pilot of the procedure was conducted prior to the commencement of the main study. In the pilot, no problems were encountered with the protocol.

The first fitness testing class (90 min) comprised of 20 meters shuttle run test (20mSRT; Léger et al. 1988) (aerobic endurance and movement skills) and flexibility tests including: squat (flexibility of the pelvis and lower limbs), lower back extension (range of motion of the lower back and hip area joints) and flexibility of the right and left shoulders (flexibility of upper limbs and shoulder area). The second fitness testing class (90 min) included four tests: curl-ups (abdominal strength and endurance), push-ups (upper body strength), 5-leaps (lower limb strength, speed, dynamic balance skills and movement skills) and throwing-catching combination (object control skills, perceptual motor skills and upper limb strength) (Jaakkola et al. 2012). The fitness tests and accompanying protocol were obtained from the Finnish Move!® system for monitoring physical functioning capacity. (www.edu.fi/move). The intended learning outcomes for the fitness testing lessons were also obtained from the national guidelines of the Move! system. According to those guidelines, the overall goal of the Move! fitness testing is to provide students with information concerning their physical fitness, and to encourage them to independently take care of their physical functioning capacity. It is noteworthy, that the Finnish PE curriculum forbids using the fitness testing results as a basis for grading.

Contextual measures

Enjoyment in physical education. The Finnish version of the Enjoyment subscale from the Sport Commitment Questionnaire -2 (SCQ-2; Scanlan et al. 2016) was used to analyze enjoyment in PE. The Scale comprises five items (e.g. 'Physical education is fun') which are rated on a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. Respondents were asked to think about their overall PE experiences. The validity and reliability of the enjoyment scale has been previously reported when used with Finnish Grade 5 (aged 11–12) (CFI = 1.00, RMSEA = 0.10, Cronbach's alpha = 0.91) and Grade 8 (aged 14–15) (CFI = 1.00, RMSEA = 0.07, Cronbach's alpha = 0.95) students during PE classes (Huhtiniemi et al. 2019).

Anxiety in physical education. The Finnish version of the Physical Education State Anxiety Scale (PESAS; Barkoukis et al. 2005) was used to measure anxiety in PE. The scale assesses three dimensions of anxiety, namely somatic anxiety, cognitive processes and worry. Each dimension is formed from six items rated on a 5-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. Somatic anxiety refers to perceptions of physical symptoms (e.g. 'I have a sense of pressure on my chest'), cognitive processes refer to symptoms related to information processing, such as memory and attention, during the activity (e.g. 'I find it difficult to focus on the task presented'), and worry refers to negative expectations from involving in the activity and the consequences of possible failures (e.g. 'I'm afraid of making mistakes while performing the exercises'). PESAS has been used in the past with Finnish students and demonstrated adequate psychometric properties (CFI = 0.94; RMSEA = 0.05; Cronbach alphas between 0.73 and 0.88) (Liukkonen et al. 2010).

Situational measures during fitness testing classes

Enjoyment during fitness testing classes was measured using the same SCQ-2 enjoyment subscale as described earlier with the exception of different situational specific wording on items (e.g. 'This fitness testing class was fun' versus 'physical education is fun'). These revisions were made to emphasize the change from contextual PE to fitness testing situation. Similarly, anxiety during fitness testing class was measured using the PESAS scale with the exception of using a different stem ('During this fitness testing class … ') emphasizing the change from contextual PE to fitness testing situation.

Statistical analyses

Before proceeding to the main analyses, the data were screened for outliers (values below or above the possible range of 1–5) and missing data patterns. All values were inside the range (1–5). Statistical analyses were performed, and missing data handled, using Mplus version 8.2 (Muthén and Muthén 2017) and implementing the robust full-information maximum-likelihood (MLR) estimation method. A series of multi-group confirmatory factor analyses (CFA) were conducted to test the measurement invariance across groups (Grade 5 and Grade 8) and over time (T0–T2). Measurement invariance (i.e. does the scale function in a similar way over time and across groups?) is a precondition for investigating latent mean differences among the study variables and it involves incorporating increasingly stringent steps of constraining different model parameters (Kline 2015). The overall model fit was evaluated using multiple indicators, as suggested by Ntoumanis and Myers (2016). More specifically, the chi-square goodness-of-fit statistics (χ^2), the comparative fit index (CFI), the Tucker–Lewis index (TLI), root mean square error of approximation (RMSEA) and standardized root mean square residual (SRMR) were used. To interpret these indices, we followed previously recommended guidelines. For CFI and TLI, cut-off values close to .95, for RMSEA values lower than .06, and for SRMR values lower than .08, were considered good (Hu and Bentler 1999).

Invariance of factor loadings, item intercepts and residuals over time and across grade-level groups were tested using the following hierarchically constructed procedure: Model M1, all parameters freely estimated over measurement time and across Grade level groups; Model M2, factor loadings set equal over time separately in both Grade level groups; Model M3, factor loadings and intercepts set equal over time separately in both Grade level groups; Model M4, factor loadings, intercepts and residual variances of observed variables set equal over time separately in both Grade level groups; Model M5, factor loadings, intercepts, and residual variances of observed variables set equal over time and factor loadings set equal between Grade level groups; Model M6, factor loadings, intercepts, and residual variances of observed variables set equal over time and factor loadings and intercepts set equal between Grade level groups; and Model M7, factor loadings, intercepts and residual variances of observed variables set equal over time and between Grade level groups. In all models, indicator-specific effects over time were accounted for by allowing autocorrelation (Little 2013).

When evaluating the level of measurement invariance between nested models, we used the Satorra–Bentler-corrected chi-square difference test (S–Bχ^2) along with the RMSEA (Satorra and Bentler 2001; Hu and Bentler 1999). A non-significant change in the S–Bχ^2 indicates that the invariance holds when comparing the more constrained model to the less constrained model. However, the χ^2 value has been recognized as overly sensitive to large sample sizes (Cheung and Rensvold

2009). Therefore, in the case of a significant χ^2 difference test, we evaluated the amount of difference between the nested models by comparing RMSEA values. When comparing the models, a criterion of ΔRMSEA ≤ .015 was seen acceptable (Chen 2007).

After evaluating the measurement invariance, we proceeded by investigating the mean differences in the latent constructs. With repeated measures, the mean of a latent variable is usually set to 0 in one group or time point (as a reference) and freely estimated in other groups or time points (Muthén and Muthén 2017). However, in this study we incorporated a model constraint setting the sum of item intercepts over time and across groups to 0 in order to estimate the latent means on the same scale as the original items (1–5). Therefore, the interpretation of the mean levels, as well as the mean differences were more convenient. Statistical significance of mean differences was determined using *z*-tests. Finally, 95% confidence interval levels and effect sizes using Cohen's *d* were calculated.

Results

Preliminary analyses

The analysis process commenced by establishing configural baseline models (model M1; see Table 1) for the three subscales of anxiety and for the enjoyment. Based on the model fit criteria by Hu and Bentler (1999), all models demonstrated a good fit. The sequential models and different levels of invariance were tested in two waves. We first investigated the invariance of factor loadings (metric or weak factorial invariance), then the equality of item intercepts (scalar or strong factorial invariance) and finally equalities of item residuals (error or strict invariance) over time separately between the two groups (models M2–M4). We continued by applying the same parameter constraints over time and also across both groups (models M5–M7). The fit indices for all nested models of enjoyment and anxiety subscales are presented in Table 1 and standardized item loadings obtained from model M7 are presented in Table 2.

For enjoyment, results indicated that all levels of measurement invariance (i.e. weak, strong, and strict factorial invariance) held over time and across groups. This is shown by the small changes in model fit (ΔRMSEA ≤.004) when comparing more constrained models to the more freely estimated models. Similarly, for cognitive processes, somatic anxiety, and worry, all levels of measurement invariances were supported based on the small changes in model fit. The values for ΔRMSEA were ≤.014, ≤.006 and ≤.005, respectively.

Main analyses

After establishing the measurement invariance, we proceeded by investigating the mean differences of latent constructs. As presented in Table 3, three pairwise comparisons were made over time for both Grade 5 and Grade 8 groups. For Grade 5 students, results showed that enjoyment was significantly lower in fitness testing classes (T1 and T2) compared to PE in general (T0). There was no difference between the two fitness testing classes (T1 vs. T2) in enjoyment. Level of cognitive processes was significantly lower and level of somatic anxiety higher in fitness testing classes than in PE in general. When comparing the two fitness testing classes, there were no statistically significant differences between the groups in levels of cognitive processes. Also, results showed that somatic anxiety was higher on the first fitness testing class (T1) compared to the second fitness testing class (T2). Finally, there were no statistically significant differences in worry among the three time points.

For Grade 8 students, results indicated that levels of enjoyment were significantly lower in fitness testing classes (T1 and T2) compared to PE in general (T0). There was no difference in enjoyment between the two fitness testing classes (T1 vs. T2). According to the results for cognitive processes, there was a statistically significant difference between PE in general (T0) and the first fitness testing

Table 1. Measurement invariance of cognitive processes, somatic anxiety, worry, and enjoyment over time and across grade level.

Scale	χ^2	df	*p*-Value	RMSEA	CFI	TLI	SRMR	$\Delta\chi^2$	Δdf	*p*-Value
Cognitive processes M1	265.75	222	0.024	0.025	0.984	0.978	0.045	–	–	–
Cognitive processes M2	287.04	242	0.025	0.024	0.984	0.979	0.052	20.81	20	0.408
Cognitive processes M3	382.66	262	0.000	0.038	0.956	0.949	0.057	117.63	20	0.000
Cognitive processes M4	404.51	286	0.000	0.036	0.957	0.954	0.063	27.95	24	0.262
Cognitive processes M5	407.77	291	0.000	0.035	0.957	0.955	0.065	2.75	5	0.738
Cognitive processes M6	424.30	296	0.000	0.037	0.953	0.952	0.065	20.62	5	0.001
Cognitive processes M7	441.72	302	0.000	0.038	0.949	0.948	0.068	13.00	6	0.043
Somatic anxiety M1	323.16	228	0.000	0.036	0.973	0.964	0.050	–	–	–
Somatic anxiety M2	357.45	248	0.000	0.037	0.970	0.962	0.057	34.68	20	0.022
Somatic anxiety M3	459.05	268	0.000	0.047	0.947	0.939	0.063	111.13	20	0.000
Somatic anxiety M4	555.89	292	0.000	0.053	0.926	0.923	0.072	81.54	24	0.000
Somatic anxiety M5	564.21	297	0.000	0.053	0.926	0.923	0.072	8.25	5	0.143
Somatic anxiety M6	583.99	302	0.000	0.054	0.921	0.920	0.073	21.28	5	0.001
Somatic anxiety M7	628.10	308	0.000	0.057	0.911	0.911	0.080	32.94	6	0.000
Worry M1	282.64	228	0.008	0.027	0.989	0.985	0.036	–	-	–
Worry M2	297.65	248	0.017	0.025	0.990	0.987	0.039	11.36	20	0.936
Worry M3	347.02	268	0.001	0.030	0.983	0.981	0.041	58.51	20	0.000
Worry M4	374.63	292	0.001	0.030	0.983	0.982	0.044	28.59	24	0.236
Worry M5	381.12	297	0.001	0.030	0.982	0.982	0.046	6.51	5	0.260
Worry M6	395.22	302	0.000	0.031	0.980	0.980	0.046	17.02	5	0.004
Worry M7	396.53	308	0.001	0.030	0.981	0.981	0.047	4.18	6	0.652
Enjoyment M1	184.19	142	0.010	0.031	0.992	0.987	0.036			
Enjoyment M2	219.99	158	0.001	0.035	0.988	0.983	0.050	44.87	16	0.000
Enjoyment M3	256.16	174	0.000	0.038	0.983	0.980	0.049	39.34	16	0.001
Enjoyment M4	302.61	194	0.000	0.042	0.978	0.976	0.058	38.56	20	0.008
Enjoyment M5	312.93	198	0.000	0.043	0.977	0.975	0.060	13.12	4	0.011
Enjoyment M6	321.76	202	0.000	0.043	0.976	0.975	0.061	9.89	4	0.042
Enjoyment M7	319.28	207	0.000	0.041	0.977	0.977	0.061	2.53	5	0.772

M1: Configural – all parameters are freely estimated across measurement time and across school classes, M2: Factor loadings are set equal across measurement time separately in both school classes, M3: Factor loadings and intercepts are set equal across measurement time separately in both school classes, M4: Factor loadings, intercepts and residual variances of observed variables are set equal across measurement time separately in both school classes, M5: Factor loadings, intercepts and residual variances of observed variables are set equal across measurement time and factor loadings are set equal between school classes, M6: Factor loadings, intercepts and residual variances of observed variables are set equal across measurement time and factor loadings and intercepts are set equal between school classes, M7: Factor loadings, intercepts and residual variances of observed variables are set equal across measurement time and school classes. The final three columns describe χ^2 differences between nested models.

class (T1: aerobic endurance) but not between PE in general (T0) and the second fitness testing class (T2: skill and strength), or between the two fitness testing classes (T1 vs. T2). The level of somatic anxiety was significantly higher in first fitness testing class (T1), and also in second fitness testing class (T2) compared to PE in general (T0). In addition, somatic anxiety was significantly higher in T1 compared to T2. Finally, there was a statistically significant, but weak, difference between the level of worry on T0 and T1. Levels of worry did not differ between T0 and T2 or between T1 and T2.

Differences between Grade 5 and Grade 8 students in study variables were also analyzed at each measurement point. As can be seen from Table 4, results indicated that levels of enjoyment were significantly higher among Grade 5 students at all three time points. Furthermore, the mean levels of cognitive processes and worry were lower among Grade 5 students than Grade 8 students at all different time points. For somatic anxiety, there was a statistically significant difference at T0 and T1 showing lower mean scores for Grade 5 students, but no significant difference at T2 was found.

Discussion

This study aimed to investigate whether students' perceptions of enjoyment and anxiety differed between two different types of fitness testing classes and PE in general. This was the first study to

Table 2. Standardized item loadings of the multi-group confirmatory factor analyses.

	Grade 5			Grade 8		
Item	PE in general (T0) Estimate (S.E.)	Fitness testing class 1 (T1) Estimate (S.E.)	Fitness testing class 2 (T2) Estimate (S.E.)	PE in general (T0) Estimate (S.E.)	Fitness testing class 1 (T1) Estimate (S.E.)	Fitness testing class 2 (T2) Estimate (S.E.)
Enjoyment						
e1	0.82 (.020)	0.89 (.011)	0.90 (.011)	0.86 (.014)	0.86 (.014)	0.85 (.016)
e2	0.85 (.018)	0.91 (.010)	0.92 (.010)	0.89 (.013)	0.89 (.012)	0.88 (.015)
e3	0.81 (.020)	0.88 (.010)	0.89 (.010)	0.85 (.013)	0.85 (.012)	0.84 (.014)
e4	0.87 (.015)	0.92 (.008)	0.93 (.008)	0.90 (.011)	0.91 (.010)	0.90 (.012)
e5	0.85 (.017)	0.91 (.009)	0.92 (.008)	0.89 (.012)	0.89 (.011)	0.88 (.012)
Cognitive processes						
a1	0.60 (.030)	0.61 (.035)	0.61 (.033)	0.67 (.031)	0.70 (.035)	0.70 (.032)
a2	0.72 (.028)	0.72 (.031)	0.73 (.030)	0.78 (.022)	0.80 (.024)	0.80 (.022)
a3	0.68 (.028)	0.69 (.033)	0.70 (.031)	0.75 (.026)	0.77 (.029)	0.77 (.026)
a4	0.65 (.032)	0.66 (.035)	0.66 (.033)	0.72 (.028)	0.74 (.032)	0.74 (.030)
a5	0.69 (.028)	0.70 (.031)	0.70 (.029)	0.76 (.025)	0.78 (.027)	0.78 (.025)
a6	0.67 (.032)	0.68 (.034)	0.68 (.032)	0.74 (.025)	0.76 (.026)	0.76 (.025)
Somatic anxiety						
a7	0.69 (.030)	0.80 (.020)	0.79 (.020)	0.75 (.025)	0.81 (.018)	0.78 (.023)
a8	0.69 (.031)	0.80 (.020)	0.79 (.022)	0.75 (.024)	0.81 (.018)	0.78 (.023)
a9	0.59 (.037)	0.72 (.028)	0.71 (.032)	0.66 (.034)	0.73 (.027)	0.70 (.034)
a10	0.68 (.029)	0.79 (.021)	0.78 (.023)	0.74 (.028)	0.80 (.020)	0.77 (.025)
a11	0.67 (.031)	0.78 (.023)	0.77 (.026)	0.73 (.031)	0.79 (.022)	0.76 (.027)
a12	0.36 (.030)	0.48 (.030)	0.47 (.031)	0.42 (.029)	0.49 (.027)	0.46 (.029)
Worry						
a13	0.79 (.020)	0.82 (.017)	0.83 (.016)	0.82 (.016)	0.83 (.015)	0.83 (.016)
a14	0.79 (.019)	0.82 (.017)	0.84 (.015)	0.83 (.018)	0.84 (.017)	0.83 (.019)
a15	0.65 (.027)	0.69 (.027)	0.71 (.024)	0.70 (.028)	0.71 (.027)	0.70 (.028)
a16	0.85 (.016)	0.88 (.013)	0.89 (.012)	0.88 (.012)	0.89 (.011)	0.88 (.012)
a17	0.79 (.021)	0.81 (.018)	0.83 (.016)	0.82 (.017)	0.83 (.015)	0.83 (.017)
a18	0.80 (.017)	0.83 (.016)	0.85 (.015)	0.84 (.015)	0.85 (.015)	0.84 (.017)

investigate the measurement invariance of SCQ-2 Enjoyment subscale and PESAS over time and between Grade 5 and Grade 8 students. Additionally, this was the first study to investigate whether students' perceptions of enjoyment and anxiety differ between PE in general and fitness testing classes.

Enjoyment in fitness testing and generally in PE

Results showed that both Grade 5 and Grade 8 students perceived lower levels of enjoyment in fitness testing classes than in general PE. As such, it indicates that fitness testing as a content area in PE might be generating less feelings of pleasure, fun and liking (Scanlan et al. 2016) among elementary and secondary school students than PE in general. However, it is noteworthy that on average students still perceived moderate levels of enjoyment in fitness testing classes. In line with previous studies (Carroll and Loumidis 2001; Soini 2006; Gråsten 2014; Huhtiniemi et al. 2019), levels of enjoyment towards PE in general were relatively high (see Table 3), indicating that students may not specifically dislike fitness testing but have significantly more positive feelings towards PE in general. Nonetheless, deflated levels of enjoyment in fitness testing situations might cause students to be less engaged towards fitness testing or fitness development in PE. Previous intervention studies in PE have shown that students' enjoyment can be positively influenced by emphasizing effort, learning, co-operation and personal development (Barkoukis, Tsorbatzoudis, and Grouios 2008). Additionally, studies have shown that PE enjoyment is positively associated with higher perceptions of mastery climate and basic psychological needs of autonomy, competence, and relatedness (Cox, Smith,

Table 3. Mean differences of study variables among PE in general and fitness testing classes.

Grade 5	T0* M (SD)	T1** M (SD)	T2*** M (SD)	T1 vs. T0 *p* (z-test)	T1 vs. T0 Cohen d (95% CI)	T2 vs. T0 *p* (z-test)	T2 vs. T0 Cohen d (95% CI)	T1 vs. T2 *p* (z-test)	T1 vs. T2 Cohen d (95% CI)
Enjoyment	4.136 (0.897)	3.369 (1.205)	3.382 (1.259)	.000	−0.856 (−1.008, −0.705)	.000	−0.841 (−0.997, −0.685)	.749	−0.015 (−0.094, 0.063)
Cognitive processes	1.591 (0.570)	1.444 (0.583)	1.448 (0.588)	.000	−0.258 (−0.360, −0.156	.000	−0.250 (−0.357, −0.143)	.890	−0.008 (−0.099, 0.084)
Somatic anxiety	2.224 (0.780)	2.743 (1.084)	2.547 (1.057)	.000	0.666 (0.512, 0.820)	.000	0.414 (0.277, 0.552)	.000	0.252 (0.136, 0.368)
Worry	2.117 (0.922)	2.139 (1.021)	2.146 (1.097)	.621	0.024 (−0.056, 0.104)	.538	0.032 (−0.054, 0.118)	.857	−0.008 (−0.083, 0.067)
Grade 8									
Enjoyment	3.519 (1.052)	2.485 (1.062)	2.574 (1.000)	.000	−0.983 (−1.124, −0.841)	.000	−0.898 (−1.035, −0.761)	.105	0.085 (−0.001, 0.170)
Cognitive processes	1.808 (0.686)	1.681 (0.731)	1.766 (0.744)	.012	−0.184 (−0.305, −0.064)	.393	−0.060 (−0.176, 0.055)	.054	−0.124 (−0.231, −0.017)
Somatic anxiety	2.430 (0.932)	2.957 (1.118)	2.618 (1.024)	.000	0.565 (0.420, 0.710)	.004	0.201 (0.080, 0.322)	.000	0.364 (0.236, 0.492)
Worry	2.344 (1.051)	2.466 (1.097)	2.432 (1.062)	.045	0.116 (0.020, 0.213)	.146	0.084 (−0.012, 0.180)	.538	0.033 (−0.054, 0.119)

*T0 = contextual PE.

**T1 = fitness testing class 1 (20 meters shuttle run test, mobility).

***T2 = fitness testing class 2 (curl-ups, push-ups, catching-throwing combination, 5-leaps).

Table 4. Mean differences of study variables between Grade 5 and Grade 8 students.

	T0* (Grade 5 vs. Grade 8)		T1** (Grade 5 vs. Grade 8)		T2*** (Grade 5 vs. Grade 8)	
	p (z-test)	Cohen d (95% CI)	*p* (z-test)	Cohen d (95% CI)	*p* (z-test)	Cohen d (95% CI)
Enjoyment	0.000	0.632 (0.486, 0.777)	0.000	0.904 (0.730, 1.077)	0.000	0.827 (0.651, 1.003)
Cognitive processes	0.000	−0.344 (−0.491, −0.198)	0.000	−0.377 (−0.536, −0.218)	0.000	−0.505 (−0.673, −0.336)
Somatic anxiety	0.007	−0.240 (−0.386, −0.095)	0.030	−0.249 (−0.436, −0.061)	0.466	−0.082 (−0.268, 0.103)
Worry	0.006	−0.230 (−0.369, −0.091)	0.000	−0.332 (−0.481, −0.182)	0.003	−0.289 (−0.448, −0.131)

*T0 = contextual PE.
**T1 = fitness testing class 1 (20 meters shuttle run test, flexibility).
***T2 = fitness testing class 2 (curl-ups, push-ups, catching-throwing combination, 5-leaps).

and Williams 2008; Ommundsen and Kvalø 2007). Although there is a lack of intervention studies investigating specifically fitness testing situations it is likely that enjoyment during testing classes can be promoted through implementing similar strategies to those used in general PE. It should also be noted that fitness testing classes might inherently contain undesirable social or behavioral factors such as peer comparison, norm-referencing or diminished opportunities for autonomous behavior that undermine feelings of enjoyment.

Interestingly, there were no differences in enjoyment levels between the two fitness testing classes although the classes consisted of different types of tests. The first fitness testing class included a 20 meters shuttle run test which can be perceived as strenuous and unpleasant because it requires working near maximal aerobic capacity (Silverman, Keating, and Phillips 2008). In contrast, the second fitness testing class included more skill-related measures and muscular strength measures. For example, the throwing-catching combination (Jaakkola et al. 2012) where one repeatedly throws a tennis ball to the wall and catches it after a bounce could easily be perceived as a fun activity that students might want to do during recess or free time. Yet, despite the content of the testing classes clearly differing, perceived enjoyment remained relatively stable between different test situations for both Grade 5 and Grade 8 students. This pattern might exist because the two fitness testing lessons share similar elements related to pedagogical aspects such as teachers' teaching style and chosen didactic approach. For example, it is likely that teachers used same kind of teaching style techniques while giving instructions or feedback during both fitness testing classes which is indicative of the style of teaching rather than the content of the fitness testing as being more influential in mediating the students' experiences of enjoyment.

Results indicated that Grade 5 students had higher enjoyment ratings than Grade 8 students at all three time points. This reflects previous studies that have revealed declining trends on individual level in students' general PE enjoyment (Yli-Piipari et al. 2012; Barkoukis, Ntoumanis, and Thøgersen-Ntoumani 2010). For example, Barkoukis, Ntoumanis, and Thøgersen-Ntoumani (2010) reported the enjoyment levels of 12-year-old Greek students declined across a 3-year period. During this age period, students go through several biological, social and psychological changes that might negatively affect their self-confidence, and therefore, reduce their feelings of enjoyment. In addition, it might be that the associated learning goals of fitness testing are not clear or adequately suited for the needs of older students which might cause deflated feelings of enjoyment.

Anxiety in fitness testing situations and generally in PE

For both Grade 5 and 8 students, levels of cognitive processes were lower in fitness testing classes than in general PE. In other words, cognitive processes were not stimulated to the same extent in fitness testing situations as in general PE classes. As cognitive processes dimension refers to symptoms related to information processing and cognitive reactions during the activity (Barkoukis, Tsorbatzoudis, and Grouios 2008; Barkoukis et al. 2005; Schwarzer 1986), it might be that these reactions are typically present during general PE classes rather than in fitness testing classes where the activities performed are very precise. Additionally, lower levels of the cognitive processes dimension might be an outcome of the more structured and teacher-oriented approach during fitness testing lessons where students have less opportunities to make choices or to be creative. Furthermore, the lack of difference in cognitive processes between the two fitness testing classes may also be due to the highly structured and teacher-oriented lessons. Analysis of the age group differences revealed that Grade 8 students experienced higher levels in the cognitive processes dimension both in general PE and in fitness testing classes than Grade 5 students. This may be due to Grade 8 students' maturation level being mediated by their biological, social and cognitive development during the early adolescence years. At this phase of puberty, adolescents tend to have stronger feelings related to self-conscious emotions such as anxiety (Wigfield, Lutz, and Wagner 2005; Eccles and Roeser 2011).

Somatic anxiety, in contrast to cognitive processes, was higher in both fitness testing classes than in general PE for Grade 5 and 8 students. This was not entirely surprising, as the fitness testing situations and physical tests encourage students to perform near their maximal physical capacity. Also, as somatic anxiety has been shown to have a curvilinear relationship with performance (i.e. moderate levels lead to optimum performance) (Craft et al. 2003), it is logical that elevated levels of somatic anxiety occurred in the performance-related fitness testing situation rather than in general PE. Moreover, as somatic anxiety captures phenomena like 'shortness of breath', 'discomfort while breathing', 'feeling dizzy' and 'feeling as if something is choking one' (Barkoukis et al. 2005), it is reasonable to see higher somatic anxiety in the first fitness testing class which included 20mSRT than in the second testing class which included skill and strength related tests. While interpreting these results, it should be noted that somatic anxiety symptoms are linked to body's normal reactions to physical exertion.

In general PE, Grade 5 students' somatic anxiety levels were lower when compared to Grade 8 students. This may be due in part to the elementary school PE curriculum, which places no emphasis on the physical intensity levels of the students and is generally more play-oriented than secondary school PE curriculum (Finnish National Board of Education 2014). Conversely, physical demands in Grade 8 PE curriculum are typically higher which could lead to more pronounced somatic anxiety levels compared to Grade 5 students. Another reason for lower somatic anxiety in Grade 5 could be that in Finland, Grades 1–6 are predominantly taught by generalist classroom teachers with only basic qualifications in PE whereas Grades 7–9 are taught by specialist PE teachers. Therefore, specific teaching qualifications in PE might lead to more active and demanding lessons (Telford et al. 2013), and as a consequence, promote an increase in the occurrence of somatic symptoms such as feeling dizziness or sense of pressure in the chest. As previously mentioned, somatic anxiety symptoms are related to body's normal reactions to physical exertion. Therefore, elevated levels of somatic anxiety are not necessarily negative if they occur during physically demanding activity. Also, other aspects of anxiety should be simultaneously considered to more comprehensively understand one's experiences.

Levels of worry among Grade 5 and Grade 8 students were approximately the same in general PE and during fitness classes, except for the slightly higher value for Grade 8 students in the first testing class. Overall, and contrary to previous findings (e.g. Hopple and Graham 1995; Luke and Sinclair 1991), the pattern of worry level indicates that students do not necessarily have inflated negative expectations of the fitness testing activities or that their fear of getting low results or performing poorly (Barkoukis 2007) is not increased. Earlier studies have shown that worry is a negative predictor of performance in physical activity contexts, such as sport and school PE (Barkoukis et al. 2005; Woodman and Hardy 2003). In considering this pattern, it could be seen as a positive outcome that fitness testing provokes no more worry than general PE. Additionally, levels of worry did not differ between the two fitness testing classes in either of the grade-level groups indicating that different test batteries did not seem to provoke increased achievement pressures.

Grade 5 students perceived lower levels of worry both in general PE and in fitness testing situations compared to Grade 8 students. Again, this might be an age-related issue as Grade 8 students are at, or are getting towards, puberty which could amplify their anxiety levels during physical activity, especially when undertaken with peers. Another explanation for Grade 8 students' higher level of worry could stem from the PE assessment or numeric grading which is usually introduced to Finnish students from Grade 7 onwards (Finnish National Board of Education 2014). However, it should be noted that the current PE curriculum in Finland – that includes the new national fitness monitoring system – clearly forbids using fitness test results as a basis for grading in PE (Salin and Huhtiniemi 2018).

Measurement invariance

Results indicated that enjoyment and all three anxiety subscales possessed full factorial invariance between different settings and across age groups. It should be acknowledged that full measurement invariance is rarely achieved in most empirical studies (Van De Schoot et al. 2015). This demonstrates that Grade 5 and Grade 8 students perceived the enjoyment and anxiety scales in a similar way when answering questions concerning PE in general (contextual) and answering questions after fitness testing classes (situational). In general, these findings indicate that comparisons between the study variables in different settings and age groups are plausible. However, caution is still warranted especially from a cross-cultural perspective as, for example, instrument adaptation and translation process or social desirability can cause variation in how respondents perceive the questions (Davidov et al. 2014).

Study limitations and future research

The current study has several limitations that need to be considered while interpreting the results. First, the study sample was not randomly selected which limits the representativeness of the results. Second, as students were asked to complete the three questionnaires in a relatively short timeframe, a fatigue or question-order effect (Pustejovsky and Spillane 2009) could influence their responses. Yet, the invariance analysis showed that students perceived the scales in a similar way at each time point. Third, although the study protocol was carefully presented to the teachers, there is no way of knowing how well they followed the written instructions as there were no observations or recordings of the classes available. By adding an objective measure, such as video or voice recording to assess teachers' actions during the classes would therefore increase the reliability of the study. However, adding an external person or device to the situation might significantly affect students' behavior, physical performance and cognitive perceptions.

In the future, it would be interesting to see intervention studies aiming to change students' affective experiences during fitness testing classes, and to test whether changes at the situational level have an effect at the contextual level, or vice versa. These bottom-up or top-down effects have been previously studied in sport contexts targeting motivational constructs (e.g. Kowal and Fortier 2000) but not in the physical education fitness testing context. It would also be interesting to study whether different subgroups of students (e.g. based on gender, ethnicity or special needs) perceive enjoyment and anxiety differently during fitness testing lessons. Additionally, as previous research has shown that PE may affect PA participation during leisure time (Hagger et al. 2003), it would be valuable to investigate how enjoyment and anxiety in school fitness testing classes impact students' willingness for fitness development and physical activity outside school.

Conclusions and practical implications

The findings of this study indicate that students' perceptions of enjoyment and anxiety towards fitness testing classes differ from their perceptions towards PE in general. More specifically, Grade 5 and Grade 8 students' perceptions of enjoyment were lower in fitness testing classes compared to PE in general. Additionally, students perceived lower levels of cognitive anxiety and higher levels of somatic anxiety in fitness testing classes than in general PE. Levels of worry among Grade 5 and

Grade 8 students were approximately at the same level in general PE and during fitness testing classes, except for the slightly higher value for Grade 8 students in the first testing class. Practitioners can make use of the results while planning and conducting fitness testing sessions for different aged children. Although the reasons underpinning affective experiences during fitness testing were not investigated in this study, previous intervention studies have shown that PE enjoyment is positively associated with higher perceptions of mastery climate and basic psychological needs of autonomy, competence and relatedness (Cox, Smith, and Williams 2008; Ommundsen and Kvalø 2007). Previous research has also shown that mastery climate is associated with lower levels of anxiety in PE (Papaioannou and Kouli 1999; Cecchini et al. 2001) and that state anxiety is negatively linked to enjoyment in the PE context (Yli-Piipari et al. 2009). Therefore, adopting strategies that promote mastery climate and need fulfillment are recommended to increase enjoyment and reduce anxiety in PE and also in fitness testing classes.

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III

THE RELATIONSHIPS AMONG MOTIVATIONAL CLIMATE, PERCEIVED COMPETENCE, PHYSICAL PERFORMANCE, AND AFFECTS DURING PHYSICAL EDUCATION FITNESS TESTING LESSONS

by

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The relationships among motivational climate, perceived competence, physical performance, and affects during physical education fitness testing lessons

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Abstract
Despite the prominence of fitness testing in school physical education (PE), there is a sparsity of research examining the antecedents of students' affective experiences during fitness testing lessons. This study aimed to investigate the associations among task- and ego-involving motivational climates, perceived physical competence, physical performance, enjoyment, and anxiety during two different types of PE fitness testing lessons. Altogether, 645 Finnish students from Grade 5 (50% boys, $M_{age} = 11.2$, SD = 0.36) and Grade 8 (47% boys, $M_{age} = 14.2$, SD = 0.35) participated in two fitness testing lessons with different content (lesson 1: 20-meter shuttle run test and a test of flexibility; lesson 2: curl-ups, push-ups, 5-leaps, and a catching-throwing combination test). Students' experiences were collected using short questionnaires immediately after the lessons. Structural equation modeling was applied to examine the direct and indirect associations among study variables. Results indicated that task-involving climate and perceived competence increased students' enjoyment and decreased their anxiety levels whereas ego-involving climate

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had no effect on students' enjoyment but increased their anxiety levels. In addition, students' actual physical performance as a mediator between motivational climate and affects, or as a direct predictor of affects, was limited. Strategies advancing task-involving motivational climate and students' perception of competence should be employed to increase enjoyment and decrease anxiety during PE fitness testing lessons.

Keywords
School-aged children, enjoyment, anxiety, physical fitness, structural equation modeling

Introduction

School physical education (PE) can have a considerable effect on building a mindset for lifelong physical activity (Sallis et al., 2012). This is because it is implemented by teaching professionals and therefore has the capability to generate positive experiences of engagement in physical activity uniformly for the school-aged cohort (Sallis et al., 2012). One commonly implemented curriculum element of secondary school PE is fitness testing (O'Keeffe et al., 2019); however, it is also a practice that has generated much debate among researchers and practitioners (Cale and Harris, 2009; Jaakkola et al., 2013; Naughton et al., 2006; Rice, 2007; Silverman et al., 2008; Simonton et al., 2019). Fitness testing may have the potential to increase students' awareness of their physical fitness status and their willingness to maintain or increase their physical activity levels (Harris and Cale, 2006). It has also been suggested that fitness testing may have other positive effects such as enhanced levels of motivation (Jaakkola et al., 2013). On the other hand, some scholars argue that if fitness testing is done in isolation from the curriculum, it can have a negative impact on students' interest in PE and willingness to be physically active (Cale and Harris, 2009; Rice, 2007). Despite an increased level of research being undertaken, the questions of how fitness testing affects students' psychological and affective experiences are still mostly unanswered. Therefore, the aim of this study was to examine associations among social, physical, cognitive, and affective factors during fitness testing lessons.

During PE and fitness testing lessons, students' perceptions of the social environment have a significant influence on their experiences (Ames, 1992; Duda, 1996; Nicholls, 1989). One representation of the social environment that is believed to influence individual motivational processes and subsequent outcomes such as affect is the concept of perceived motivational climate (Ames, 1992; Ames and Archer, 1988). Students' motivational climate is often instigated through the actions of both teachers and significant others (Nicholls, 1989). The two main elements of motivational climate are task- and ego-involving climates (Ames, 1992). Task-involving climate is characterized by elements such as trying one's best, focusing on learning and self-improvement, showing effort, and working in co-operation with others. Ego-involving climate, on the other hand, is characterized by elements such as social or normative comparison and competition between students (Ames, 1992). Previous studies in PE have demonstrated that students' perceived task-involving motivational climate is positively associated with a range of adaptive outcomes such as perceived competence and enjoyment (Cox and Williams, 2008; Gråsten and Watt, 2017). Students' perceived ego-involving climate, however, has been found to be related to maladaptive outcomes such as boredom, anxiety, and feelings of less enjoyment (Carpenter and Morgan, 1999; Ommundsen and Kvalo, 2007; Papaioannou and Kouli, 1999). Despite the extensive research attention, there is a lack of research on motivational climate conducted specifically in PE fitness testing situations.

In addition to social influences, many other psychological and physiological factors such as perceived physical competence and actual physical performance have the potential to influence students' affects during fitness testing lessons. Perceived physical competence can be described as the students' own assessment of their ability to accomplish different tasks in given domains such as school, sport, or physical activity (Fox, 1997). According to Harter's (1978) competence motivation theory, perceptions of one's abilities are cumulatively formed when interacting with the environment. Individuals with high perceived competence are more persistent in chosen activities than those with low perceived competence (Harter, 1978). In previous studies, higher perceived physical competence has been linked with increased enjoyment in PE lessons (Carroll and Loumidis, 2001; Fairclough, 2003), and lower anxiety in test situations (Putwain and Symes, 2012). However, there is a lack of research conducted in a PE fitness testing context that has investigated the relationships between perceived competence and affective outcomes. One exception to this is a study by Lodewyk and Muir (2017) where they showed that self-efficacy—a central construct to social cognitive theory (Bandura, 1986) and closely related to perceived competence—was negatively associated with state anxiety and social physique anxiety.

Similar to perceived physical competence, the actual physical performance also influences students' affects in PE. More specifically in this study, physical performance is operationalized as motor competence and health-related fitness. Motor competence refers to students' locomotor (e.g. run and jump), stability (e.g. dynamic balance), and object control (e.g. throw and catch) skills (Donnelly et al., 2017). Health-related fitness includes students' cardio-respiratory fitness and muscular fitness. A review by Ortega et al. (2008) demonstrated that physical fitness, especially cardio-respiratory fitness and muscular fitness in childhood and adolescence, are powerful determinants of overall health. Although previous research on the associations between physical performance and affective outcomes related to fitness testing is limited, a recent investigation by Simonton et al. (2019) demonstrated that students' fitness test performance was weakly related to students' attitudes and perceptions of enjoyment, boredom or anger towards PE.

Both situational social and individual factors, related to perceived physical competence and actual physical performance, can provoke negative or positive affects among students (Fairclough, 2003; Gråsten and Watt, 2017). One example of positive affect is enjoyment, which can be operationalized through terms such as liking, pleasure, happiness, and fun (Scanlan and Simons, 1992). It is also seen to represent more generalized feelings and not specific emotions such as excitement. According to Hashim et al. (2008), enjoyment can also be characterized as a multidimensional construct firmly related to enthusiasm and perceptions of competence. Moreover, Goetz et al. (2006) proclaimed enjoyment as a hierarchically structured concept meaning that perceptions of it may be different in general life than in specific contexts, such as in sport or in PE. Despite the substantial interest in enjoyment within activity settings and specifically in the PE context (e.g. Dishman et al., 2005; Hashim et al., 2008), there are only a few investigations of enjoyment concerning fitness testing situations. For example, Huhtiniemi et al. (2021) showed that Finnish 11–15 year old students perceived lower levels of enjoyment during fitness testing lessons than in PE in general, despite still being on average at the moderate level. Furthermore, O'Keeffe et al. (2020) demonstrated that Irish high school students (mean age 13.2 years) had positive attitudes toward a student-centered health-related fitness test battery.

Irrespective of the fact that the majority of students find PE fun and likeable, there might be some who experience negative thoughts and feelings during PE lessons (Barkoukis et al., 2005;

Liukkonen et al., 2010). For example, fitness testing situations could be particularly stressful if performances are visible to others and scores are used in grading (Clarke, 2006). One of the most regularly studied negative affects in PE settings is anxiety. During PE lessons, there are many psychosocial factors such as lesson content, teacher's interpersonal teaching style, class atmosphere, and motivational climate that might cause a response towards anxiety (Barkoukis et al., 2005; Liukkonen et al., 2010). From a wider educational perspective, negative associations between anxiety in test situations, a range of behavioral and affective outcomes, have been consistently shown (Von der Embse et al., 2018). However, previous research concerning anxiety in PE fitness testing situations is limited. Recently Huhtiniemi et al. (2021) demonstrated that Finnish Grade 5 and 8 (11–12 and 14–15 year old) students perceived lower levels of cognitive anxiety and higher somatic anxiety in fitness testing than in general PE. They also concluded that levels of worry remained relatively stable between fitness testing and PE in general. Despite limited research concerning motivational climate in fitness testing, it can be hypothesized, based on previous findings, that task-involving motivational climate in PE should be associated with lower levels of anxiety, and ego-involving climate with higher levels of anxiety (Barkoukis et al., 2008; Cecchini et al., 2001; Papaioannou and Kouli, 1999).

Previous literature presents only a few studies that have explored motivational variables in fitness testing lessons in PE. Goudas et al. (1994) found that 12–15 year old students' reactions to fitness testing vary based on their goal orientations, performance, and perceived success. They demonstrated that participants with high task and low ego orientation also showed high levels of enjoyment regardless of their performance in a 20-meter shuttle run test. Similarly, Garn and Sun (2009) investigated the effects of achievement and social goals on middle school students' (aged 11–15 years) effort and test performance on the Progressive Aerobic Cardiovascular Endurance Run (PACER). They concluded that mastery-, task-, and friendship-approach goals have the ability to positively influence either effort or performance. Moreover, Jaakkola et al. (2013) conducted an investigation in which students performed three tests: 5-leaps, figure-8 running, and curl-ups. Results showed that students reported higher levels of autonomous motivation, and also higher levels of amotivation during fitness testing lessons than in the general PE program. In addition, they found that students' fitness levels were positively associated with perceived competence which, in turn, was positively associated with intrinsic motivation during fitness testing. It is noteworthy that previous studies conducted on fitness testing in a PE context have mainly pertained to individual cognitive attributes such as goal orientations or motivational regulations.

Despite previous studies providing pertinent information concerning the motivational and affective experiences during fitness testing, there are several reasons for additional investigations. Firstly, there are no studies on fitness testing in PE contexts where the role of students' perceived motivational climate has been investigated. Also, none of the previous investigations have considered the concurrent mediational roles of perceived competence and actual physical performance (Stodden et al., 2008) when predicting students' affective experiences during fitness testing lessons. Such investigations are warranted as previous research has demonstrated associations between perceived competence and affects (e.g. Fairclough, 2003; Putwain and Symes, 2012), and between actual physical performance and affects (e.g. Simonton et al., 2019) in PE and test settings. Furthermore, some previous studies have focused on just one fitness test (e.g. PACER) (Garn and Sun, 2009; Goudas et al., 1994) which narrows the perspective as students might perceive different tests affectively in various ways (e.g. skill-related fitness tests might be more fun than endurance-related fitness tests). Hence, a wider battery of tests would allow not only more detailed investigations of students' perceptions but also a more comprehensive selection of physical performance indicators. Stemming from these arguments, and to add to the current body of knowledge, we created a model to investigate how social factors (motivational climate) and individual cognitive and physical factors (perceived physical competence and actual physical performance) influence students' affective responses during fitness testing lessons. More specifically, the aim of the study was to investigate direct and indirect associations among task- and ego-involving motivational climates, perceived physical competence, physical performance, enjoyment, and anxiety during fitness testing lessons. As it has been previously shown that fitness test type can have an impact on students' affect-related attitudes towards fitness testing (Mercier and Silverman, 2014), the investigation was conducted on two different types of fitness testing lessons (lesson 1: 20-meter shuttle run test and a test of flexibility, lesson 2: curl-ups, push-ups, 5-leaps, and catching-throwing combination tests).

Methods

Study design and participants

This investigation employed a cross-sectional design. Participants of the study represented 12 schools and 36 classes that were recruited from different regions in the southern, western, and central parts of Finland. The description of the study with an invitation to participate was sent to the school principals and willing schools were recruited. There were 25 students (3.7%) who did not participate because they were absent due to sickness at the time of the study. This resulted in a total of 645 participants from Grade 5 ($n = 328$) and Grade 8 ($n = 317$). The mean age of students in the Grade 5 sample was 11.2 years (SD = .36) and in the Grade 8 sample 14.2 years (SD = .35). Both samples were approximately equal in terms of gender (50.0% boys in Grade 5 and 47.3% boys in Grade 8). Grade 5 and 8 students were selected for the study because fitness tests are a mandated part of the national curriculum at those grades (Finnish National Agency for Education, 2014).

Following common practice in Finland, students in Grades 1–6 were taught by classroom generalist teachers with non-specialist training in PE, and in Grades 7–9 by specialist PE teachers. All schools represented typical Finnish comprehensive schools, that is, Finnish-speaking, middle-sized (~300–500 students) and not specifically profiled towards any subject area (e.g. sport or science). Moreover, all schools followed the same national core curriculum that states the mission, objectives, content, and evaluative practices in PE.

Procedure

The study was conducted in three phases. In phase one of the study, students' perceived physical competence was measured via a short questionnaire during a regular PE lesson (contextual level). Two weeks later, during phase two, students took part in the first fitness testing lesson, and one week later, during phase three, they took part in the second fitness testing lesson. Immediately after the completion of the testing lessons students answered short questionnaires (~5–8 min). Questionnaires were completed in the gym hall and students were specifically asked to reflect upon their perceptions of the lesson they completed (situational level). In order to study possible differences between the two types of fitness testing lessons, the situational questionnaires were completed after both testing lessons. The questionnaire were administered by students' own PE teachers who were briefed regarding the research, and who followed written step-by-step instructions during the procedure. In order to protect confidentiality of the questionnaires data, participants used codes instead of names, and returned their answer sheets directly into a sealed envelope and not to their teachers. Students were allowed to ask for guidance if they did not comprehend some of the questions. Participation in the study was voluntary and students had an opportunity to withdraw at any time without consequences. Student assents and parental consents were collected prior to the study. The ethics committee of the local university approved the study protocol.

The first fitness testing lesson (90 min) contained a warm-up session, followed by a 20-meter shuttle run test which was conducted in two or three phases depending on the size of the class, and a short flexibility and mobility session where students performed squat, lower back extension and shoulder stretch tests. At the conclusion of the first lesson, a cool-down was performed. The second lesson (90 min) contained a warm-up session, followed by curl-ups, push-ups, 5-leaps, and catching-throwing combination tests, and a cool-down session. The protocol and test instructions (including the order of the tests) were obtained from the Move!—Finnish national monitoring system for physical functioning capacity that is a mandated part of the PE curriculum for all students in Grade 5 and 8 (Finnish National Agency for Education, 2014). Fitness testing lessons were taught by students' regular teachers as researchers' presence might have influenced students' experiences. It is noteworthy that only the fitness testing protocol was instructed whereas teachers' pedagogical and didactic actions, such as giving feedback or organizing tasks, were not instructed.

Measures

Enjoyment during fitness testing. The Finnish version of the Enjoyment subscale from the Sport Commitment Questionnaire-2 (SCQ-2; Scanlan et al., 2016) was used to assess enjoyment during PE fitness testing lessons. The scale items were modified to reflect the situational fitness testing lesson (e.g. "This fitness testing lesson was fun"). All five items were rated on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. The scale has been previously used among Finnish students in the PE fitness testing context with good psychometric properties ($\chi^2(207) = 319.3$, $p < .000$, CFI = .98, TLI = .98, RMSEA = .041, SRMR = .061) and factorial measurement invariance across Grade 5 and Grade 8 age groups (Huhtiniemi et al., 2021).

Anxiety during fitness testing. The Finnish version of the Physical Education State Anxiety Scale (PESAS; Barkoukis et al., 2005) was used to measure anxiety during the PE fitness testing lessons. The scale assesses three dimensions of anxiety, namely somatic anxiety, cognitive processes, and worry. Each dimension is formed from six items rated on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. Somatic anxiety refers to perceptions of physical symptoms (e.g. "I feel as if something is choking me"), cognitive processes refers to symptoms related to information processing, such as memory and attention, during the activity (e.g. "I find it difficult to memorize information regarding the tasks presented"), and worry refers to negative expectations from involvement in the activity and the consequences of possible failures (e.g. "when performing the tasks, I feel uneasy about potential mistakes"). In the questionnaire, the following item stem was used: "During the fitness testing lesson…". All dimensions of the PESAS have been previously used with Finnish students in the PE fitness testing context and shown to have appropriate psychometric properties and factorial measurement invariance across Grade 5 and Grade 8 age groups (cognitive processes: $\chi^2(302) = 441.7$, $p < .000$, CFI = .95, TLI = .95, RMSEA = .038, SRMR = .068; somatic anxiety: $\chi2(308) = 628.1$, $p < .000$, CFI = .91, TLI = .91, RMSEA = .057, SRMR = .080; worry: $\chi^2(308) = 396.5$, $p = .001$, CFI = .98, TLI = .98, RMSEA = .030, SRMR = .047) (Huhtiniemi et al., 2021).

Motivational climate. Motivational climate during fitness testing lessons was measured by using the Finnish version of the Motivational Climate in Physical Education Scale (MCPES; Soini et al., 2014). The scale items were modified to reflect the situational fitness testing lesson. The scale includes four dimensions, namely autonomy climate, relatedness climate, task-involving climate, and ego-involving climate. For the purposes of this study, only the task-involving (five items; e.g. "Learning new things makes me want to learn more") and ego-involving (e.g. "During the fitness testing lesson students compete with each other in their performance") subscales were used. Items were rated on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree. In the questionnaire the following item stem was used: "During the fitness testing lesson …". The Finnish version of the MCPES has been found to produce valid and reliable scores when used with adolescent students during PE lessons (CFI = .97, TLI = .97, RMSEA = .037, Cronbach's alphas ranged from 0.78 to 0.88) (Soini et al., 2014).

Perceived physical competence. To analyze students' perceived competence towards physical activity we used the Finnish version of the sport competence dimension in the Physical Self-Perception Profile (PSPP; Fox and Corbin, 1989). The scale comprised five items that were each rated on a five-point Osgood scale from 1 = I'm among the best when it comes to athletic ability to 5 = I'm not among the best when it comes to athletic ability. The individual item stem of the scale is: "What am I like?". The Finnish version of the perceived competence scale has been found to produce valid and reliable scores when used with students during PE lessons ($\chi^2(5) = 22.67$, $p < .001$, CFI = .98, TLI = .97, RMSEA = .074, SRMR = .020) (Gråsten, 2014).

Cardio-respiratory fitness, muscular fitness, and motor competence. Students' cardio-respiratory fitness was measured using the 20-meter shuttle run test (Leger et al., 1988), also known as PACER (Plowman and Meredith, 2013). Muscular fitness was measured using the push-up and curl-up tests (Plowman and Meredith, 2013). Students' locomotor skills were measured using the 5-leaps test (Jaakkola et al., 2012), and their object control skills were measured using the throwing-catching combination test (Jaakkola et al., 2012) where one throws a tennis ball to a specified target area on the wall (sized 1.5 × 1.5 m and situated 90 cm above the floor level) from a given distance (7 m for Grade 5 girls, 8 m for Grade 8 girls and Grade 5 boys, and 10 m for Grade 8 boys) and catches the ball after one bounce from the floor. All tests have been proven to produce reliable and valid scores among adolescents (Jaakkola et al., 2012; Olds et al., 2006; Plowman and Meredith, 2013). Students also performed three short flexibility and mobility tests (squat, lower back extension, and shoulder stretch test; Jaakkola et al., 2012) that were dichotomously scored (successful/unsuccessful). However, scores from these measures were not used in the analyses.

Statistical analyses

Normality of the data and possible outliers were examined during preliminary data screening. Descriptive statistics, with means, standard deviations and correlations, were established for the study variables. After the preliminary analyses, the direct and indirect associations between latent study variables were investigated using structural equation modeling (SEM). Two separate models were created in order to study the two fitness testing lessons with different content. A robust full-information maximum likelihood (MLR) procedure was implemented to estimate model parameters and to account for the possible non-normality of observations (Muthén and Muthén, 2017). Models were estimated using the TYPE = COMPLEX approach (Muthén and Muthén, 2017) which corrects standard error distortions caused by students being clustered in classes. To conduct mediation analyses in Mplus, MODEL INDIRECT command was used (Muthén and Muthén, 2017). Bootstrapping was applied to create confidence intervals for the indirect effects and to test the statistical significance of the mediation analyses (Hayes, 2013). Model fit was evaluated using the chi-square goodness-of-fit statistics (χ^2), the comparative fit index (CFI), the Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR). To interpret the fit indices, guidelines recommended by Hu and Bentler (1999) were used. The fit was considered good if the values for CFI and TLI were close to .95, for RMSEA < .06, and for SRMR < .08 (Hu and Bentler, 1999). All statistical analyses were performed using SPSS version 26.0 and Mplus version 8.2.

Results

A visual inspection of the histogram showed that the data were approximately normally distributed. Values for skewness and kurtosis were below 1.6. There were no significant outliers based on the standardized values (+ 3.0). Descriptive statistics and correlations among study variables are presented for both fitness testing lessons in Tables 1 and 2. Examination of the bilateral correlations between the study variables showed that enjoyment was positively correlated with perceived competence and fitness test scores, except for the 5-leaps test in the second fitness testing lesson. Additionally, there was a positive significant correlation between enjoyment and task-climate, and a nonsignificant correlation between enjoyment and ego-climate. In turn, all three anxiety dimensions were negatively correlated, or negligibly correlated with perceived competence and different fitness test scores. Furthermore, anxiety dimensions were positively correlated with ego-climate, and negatively with task-climate in both fitness testing lessons with the exception of the nonsignificant relationship between somatic anxiety and task-climate in the first fitness testing lesson.

Because students' perceptions were assessed during two different fitness testing lessons with different content, we first established separate baseline models (measurement models) for both lessons. The model for fitness testing lesson 1 demonstrated a good fit to the data [$\chi^2(645) = 1244.1$, $p < .000$, CFI = .95, TLI = .94, RMSEA = .038, 90% CI [.035, .041], SRMR = .07] and the model for lesson 2 demonstrated an adequate fit to the data [$\chi^2(762) = 1560.5$, $p < .000$, CFI = .92, TLI = .91, RMSEA = .040, 90% CI [.037, .043], SRMR = .083]. After confirming the appropriateness of the measurement models, we proceeded to investigate the structural portions of the models by adding the regression paths between the study variables. Examination of the fit indices revealed that both final models had a good fit to the data [Fitness testing lesson 1: (χ^2 (638) = 1160.8, $p < .000$, CFI = .95, TLI = .95, RMSEA = .036, 90% CI [.032, .039], SRMR = .057) and Fitness testing lesson 2: (χ^2 (738) = 1412.5, $p < .000$, CFI = .93, TLI = .92, RMSEA = .037, 90% CI [.035, .040], SRMR = .066)]. The models revealed statistically significant direct and indirect paths between study variables as shown in Figures 1 and 2. The results of the mediation analyses with all specific and total indirect associations among study variables are presented in Table 3. Finally, squared multiple correlations showed that the model for the first fitness testing lesson accounted for 49% of variance in enjoyment, 20% in cognitive processes, 17% in somatic

Table 1. Descriptive statistics and bivariate correlations among study variables in fitness testing lesson 1.

	1.	2.	3.	4.	5.	6.	7.	Range	*M*	SD	α
1. Enjoyment	—							1–5	3.04	1.29	.96
2. Cognitive processes	−.20***	—						1–5	1.72	.83	.90
3. Somatic anxiety	−.23***	.51***	—					1–5	2.47	.99	.86
4. Worry	−.30***	.57***	.53***	—				1–5	2.27	1.12	.93
5. Ego-climate	−.01	.24***	.20***	.26***	—			1–5	2.63	1.07	.88
6. Task-climate	.59***	−.27***	−.07	−.11**	.01	—		1–5	3.76	.90	.85
7. Perceived competence	.44***	−.25***	−.29***	−.36***	.03	.33***	—	1–5	3.41	.97	.91
8. 20mSRT (shuttles)	.24***	−.15***	−.13**	−.23***	.13**	.12**	.40***	3–137	38.15	20.70	—

Note: ***$p < .001$, **$p < .01$, *M*: mean, SD: standard deviation, α: Cronbach's alpha, 20mSRT: 20-meter shuttle run test.

Table 2. Descriptive statistics and bivariate correlations among study variables in fitness testing lesson 2.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	Range	*M*	SD	α
1. Enjoyment	–										1–5	3.10	1.28	.95
2. Cognitive processes	–.24***	–									1–5	1.76	.84	.88
3. Somatic anxiety	–.15***	.54***	–								1–5	2.17	.93	.85
4. Worry	–.29***	.59***	.50***	–							1–5	2.24	1.13	.93
5. Ego-climate	–.05	.21***	.19***	.28***	–						1–5	2.66	1.06	.88
6. Task-climate	.54***	–.24***	–.10**	–.10*	.07	–					1–5	3.73	.92	.86
7. Perceived competence	.42***	–.29***	–.25***	–.34***	.07	.29***	–				1–5	3.41	.97	.91
8. Curl-up	.20***	–.18***	–.07	–.12*	.11*	.20***	.31***	–			0–75	38.97	20.93	na
9. Push-up	.17***	–.16***	–.09	–.02	.07	.19***	.34***	.38***	–		0–68	23.26	13.02	na
10. 5-leaps	.07	–.08	–.14**	–.13**	.11*	.03	.27***	.28***	.44***	–	4.4–11.7	8.41	1.27	na
11. Catching-throwing	.21***	–.20***	–.12*	–.11*	.06	.15**	.36***	.28***	.32***	.40***	0–20	12.57	5.01	na

Note: ***$p < .001$, **$p < .01$, *$p < .05$, *M*: mean, SD: standard deviation, α: Cronbach's alpha.

Table 3. Standardized total indirect and specific indirect effects of task and ego-involving climate for fitness testing lessons 1 and 2.

	Enjoyment		Cognitive processes		Somatic anxiety		Worry	
Relationships	Estimate [95% CI]	*p*	Estimate [95% CI]	*p*	Estimate [95% CI]	*p*	Estimate [95% CI]	*p*
Fitness testing lesson 1								
Task-climate	**0.098 [0.066, 0.129]**	**0.000**	**−0.074 [−0.114, −0.035]**	**0.002**	**−0.123 [−0.163, −0.083]**	**0.000**	**−0.141 [−0.182, −0.099]**	**0.000**
Task-climate via PC	**0.087 [0.055, 0.119]**	**0.000**	**−0.060 [−0.101, −0.020]**	**0.014**	**−0.110 [−0.152, −0.068]**	**0.000**	**−0.124 [−0.165, −0.083]**	**0.000**
Task-climate via 20mSRT	0.010 [0.001, 0.020]	0.081	−0.014 [−0.026, −0.002]	0.057	−0.013 [−0.026, 0.000]	0.093	**−0.017 [−0.030, −0.003]**	**0.040**
Ego-climate	0.021 [−0.002, 0.044]	0.139	−0.021 [−0.040, −0.003]	0.062	−0.026 [−0.054, 0.002]	0.124	−0.032 [−0.063, 0.000]	0.098
Ego-climate via PC	0.010 [−0.009, 0.029]	0.389	−0.007 [−0.020, 0.007]	0.405	−0.012 [−0.036, 0.011]	0.386	−0.014 [−0.041, 0.013]	0.389
Ego-climate via 20mSRT	0.011 [−0.001, 0.022]	0.121	−0.014 [−0.027, −0.002]	0.065	−0.014 [−0.026, −0.001]	0.074	−0.018 [−0.031, −0.004]	0.035
Fitness testing lesson 2								
Task-climate	**0.092 [0.056, 0.127]**	**0.000**	**−0.109 [−0.157, −0.061]**	**0.000**	**−0.087 [−0.134, −0.040]**	**0.002**	**−0.107 [−0.160, −0.054]**	**0.001**
Task-climate via PC	**0.086 [0.048, 0.123]**	**0.000**	**−0.067 [−0.112, −0.022]**	**0.014**	**−0.094 [−0.142, −0.046]**	**0.001**	**−0.133 [−0.186, −0.079]**	**0.000**
Task-climate via 5-leaps	−0.001 [−0.004, 0.003]	0.663	0.001 [−0.003, 0.006]	0.689	−0.004 [−0.014, 0.006]	0.472	−0.006 [−0.018, 0.007]	0.455
Task-climate via curl-up	0.006 [−0.009, 0.022]	0.505	−0.015 [−0.037, 0.006]	0.237	0.005 [−0.017, 0.026]	0.733	−0.014 [−0.034, 0.005]	0.230
Task-climate via push-up	−0.007 [−0.024, 0.010]	0.516	−0.014 [−0.038, 0.009]	0.318	0.009 [−0.013, 0.031]	0.517	**0.038 [0.014, 0.063]**	**0.010**
Task-climate via catch-throw	0.007 [−0.004, 0.019]	0.299	−0.014 [−0.030, 0.002]	0.162	−0.002 [−0.018, 0.015]	0.869	0.007 [−0.006, 0.021]	0.366
Ego-climate	0.016	0.267	−0.024	0.124	−0.025	0.173	−0.034	0.139

(continued)

Table 3. (continued)

Relationships	Enjoyment Estimate [95% CI]	Enjoyment *p*	Cognitive processes Estimate [95% CI]	Cognitive processes *p*	Somatic anxiety Estimate [95% CI]	Somatic anxiety *p*	Worry Estimate [95% CI]	Worry *p*
	[−0.008, 0.041]		[−0.049, 0.002]		[−0.054, 0.005]		[−0.071, 0.004]	
Ego-climate via PC	0.015 [−0.008, 0.038]	0.275	−0.012 [−0.030, 0.006]	0.279	−0.017 [−0.042, 0.008]	0.276	−0.023 [−0.057, 0.011]	0.258
Ego-climate via 5-leaps	−0.002 [−0.010, 0.005]	0.596	0.003 [−0.007, 0.013]	0.649	−0.011 [−0.024, 0.001]	0.139	−0.014 [−0.029, 0.000]	0.104
Ego-climate via curl-up	0.003 [−0.005, 0.011]	0.538	−0.007 [−0.018, 0.004]	0.309	0.002 [−0.008, 0.012]	0.737	−0.007 [−0.017, 0.004]	0.292
Ego-climate via push-up	−0.001 [0.006, 0.003]	0.574	−0.003 [−0.010, 0.004]	0.466	0.002 [−0.004, 0.008]	0.600	0.008 [−0.006, 0.023]	0.347
Ego-climate via catch-throw	0.002 [−0.003, 0.008]	0.469	−0.005 [−0.013, 0.004]	0.368	−0.001 [−0.006, 0.005]	0.871	0.002 [−0.003, 0.008]	0.500

Bolded = p <.05, PC: perceived competence, 20mSRT: 20-meter shuttle run test.

anxiety, 22% in worry, 15% in perceived competence, and 4% in 20-meter shuttle run test; and for the second fitness testing lesson, 46% in enjoyment, 19% in cognitive processes, 18% in somatic anxiety, 27% in worry, 18% in perceived competence, 10% in curl-up, 10% in push-up, 4% in 5-leaps, and 6% in catching-throwing combination.

Discussion

The purpose of this study was to investigate direct and indirect associations among task- and ego-involving motivational climates, perceived competence, physical performance, enjoyment, and anxiety during two PE fitness testing lessons with different content. The first testing lesson included a 20-meter shuttle run and flexibility tests, and the second lesson consisted of curl-up, push-up, 5-leaps, and catching-throwing combination tests. Generally, the analyses revealed that task-involving climate and perceived physical competence increased students' enjoyment and decreased their anxiety whereas ego-involving climate had no effect on students' enjoyment but had a negative effect on their anxiety levels. Furthermore, the role of students' actual physical performance was limited as a mediator between motivational climate and affects, or as a direct predictor of affects.

One of the most significant findings to emerge from this study was that task-involving climate and perceived competence directly associated with enjoyment in both fitness testing lessons. Besides the direct associations, an indirect effect was observed from task-involving climate to enjoyment via perceived competence. In other words, students who experienced factors such as effort, learning, and personal development during the fitness testing activities, perceived the

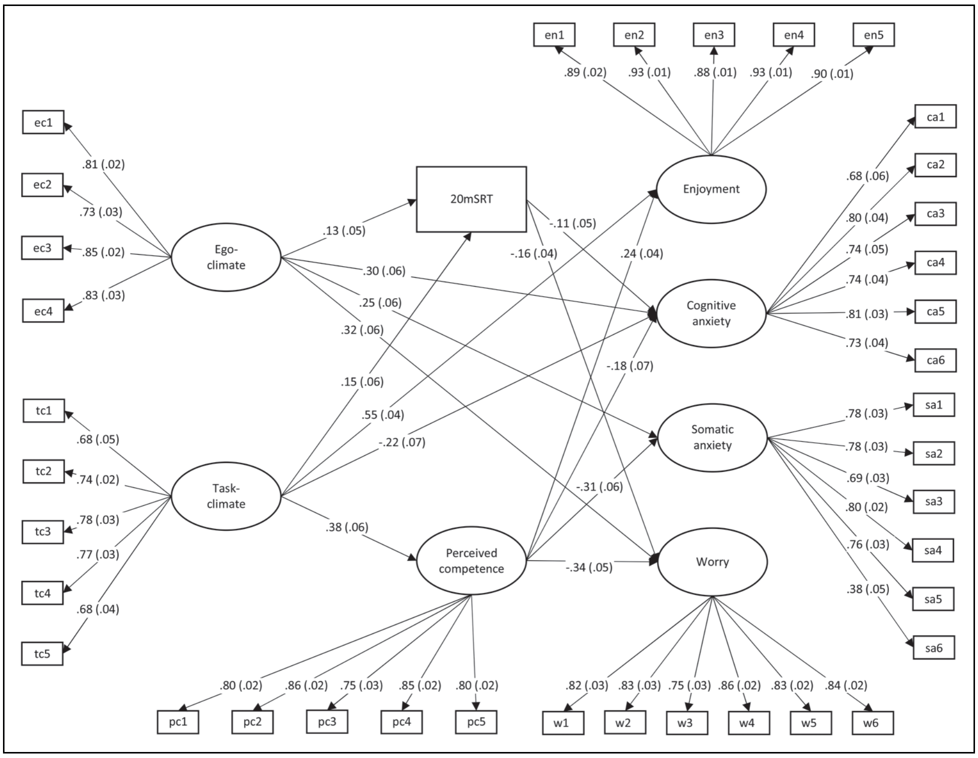

Figure 1. Structural equation model for fitness testing lesson 1. All paths are standardized and significant at the $p < 0.05$ level.

lessons as more enjoyable. These findings support the theoretical assumptions of motivational climate (Ames, 1992) whereby task-involving climate is believed to promote positive changes in behavioral, cognitive, and affective outcomes. Interestingly, students' actual physical performance was not associated with enjoyment, indicating that irrespective of whether students are performing at high or low levels based on actual test scores does not seem to affect their feelings of satisfaction and enjoyment. This aligns well with previous findings by Simonton et al. (2019) who demonstrated that students' fitness test performances were only weakly related to enjoyment in PE, and also links with results by Goudas et al. (1994) who reported that students with high task and low ego orientation had high levels of enjoyment regardless of their performance in a 20-meter shuttle run test (PACER). Overall, these findings highlight the importance of emphasizing task-involving motivational climate and perceived competence while conducting fitness testing lessons. Previous intervention studies in PE have consistently shown that this can be accomplished, for example, by implementing elements such as personal development, effort, and co-operation from the TARGET-model (Barkoukis et al., 2008; Digelidis et al., 2003).

Another interesting finding of this study was the similar pattern of associations between motivational climates and anxiety subscales during both fitness testing lessons. More specifically, students perceived higher levels of cognitive anxiety, somatic anxiety, and worry when ego-involving climate was rated higher. Furthermore, task-involving climate was either directly or indirectly,

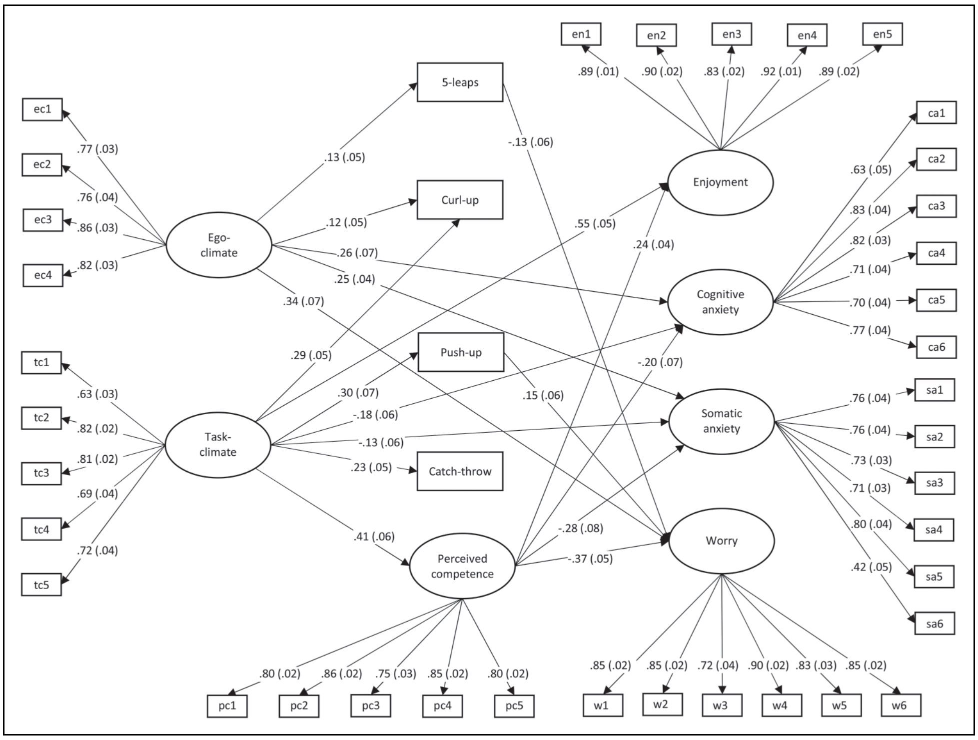

Figure 2. Structural equation model for fitness testing lesson 2. All paths are standardized and significant at the $p < 0.05$ level.

via perceived competence, associated with lower levels of cognitive anxiety, somatic anxiety, and worry. These findings reflect both the theoretical assumptions of motivational climate (Ames, 1992) and previous findings in PE contexts in which ego-involving climate has been shown to have maladaptive associations, and task-involving climate adaptive associations, with affective experiences (Carpenter and Morgan, 1999; Ommundsen and Kvalo, 2007; Papaioannou and Kouli, 1999). Thus, to diminish feelings of anxiety in PE fitness testing lessons, teachers should focus on strategies that incorporate elements such as personal development, progression, and effort (Barkoukis et al., 2008).

While interpreting the results it is important to consider the differences and similarities between the two fitness testing lessons. In the first fitness testing lesson, students took part in a 20-meter shuttle run test where they are required to work near maximal aerobic capacity, and which some might understandably perceive as unpleasant (Silverman et al., 2008). In contrast, in the second fitness testing lesson measures were more related to skill and strength. For example, the throwing-catching combination test (Jaakkola et al., 2012) where students repeatedly throw a tennis ball at the wall could be perceived as a fun activity, and something many would like to do also during recess or free time. Despite the apparent differences in the content of the lessons, students' perceptions were generally quite similar. It may be that aspects related to teachers' actions such as their teaching style or didactic approach, and not specific content of testing, have a more pronounced effect on students' affects (O'Keeffe et al., 2020).

The investigation of students' perceived competence and physical performance as possible mediators between task- and ego-involving motivational climate, and students' enjoyment and anxiety, revealed interesting results. Results showed that perceived competence mediated the relationships between task-involving climate and enjoyment, and between task-involving climate and anxiety in both fitness testing lessons. Students' physical performance (i.e. motor competence and fitness test results), however, did not mediate these same relationships except for a few minor peculiarities. The PACER and push-up tests mediated the associations between task-involving climate and worry in the first and second fitness testing lessons. Yet, these findings should be interpreted with caution because of the small observed effect sizes. It should be noted that there were few direct links between fitness test scores and anxiety subscales. In the first fitness testing lesson, better performance in the 20-meter shuttle run test was associated with lower levels of cognitive anxiety and worry. Moreover, in the second fitness testing lesson, better performance in 5-leaps was associated with lower levels of worry whereas better performance in push-up was associated with higher levels of worry. These mixed findings could represent anomalies and should be interpreted with caution as the effect sizes were small, but some possible reasons are discussed below. For instance, it might be that high-performing students were less worried because the worry subscale taps into making mistakes or performing poorly (Barkoukis et al., 2005) and naturally these aspects are less evident if students are performing at a high level. Also, it is possible that the small worry-increasing effect of push-ups resulted from the different test protocol and different reference values for boys and girls (girls used knees and boys used toes as balance points; Jaakkola et al., 2012).

Limitations and future directions

Despite the merits of the current study, several limitations should be acknowledged in relation to the findings. Firstly, although the student cohort represented 12 schools from different geographical locations, the sample was not randomly selected which limited the generalizability of the results. Another possible limitation related to the sample was the use of both Grade 5 and Grade 8 students in the models. Previous research has demonstrated that students' maturation level and developmental phase could affect their motivational and affective experiences during fitness testing situations (Garn and Sun, 2009; Nicholls, 1989; Wigfield et al., 2005). Based on this behavior, Grade 5 and Grade 8 experiences of fitness testing situations might differ. However, the sample was analyzed together as preliminary analyses showed similar patterns of associations among study variables for both grade-level groups. This also allowed a more parsimonious way to model the research data. The third limitation of the study was that there were no observations or recordings of the lessons available, and therefore, although the study protocol (including test order) was carefully presented to the teachers, there is no way of knowing how precisely they followed the written instructions. From that perspective, using observers or recordings to evaluate teachers' actions during the lessons would have increased the reliability of the study. However, adding an external person or device to the situation might significantly affect students' behavior, physical performance and cognitive perceptions.

Future research should consider examining possible group differences concerning the associations between motivational constructs and affects in fitness testing lessons. These subgroups might be based on gender, ethnicity, disability, level of perceived or actual competence, or fitness level. This would be beneficial for teachers who often work with heterogeneous groups of students while conducting testing in PE. In addition, intervention studies are needed to better understand how positive affects can be fortified and negative affects minimized specifically in fitness testing lessons. Together with subgroup analyses this information could contribute to an increase in both positive testing experiences, and willingness to maintain physical activity and fitness levels. In addition to students' perceptions, future studies could also emphasize an examination of the pedagogical modalities used by teachers to better understand the specifics of their fitness testing implementation practices. Finally, longitudinal studies are needed to investigate the long-term behavioral, cognitive, and affective effects of regular PE-based fitness testing.

Conclusion

This study investigated the associations among task- and ego-involving motivational climates, perceived physical competence, physical performance, and affects during two different types of PE fitness testing lessons. Results indicated that regardless of the testing class content or students' performance, task-involving climate and perceived competence were directly associated with enjoyment. Findings from this study suggest that students' perceived competence has a greater influence on their affective experiences in fitness testing lessons than their actual performance level. This finding is especially important regarding low-performing students, as their test scores do not dictate their affective perceptions. From a practical perspective, strategies promoting task-involving motivational climate and students' perception of competence are recommended to increase enjoyment and decrease anxiety during PE fitness testing lessons.

Declaration of conflicting interests

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IV

A SCALABLE SCHOOL-BASED INTERVENTION TO INCREASE EARLY ADOLESCENTS' MOTOR COMPETENCE AND HEALTH-RELATED FITNESS

by

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ORIGINAL ARTICLE

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A scalable school-based intervention to increase early adolescents' motor competence and health-related fitness

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Abstract

Schools are key settings for the promotion of students' physical activity, fitness, and motor competence. The purpose of our study was to investigate the efficacy of a 5-month-long intervention program that aimed to increase students' motor competence and health-related fitness during school days. We conducted a quasi-experimental study with 325 Finnish Grade 5 ($M_{age}=11.26$, SD = 0.33) students from five schools. Two schools were allocated to the intervention group and three schools to the control group. The intervention consisted of three components: (a) weekly 20 min session during regular PE lessons, (b) weekly 20 min session during recess, and (c) daily 5-minute-long classroom activity breaks. All activities were designed to systematically develop different elements of motor competence and fitness. The following assessments were conducted at baseline and 5-months: cardiorespiratory fitness levels were measured by 20-meter shuttle run test, muscular fitness by curl-up and push-up tests, and motor competence by 5-leaps and throwing–catching combination tests. We analyzed the data using a multi-group latent change score modeling. Results showed that students in the intervention group developed significantly better in 20-meter shuttle run test ($\beta=0.269$, $p=0.000$, 95% CI [0.141, 0.397]; +5.0 laps), push-up ($\beta=0.442$, $p=0.000$, 95% CI [0.267, 0.617]; +6.5 repetitions), curl-up ($\beta=0.353$, $p=0.001$, 95% CI [0.154, 0.552]; +7.8 repetitions), and throwing–catching combination tests ($\beta=0.195$, $p=0.019$, 95% CI [0.033, 0.356]; +1.1 repetitions) than students in the control group. The intervention program appeared to be feasible and effective in increasing students' cardiorespiratory fitness, muscular fitness, and object control skills. This indicates that guided school-based physical activity programs can be influential in promoting physical fitness and motor competence among early adolescent students.

KEYWORDS
adolescents, fitness, intervention, motor competence, school

1 | INTRODUCTION

It is evident that a vast majority of children and adolescents do not meet the current physical activity guidelines.[1] Concurrently, negative trends have been documented in young people's motor competence[2] and health-related fitness.[3,4] These findings are alarming as lowered physical performance in adolescence has been shown to negatively influence several health outcomes such as weight status and cardiovascular disease risk factors.[5–8] Drawing from these findings, a wide range of actions in multiple domains have been explored to reverse the negative course. The school setting has been identified as one of the most compelling contexts to promote motor competence and health-related fitness as it effectively reaches the whole age cohort of children and adolescence.[9,10] In addition to the effective reach of the population, schools also have teachers and other experts with access to equipment and facilities for physical activity promotion.[11] Therefore, the aim of this study was to investigate the effectiveness of a multicomponent school-based intervention that targeted early adolescent students' motor competence and health-related fitness.

Motor competence is a global term to describe goal-directed human movement and is often used interchangeably with the following: motor proficiency, motor ability, and motor coordination.[12] It has been shown that for optimal motor competence development during childhood systematic training and practice are needed.[13–15] The proficient level and progression of motor competence form the building blocks for various physical activities, sport skills, and motor behaviors across the life course.[13,16] Previous studies and systematic reviews have shown that motor competence is associated with several important health-related factors, including higher levels of CRF and muscular fitness,[14,17–19] higher physical activity engagement in organized settings,[20] and improved weight status.[5,17] Moreover, previous studies have demonstrated the potential of school-based interventions to improve students' motor competence. For example, in a meta-analysis including 56 trials and over 48 000 participants (aged 3–18 years) quality-based PE interventions were positively related with increases in motor competence (pooled effect size: Hedges $g = 0.38$; 95% CI = 0.27–0.49).[9] Another review and meta-analyses by Dudley et al. showed that the highest effects in PE learning interventions were observed in psychomotor outcomes (e.g., motor competence, fundamental movement skills) ($d = 0.52$) followed by affective ($d = 0.47$), social ($d = 0.32$), and cognitive ($d = 0.17$) outcomes.[21] Moreover, the systematic review and meta-analysis by Morgan et al. found that school-based programs delivered by physical education (PE) professionals can improve children's motor competence (standardized mean difference [SMD] = 1.42, 95% CI = 0.68–2.16).[22]

Health-related fitness (HRF) is a multidimensional construct comprising cardiorespiratory fitness (CRF), musculoskeletal fitness, flexibility, and body composition.[7,23] Previous research has well established that HRF in youth, especially cardiorespiratory and muscular fitness, are significant markers of overall health.[7,8,24,25] Moreover, previous studies have demonstrated that school-based interventions can improve young people's HRF. For example, Villa-Gonzales et al. concluded that school-based activities that include strength exercises may enhance muscular fitness among primary school students (aged <13 years).[26] In another review and meta-analytic study, school-based interventions which targeted muscular fitness in adolescent boys showed small to-moderate effects.[27] Moreover, Hartwig et al. showed that physical activity interventions have a modest effect on CRF among 4–18-year-old students based on a pooled analysis of 20 controlled trials (overall effect: 0.47 mL/kg/ min [95% CI 0.33 to 0.61]).[28]

Although there is a wealth of information regarding the effects of different physical activity interventions on young people's motor competence[22,29–31] and health-related fitness,[10,26–28] more studies especially in the school context are needed. In a recent Delphi study utilizing 46 experts in the field, school-based interventions for increasing HRF that are feasible and scalable was ranked fourth in international priorities for physical fitness research.[32] Hence, more evidence-based empirical procedures to contribute students' motor competence and health-related fitness are needed. Additionally, there is a need for programs where the cost-effectiveness and the potential scalability to wider use have been considered.[32] This intervention has the potential to be scaled-up to improve public health among Finnish students. As noted by Milat and colleagues for interventions to be scalable, they need to have: (i) evidence of effectiveness, (ii) potential for extended reach, (iii) show high acceptability among the target population and setting, and (iv) acceptable delivery costs.[33,34] Interventions that are integrated into existing school structures such as PE lessons and recess time are more likely to be scalable because they address the criteria outlined above.[35] Stemming from these arguments, our study adds to the existing literature by examining the effects of an intervention program that was integrated into PE lessons, academic lessons, and recess time.

More specifically, the aim of our study was to assess the effectiveness of a multicomponent school-based intervention on adolescents' motor competence and HRF. We hypothesized that students allocated to the intervention group would have significantly higher CRF, muscular fitness, locomotor, and object control skill proficiency compared to students in the control group. Additionally, the effects of body mass index (BMI) and gender were investigated in our analysis.

2 | METHOD

2.1 | Participants and recruitment

The reporting of the current study was aligned with the Transparent Evaluations with Non-Randomized Design (TREND) statement.[36] A quasi-experimental intervention design, with experimental and control groups, and pre- and posttests was implemented. Participants of the study were 325 Finnish Grade 5 students (baseline $M_{age}=11.26$, SD = 0.33) from Central-Finland. Participants represented 16 classes from five schools that were conveniently selected based on their distance from the University. In the beginning of the study, schools were allocated to intervention or control groups. The intervention group consisted of 157 students (78 boys and 78 girls, one student unknown) from two schools and seven classes. The control group consisted of 168 students (81 boys and 83 girls, four students unknown) from three schools and nine classes. The study schools represented typical Finnish elementary schools, and they shared many attributes that were similar. All schools were similar in size, had similar indoor and outdoor facilities for physical activity, had teachers with similar master-level education and teaching experience (general classroom teachers), and had similar student populations (e.g., ethnicity mostly white, drawing from similar neighborhoods). Both control and intervention schools followed the same national core curriculum for PE which specifies the overall aims in PE and guides the selection of different contents and methods.[37,38]

The students' guardians were informed about the study protocols and provided written informed consent for their children to participate in the study. The study protocol was approved by the ethics committee of the local university.

2.2 | Intervention description and components

The intervention program aimed to increase students' motor competence and health-related fitness through weekly guided activities, aligned with the aims of the national PE curriculum. The 5-month-long program was implemented during regular school days and consisted of the three components described below. Two example weeks elaborating the intervention activities and structure in more detail are provided in the Supporting Information Table S1. The selection and design of the components were aligned with the Theory of Expanded, Extended, and Enhanced Opportunities (TEO) which describes a practical threefold taxonomy to identify intervention targets and to better understand physical activity engagement of youth.[35] The three elements of TEO include: (a) the expansion of opportunities to be active (e.g., breaks during academic lessons), (b) the extension of an existing physical activity opportunity (e.g., a long recess devoted for activity), and (c) the enhancement of existing physical activity opportunities (e.g., increasing the intensity of PE lessons).

2.2.1 | PE lesson component

A 20-minutes-long specific fitness and motor competence unit that was implemented weekly in the beginning of students' regular 90-minutes physical education lesson (i.e., extended warm-up). The unit contained different activities, games, and tasks that systematically developed different elements of physical fitness and motor competence. Each unit targeted one or two different elements, such as CRF and throwing skills through a certain game or movement task (see Supporting Information Table S1 for detailed examples). This component was delivered by two trained researchers.

2.2.2 | Recess component

A 20 min-long recess activity that was implemented once a week during students' regular recess time. Similar, to the PE lesson component, the recess component contained a variety of activities, games, and tasks that systematically developed different elements of fitness and motor competence (see Supporting Information Table S1 for detailed examples). To effectively use the recess time, students were instructed for the activities at the end of the preceding academic lesson. This component was delivered by two trained researchers.

2.2.3 | Classroom activity breaks

Daily 5-minute-long activity breaks were organized during academic lessons. The research team designed the activities and their order of implementation. Each activity break was designed to promote a certain physical performance indicator, for example muscular fitness (see Supporting Information Table S1 for detailed examples).

The breaks were administered by the class teachers who followed written instructions and education given by the research team.

All activities and their implementation were planned by the research team. All classes in the intervention group received the same standardized program. The total duration of the intervention program was 5 months starting in October and finishing in the end of March. During regular school breaks (e.g., Christmas holiday period) there were no activities, and therefore, the program consisted of 18 active weeks with 65 min of structured content per week. The weekly activities were instructed by trained research assistants who were fifth-year master's degree students from the PE teaching education program of the local university. The various games, tasks and other activities chosen to the program were easy to implement and did not require any special equipment or other special arrangements. Tasks and activities included an abundance of variation (e.g., easy or hard option for a certain task) to enable students with different fitness and skill levels to participate. Moreover, students' engagement and commitment were fortified by including a student-designed elements to the intervention program. Each class designed their own favorite activity week which was then executed at the end of the intervention period.

Students in the control group did not receive the intervention but they had a similar school week structure. Physical education classes (one 90 min class once a week) and recesses (one long recess per day but without guided activities) were structured in a similar way compared to the intervention schools. After the post-measurements, the intervention activities were also provided to the control group schools.

2.3 | Intervention fidelity and adherence

We confirmed intervention fidelity through a set of measures. A predesigned structured intervention plan was followed in all intervention classes that allowed the research team to evaluate how precisely the plan was executed. Research assistants used lesson plans to deliver the activities and they were instructed to write down all possible changes at the end of each lesson. They were also instructed to report possible problems regarding participation or other influencing factors. In addition, the regular teacher of the class was present during the activities and was also guided to report any issues (e.g., misbehaviors). The research team met weekly to discuss the implementation process. Teachers or research assistants did not report any deviations from the structured plan or other problems during the intervention period.

Participation rate was monitored throughout the study. As the intervention program was integrated to the school day structure, all students in the class took part in the activities, including those who did not want to participate in the study. During the intervention period, regular absences were reported resulting typically from short-term sickness. All intervention group students participated to at least 16 out of 18 intervention weeks which was considered acceptable, and therefore, no students were excluded from the analysis.

2.4 | Measures

Baseline measures were conducted in September 2018 for both groups. The intervention program started 2 weeks after the pretests. The weekly program followed the regular yearly schedule of Finnish schools. All posttests were completed in April 2019 for both groups. The intervention group completed posttests 1 week after the end of the program.

All physical performance tests were administered by the trained researchers for both intervention and control groups in pre- and post-testing phases. Researchers who conducted the measurements were blinded regarding the groups condition. All tests were completed in gym hall during a 90-minute class, and the order of tests was the following: (1) throwing–catching combination test, (2) 5-leaps test, (3) curl-up test, (4) push-up test, and (5) 20-meter shuttle run test. In addition, students' height and weight were measured. A separate session was organized to collect students' background information using a questionnaire administered during a regular school class.

2.4.1 | Motor competence

Students' motor competence was measured using two product-oriented measures; the throwing–catching combination test (object control skills) and 5-leaps test (locomotor skills).[39] In the throwing–catching combination test, the participant throws a tennis ball at a target area 1.5×1.5 m square situated at 90 cm above floor level. Throwing distance is 7 m for girls and 8 m for boys. The participant throws the ball behind a marked line, hits the target area, and catches the ball after one bounce. The final score is the number of correctly performed throwing–catching combinations from 20 attempts. In the 5-leaps test, the participant completes five leaps, beginning and finishing with the legs in a parallel position. The final test score was the distance from the start to finish position measured from the heel of the nearest foot. Both motor competence tests have demonstrated acceptable validity and reliability among Finnish adolescents.[40,41] More specifically, the test–retest intraclass correlations have been adequate in both throw-catch combination (0.69) and 5-leaps (0.84) tests.[39]

2.4.2 | Cardiorespiratory fitness

Students' CRF was measured using the 20-meter shuttle run test also referred as the Progressive Aerobic Cardiovascular Endurance Run (PACER).[42] In the test, the participant runs continuously between two lines that are set 20 m apart following a progressive cadence. The final score is the number of shuttles reached before the participant is unable to keep pace with the signals.

2.4.3 | Muscular fitness

Students' muscular fitness was measured with curl-up and push-up tests.[39] In the curl-up test, participants lie on their back with legs bent to 100 degrees and curl-up slowly keeping their heels on the floor. A measuring strip is located on the mat under their legs such that, in the start position, their fingertips are resting on the nearest edge of the measuring strip. As the participants curl-up, their fingers slide across the strip. When their fingertips reach the other side of the measuring strip, the participants curl back down until their head touches the floor. Before the actual test, a participant was allowed tries. The test score is the number of correctly completed curl-ups performed before being unable to keep pace with the rhythm set by the audio recording or when they reach 75 curl-ups. The push-up test is conducted for boys and the girls in a slightly different way. Boys use a starting position where their hands and toes touch the floor, whereas girls use a starting position where their hands and knees touch the floor. In both versions of the test, body and legs are kept in a straight line and arms are shoulder-width apart. In the test, a participant lowers their body until there is a 90-degree angle in the elbows (with the upper arms parallel to the floor). The final score is the number of correctly completed push-ups in 60 seconds. Both muscular fitness tests have shown adequate reliability and validity among Finnish adolescents.[39]

2.4.4 | Body mass index

Participants' weight and height were measured using a calibrated scale and a portable measuring equipment to the nearest 0.1 kg and 0.1 cm, respectively. Participant were barefoot and wearing light clothes. Participants body mass index was calculated using a weight (kg) and height (m) formula (kg/m^2).[43]

2.5 | Statistical analyses

Preliminary analyses were performed with IBM SPSS 26 software.[44] Data were first inspected for inputting errors, outliers, and missing data patterns. Following this, descriptive statistics and standardized data values were calculated. Because fitness measurements procedures were different between boys and girls in push-ups and throwing–catching combination tests, the standardization was performed separately for boys and girls using pretest means and variances. Main analyses were conducted using Mplus 8.6 software.[45] Latent change score analysis, in the structural equation modeling framework, was used to examine the effects of the intervention in the 20-meter shuttle run, 5-leaps, curl-up, push-up and throwing–catching combination tests, along with the body mass index. Baseline scores were controlled in the analysis. All analyses followed the intention-to-treat principles.[46]

Latent change score modeling combines features from cross-lagged regression modeling and latent growth curves.[47–49] In latent change models, the change between T0 and T1 is represented as a latent variable with a mean (i.e., average change), a variance (i.e., individual differences in change), and a covariation of the change with the initial factor and possible other factors in the model.[49] This means that the model can estimate latent means and latent intraindividual mean changes (e.g., between pretest and posttest) but also interindividual differences in these variables.[50] The latent change score modeling has been successfully applied in previous intervention studies.[50–52]

In the current study, a multi-group latent change modeling was used to test the differences between groups. More specifically, mean parameters for latent change were constrained to be equal between boys and girls, and between intervention and control groups, and the subsequent change in model fit was evaluated. Wald test was used to test the difference between intervention and control groups, and between boys and girls.[45]

To take possible non-normality of data into account, the robust full information maximum likelihood estimator (MLR) was used in the analyses. The standard procedure for handling missing values in Mplus was used, which utilizes all observations in the data without imputing the data.[45] Multiple indicators were used to evaluate the overall model fit. More specifically, the chi-square goodness-of-fit statistics (χ^2), the comparative fit index (CFI), the Tucker-Lewis index (TLI), root mean square error of approximation (RMSEA), and standardized root mean square residual (SRMR) were used. Following guidelines by Hu and Bentler, the model fit was considered good when values of CFI and TLI are close to 0.95, the SRMR is lower than 0.08, and the RMSEA is lower than 0.06.[53]

3 | RESULTS

3.1 | Preliminary analyses

Graphical inspection showed that the variables were approximately normally distributed. Values for skewness and kurtosis were below 1.2. In addition, no significant outliers were detected. The missing completely at random (MCAR) test ($\chi^2=210.8$, $df=186$, $p=0.103$) demonstrated that the data with and without missing values were similar, and thus, the missing data were considered to be missing completely at random.[54]

The means and standard deviations for both intervention and control groups are presented in Table 1. All bivariate correlations among study variables are presented in Supporting Information Table S2.

3.2 | Intervention effects

A latent change score model was established to study the effect of the intervention on the change between T0 and T1. All five fitness and motor competence test variables, that is, 20-meter shuttle run, 5-leaps, curl-up, push-up, and throwing–catching combination tests, along with the body mass index, were used in the final model. The baseline scores were controlled in the analysis. The model (Figure 1) demonstrated a good fit to the data [$\chi^2(6)=8.54$, $p<0.201$, CFI=0.999, TLI=0.993, RMSEA=0.036, 90% CI [0.000, 0.087], SRMR=0.02]. Model parameters, including regression and correlation estimates, are presented in Table 2. Results revealed that the group condition had a statistically significant positive effect on the latent change in 20-meter shuttle run ($\beta=0.269$, $p=0.000$, 95% CI [0.141, 0.397]; adjusted mean difference=5.0 laps), curl-up ($\beta=0.353$, $p=0.001$, 95% CI [0.154, 0.552]; adjusted mean difference=7.8 repetitions), push-up ($\beta=0.442$, $p=0.000$, 95% CI [0.267, 0.617]; adjusted mean difference=6.5 repetitions) and throwing–catching combination tests ($\beta=0.195$, $p=0.019$, 95% CI

TABLE 1 Means and standard deviations for control and intervention groups at pre- and posttests.

	Control group		Intervention group	
	Pretest	Posttest	Pretest	Posttest
	M (SD)	*M* (SD)	*M* (SD)	*M* (SD)
All				
Body mass index (kg/m^2)	18.66 (2.82)	18.99 (2.94)	18.46 (2.48)	18.97 (2.57)
20-m shuttle run test	38.71 (17.81)	42.06 (18.22)	36.66 (18.56)	45.06 (19.33)
5-leaps	7.91 (0.97)	8.17 (1.04)	8.11 (0.87)	8.38 (0.90)
Catching–throwing	11.61 (4.67)	12.91 (4.69)	11.25 (5.36)	13.65 (4.74)
Curl-up	45.39 (23.29)	42.47 (21.00)	37.59 (21.79)	42.49 (21.59)
Push-up	24.14 (13.31)	23.15 (13.38)	20.66 (11.99)	26.16 (14.34)
Boys				
Body mass index (kg/m^2)	18.55 (2.69)	19.12 (3.07)	18.61 (2.64)	19.21 (2.77)
20-m shuttle run test	42.44 (18.70)	45.45 (19.21)	40.22 (21.27)	48.63 (22.89)
5-leaps	7.92 (0.94)	8.16 (1.10)	8.15 (0.89)	8.40 (0.89)
Catching–throwing	12.77 (4.45)	13.22 (4.46)	11.58 (5.83)	14.15 (4.84)
Curl-up	44.81 (23.80)	40.42 (21.71)	38.37 (22.08)	40.15 (21.21)
Push-up	19.85 (11.85)	19.48 (12.89)	19.25 (13.00)	22.08 (13.27)
Girls				
Body mass index (kg/m^2)	18.75 (2.96)	18.87 (2.82)	18.32 (2.31)	18.77 (2.38)
20-m shuttle run test	35.28 (16.32)	38.89 (16.78)	32.90 (14.49)	41.90 (14.77)
5-leaps	7.89 (1.00)	8.17 (0.98)	8.06 (0.85)	8.37 (0.91)
Catching–throwing	10.54 (4.64)	12.61 (4.93)	10.96 (4.82)	13.17 (4.67)
Curl-up	45.91 (22.95)	44.44 (20.27)	36.24 (21.27)	44.22 (21.71)
Push-up	28.10 (13.43)	26.93 (12.92)	22.14 (10.78)	29.83 (14.45)

[0.033, 0.356]; adjusted mean difference = 1.1 repetitions), but not on 5-leaps ($\beta = 0.060$, $p = 0.402$, 95% CI [−0.080, 0.199]; adjusted mean difference = 0.01 m) or body mass index ($\beta = -0.066$, $p = 0.580$, 95%CI [−0.302, 0.169]; adjusted mean difference = 0.18 kg/m^2). Based on the two-group test [$\chi^2(6) = 43.63$, $p < 0.001$], there was an overall intervention effect, indicating that students in the intervention group developed significantly better than students in the control group when considering all motor competence and HRF variables simultaneously. The effect of gender was also investigated, and based on the Wald test results, the change between pre- and posttests were similar between boys and girls in both control and intervention groups ($\chi^2(5) = 8.62$, $p = 0.125$).

4 | DISCUSSION

The aim of our study was to investigate the efficacy of a multicomponent school-based intervention program on students' motor competence and HRF. In general, we found that students allocated to the intervention group showed significant improvements in most indicators of motor competence and HRF. More specifically, students in the intervention group developed significantly better in 20-meter shuttle run test, push-up, curl-up, and throwing–catching combination tests than students in the control group. Furthermore, neither weight status nor sex moderated the intervention effect.

The overall positive findings of the intervention are in line with previous review studies demonstrating that interventions can improve both motor competence and health-related fitness among children and adolescents.[9,26–28] It is noteworthy, that professionally instructed activities in schools are targeted to all students, including those who are inactive or who perceive themselves as poor movers, and not just for those who are already physically active. Unfortunately, it is not uncommon for school-based physical activity interventions to be ineffective among those who need it the most.[55] Moreover, Hartwig et al. showed based on a pooled analysis from 20 trials that students with lower levels of baseline physical activity benefitted less from school-based physical activity interventions.[28] This finding, highlighting organized and guided activities, is especially important for decision-makers who decide what kind of elements are included in future physical activity programs. Recent analysis of systematic reviews indicated that school-based interventions have shown limited effects on physical activity,[10] whereas our study suggests that they may improve motor competence and health-related fitness.

One key finding of the 5-month-long study was the positive development of CRF in intervention group students (+8,4 laps) compared to the control group students (+3,4 laps). In the intervention program, the time allocated to enhancing the activity of students was relatively short, roughly an hour per week, and only a part of the activities specifically developed CRF. Hence, positive development in CRF achieved with relatively low effort, is especially important as researchers and societies have been increasingly worried in declining trends of youth cardiorespiratory fitness levels.[56] Our finding is mostly in line with, or succeeding, the results of previous intervention programs that have analyzed the effects of vigorous, high-intensity PA programs on the development of CRF. For example, Lubans et al. reported similar development (+4.1 laps) on 20-meter shuttle run test at 6-months follow-up for adolescent students.[57] However, Wassenaar et al. found that vigorous PA intervention did not improve students' CRF following a 10-months long program,[58] and Martínez-Vizcaíno et al. reported positive development only for girls (+3,4 laps), but not for boys in a academic-year-long high-intensity PA intervention.[59] It is clear that positive development of youths' CRF is called for as it has been linked with overall health.[6–8,60]

Another key finding of the study was that muscular fitness of the intervention group students developed significantly better compared to the control group. Results in both push-up (difference = 6,5 repetitions) and curl-up tests (difference = 7,8 repetitions) improved more in the intervention group compared to the control group which was expected as the performed exercises and tasks in the program systematically and progressively developed muscular fitness attributes. Compared to similar studies, the effect in muscular fitness was substantial. For example, in a previous cluster-randomized controlled trial among adolescents push-up test results improved by 2.0 repetitions at 6-months follow-up.[61] In general, the findings are in line with previous studies as shown by a recent review of school-based interventions targeting muscular fitness.[27] In the control group, push-up test results declined from baseline to posttest. A corresponding declining trend in push-ups has been documented among similarly aged Finnish students in a nationally representative sample.[40] Taking these together, it is encouraging that a relatively short and easily executable intervention was able to improve students' upper-body strength and endurance, as well as their abdominal strength and endurance. This positive finding is further amplified by the fact that muscular fitness has been associated with the overall health status of youth.[7,8,24,25]

Intervention effects on motor competence measures were mixed as students in the intervention group developed significantly better in throwing–catching combination test (difference = 1,1) but no differences were found in 5-leaps. As previously described, the throwing–catching

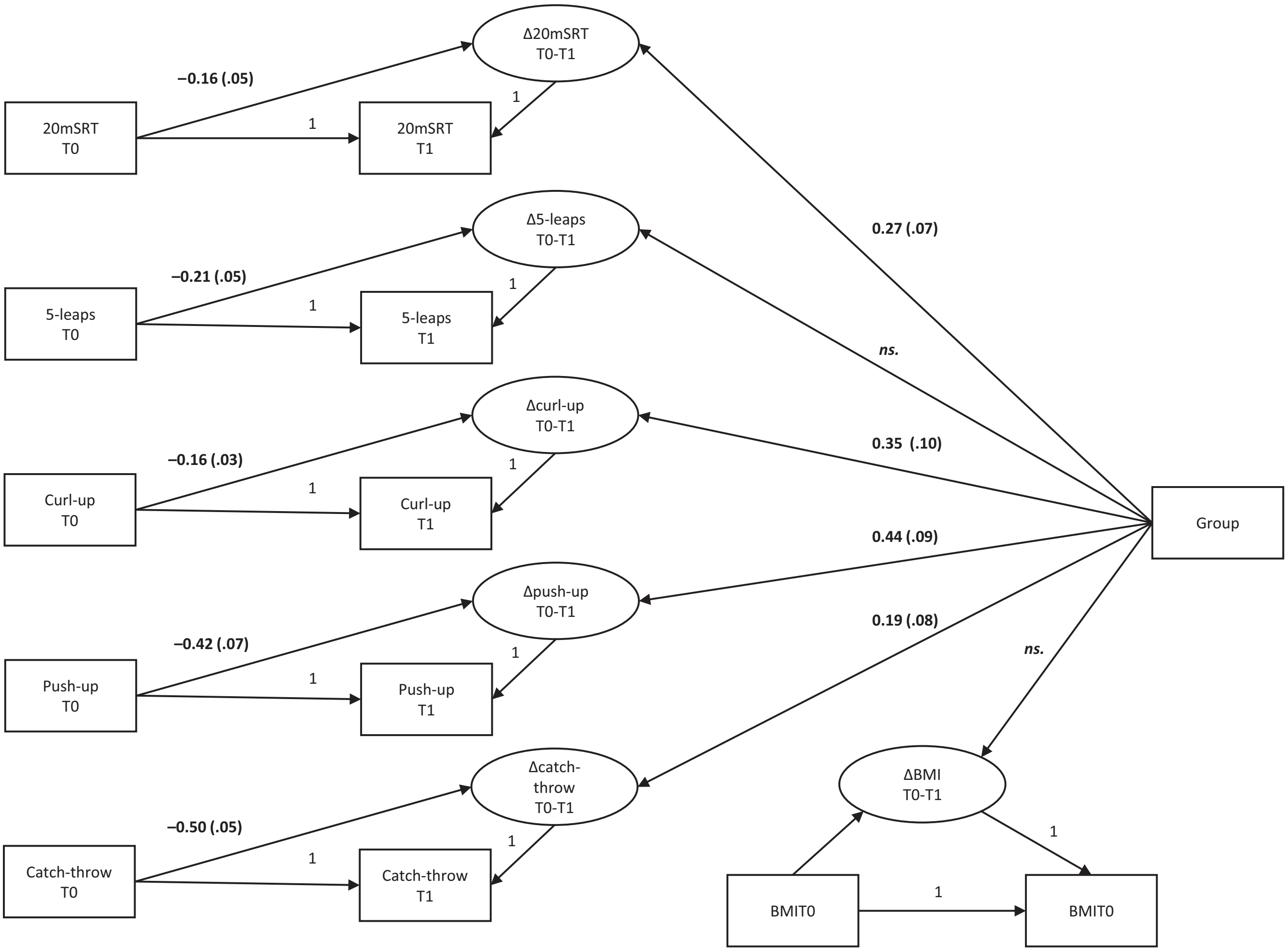

FIGURE 1 The latent change score model. All paths are significant at the $p < 0.05$ level.

combination test measures students' object control skill proficiency. The increase in object control skills is an important positive finding as object control skills have been shown to be clear predictors of adolescent PA engagement.[12] It is also notable that both girls' and boys' object control skills developed positively in the current study, which is especially important as previous findings have indicated girls performing more poorly in object control skills than boys.[14] There might be several reasons for the lack of intervention effect in 5-leaps test. As a performance, it requires both physical and skill-related qualities, especially explosive strength, dynamic balance, and rhythmical skills.[62,63] These multiple requirements might make it more difficult for students to develop in the leaping distance. Moreover, it could also be that the intervention activities were not specific enough for this kind of multifaceted leaping performance to develop, even though the program consisted of several activities that were aimed to enhance locomotor skills. In future studies and intervention programs, it might be reasonable to increase the specificity of the guiding, especially in skill-related activities.

Equitable access of all students in PA promotion programs should be driven not only because of the clear health benefits but also because improving students' physical performance and their physical activity engagement might help their academic achievement.[64] Hence, it should be in schools' interest to promote physical activity and fitness programs, especially when program goals are corroborating wider curricular aims. Nevertheless, the feasibility, scalability, and effectiveness of school-based physical fitness and motor competence interventions are important aspects to consider.[33,34] All activities and tasks included in the current intervention were designed to be easy to perform by students and easy to be instructed by practitioners. In addition, no additional equipment or special sport venues were needed. Therefore, the intervention can be widely adapted to different schools, and the program activities can be implemented by regular school staff members such as general classroom teachers. From a cost perspective, the PE and classroom activity break components were delivered during regular school hours, and therefore require no additional staff or funding. The only component in this intervention that would require extra

TABLE 2 Regression and correlation estimates of the latent change score model.

	Δ20mSRT	Δ5-leaps	ΔCurl-up	ΔPush-up	ΔCatch-throw	ΔBMI	Group condition 0 = control 1 = intervention
	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)	β (SE)	
20mSRT T0	**−0.164 (0.05)****	0.051 (0.05)	0.036 (0.02)	0.027 (0.05)	0.027 (0.04)	−0.009 (0.01)	0.083 (0.23)
5-leaps T0	0.075 (0.05)	**−0.212 (0.05)****	−0.029 (0.02)	0.047 (0.04)	0.028 (0.04)	−0.029 (0.02)	**0.256 (0.12)***
Curl-up T0	**0.396 (0.07)****	−0.116 (0.07)	**−0.155 (0.03)****	−0.071 (0.06)	−0.016 (0.06)	0.005 (0.02)	0.139 (0.49)
Push-up T0	**0.326 (0.06)****	−0.029 (0.07)	**0.098 (0.03)****	**−0.418 (0.07)****	−0.012 (0.05)	0.000 (0.02)	−0.095 (0.18)
Catch-throw T0	0.139 (0.07)	**0.137 (0.05)***	0.039 (0.02)	0.084 (0.05)	**−0.500 (0.05)****	0.015 (0.02)	−0.033 (0.12)
BMI T0	0.139 (0.07)	0.002 (0.08)	0.041 (0.04)	0.026 (0.09)	**0.147 (0.07)***	0.020 (0.03)	−0.182 (0.29)
Δ20mSRT							**0.269 (0.07)****
Δ5-leaps	**0.083 (0.03)***						0.059 (0.07)
ΔCurl-up	0.019 (0.03)	0.053 (0.04)					**0.353 (0.10)****
ΔPush-up	**0.100 (0.02)****	**0.094 (0.03)***	**0.127 (0.05)***				**0.442 (0.09)****
ΔCatch-throw	0.044 (0.03)	0.077 (0.04)	**0.090 (0.04)***	**0.079 (0.03)***			**0.194 (0.08)***
ΔBMI	**−0.074 (0.03)***	**−0.130 (0.06)***	−0.007 (0.05)	−0.080 (0.05)	**−0.114 (0.05)***		−0.057 (0.12)

*$p<0.05$; **$p<0.001$.

funding, is the guided recess activity. Yet, some schools in Finland currently use teaching assistants or older students as recess activators.[65] These recess activators, with the help of the structured program, might be able to increase students' physical activity but also their physical performance during school hours.

This study includes a number of strengths and weaknesses that should be noted. One of the major strengths of the study is the feasible and scalable program design that enabled it to be integrated into the school day. This also allows the inclusion of all students to the activities without anyone being left out based on gender, ethnicity, fitness status, or motor skill status. In addition, the study utilized a latent change score modeling approach that has been described as a flexible and powerful tool for intervention study analysis.[50]

The limitations of this study should be considered while interpreting the results. The first limitation is our failure to include long-term follow-up. As such, we do not know if our intervention effects were sustained over time. Also, the non-random allocation of schools to different study conditions limits the representativeness of the results. In addition, the measurement of MC was based on two tests whereas a more comprehensive battery would have provided additional information. For example, the MC measures in this study did not include a specific stability component. Also, the measures were product-oriented meaning that the qualitative aspects of motor skills (process-oriented measures) were not considered while interpreting the results.

In conclusion, the 5-month-long school-based intervention program was found to be effective in increasing students' Motor competence and health-related fitness. More specifically, students allocated to the intervention group developed significantly better in 20-meter shuttle run test, push-up, curl-up, and throwing–catching combination tests than students in the control group. This indicates that the intervention program appeared to be effective in increasing students' CRF, muscular fitness, and object control skills. The intervention effect was found to be similar for boys and girls. Findings demonstrate that guided school-based physical activity programs can be influential in promoting physical fitness and motor competence among early adolescent students.

4.1 | Perspectives

Negative trends have been documented for early adolescents' motor competence[2,41] and HRF.[3,4,66] This is especially worrying from a public health perspective, as weak physical performance in adolescence has been negatively linked to many health outcomes.[5–8] School has been clearly identified as an important context to promote motor competence and HRF.[9–11,67] Also recently, an expert panel recognized scalable school-based interventions as one of the top priorities in physical fitness research.[32] Our present study described a 5-month-long, easy-to-administer, cost-effective intervention program that was conducted during PE lessons, academic lessons, and recess time in Finnish elementary school setting. The results showed that students allocated to the intervention group developed significantly better in different physical performance elements compared to the control group students. This study provides preliminary evidence of the effectiveness of the program; however, future studies are needed with larger and fully randomized samples to confirm the findings.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data are not publicly available due to privacy or ethical restrictions. Contact the corresponding author for more information.

SPECIALTY SECTION

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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