PHYSICAL EDUCATION TEACHERS' KNOWLEDGE, PERCEPTIONS, AND APPLICATION OF KINESIOLOGY SUBDISCIPLINES

BY

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DISSERTATION

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ABSTRACT

This dissertation employed a sequential explanatory mixed-methods research design to investigate kinesiology subdisciplinary knowledge in physical education. The study consisted of three stages with a scoping review followed by quantitative and qualitative studies. The scoping review aimed to identify research trends related to kinesiology subdisciplinary knowledge in the existing literature. Subsequently, the quantitative research phase was undertaken to evaluate the proficiency of physical education teachers in three key domains: exercise physiology, biomechanics, and motor learning. To complement these findings and gain a comprehensive perspective, the qualitative research phase was conducted, yielding valuable descriptive, interpretive, and empirical data on kinesiology subdisciplinary knowledge in physical education.

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To my family

TABLE OF CONTENTS

CHAPTER 1: INTRODUCTION

Physical education is portrayed as "the only curriculum subject whose focus combines the body and physical competence with values-based learning and communication, (which) provides a learning gateway to grow the skills required for success in the 21st Century" (United Nations Educational, Scientific and Cultural Organization [UNESCO], 2015, p. 6). To that end, a physical education teacher should actively be involved in designing quality lessons (Tannehill et al., 1994) because teachers play a key role in linking student achievement to further success (Napper-Owen et al., 2008). As such, training and maintaining high-quality teachers has become a national priority in the U.S. (Napper-Owen et al., 2008). According to the U.S. Department of Education (2005), "highly qualified" teachers are those who have a four-year bachelor's degree, a valid state teaching license, and have demonstrated knowledge of the subject. However, evaluating teacher quality is a multifaceted endeavor, necessitating a comprehensive assessment from various angles, including content knowledge, pedagogical knowledge, and their impact on student outcomes (Stronge et al., 2007).

The scope and breadth of what should be assessed not only affects assessment strategies but also professional socialization practices. The U.S. Department of Education Office of Postsecondary Education (DOE) (2005), reported teacher preparation programs at colleges are required to offer courses delivering an up-to-date and reliable body of knowledge for teachers' preparation. However, the question, "what knowledge is of most worth in physical education?" is still an ongoing debate (Ennis, 2006; Lawson & Kretchmar, 2017; Lorusso & Richards, 2018; Rink, 2007). Some argue that content knowledge is the most important part of teacher quality, and others claim that pedagogical knowledge is most important (Stronge et al., 2007). In physical

education, SHAPE America (2017), in the National Standards for Initial Physical Education Teacher Education document, stated that "physical education candidates demonstrate an understanding of common and specialized content and scientific and theoretical foundations for the delivery of an effective preK-12 physical education program" as the first national standard. Similarly, previous studies noted that content knowledge is a prerequisite for effective teaching practices that lead to student achievement (Siedentop, 2002).

Because content knowledge has been recognized as a vital factor in teacher quality, numerous studies in physical education have been conducted to evaluate the influence of teachers' expertise, quality, efficiency, and teaching performance (Capel et al., 2011; Herold & Waring, 2017; Iserbyt et al., 2017; Tinning, 2010; Ward & Ayvazo, 2016). For example, Siedentop (2002) noted that it is crucial for teachers to have content knowledge for enhancing teaching effectiveness that, in turn, is then linked with students' learning outcomes. He also noted that content knowledge is a fundamental component in the development of pedagogical content knowledge (PCK) (Siedentop, 2002). In other words, content knowledge is essential for quality teaching.

While the literature on the development of content knowledge is relatively extensive, research on kinesiology subdisciplinary knowledge, a form of content knowledge, remains relatively unexplored (Herold & Waring, 2009; Tinning, 2002). Furthermore, a lack of consistency in the use of terminology and standard categorizations exists. For example, the terms subdisciplinary knowledge (e.g., Ayers, 2004; Johnson, 2015), exercise science knowledge (e.g., Bulger & Housner, 2007), subject matter knowledge (e.g., Vickers, 1987), and scientific knowledge (e.g., Silva, 2020) are often used interchangeably in the literature. For the purposes of this study, the term kinesiology subdisciplinary knowledge is defined as knowledge about

academic content areas such as exercise physiology, biomechanics, sport pedagogy, sport psychology, sport sociology, and motor development. It is from these that the typical kinesiology curriculum derives its principles and concepts (Estes, 1994). Shulman (1986) noted that content knowledge is comprised of facts and principles in a specific domain as well as evidence as to why facts and principles are reliable and how they are created and organized. Additionally, Ayers (2001) analyzed subdisciplines in Kinesiology (i.e., aesthetic experience, biomechanics, exercise physiology, historical perspectives, motor development, motor learning and social psychology) among pre-service physical education teachers using the Assessment of Subdisciplinary Knowledge in Physical Education (ASK-PE) test. Based on this evidence, it is reasonable that subdisciplinary knowledge in Kinesiology encompasses a variety of diverse content areas.

Given that kinesiology is an evolving academic discipline, physical education teachers' subdisciplinary knowledge will vary as well. In the physical education literature, however, research on content knowledge has tended to focus on general content knowledge (Siedentop, 2002; Ward, 2013), common content knowledge (Devrilmez et al., 2019), and specialized content knowledge (He et al., 2022; Ward et al., 2018) rather than subdisciplines of Kinesiology. Considering that pre-service physical education teachers spend a significant amount of time learning concepts from subdisciplinary courses during their teacher preparation programs, a need to better understand physical education teachers' subdisciplinary knowledge exists. According to Rink (2007), specifically, there are two issues related to subdisciplinary courses in Physical Education Teacher Education (PETE) programs in teacher preparation that should be addressed. The first is a need to identify the role of subdisciplines within the overarching curriculum of the

PETE program. Second, improving the knowledge to increase teaching effectiveness is warranted (Rink, 2007).

In terms of the former, ideally, PETE programs provide subdisciplinary courses to help pre-service teachers understand how the human body responds and adapts to physical activity (Bulger et al., 2008). Accordingly, SHAPE America (2017) Standard 1 provides guidelines related to the role of kinesiology subdisciplinary knowledge in producing qualified teachers. However, misalignments between the standards and actual PETE curricula are prevalent (Chen, 2006). This discrepancy can result in failure to achieve recommended physical activity levels, that are age-appropriate physical activity for at least 60 minute or more of moderate-to-vigorous physical activity daily, at least 3 days a week (Azar et al., 2018), in physical education classes (Hayman et al., 2004). This is because how teachers utilize the time during classes to promote physical activity is inefficient since they aren't being trained to understand physiological concepts, for example. In 1983, The National Commission on Excellence in Education (1983) published "A Nation at Risk" in an effort to improve education in the United States by describing how the educational system in America was failing to properly teach students.

In response, the National Board for Professional Teaching Standards (NBPTS) began to establish national standards for training effective teachers to improve the quality of teachers (Hatry, et al., 1994). In 1994 with the goal of identifying qualified teachers who meet stringent requirements, NBPTS began the process of certifying teachers across 25 subject areas (NBPTS, 2014; NBPTS, 2021). Although, NBPTS did not offer physical education as a National Board Certification (NBC) option until 2001 (NBPTS, 2010), the standards for physical education were, like other subject areas, established based on five core propositions (i.e., commitment, knowledge, responsibility, systematic thinking, and learning communities) (Rhoades, 2010). In

other words, NBC candidates must also demonstrate these five core propositions through their portfolio and assessment activities to achieve National Board certification (Rhoades, 2010).

In terms of improving knowledge to enhance teaching effectiveness, Standard 2 for the subject of physical education provided by NBPTS, specifies that qualified teachers should be aware of and apply the knowledge of subject matter (NBPTS, 2014), and the process of licensing NBC educators consists of 10 evaluations to assess teachers' content knowledge (NBPTS, 2014). Specifically, the knowledge of subject matter in physical education includes exercise science, motor development and motor learning, movement forms in context, physical activity and wellness, sociology and psychology of movement, legal and safety issues, technology, as well as current issues and trends in physical education (NBPTS, 2014).

Previously, several studies focusing on NBC physical educators were conducted to examine the positive aspects of NBC. For example, employing the South Carolina Physical Education Assessment Program (SCPEAP) as indicators of student competency, Phillips (2008) investigated a comparative study of NBC physical educators with non-NBC physical educators in terms of student competency. The SCPEAP assesses students' motor skill performance, cognitive fitness knowledge, outside-of-class participation, and health-related fitness levels. In this particular study, students of NBC physical educators demonstrated higher measures of student competency on all indicators. Phillips (2008) also investigated the characteristics of NBC physical educators and found that these physical educators were effective and qualified teachers in terms of teaching, assessing, managing, and communicating to promote student learning.

Similarly, Woods and Rhoades (2010) investigated NBC physical educators' background characteristics, subjective warrants, and motivations, and they found that NBC physical educators are predominantly female (79%), Caucasian (78.9%) with a subjective warrant that

associates with the joy of working, and with the motivation of financial incentives, confronting the challenge, and developing professionalism. Later, Rhoades and Woods (2012), once again, investigated NBC physical educators, this time with a focus on task presentations and learning environments and perceptions of change as a result of certification. They found that NBC physical educators had improved teaching reflections, enhanced student learning and assessment strategies, as well as an increased emphasis on individualizing teaching (Rhoades & Woods, 2012).

Significance and Study Purpose

As mentioned previously, the primary objective of this research is to delve into the domain of kinesiology subdisciplinary knowledge studies within physical education, specifically focusing on how physical education teachers perceive and apply this knowledge in their teaching practices. To achieve this, a three-article dissertation format was utilized, employing a sequential explanatory mixed-methods research design. This comprehensive approach involved a scoping review, a knowledge test, and semi-structured interviews, providing a dataset that encompasses both descriptive and interpretive aspects of kinesiology subdisciplinary knowledge in physical education.

The study's significance lies in its potential to contribute valuable insights to PETE programs. By shedding light on how kinesiology subdisciplinary knowledge is understood and utilized by teachers, this research can aid in enhancing the effectiveness of physical education teaching and student learning outcomes. Overall, the findings have the potential to positively impact the field, guiding future improvements in pedagogical practices.

To address the existing research gap, it is essential to recognize that while extensive research has been conducted on physical education teachers' knowledge, far too little attention

has been paid to kinesiology subdisciplinary knowledge. For example, researchers should address questions related to physical education teachers' levels of knowledge, perceptions, and applications of subdisciplinary content in kinesiology by comparing NBC physical education teachers and non-NBC physical education teachers. Accordingly, the three primary aims of this study are as follows:

1. Analyze the literature on kinesiology subdisciplinary knowledge in physical education in order to investigate the predominant tendency in terms of topic, research design, terminology, background and population of participants.
2. Compare secondary-level NBC physical education teachers' and non-NBC physical education teachers' levels of kinesiology subdisciplinary knowledge.
3. Investigate physical education teachers' perceptions of kinesiology subdisciplinary knowledge and its applications in teaching physical education.

Reporting of the Result

To achieve the aforementioned objectives, this investigation provided analysis through a three-article dissertation format (Chapters 4, 5, and 6). The overview of these three articles is described in the following paragraphs.

Article One

The first article explored the trends and sources related to kinesiology subdisciplinary knowledge in physical education within the existing literature. The goal was to identify research trends and issues in both K-12 physical education and PETE contexts. A scoping review methodology, following the guidelines established by Arksey & O'Malley (2005), was employed. These included the following components: (a) identifying the research question, (b)

identifying relevant studies, (c) studying selection, (d) charting the data, and (e) collating, summarizing, and reporting the results.

Article Two

The second article examined differences in NBC physical education teachers' and non-NBC physical education teachers' levels of kinesiology subdisciplinary knowledge through quantitative research methods. In short, kinesiology subdisciplinary knowledge was assessed using a knowledge test instrument, the Assessment of Subdisciplinary Knowledge in Physical Education (ASK-PE) (Ayers, 2001). This tool assessed three major aspects of knowledge in Kinesiology: exercise physiology, biomechanics, and motor learning.

Article Three

The third article investigated, through the lens of Occupational Socialization Theory (OST), a comparison of NBC physical education teachers' and non-NBC physical education teachers' perceptions and applications of kinesiology subdisciplinary knowledge in secondary schools. The OST was chosen because it provides a framework for understanding how individuals are socialized into a profession and how they acquire the knowledge and skills necessary to perform their roles effectively. The analysis of this article was conducted using a grounded theory approach (Glaser & Strauss, 1967; Strauss & Corbin, 1998).

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CHAPTER 2: REVIEW OF LITERATURE

This literature review focuses on the kinesiology subdisciplinary knowledge of National Board Certified (NBC) physical education teachers and non-NBC physical education teachers through the lens of teacher socialization. This chapter consists of the following three sections: (a) a review of teachers' knowledge (Content Knowledge in General Education, Content Knowledge in Physical Education, and Subdisciplinary knowledge), (b) a review of the National Board Professional Teaching Standards and the National Board Certification process, and (c) a review of Occupational Socialization Theory (OST).

To this end, this chapter examines teachers' knowledge, from content knowledge in general education to subdisciplinary knowledge in physical education. Because subdisciplinary knowledge is a specific area of knowledge, this chapter initially covers the foundational aspects of knowledge to provide a more in-depth analysis of subdisciplinary knowledge. Second, one way to investigate teachers' expertise and the process of teacher preparation for quality teachers is to scrutinize the National Board Certification process. Research on NBC physical education teachers indicates that high quality physical education teachers often hold this certification (Woods & Rhoades, 2012, Woods & Rhoades, 2013), and because the NBC process includes confirmation of teachers' content knowledge (i.e., subdisciplinary knowledge) (NBPTS, 2014), the literature on NBC will be reviewed. Third, OST has been employed to understand teachers' experiences with the three socialization phases in the physical education literature. Teacher socialization helps describe physical education teachers' experiences with the process of knowledge acquisition, the formation process of their perceptions of subdisciplinary knowledge, and their experiences applying the knowledge that they acquired during the three phases of

socialization while teaching physical education. Accordingly, the three phases of teacher socialization will be reviewed.

Teachers' Knowledge

Content Knowledge in General Education

In general education, Shulman (1986) initially proposed the concept and definition of content knowledge. This initial classification was divided into the following three areas: (a) subject matter content knowledge, (b) pedagogical content knowledge (PCK), and (c) curricular knowledge (Shulman, 1986). The first type, subject matter content knowledge, refers to "the amount and organization of knowledge per se in the mind of the teacher" (Shulman, 1986, p. 9). The second type, PCK, was defined as "the ways of representing and formulating the subject that make it comprehensible to others" (Shulman, 1986, p. 9). Lastly, curricular knowledge, the third classification, was defined as "the full range of programs designed for the teaching of particular subjects and topics at a given level, the variety of instructional materials available in relation to those programs, and the set of characteristics that serve as both the indications and contraindications for the use of particular curriculum or program materials in particular circumstances" (Shulman, 1986, p. 10).

Later, Shulman further divided teacher knowledge into seven categories by incorporating four additional forms of knowledge. The new categorizations included the following: (a) content knowledge, (b) general pedagogical knowledge, (c) curriculum knowledge, (d) pedagogical content knowledge, (e) knowledge of learners, (f) knowledge of educational contexts, and (g) knowledge of educational aims, purposes, and values (Shulman, 1987). The development and redefining these seven categories of teacher knowledge was important because content and

pedagogy were being viewed as distinct areas that teacher education programs should integrate to better educate or prepare teachers (Mitchell & Walton-Fisette, 2016).

The first of the seven categories, content knowledge, describes the amount and organization of knowledge in the teacher's mind. Shulman provided diverse perspectives, such as Bloom's cognitive taxonomy, Gagne's varieties of learning, Schwab's distinction of content knowledge (i.e., substantive and syntactic knowledge), and Peter's notions of content knowledge to interpret the concept of content knowledge. The second category, general pedagogical knowledge, is related to broad principles and strategies of classroom management. In other words, it means "knowledge about teaching methods that pertain to all subjects and situations" (Metzler, 2011, p. 46). The next type of knowledge, curriculum knowledge, is knowledge of the materials and programs for teachers (Shulman, 1987). In other words, curricular knowledge involves knowledge of organizing of teaching a specific curriculum to a specific group of students at a certain level (Shulman, 1986). Pedagogical content knowledge, the fourth category, is a "special amalgam of content and pedagogy that is uniquely the province of teachers, their own special form of professional understanding" (Shulman, 1987, p. 8). The fifth category, knowledge of learners, refers to the teacher's knowledge of students' characteristics and backgrounds (Shulman, 1987). The sixth category, knowledge of educational contexts, includes "the knowledge of the contexts from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures" (Shulman, 1987, p. 8). The last category, knowledge of educational ends, purpose, and values, describes a teachers' philosophical and historical foundations (Shulman, 1987).

The Importance of Content Knowledge in Physical Education

In physical education, the importance of content knowledge for teacher quality in relation to student learning has been highlighted (Iserbyt et al., 2017; Siedentop, 2002; Ward et al., 2015). To begin, Ward (2009) categorized content knowledge in physical education into four dimensions as follows: (a) knowledge of rules and etiquette, (b) knowledge of technique and tactics, (c) knowledge of skill discrimination, and (d) knowledge of tasks including instructional activities. He further categorized the knowledge of rules and etiquette and the knowledge of technique and tactics as common content knowledge, while the knowledge of students errs and the knowledge of task progressions were categorized as specialized content knowledge (See Figure 2.1).

Knowledge of rules and etiquette. This category includes basic rules, etiquette, and safety in sports (Ward, 2009). For example, students in a tennis unit should understand fundamental rules such as how to keep score and when to switch the service (Tsuda, 2017). Students playing volleyball, for example, should understand that rolling the ball under the volleyball net to an opponent after a side out is basic etiquette (Santiago & Morrow, 2021). Additionally, students developing competency in softball skills need to be aware that throwing the bat is not a safe behavior (Santiago & Morrow, 2021).

Knowledge of techniques and tactics. This includes the specific techniques and tactics used in sports (Ward, 2009). Being able to describe proper form for a tennis serve or explaining the steps in a basketball pick-and-roll would be examples of techniques and tactics (Santiago & Morrow, 2021).

Knowledge of student errors. This type of knowledge allows the physical education teacher to discriminate errors related to performance in sports (Ward, 2009). For example, failing

to return to the center of the baseline after a tennis stroke is an example of a common error that teachers should be aware of (Tsuda, 2017).

Knowledge of task progressions. As a teacher, learning how to teach skill progressions is crucial for providing a quality experience for students (Ward, 2009). One example in basketball is teaching students how to progress from dribbling a ball with their dominant hand to using a cross-over dribble during gameplay.

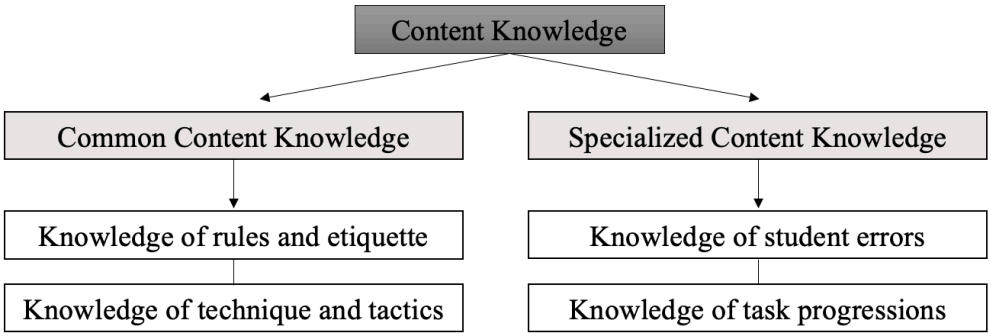

Figure 2.1. Four dimensions of content knowledge in physical education

Subdisciplinary Knowledge

Unfortunately, the field of physical education lacks a unified terminology used to refer to kinesiology subdisciplinary knowledge such as exercise physiology, biomechanics, and motor learning. The notion of a "unified terminology" denotes a singular and widely agreed-upon expression or phrase adopted by the majority of scholars in a particular field to represent a specific concept. Several factors may account for the absence of a unified term in physical education. One plausible explanation is the evolving nature of the discipline and ongoing research, which could contribute to the lack of a standardized term. The continuous pursuit of knowledge and the exploration of novel perspectives may contribute to the existence of multiple

competing terms or expressions for the same concept. Researchers may approach a topic from different angles, leading them to coin distinct terminologies to represent their unique viewpoints. Additionally, the diverse academic backgrounds and research interests of researchers and scholars in the field might contribute to the variation in terminology. Depending on their specialized training and areas of expertise, individuals may prefer specific terms, leading to a lack of consensus on a standardized expression.

In the current study, the operational definition of subdisciplinary knowledge is based on Schwab's (1964) perspective of substantive knowledge. According to this viewpoint, subject content knowledge can be categorized into two knowledge concepts: substantive knowledge and syntactic knowledge. The former, substantive knowledge, refers to principles and concepts, and the latter, syntactic knowledge, refers to rules. By accepting the concept of substantive knowledge from Schwab's, examples of substantive knowledge in physical education would encompass concepts from exercise physiology, biomechanics, motor learning and others subdisciplines in kinesiology (Hetland & Strand, 2010). Additionally, syntactic knowledge in physical education would refer to the common content knowledge, knowledge of rules and etiquette and the knowledge of technique and tactics, as defined by Ward (2009). Although a unified terminology on subdisciplinary knowledge in physical education, does not exist, relevant studies have been conducted with various discourses.

The previous studies on subdisciplinary knowledge focused on whether subdisciplinary courses are necessary components for physical education teacher education (PETE) curricula. The earlier studies in the 1960s and 1970s focused on the meaning of the presence of subdisciplinary knowledge in PETE programs (Abernathy & Waltz, 1964; Henry, 1964; Zeigler & McCristal, 1967). This issue was predominant at this time given that it was the era of the

academicization of physical education. Because physical education was criticized for its academic identity (Conant, 1959), many programs, by accepting diverse subdiscipline courses (Bulger et al., 2008), transitioned to a focus on kinesiology to establish academic legitimacy (Kirk, 2010; Kirk & Tinning, 1990; Lineham, 2003; Tinning, 2010). Later, studies of subdisciplinary knowledge tended to focus on why such knowledge matters in terms of effective physical education teaching and the expertise of physical education teachers (Bulger et al., 2008; Graham, 2008; SHAPE America, 2017). With limited time and recourses, physical education teacher educators have attempted to enhance the effectiveness of physical education teacher programs to produce qualified and successful physical education teachers. Accordingly, the debate on the value of subdisciplinary courses in the curricula of pre-service physical education teachers remains an ongoing issue in PETE programs.

Despite the presence of research related to this topic, the study of subdisciplinary knowledge in physical education is still not widely understood when compared to other aspects of content knowledge (e.g., common content knowledge, specialized content knowledge; Devrilmez et al., 2019; Ward et al., 2018). The issues surrounding this lack of understanding may stem from several factors. For example, several studies were conducted on why subdisciplinary knowledge is important, but they focused on the perspective of scholars instead of practitioners (Abernathy & Waltz, 1964; Backman et al., 2019; Bulger et al., 2008; Bulger & Housner, 2007; Henry, 1964; Herold & Waring, 2017; Kovač et al., 2008; Rink, 2007; Siedentop, 2002; Taliaferro et al., 2017; Tinning, 2002; Wiegand et al., 2004). In fact, only one study addressed this topic from pre-service teachers' perspective (Herold & Waring, 2010). In other words, most studies have tended to focus on scholars' perceptions and have failed to address practitioners' perceptions of subdisciplinary knowledge. Moreover, no study has

explicitly addressed how teachers' subdisciplinary knowledge is formed and how it can be applied in physical education teaching. Considering that diverse perspectives play a significant role in inspiring creativity and driving innovation in research, practitioners' (in-service physical education teachers) perceptions on this topic are necessary to better understand the importance of the role of subdisciplinary knowledge in physical education. The importance of this will be discussed in the NBC section that follows.

National Board Certification

At the request of *A Nation Prepared,* published in 1986 by the Carnegie Task Force on Teaching as a Profession (CTFTP), the National Board for Professional Teaching Standards (NBPTS), an independent, nonpartisan, nonsectarian, and nonprofit organization, was established as an avenue to recognize and retain qualified teachers. In the initial stages of development, five core propositions were established to provide a fundamental framework for defining the direction of NBPTS (Rhoades, 2010). These form the foundation of standards for qualified teachers (See Table 2.1).

Table 2.1

Five Core Propositions (NBPTS, 2014)

Five Core Propositions	Description
1. Teachers are committed to students and their learning	Accomplished teachers base their practice on the fundamental belief that all students can learn and meet high expectations. They treat students equitably, recognizing the individual differences that distinguish one student from another and taking account of these differences in their practice….
2. Teachers know the subjects they teach and how to teach those subjects to students.	Accomplished teachers have a rich understanding of the subject(s) they teach and appreciate how knowledge in their subject is created, organized, linked to other disciplines, and applied to real-world settings. While maintaining the integrity of disciplinary methods, content, and structures of organization, accomplished teachers develop the critical and analytical capacities of their students so they can think for themselves….

Table 2.1 (cont.)

3. Teachers are responsible for managing and monitoring student learning	Accomplished teachers view themselves as facilitators of student learning within dynamic instructional settings. They create, enrich, maintain, and alter learning environments while establishing effective ways to monitor and manage those environments and the student learning that occurs within them….
4. Teachers think systematically about their practice and learn from experience	Accomplished teachers possess a professional obligation to become perpetual students of their craft. Committed to reflective learning, they are models of educated persons. They exemplify the virtues they seek to inspire in students—curiosity, honesty, fairness, respect for diversity and appreciation of cultural differences—and the capacities that are prerequisites for intellectual growth: the ability to reason and take multiple perspectives, to be creative and take risks, and to adopt an experimental and problem-solving orientation…
5. Teachers are members of learning communities	Accomplished teachers participate actively in their learning communities to promote progress and achievement. They contribute to the effectiveness of the school by working collaboratively with other professionals on policy decisions, curriculum development, professional learning, school instructional programs, and other functions that are fundamental to the development of highly productive learning communities….

Five Core Propositions

First, teachers are committed to students and their learning. Effective teaching should be based on an understanding of students' diversity. This includes details such as levels of prior knowledge, skills, cognitive abilities, language, personal interests, and learning styles. Thus, the NBC teacher possesses the ability to integrate their understanding of students' diversity into their teaching, focusing on students learning (NBPTS, 2014).

Second, teachers know the subject matter they teach and how to teach that content to students. In other words, the qualified teacher should have a great deal of content knowledge to apply to teaching in their subject area. For the most effective pedagogical practices, teachers should possess advanced content knowledge that can be applied flexibly to various teaching contexts to better mediate difficulties that students might encounter. For example, revising

teaching practices based on an understanding of students' preconceived notions and prior knowledge would be beneficial for meeting the learning demands of students (NBPTS, 2014).

Third, teachers are responsible for managing and monitoring student learning. In various educational contexts, the role of qualified teachers is to aid student learning. As such, they manage learning environments in order to provide optimal settings for students learning. Effective teachers can effectively utilize pedagogical methods and resources for teaching and learning within their lesson as well as understand how to engage students in a variety of situations (NBPTS, 2014).

Fourth, teachers think systematically about their practice and learn from experience. Qualified teachers have a professional commitment to seek ways to improve their own learning related to increasing their base of knowledge, broadening their repertoire, and applying new ideas and theories to their instruction. Their decisions are supported not only by well-established theories but also by reason developed through experience (NBPTS, 2014).

Last, teachers are members of learning communities. Qualified teachers collaborate with other experts in relation to educational policy, designing curriculum, and professional development in order to advance educational progress and accomplishment. Thus, accomplished teachers can assess academic progress and resource allocation in light of their comprehension of national, state, and local educational goals as well as their awareness of student needs. They are adept at utilizing such resources when necessary and are familiar with specialized school and community resources that can be used for their pupils' benefit (NBPTS, 2014).

In summary, qualified teachers should possess the abilities, skills, knowledge, and commitments toward teaching and learning based on the, aforementioned, Five Core Propositions. Each subject area, including physical education (See Table 2.2), provides

additional specific standards to specify its ultimate goal for training qualified teachers (NBPTS , 2021).

Table 2.2

Certification Areas & Developmental Level Provided by NBPTS (2021)

Certification Areas	Developmental Levels
Art	Early and Middle Childhood Early Adolescence through Young Adulthood
Career and Technical Education	Early Adolescence through Young Adulthood
English as a New Language	Early and Middle Childhood Early Adolescence through Young Adulthood
English Language Arts	Early Adolescence Adolescence and Young Adulthood
Exceptional Needs Specialist	Early Childhood through Young Adulthood
Generalist	Early Childhood Middle Childhood
Health Education	Early Adolescence through Young Adulthood
Library Media	Early Childhood through Young Adulthood
Literacy: Reading–Language Arts	Early and Middle Childhood
Mathematics	Early Adolescence Adolescence and Young Adulthood
Music	Early and Middle Childhood Early Adolescence through Young Adulthood
Physical Education	Early and Middle Childhood Early Adolescence through Young Adulthood
School Counseling	Early Childhood through Young Adulthood
Science	Early Adolescence Adolescence and Young Adulthood
Social Studies–History	Early Adolescence. Adolescence and Young Adulthood
World Languages	Early Adolescence through Young Adulthood

Note. Early Childhood = ages 3-8, Middle Childhood = ages 7-12, Early Adolescence = ages 11-15, Adolescence and Young Adulthood = ages 14-18+

National Board Certification Requirements

Basic requirements of NBC include that all eligible teachers have a baccalaureate degree, at least three years of Pre-K-12 teaching experience, and a state teaching license. In addition,

four necessary components are required for acquiring qualifications in all subject areas. More specifically, teachers are required to complete three portfolio entries and an assessment of content knowledge. First, the portfolio entries should analyze teaching practices pertaining to effective teaching and student learning as well as contain videos and student work samples that demonstrate the teacher's practical knowledge in authentic settings. Second, the portfolio should contain reflections on how their teaching affects student learning. Lastly, teachers should prove their content knowledge related to their own subjects through an assessment consisting of open-ended and multiple-choice format questions.

National Board Certification in Physical Education

Based on the Five Core Propositions (See Table 2.1) developed as part of NBTPS, specific subject areas (See Table 2.2) developed their own standards. As such, physical education certification contains 12 standards (See Table 2.3). While many studies have examined NBCTs, relatively few have examined NBC physical education teachers. A brief summary of the research conducted will be described in the section that follows.

The first study related to NBC physical education teachers was conducted by Phillips (2008). She found that NBC physical education teacher' students performed better on the South Carolina Physical Education Assessment Program (SCPEAP) assessments, used to assess four distinct student performance indicators, than students of non-NBC physical education teachers. Two years after this study, Woods and Rhoades (2010) examined NBC physical education teachers' background information, subjective warrants, and motivations. The majority of NBC physical education teachers at that time were white females with advanced degrees who were an average of 45 years old. In terms of the subjective warrant, a number of themes arose, including the enjoyment of working with and assisting children, the continuation of involvement in sports

and physical activity, the lack of aspirations to become a coach and the enjoyment of the physical activity. The desire to advance professionally, to take on a challenge, and to obtain financial incentives were the most common motivations for pursuing NBC. Two years later, Rhoades and Woods (2012) published an examination of National Board Certified Physical Education Teachers suggesting that these teachers had the ability to positively impact student achievement through appropriate task presentations and proper use of class time. Next, Gaudreault and Woods (2012a, 2012b) reported that the process of certification could improve teachers' confidence, credibility, and professional opportunities as well as help teachers feel more vocal, and ready to provide leadership. In 2013, Woods and Rhoades found that NBC physical educators displayed strong self-efficacy. More recently, Richards and colleagues (2021) compared the perceived workplace experiences of NBC physical educators and non-NBC physical educators. The results showed that NBC teachers reported feeling less isolated than non-NBC teachers, and they perceived that they mattered more than non-NBC teachers. Furthermore, NBC certified teachers reported higher degrees of role conflict and role overload than non-NBC certified teachers.

The preceding paragraphs have briefly summarized the research related to NBC as it applies to physical education settings. However, despite the importance for physical education teachers to develop knowledge of subject matter (Standards II, Table 2.3), the relationship between the level of NBC physical education teachers' subdisciplinary knowledge with perceptions, and applications remains to be explored.

Table 2.3

Physical Education Standards Statements (Standard II) Provided by NBPTS (2014)

Standards	Description
Standard II: **Knowledge of Subject Matter**	Accomplished teachers utilize the depth and breadth of their content knowledge to develop physically educated learners.

Note. Adapted, with permission of National Board for Professional Teaching Standards (NBPTS, 2014).

Occupational Socialization Theory

Individuals learn the skills, knowledge, values, and standards of the social groups or organizations to which they aspire to belong through the process of socialization (Billingham, 2007). Occupational Socialization Theory (OST), initially articulated by Lawson (1986), was applied to illustrate the process of how physical education teachers are socialized into physical education in terms of beliefs, perceptions, and attitudes. According to Lawson (1986), OST includes "all the kinds of socialization that initially influence persons to enter the field of physical education and that later are responsible for their perceptions and actions as teacher educators and teachers" (p. 107). This process is typically comprised of three phases including acculturation, professional socialization, and organizational socialization (Lawson, 1986).

Acculturation Socialization

The phase of the socialization process, acculturation, is defined by initially recruiting individuals into the subject of physical education. It can also be called anticipatory socialization (Curtner-Smith, 1999; Lawson, 1983a). It begins at birth and continues until the individual enters a professional preparation program. During acculturation, individuals have a wide range of experiences interacting with a variety of socializing agents, such as guardians and educators, who can influence individuals in relation to value of teaching (Lortie, 1975). This

results in the growth of individuals related to their self-identity in the teaching role (Bullough & Pinnegar, 2001).

Furthermore, during this phase, according to Lortie (1975) and Templin and Richards (2014), an apprenticeship of observation occurs during K-12 school education. This means individuals learn and develop their values by participating in physical education classes and observing and imitating physical education teachers. According to Schempp (1989), "the apprenticeship of observation represents collected and recollected experiences from days as a student, and those experiences provide a continuing influence over the pedagogical practices and orientations of PE teachers" (p. 35). In fact, individuals form perceptions toward teaching physical education that they may eventually integrate as members of the teaching profession (Lawson, 1983a).

Further, the subjective warrant, which is a result of the apprenticeship of observation, is an individual's perceptions of requirements for teaching in schools (Lawson, 1983a). This subjective warrant develops during acculturation over thousands of hours (Lawson, 1983a; Lortie, 1975; Parkes & Hemphill, 2021) and evolves from an individual's experience in physical education classes and with physical education teachers (Heidel, 2020). For example, previous studies noted that there are two types of orientations, teaching and coaching, that are impacted by individuals' perspectives and experience (Betourne & Richards, 2015; Vollmer & Curtner-Smith, 2016). More recently, Richards & Padaruth (2017) proposed third category, fitness, in which pre-service teachers have an orientation toward fitness, health, and wellness (Figure 2.2).

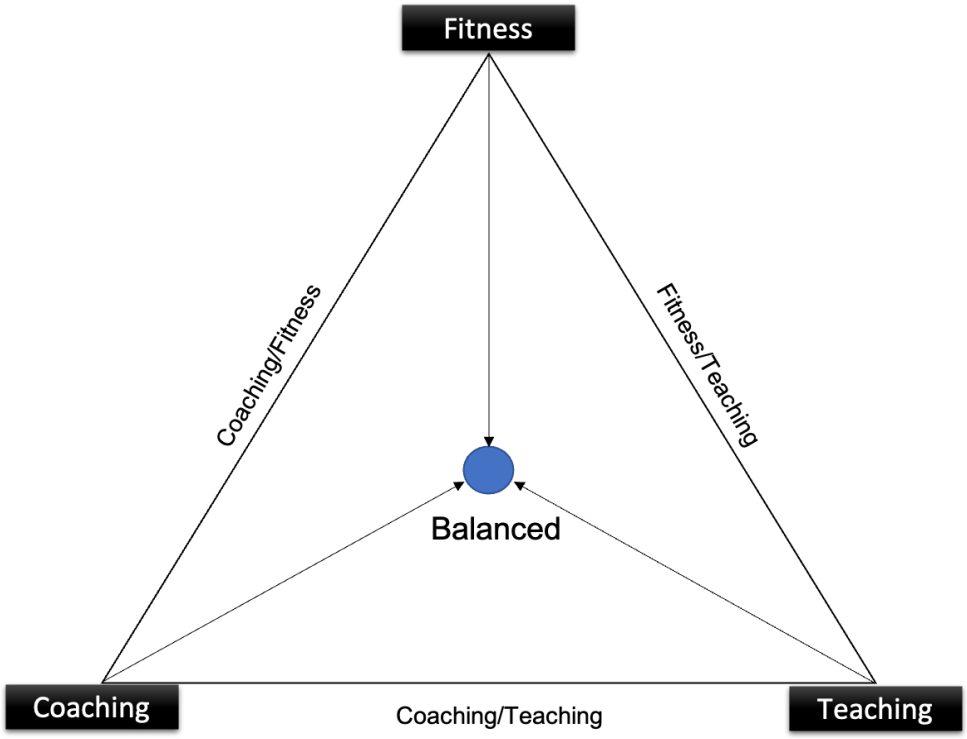

Figure 2.2. Three Types of Orientations in Accumulation Stage in Occupational Socialization Theory. Adapted, with permission of Society of Health and Physical Educators, www.shapeamerica.org, from K.A.R Richards and S. Padaruth (2017). Motivations for Pursuing a Career in Physical Education: The Rise of a Fitness Orientation, Journal of Physical Education, Recreation & Dance, 88(4), 40–46. https://doi.org/10.1080/07303084.2017.1280438

The Impact of Orientations on Physical Education Teaching. Specifically, individuals who have teaching orientations focus on teaching physical education rather than coaching extracurricular sports (Lawson, 1983a). As such, physical education teachers with teaching orientations embrace more liberal or innovative approaches to the subject matter in general, so they are more willing to attempt new practices and models of instruction. They are also more willing to attempt to improve the quality of physical education programs (Richards & Gaudreault, 2017). Previous studies indicated that teaching-oriented individuals are more likely to be female than male, and they have more experience in physical activity rather than

competitive sport (Curtner-Smith, 2001; Lawson, 1983a). Also, teaching-oriented individuals either experienced high-quality physical education classes or, in contrast, experienced low quality physical education classes, thereby increasing their motivation to change and elevate the quality of physical education (Curtner-Smith, 2001; Curtner-Smith et al., 2008). Later, as these individuals enter the professional socialization phase as pre-service teachers, they have a tendency to follow the current practices that are instilled during their PETE training (Curtner-Smith, 2001; Curtner-Smith et al., 2008).

In contrast, pre-service physical education teachers who had experience in competitive sports during the acculturation stage tended to have coaching orientations and emphasized sports activity over physical education (Lawson, 1983a). Previous research noted that males tended more often to have coaching orientations than females (Lawson, 1983a). Additionally, the pre-service teachers who participated at elite levels of sport did not have a tendency to adapt existing practices from faculty members and PETE programs (Curtner-Smith et al., 2008; Sofo & Curtner-Smith, 2010).

The fitness orientation, newly recognized by Richards & Padaruth (2017) as a third orientation perspective, is centered on the values of lifelong fitness, health, wellness, and physical activity. This categorization is underlined by evidence that there are pre-service teachers who are motivated to enhance health and wellness and place a high value on movement. These physical education teachers may value nontraditional physical activities such as yoga while gravitating away from physical activity with non-fitness-related goals (McCullick et al., 2012; Richards & Padaruth, 2017). As a result of increased interest in health and well-being as part of K-12 school education, the number of pre-service teachers who have fitness orientations might be increasing (McKenzie & Lounsbery, 2009, 2014). Accordingly, it is critical for those in the

physical education profession to comprehend the impact of the acculturation stage in order to contribute insight into quality PETE programming (Curtner-Smith, 2017; Parkes & Hemphill, 2021).

Professional Socialization

Professional socialization refers to the time between matriculating into a PETE program and starting a career as a physical education teacher. In other words, this phase typically occurs during a college program (PETE), but it is not confined to college. In this stage, pre-service teachers acquire subject content knowledge and pedagogical skills and practices through PETE courses and field-based experiences by interacting with PETE faculty members who teach courses to physical education teachers (Graber et al., 2017; Parkes & Hemphill, 2021). In addition, they also gain the values, sensitivities, skills, and knowledge needed to become effective physical education teachers (Lawson, 1983a). However, based on previous studies on teacher socialization, professional socialization is considered the weakest impact on the socialization of pre-service teachers as it does little to alter their values acquired prior to entering professional socialization (Lawson, 1986; Morgan & Hansen, 2008; Parkes & Hemphill, 2021; Templin & Richards, 2014). In particular, the pre-service teachers who have strong coaching orientations from acculturation socialization are less affected by PETE faculty (Curtner-Smith et al., 2008; Sofo & Curtner-Smith, 2010). Although this stage is considered to have less effect on pre-service teachers' development compared to the other two stages, PETE programs and faculty do have the potential to provide positive impacts on pre-service teachers' values and orientation (Richards et al., 2013).

Organizational Socialization

The last phase of OST is organizational socialization, and this is the part of the process in school settings in which new teachers learn the knowledge, values, and skills alongside co-workers, students, and parents (Lawson, 1983a). It begins right after becoming a physical education teacher and continues until retirement. One salient feature in this phase is that it is more influential than the previous professional socialization phase. Richards et al. (2014) mentioned that organizational socialization is frequently a crucial stage that affects how physical education teachers continue to build their teaching practices. Richards et al. (2013) regarded this stage of organizational socialization as "a powerful phase that impacts the continued development of the teaching practices of PE teachers" (p. 438). However, this stage can also include a period of "reality shock" when beginning physical education teachers encounter the gap between theory from PETE programs and practice in authentic school settings (Heidel, 2020). For instance, the new teacher might feel marginalized due to role conflict, lack of resources, or teaching large class sizes (Blankenship & Coleman, 2009; Curtner-Smith et al., 2008).

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CHAPTER 3: METHOD

Research Design

This research proceeded in three stages by employing a three-article dissertation format with a sequential explanatory mixed-methods research design (Chapters 4, 5, and 6). This methodology was frequently used among researchers and entailed gathering and analyzing quantitative data before analyzing qualitative data during two separate periods within a single study (Ivankova et al., 2006). Prior to the quantitative and qualitative studies, a scoping review was conducted to ascertain research trends related to subdisciplinary knowledge in the existing literature. Scoping reviews are frequently utilized when a topic's body of literature is extensive and diverse (Tricco et al., 2016). The five stages outlined by (Arksey & O'Malley, 2005) were used as a methodological framework for a scoping review including identifying relevant studies, selecting studies, charting the data, and collating, summarizing, and reporting results.

Mixed-Methods Research Design

A mixed methods research design (Creswell, 2018) was applied in this study to gain a more comprehensive understanding and to provide both descriptive, interpretive, and empirical data of subdisciplinary knowledge studies in physical education. The assumption of mixed-method research is to investigate a phenomenon by analyzing it through both quantitative and qualitative approaches. This not only helped to understand the phenomenon but also to reduced weaknesses from a singular (quantitative or qualitative) method (Tashakkori & Teddlie, 2010). Using the sequential explanatory mixed methods design allows complementing the weakness of both quantitative and qualitative methods for the following two reasons. First, it allows development of qualitative data based on the findings of the statistical tests. It also allows for

analysis of the entire study's findings and conclusions to be drawn synthetically by combining quantitative and qualitative findings (Tashakkori & Teddlie, 2003). Thus, the strength of mixed-methods research not only generally minimizes the limitations of both quantitative and qualitative research methods but also provides sophisticated perspectives (Creswell, 2018).

Participant Recruitment

The non-NBC participants for this study were selected from the National Center for Education Statistics (NCES) online public-school database, while NBC physical education teachers were recruited from the NBCT website directory (https://www.nbpts.org/nbct-search/). Potential participants' contact information (e.g., email address) was manually retrieved via official school websites, and a recruitment email was sent after gathering contact information. In total, 95 participants (48 NBC physical education teachers and 47 non-NBC physical education teachers) were recruited by email and invited to participate in a survey.

Instruments

To begin, all participants were asked to complete a knowledge test (ASK-PE) for physiology, biomechanics, and motor learning developed by Ayers (2001). All respondents who complete the survey were asked if they would participate in an additional semi-structured, in-depth interview (approximately 45-60 minutes) via Zoom to gauge their perceptions and applications of subdisciplinary knowledge in teaching physical education. In terms of follow-up interviews, a total of 30 participants, 15 NBC physical education teachers and 15 non-NBC physical education teachers, were recruited from the participant pool of those who participated in the ASK-PE survey using a purposeful sampling technique (Patton, 2002). The informed consent form was obtained before conducting interviews (See Appendix C). After the ASK-PE knowledge test, all participants received a $10 Amazon eGift Card for participating.

Additionally, those who have also completed the interview received an additional $20 Amazon eGift Card for their participation.

Data Collection

As part of the mixed-method design, a knowledge survey tool provided quantitative data, and an interview guide (Patton, 2002) provided qualitative data. The instrument used in the quantitative part (ASK-PE) was modified from previous instruments to meet this purpose of establishing validity and reliability. Interviews were transcribed by professional transcription services and undergraduate research assistants who were trained in qualitative research methods.

Quantitative Measures

Assessment of Subdisciplinary Knowledge in Physical Education (ASK-PE). This study utilized a cognitive tool to assess physical education teachers' subdisciplinary knowledge in physical education. The ASK-PE was originally designed to assess seven content areas in physical education, as outlined by Mohnsen (1998). These include the following: (a) aesthetic experience, (b) biomechanics, (c) exercise physiology, (d) historical perspectives, (e) motor development, (f) motor learning, and (g) social psychology. By conducting two pilot tests of ASK-PE, the content validity of the test was established (Ayers, 2001). In this study, three major content areas of Mohnsen's (1998) original seven via a merging of Hetland and Strand's (2010) perspective were utilized to assess the major subdisciplinary knowledge. These include exercise physiology, biomechanics, and motor learning as the most frequently taught subdisciplinary courses in PETE programs (Hetland & Strand, 2010). These three content areas are related to the goal of physical activity as well as content standards in physical education (Thomas & TI, 2021). More specifically, exercise physiology content addressed the effects of exercise on the body, such as the fundamental principles of training methods, nutrition requirements for exercise, and

physical activity injury prevention. Biomechanics content dealt with mechanical characteristics of human movement such as the production and use of lift, buoyancy, gravity, and force. Motor learning content addressed behavior change from practice or experience. This included topics such as the mechanism of how motor performance improves and how physical activity improves fitness (Ayers, 2001). The test consists of 92 items and can be completed in approximately 40 minutes, featuring both multiple-choice and case-based questions for each of the three specified content areas in Table 3.1.

Table 3.1

Example Questions of ASK-PE (See Appendix D for Full Version)

Exercise Physiology
(Multiple-choice question) Q4. 12. Consuela has been riding the stationary bike for eight weeks in an effort to improve her cardiovascular fitness. She started riding at level one and is still riding at that level. Which fitness principle is she ignoring? A. Interest B. Progression C. Regularity D. Specificity
(Case-based questions) Directions: Read the following comments about Nikki then answer questions 8-11 by marking the letter of the best answer on your answer sheet. Nikki has never done cardiorespiratory exercise or lifted weights before, but she stretches twice a week. She is going to try out for her high school track team next semester, so as part of her training, she has asked a friend to teach her how to lift weights correctly. Q4. 8. When Nikki adds more weight to her exercises as she gets stronger she is ____ A. risking injury B. using the principle of specificity C. using the principle of progression D. ignoring a major principle of lifting Q4. 10. Nikki's strength-training program should be set up ____ A. based on her starting abilities B. based on the fitness scores for her age group C. differently than a boy who has never lifted before

Table 3.1 (cont.)

D. according to the work-out Muscle and Fitness magazine recommends for the women's national body building champion

Biomechanics

(Multiple-choice question)

Q5. 4. If a weight is held further away from the body, it will feel ____

A. bulkier
B. heavier
C. lighter
D. none of the above

(Case-based questions)

Directions: Read the following comments about Jamaal then answer questions 6-8 by marking the letter of the best answer on your answer sheet.

Jamaal's family is moving to another state, and he is helping pack the truck. He is the oldest of his brothers and sisters, so he is helping load the big items such as dressers and appliances. Jamaal has never played on any of his school's sport teams and he does not work out regularly.

Q5. 6. When moving bulky things like large mirrors and bed mattresses, what is the best way for Jamaal to lift these types of things?

A. Use only his arms.
B. Bend at the waist with his knees locked.
C. Hold the item as far away from his body as possible.
D. Lift with his arms and legs, bend his knees, and keep his back straight.

Q5. 8. What is one way Jamaal can generate more force to pick up a heavy item?

A. Pick it up very slowly
B. Pick it up while running
C. Forcefully stretch his muscles just before lifting the item
D. Avoid stretching his muscles before lifting something heavy

Motor Learning

(Multiple-choice questions)

Q6. 14. When first learning how to do a set shot in basketball, your attention should be on ____

A. perfecting the skill.
B. how to shoot against a defender.
C. figuring out how to do the skill.
D. none of the above.

(Case-based question)

Directions: Read the following comments about Sarah then answer questions 2-4 by marking the letter of the best answer on your answer sheet.

Sarah has been challenged by her best friend to learn how to play soccer without instruction from anyone else. After getting some books from the school library, she has decided to start by teaching herself how to dribble.

Table 3.1 (cont.)

Q6. 2. Which would be the best way for Sarah to start learning how to play soccer? A. Run as fast as possible while trying to control the ball. B. Dribble slowly until she gets used to moving with the ball. C. Ask a friend to try and take the ball from her while she is learning how to dribble. D. None of the above
Q6. 4. Once Sarah can dribble down the field without losing control of the ball, which would be the best way for her to get better? A. Ask a friend to try to take the ball away from her. B. Ask three people to try to take the ball from her at the same time C. Keep practicing the same way she did when she started learning how to dribble D. Change the way she practices by gradually adding more difficult objects to avoid

*Qualitative Me*asures

Interviews. A semi-structured interview with open-ended questions as a primary source of data was conducted by the author and research assistants to elicit an in-depth understanding of physical education teachers' perceptions and applications of subdisciplinary knowledge (Patton, 2015). During the early part of the interview, structured interview questions were employed, and then, the researcher had the flexibility to ask follow-up questions to clarify any unanticipated answers or perspectives from participants. Interview questions were grounded in the theoretical framework of occupational socialization theory. As such, interview questions were mainly focused on the following: (a) physical education teachers' perceptions of subdisciplinary knowledge, and (b) the applications of subdisciplinary knowledge in teaching physical education. Each interview lasted approximately 45 minutes and was digitally recorded. A sample of interview questions is presented in Table 3.2.

Table 3.2

Example Interview Questions Grounded in OST, NBC Physical Education Teachers, and Subdisciplinary Knowledge.

OST & Subdisciplinary Knowledge
3. K-12 experience and science-based physical education
a. Have you experienced or observed science-based physical education in your K-12 education experience?
b. If so, what was your perception of it.
4. College (or graduate school) curriculum and exercise science courses
a. What did you learn in college related to exercise science that you now apply to your teaching?
b. How have you applied the exercise science knowledge that you learned in college into real teaching situations?
c. In what ways does a college curriculum provide help for applying exercise science knowledge content in your role as a physical educator?
5. Teaching experience and applied exercise science based physical education
a. For your current school, in what ways does your teaching experience help to apply exercise science knowledge into the teaching of physical education?
c. If so, how did you learn to apply exercise science content into the teaching of physical education?
d. What strategies do you use to apply exercise science concepts? Are the strategies effective?
NBC physical education teachers & Subdisciplinary Knowledge
6. National Board Certification curriculum and exercise science knowledge
a. What did you learn in National Board Certification process related to exercise science that help you to apply that content to your teaching?
b. Did you apply the exercise science knowledge that you learned into real teaching situations?

Data Analysis

To review, both quantitative and data analysis methods were employed in this investigation. Quantitative methods were conducted in order to identify teachers' levels of subdisciplinary knowledge, and qualitative methods were conducted to understand teachers' perceptions and applications of subdisciplinary knowledge in teaching physical education.

Quantitative Data Analysis

Collected data was coded and entered into a computer database, and data management and analysis were performed by using IBM SPSS software version 27.0. First, a one-way

Analysis of Variance (ANOVA) was applied to demographic features, including gender, years of teaching, grade level to teach, and school location. Second, a t-test was used for comparing the NBC physical education teachers and non-NBC physical education teachers' data from the ASK-PE survey. With respect to the comparison of all groups, post hoc analysis (Tukey test) was calculated. Significance was established at $p < .05$. The findings of the quantitative study were presented in the second paper (Chapter 5) in this dissertation.

Qualitative Data Analysis

Qualitative analysis of the transcripts was carried out based on a grounded theory approach (Glaser & Strauss, 1967; Strauss & Corbin, 1998). All interview data were recorded and transcribed verbatim and then, were analyzed by means of open and axial techniques (Corbin & Strauss, 2008). Open coding procedures included conceptualizing and categorizing data from the raw interview data. Then, the axial coding was used for reassembling "data that were fractured during open coding" (Strauss, & Corbin, 1998, p. 124). This process included both inductive and deductive analysis (Glaser & Strauss, 1967; Patton, 2015), as axial codes were created inductively at first, and then, the process became increasingly deductive as it progresses (Strauss & Corbin, 1998).

Trustworthiness

To establish trustworthiness, Guba's (1981) perspectives were applied to four elements for transparency and trustworthiness of qualitative research. These included dependability, credibility, confirmability, and transferability (Cutcliffe & McKenna, 1999; Lincoln & Guba, 1985; Sandelowski, 1986).

Dependability refers to the consistency, stability, and reliability of research findings, indicating the degree of consistency of the results produced by repeatedly measuring the same

study design and procedures (Sandelowski, 1986). To ensure the dependability of the data, all processes of this study, including methods and data collection, were documented (Shenton, 2004). Additionally, the findings from the interview data were triangulated with field notes and a lesson plan.

Credibility refers to the degree of truth and the believability of the data produced and whether the results are based on faithful descriptions provided by the participants (Lincoln & Guba, 1985). Member checks were conducted by participants in relation to the interview data and its interpretations (Lincoln & Guba, 1985; Patton, 2015).

Confirmability refers to the degree of objectivity of the study such as the researcher's objectivity and data analysis and result (Olsson Möller et al., 2014). A detailed methodological description such as the process of data collection and analysis and theories was included, so readers could determine whether confirmability was established in this study (Shenton, 2004).

Finally, transferability is the degree to which the result of this study can apply or transfer to future research (Lincoln & Guba, 1985). While quantitative research should provide statistical analyses of numerical data, qualitative research should provide rich, detailed, and comprehensive descriptions of non-numerical data in order to establish transferability (Lincoln & Guba, 1985). Detailed information such as methods and participants were described to aid this criteria.

For all processes to establish the trustworthiness of qualitative research, triangulation, corresponding to dependability, credibility, confirmability, and transferability, was utilized through member checking, peer debriefing, multiple interviewers, and multiple methods. To be specific, researcher and data triangulation was achieved by having multiple researchers analyze the data and collecting data from various sources. Periodic debriefing was completed by a peer who was familiar with research related to occupational socialization theory. The peer's role was

not only be to provide guidance and support on thematic development but also to force the investigators to justify interpretations of existing themes (Patton, 2015). Lastly, negative case analysis was applied to ensure the validity of emerging themes.

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CHAPTER 4: RESEARCH TRENDS RELATED TO KINESIOLOGY SUBDISCIPLINARY KNOWLEDGE IN PHYSICAL EDUCATION: A SCOPING REVIEW

Physical education teachers are essential in promoting student learning within the discipline (Iserbyt et al., 2016; Moy et al., 2016). Since teachers play a pivotal role in class organization and management, such as planning, performing, and redesigning instruction (Rovegno, 1995; Ward & Ayvazo, 2016), the teacher's understanding of what to teach is vital for teaching quality (Rovegno, 1995; Siedentop, 2002). Several studies have shown that teacher knowledge is essential for professional teaching competence. Siedentop (2002) contended that teachers' understanding of the content they teach is the most critical factor in quality teaching. Ward and Ayvazo (2016) also supported this point by illustrating that teachers' knowledge affects teaching quality and effectiveness.

Shulman (1987) defined content knowledge as "the specific subject matter knowledge, understanding, skill, and disposition that are to be learned by school children" (p. 8-9). Shulman (1986) originally proposed three knowledge domains: subject matter content knowledge (i.e., what teachers know about what they teach), pedagogical content knowledge (i.e., a combination of content and pedagogy), and curricular knowledge (i.e., teachers' understanding of the school's educational programs and materials, enabling them to design effective instruction). Later, he recategorized knowledge domains into content knowledge, general pedagogical knowledge, pedagogical content knowledge, curriculum knowledge, knowledge of learners and characteristics, knowledge of educational contexts, and knowledge of educational ends and purpose (Shulman, 1987).

In physical education, there is an ongoing debate over what content should be prioritized (Solmon, 2021). Initially, as Henry (1964) noted, physical education programs for teachers primarily focused on pedagogy-oriented rather than subdisciplines-oriented. This was evidenced by the fact that a considerable number of physical education teacher educators during that time earned their doctoral degrees from education departments. He also noted that PETE programs did not require students to take subdiscipline courses, such as exercise physiology, to earn a bachelor's degree. In contrast, other majors, such as chemistry and mathematics, consisted of advanced-level courses that students took because, as teachers, they would teach the material after graduation. Furthermore, Henry (1964) added, "The study of the heart as an organ is physiology, whereas determining the quantitative role of heart action as a limiting factor in physical performance in normal individuals is perhaps more physical education than physiology" (p. 33), establishing that physical education has a firm foundation in academe. Later, this argument was supported by additional studies conducted in a subsequent generation (Bulger et al., 2008; Herold & Waring, 2017; Metcalf et al., 2020; Siedentop, 2002). For instance, Siedentop (2002) noted that practical subject content knowledge (i.e., subdisciplinary knowledge) could be a fundamental component of teaching effectiveness. Moreover, Bulger et al. (2008) stated that students with subdisciplinary knowledge could apply their knowledge to diverse situations. Interestingly, the author of this review found research direction differences between early and later studies. While the earlier studies on subdisciplinary knowledge focused more on academic identity, the later studies focused on teaching effectiveness. Additionally, Siedentop (2002) and Ward (2009) suggested that teachers' content knowledge is a necessary factor for teaching effectiveness, which is related to effectively educating students. To support this point, Siedentop (2002) stressed the importance

of content knowledge by connecting it to pedagogical content knowledge, which means, because content knowledge is an essential factor of pedagogical content knowledge, it cannot be improved without content knowledge. Content knowledge is also relevant to teachers' teaching confidence. Herold and Waring (2017) noted that pre-service teachers considered teaching confidence a crucial factor for teaching effectiveness, associating it with professional identity and self-image. Said differently, a lack of content knowledge may result in teachers having negative responses, such as increased anxiety (Herold & Waring, 2017). Most recently, Solmon (2021) supported the aforementioned claims through the assertion that "All kinesiology majors, including PETE students, should master the content that constitutes the core elements of the discipline." While he agreed that there is ongoing debate regarding the emphasis of PETE programs, with differing opinions on whether disciplinary knowledge or the development of expertise in K-12 physical education content should take precedence. Furthermore, even among proponents of expertise in K-12 content, a consensus regarding the specific content areas remains elusive.

The argument regarding the importance of subdisciplinary knowledge for physical education teachers, however, has been challenged by many studies demonstrating the opposite. Rink (2007) provided input on this issue using an analogy, "when someone asks you what time it is - do you tell them how to make a watch?" (p. 33). She mentioned this is called inert knowledge by teacher educators and deserves attention because this may hinder students from effectively learning. "Inert knowledge" refers to information that is not applied or used in any practical way. This analogy illustrates merely having a grasp of the information without comprehending its application fails to suffice as a means of fostering the efficacy of teaching. Physical education teachers must understand how theory and principles can be applied to their

teaching of physical education lessons rather than simply memorizing them. Moreover, several studies have criticized subdiscipline-centered curriculum in physical education. For instance, overemphasized subdisciplinary knowledge is a factor that potentially deters establishing student-centered pedagogies (Herold & Waring, 2009). Furthermore, Lineham (2003) noted that excessively science-based physical education curricula can influence teachers to neglect socio-cultural perspectives that are also needed to encourage student critical thinking.

Shulman (1986) described content knowledge as concepts, principles, and skills within a particular subject discipline. Although there is no precise categorization of subdisciplinary knowledge within physical education research, many studies have been conducted under the assumption that subdisciplinary knowledge, such as physiology, biomechanics, and sport psychology is considered a part of content knowledge (Castelli & Williams, 2007; Fernéndez-Balboa et al., 1996; Solmon, 2021). Subdisciplinary knowledge in physical education should be clearly defined. In this paper, Schwab's (1964) perspective concerning subject content knowledge was accepted, which contains substantive knowledge (i.e., scientific theory concepts) rather than syntactic knowledge (i.e., rules for sports and activities). The author of this study defined subdisciplinary knowledge as knowledge related to exercise science, such as physiological, biomechanical, motor learning/development, psychological, historical, philosophical, and social principles. This definition is based on the official SHAPE America document for Initial Physical Education Teacher Education Standards (2017) related to what scientific and theoretical knowledge physical education teachers should know. In this study, the perspectives of syntactic knowledge that were excluded were the set of rules, etiquette, general techniques, and tactics. Considering this research area is unexplored, unsolved questions remain

(Stiles & Katene, 2013), such as whether subdisciplinary knowledge is helpful to physical education teaching and how subdisciplinary knowledge should be defined.

During the early stages of subdisciplinary knowledge research, Henry (1964) criticized physical education teacher education (PETE) programs for being overly oriented toward pedagogy rather than subject field knowledge (i.e., subdisciplinary knowledge), while other subject teaching degree programs, such as chemistry and mathematics, were oriented toward acquiring more advanced levels of subject expertise for pre-service teachers than needed to teach in school. He also explained that the PETE program needed to provide sufficient discipline courses, such as exercise physiology, anatomy, sociology, and psychology. More recently, Graham (2008) supported this contention by asserting that teachers' subject knowledge (i.e., subdisciplinary knowledge) has a positive effect on designing meaningful physical education, enhancing students' motivation to participate in physical activity. In addition, several studies have shown that subject knowledge (e.g., contextually, subdisciplinary knowledge) helps improve teachers' pedagogical practices (Graber, 1995; Hayes et al., 2008; McCarthy & Youens, 2005). Along similar lines, Metcalf et al. (2020) also supported findings in previous studies by asserting that subdisciplinary courses (e.g., history, philosophy, sociology) were crucial components in a PETE program since subdisciplinary knowledge provides diverse perspectives concerning physical education and sports for prospective physical education teachers.

When physical education transitioned to kinesiology in the U.S., colleges began to provide more exercise science courses. According to Bulger et al. (2008), prospective physical education teachers with subdisciplinary knowledge can utilize their knowledge in diverse sports settings. To be more specific, understanding and appropriate application of exercise physiology concepts are associated with injury prevention, promoting physical fitness, and improving sports

performance (Bulger et al., 2000). Furthermore, physical education teachers with biomechanical knowledge can effectively teach motor performance, sport skill, evaluation of the structure of the human body, and injury prevention (Hamill & Knutzen, 2003; Wells & Luttgens, 1976). In terms of the sociological perspectives, teachers who understand social trends (e.g., economy, politics, culture), subcultures (e.g., minorities), social institutions (e.g., education), and social issues (e.g., obesity, diversity, poverty, bullying) which potentially affect teaching-learning interactions, can support child and youth development (Metcalf et al., 2020). Additionally, the Society of Health and Physical Educators (SHAPE) America (2017) has officially stated that physical education teacher candidates should obtain scientific and theoretical knowledge in a PETE program and apply this in their teachings.

Nevertheless, uncertainty remains about the role and importance of subdisciplinary knowledge in practice primarily because subdisciplinary courses have not provided pre-service teachers with a solid connection between theory and practice in teaching physical education (Herold & Waring, 2009). It is also argued that an excessive focus on subdisciplinary knowledge may lead to a decreased emphasis on student-centered learning (Herold & Waring, 2009). According to Tinning (2002), "While more physical activity subject matter knowledge is definitely needed in some programs, in and of itself it will not be sufficient to help prospective teachers cope with the demands of teaching today's youth the activities they consider as meaningful in their lives" (p. 388). He also goes on to explain that other factors, such as the teacher's attitude and ability to connect with students and facilitate the general purposes of physical education, should be considered just as important as content knowledge. Furthermore, Capel (2007) argued that an overemphasis on subdisciplinary knowledge could hinder the emergence of effective, pupil-centered pedagogies.

Studies focused on subdisciplinary knowledge have been conducted in various areas and have examined factors, including specific target populations, research methodologies, terminologies, and a range of subjects. In the existing literature, the terms subdisciplinary knowledge (e.g., Ayers, 2004; Johnson, 2015), exercise science knowledge (Bulger & Housner, 2007), subject matter (e.g., Vickers, 1987), and health-related fitness knowledge (e.g., Santiago & Morrow, 2021) were used interchangeably. This could cause confusion since using different terms to mean the same thing could hinder reader understanding. While many studies concerning subdisciplinary knowledge have been conducted, a comprehensive understanding of this area is still lacking, which might reflect issues with terminology. Understanding the trends and gaps in subdisciplinary knowledge research will expose what has been done and provide a blueprint for future studies. There is a need to explore how subdisciplinary knowledge has been implemented in physical education to understand the associated research comprehensively and thoroughly.

This study focuses on understanding the research trend of subdisciplinary knowledge in physical education using a scoping review methodology. A scoping review is referred to as "mapping" because it summarizes a range of literature to gain a comprehensive understanding of a topic (Levac et al., 2010). Furthermore, a scoping review is an effective research method for forming a complete picture of a topic including characteristics, definitions, and various other pertinent factors such as historical context, key concepts, theoretical frameworks, research gaps, and emerging trends (Schnitzius et al., 2019). Therefore, this scoping review aims to analyze the literature on subdisciplinary knowledge in physical education to investigate predominant research tendencies and to capture a more comprehensive view to provide scholars with a future research agenda. In this context, the objective of this study is to answer the following research questions: (a) What research has been conducted on physical education teachers' subdisciplinary

knowledge in the K-12 physical education context? and (b) What are the subdisciplinary knowledge research trends and issues in the K-12 physical education context?

Methods

This study aims to investigate and examine the existing literature regarding subdisciplinary knowledge in physical education to determine research trends and gaps and inform future research agendas in the physical education field. The scoping review methodology is well-known as a practical and helpful research method for identifying and classifying broad and diverse literature papers to identify general trends and derive new research questions about a specific theme (Tricco et al., 2016). This study was guided by the scoping review methodological framework developed by Arksey and O'Malley (2005). This review consecutively followed five stages of Arksey and O'Malley's (2005) guidelines: (a) identifying the research question, (b) identifying relevant studies, (c) study selection, (d) charting the data, (e) collating, summarizing, and reporting results. These five stages are outlined below.

Stage One: Identifying the Research Question

This review aims to examine research trends in subdisciplinary knowledge in physical education. Considering that the scope of a research question needs to be comprehensive to provide a roadmap for a topic (Arksey & O'Malley, 2005), the research questions in the study are broad. They are as follows: (a) What research has been conducted on physical education teachers' subdisciplinary knowledge in the K-12 physical education context? and (b) What are the subdisciplinary knowledge research trends and issues in the K-12 physical education context?

Stage Two: Identifying Relevant Studies

Research literature was identified using electronic searching databases, including SCOPUS, SPORTDiscuss (sports and recreation research), ERIC (research in education),

PROQUEST Education, Web of Science, and Google Scholar. The author used these six web search databases to attain all the relevant articles within the target topic. Data search keywords used included combining "subdisciplinary knowledge," "exercise science knowledge," "scientific knowledge," "health related fitness knowledge," "sports science knowledge," and "subject matter knowledge" with "physical education," "physical education teacher," and "physical education teacher education." The search keywords were simultaneously inserted into the web databases using the "and" function between the two terms. Considering that no scoping review research related to subdisciplinary knowledge in physical education has been conducted, peer-reviewed articles published in English were collected without period limiting to determine overall trends and analyze changes over time.

Stage Three: Study Selection

After removing duplicate articles by titles, the research team removed irrelevant studies (e.g., those regarding topics outside of physical education, such as athletic coaching) by reading and screening abstracts. The search strategy and keywords were broad with lenient inclusion criteria, given that this review aims to provide a roadmap for subdisciplinary knowledge studies. The inclusion criteria of this study were as follows: (a) written in English, (b) peer-reviewed journal articles, and (c) focused on subdisciplinary knowledge in physical education (K-12) or PETE settings. Throughout the scoping review, multiple types of evidence were considered, incorporating diverse research methodologies, primary research studies, reviews, and non-empirical evidence (Peters et al., 2021). This approach allowed for a comprehensive exploration of the subject matter, drawing on various forms of knowledge to enhance the understanding of subdisciplinary knowledge in physical education. In addition, subdisciplinary knowledge could

be articulated using other synonyms, such as subject matter knowledge and exercise science knowledge. Forty-two articles were included in this study.

Stage Four: Charting the Data

In the scoping review methodology, charting data is the process of extracting data from each article (Peters et al., 2015). The author of this study thoroughly reviewed the included articles respectively to define critical characteristics and document them for analysis (Arksey & O'Malley, 2005). In this phase, the relevant data from articles were organized and analyzed using Microsoft Excel 2022. Specifically, extracted data from articles were cataloged and organized into (a) author(s) and countries, (b) title, (c) publication year, (d) research design or method, (e) purpose and research questions, (f) primary outcomes, and (g) terminology used.

Stage Five: Collating, Summarizing, and Reporting Results

The final stage of the scoping review included creating tables and charts to numerically analyze data and provide characteristics and scope of literature for precise and consistent reporting outcomes (Arksey & O'Malley, 2005). Accordingly, the author of this study organized the data extracted from articles into tables to organize extensive findings. Then, using the tables, a numerical analysis was conducted to identify objective information related to research trends and gaps. The collected data is included below. .

The consultation process with experts in this research area was included as per the recommendation by Arksey and O'Malley (2005). To ensure the rigor of this study, three professors and three graduate students (including the author) thoroughly reviewed the entire research process, including research questions, search keywords, inclusion and exclusion criteria, and data extraction of the Excel file. During this review, the consultation team members evaluated and analyzed all the articles extracted and organized into Excel files. Inconsistent

outcomes among researchers were thoroughly discussed until agreement was reached. Eventually, author, country, publication year, research designs, purpose, research questions, primary outcomes, and terminology used were decided upon.

Results

Preliminary Results

Using the search keywords mentioned above, a total of 3,663 articles were found using a comprehensive literature search. After 3,292 duplicate articles were excluded, 189 were screened by title since excluding duplicate articles was important to ensure each unique article was only considered once in the study selection process. Then, 163 articles were thoroughly reviewed and excluded based on inclusion and exclusion criteria. Following review, 38 articles that met all inclusion criteria for this review study remained.

Publication Year and Country

The number of subdisciplinary knowledge articles published over time is illustrated in Figure 2. A total of 38 articles were published from 1964 to 2020. The first article related to subdisciplinary knowledge was published by Henry (1964) as part of the debate on the academicization of physical education into kinesiology in the United States. While a few articles were published after Henry's, no research was published from 1968 to 1986. However, studies have been consistently conducted since 1997. For the last two decades, between 2000 and 2020, 30 articles were published as part of the discussion related to content knowledge and teaching effectiveness.

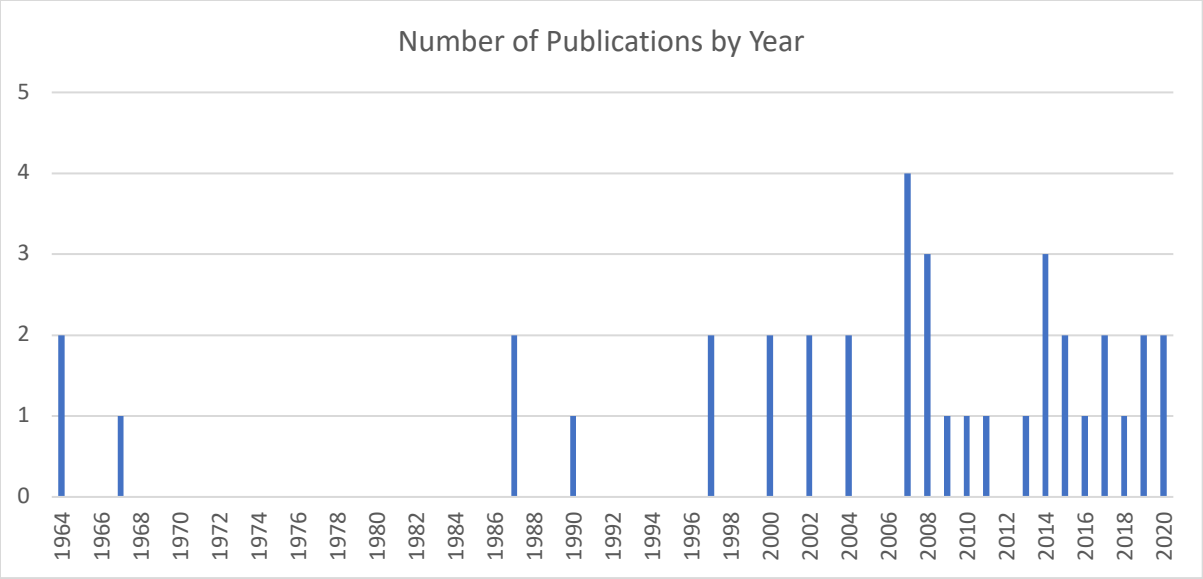

Figure 4.1. Number of Publication by Year

Most of the studies in this review were conducted in the United States (*n* = 26, 68%), followed by England (*n* = 3, 8%). In addition, two studies were conducted in Australia (5%) and Brazil (5%). Finally, a single study was conducted in each of the following: the United Arab Emirates (3%), New Zealand (3%), Slovenia (3%), Canada (3%), and Sweden (3%). Figure 3 illustrates the 38 included studies by country of publication.

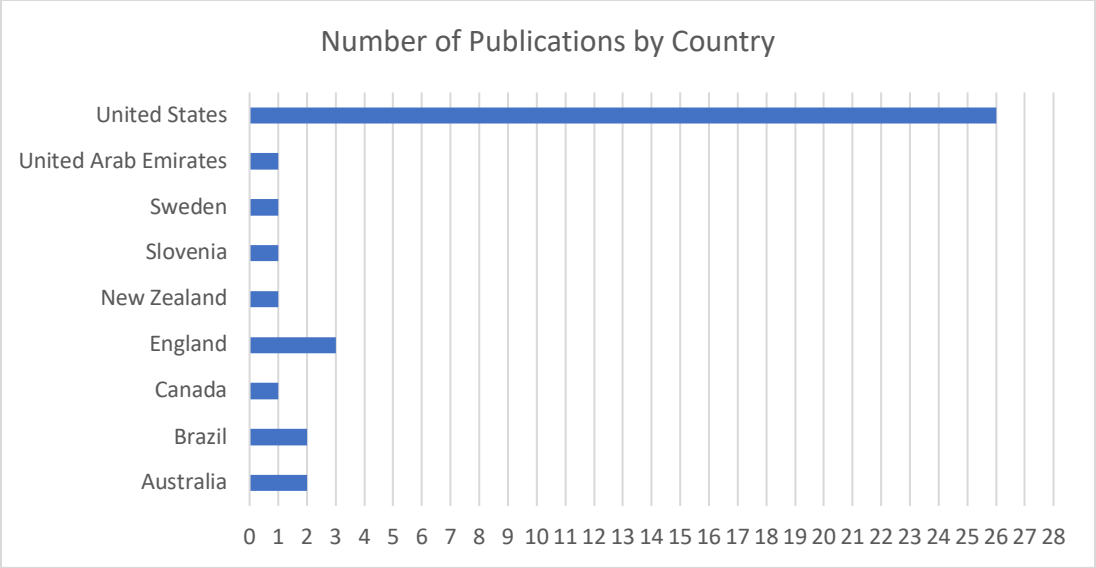

Figure 4.2. Publications by Country

Research Design

Of the 38 studies, most research was conducted using qualitative research methods (*n* = 31, 82%), such as qualitative-driven literature reviews (*n* = 23), Delphi methods (*n* = 4), and interviews (*n* = 4). Quantitative research methods, such as survey research designs, were utilized by four studies (11%), and mixed methods were utilized by two studies (5%). Only one study (1%) was conducted using an experimental research method (i.e., intervention).

Figure 4.3. Publications by Research Methods

Terminology Referring to Scientific Concepts and Principles Used in PE

In this section, the usage of terms denoting subdisciplinary knowledge, including subdisciplinary knowledge itself, was analyzed in the selected papers. (Figure 5). Of the 44 terms used, 13 studies used 'category in subdisciplinary knowledge' (e.g., subject disciplines, subdiscipline, academic discipline of physical education, disciplinary knowledge, subdisciplinary knowledge, subdisciplinary areas, subdisciplinary content within physical education), accounting for 30% of the studies, indicating that it is the type of term most widely used. Eleven studies (25%) used 'category in a specific discipline' (e.g., exercise physiology, physiological concepts in physical education and sports, knowledge of resistance training principles, biomechanics, motor development and learning, sociological knowledge, history). 'Category in subject matter knowledge' (e.g., subject knowledge, subject matter, subject matter knowledge, practical subject matter knowledge, subject content knowledge, subject matter content knowledge) was used in

nine studies (20%), followed by 'category in exercise science knowledge' (e.g., knowledge on sport and exercise science, exercise science content knowledge, exercise science knowledge) (*n* = 3, 7%), 'category in the body of knowledge' (e.g., body of knowledge of human movement, body of knowledge in kinesiology, body of knowledge in physical education) (*n* = 3, 7%), and 'scientific knowledge' (*n* = 2, 5%). The terms 'movement content knowledge (2%),' 'HPSS (history, philosophy, and sociology of sport) knowledge (2%),' and 'academic field of knowledge (2%)' were used in each of the remaining three studies.

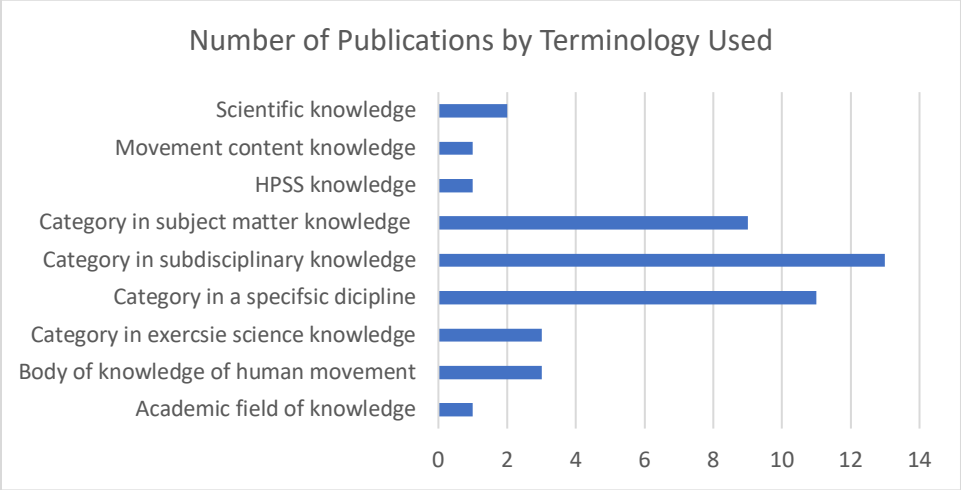

Figure 4.4. Number of Publications by Terminology Used

Note. **Category in subdisciplinary knowledge** = subject disciplines, subdiscipline, academic discipline of physical education, disciplinary knowledge, subdisciplinary knowledge, subdisciplinary areas, subdisciplinary content within physical education; **Category in a specific discipline** = exercise physiology, physiological concepts in physical education and sports, knowledge of resistance training principles, biomechanics, motor development and learning, sociological knowledge, history; **Category in subject matter knowledge** = subject knowledge, subject matter, subject matter knowledge, practical subject matter knowledge, subject content knowledge, subject matter content knowledge; **Category in exercise science knowledge** = knowledge on sport and exercise science, exercise science content knowledge, exercise science knowledge; **Category in body of knowledge** = body of knowledge of human movement, body of knowledge in kinesiology, body of knowledge in physical education; **HPSS knowledge** = history, philosophy, and sociology of sport.

Target Group and Research Background

Most of the studies in this review were conducted with pre-service teachers (*n* = 24, 48%). Thirteen studies (26%) examined in-service teachers in physical education, while eight (16%) examined teacher educators such as PETE and other subject faculty (e.g., exercise physiology). In addition, one study focused on K-12 students (2%), and another dealt with Ph.D. students (2%). The remaining three studies did not specify their target group (6%).

In terms of research background, many studies were conducted regarding PETE settings (*n* = 31, 76%), followed by graduate programs (*n* = 5, 12%) and K-12 physical education settings (*n* = 3, 7%). The graduate program articles contained physical education graduate programs found in the United States and a one-year postgraduate certificate in education (PGCE), which is postgraduate teacher education in the United Kingdom. In addition, an in-service training program was studied in one study (2%), and one study did not have a specified background (2%).

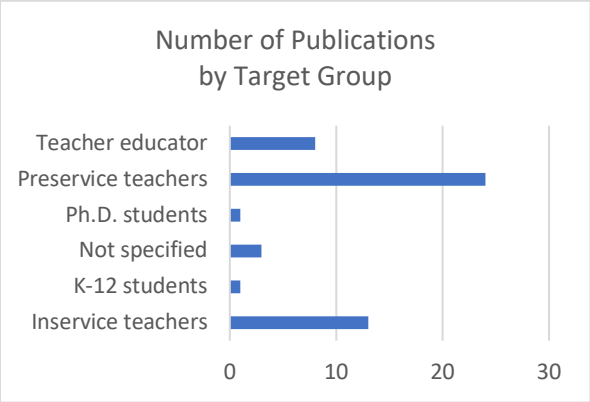

Figure 4.5. Number of Publications by Target Group

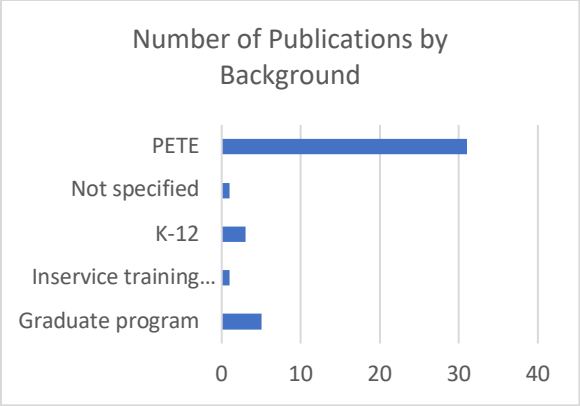

Figure 4.6. Number of Publications by Background

Classification by Topic

Twenty-three research studies addressed how the curricula of the PETE programs were designed to be taught in conjunction with delivering subdisciplinary knowledge for pre-service physical education teachers (Table 4.1). Of the studies that occurred utilizing PETE curriculum content (n = 22, 56%), eight were conducted about curriculum focus, followed by subdisciplinary knowledge (n = 4), exercise physiology (n = 3), integration (n = 3), PETE standards (n = 1), history (n = 1), sociology (n = 1), and HPSS: History, Philosophy, and Sociology of Sport (n = 1). Studies related to academic identity (n = 5, 13%) were also conducted. In terms of subdisciplinary concepts (n = 3, 8%), one study was conducted with physiology concepts, one with subdisciplinary knowledge, and one with motor development concepts taken into consideration. The studies concerning assessing knowledge (n = 3, 8%) were conducted with in-service teachers (n = 2) and high school students (n = 1). Also, study perceptions (n = 3, 8%) were conducted with pre-service teachers (n = 2) and teacher educators (n = 1). Only one intervention study (3%) was conducted. Lastly, studies that described competencies (n = 1) and

what teachers need to know (n = 1) were conducted (5%). A numerical analysis of all the articles identified in this review is provided in Table 4.2.

Table 4.1

Classification by Topic

Category	Subcategory	n
Curriculum contents in PETE	Curriculum (n = 8), Subdisciplinary knowledge (n = 4), Exercise physiology (n = 3), Integration (n = 3), PETE standards (n = 1), History (n = 1), Sociology (n = 1), HPSS: History, Philosophy, and Sociology of Sport (n = 1)	22
Academic identity	Academic identity (n = 5)	5
Recommendations of subdisciplinary concepts	Physiology concepts (n = 1), Subdisciplinary knowledge (n = 1), Motor development (n = 1)	3
Assessing knowledge	In-service teachers (n = 2), High school students (n = 1)	3
Perceptions	Pre-service teachers (n = 2), Teacher educators (n = 1)	3
Intervention	Biomechanical subject knowledge module (n = 1)	1
Others	Competencies (n = 1), What teachers need to know (n = 1)	2

Table 4.2

Numerical Analysis on Subdisciplinary Knowledge

	n	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Research Design																					
Quantitative	4	X					X														
Qualitative	31		X		X	X			X	X	X	X	X	X	X	X	X	X	X	X	X
Mixed methods	2			X				X													
Experimental study	1																				
Terminology Used																					
Category in subdisciplinary knowledge	13						X			X					X						
Category in a specific discipline	11		X			X		X			X			X					X	X	
Category in subject matter knowledge	9								X			X			X			X			X
Category in exercise science knowledge	3	X		X										X							
Category in body of knowledge	3																				
Scientific knowledge	2				X											X					
Movement content knowledge	1																X				
HPSS knowledge	1																				
Academic field of knowledge	1												X								
Research Background																					
Physical Education Teacher Education (PETE)	31		X	X						X	X	X	X	X	X	X	X	X	X	X	X
Graduate program	5				X				X												
K-12	3					X	X														
In-service training programs	1							X													
Not specified	1	X																			
Target Population																					
Pre-service teachers	24		X	X				X	X	X		X				X	X	X	X	X	X
In-service teachers	13	X				X		X						X	X						
Teacher educators	8										X		X	X	X						
Not specified	3				X																
K-12 students	1						X														
Ph.D. students	1																				
Classification by Topic																					
Curriculum content in PETE	3		X	X	X					X	X	X			X	X	X	X	X		
Academic identity	23																				
Recommendations of subdisciplinary concepts	2					X								X						X	
Assessing knowledge	4	X					X	X													
Perceptions	1								X				X								X
Intervention	4																				
Others	2																				

Note. The articles have been given numerical values (1–38), which are listed in the List of Reviewed Studies.

Table 4.2 (cont.)

	n	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38
Research Design																			
Quantitative	4		X											X					
Qualitative	31			X	X	X	X	X	X	X	X	X	X		X	X	X	X	X
Mixed methods	2																		
Experimental study	1	X																	
Terminology Used																			
Category in subdisciplinary knowledge	13		X				X	X	X				X	X	X	X		X	X
Category in a specific discipline	11	X	X									X	X						
Category in subject matter knowledge	9	X			X					X							X		
Category in exercise science knowledge	3																		
Category in body of knowledge	3					X	X				X								
Scientific knowledge	2																		
Movement content knowledge	1																		
HPSS knowledge	1			X															
Academic field of knowledge	1																		
Research Background																			
Physical Education Teacher Education (PETE)	31		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	
Graduate program	5	X						X					X						
K-12	3																X		
In-service training programs	1																		
Not specified	1																		
Target Population																			
Pre-service teachers	24	X		X			X	X	X	X		X	X		X		X	X	X
In-service teachers	13				X		X		X				X	X		X	X		X
Teacher educator	8		X		X			X											X
Not specified	3					X					X								
K-12 students	1																		
Ph.D. student	1							X											
Classification by Topic																			
Assessing knowledge	3				X		X	X	X	X		X	X		X	X	X	X	
Curriculum content in PETE	23			X	X	X					X						X		
Perceptions	2																		
Recommendations of subdisciplinary concepts	4																		
Intervention	1																		
Academic identity	4	X																	
Others	2													X					X

Note. The articles have been given numerical values (1–38), which are listed in the List of Reviewed Studies.

Discussion

This scoping review aims to establish the nature of subdisciplinary knowledge studies in physical education that have been conducted to capture research trends. Thirty-eight articles were identified and thoroughly scrutinized through descriptive and numerical analyses. The studies were analyzed using descriptive and numerical analysis techniques in order to identify trends in physical education subdisciplinary knowledge research.

Thematic Review

The primary objective of the thematic review entailed a qualitative examination of the article findings in order to identify thematic patterns, thereby offering a comprehensive synthesis of the existing knowledge pertaining to subdisciplinary knowledge in physical education.

Effective curriculum design in PETE programs is essential for ensuring that future physical education teachers acquire the necessary knowledge, skills, and competencies. In the reviewed studies, various aspects of PETE curriculum design have been explored regarding subdiscipline courses. One crucial aspect of PETE curriculum is how subdisciplinary knowledge should be delivered to pre-service teachers. However, there is a growing concern that the emphasis on theoretical concepts and subdisciplinary knowledge in PETE programs may not sufficiently align with the practical demands of teaching (Bulger & Housner, 2007; Ross, Metcalf, Bulger, & Housner, 2014). This is because there is a significant gap between subdisciplinary knowledge and its application in teaching practice within PETE programs. Several studies have highlighted that the predominant focus of PETE curricula revolves around theoretical concepts and disciplinary content, often neglecting the practical aspects of teaching and classroom management (Wiegand et al., 2004). This disconnect raises concerns about the extent to which pre-service physical education teachers are adequately prepared to translate their

knowledge into effective instructional strategies. Therefore, efforts should be made to bridge the gap between subdisciplinary knowledge and pedagogical practice in PETE programs. This can be achieved through curriculum redesign, incorporating more opportunities for practical application of subdisciplinary knowledge, and emphasizing the development of pedagogical competencies. Providing pre-service teachers with authentic teaching experiences, such as practicum placements, can facilitate the integration of theoretical concepts into real-world classroom settings. Collaborative partnerships between PETE programs and schools can also enhance the alignment between program content and the actual demands of teaching.

Physical education faced criticism questioning its academic value and legitimacy as a discipline (Conant, 1959). In response, a notable shift has occurred, with PE programs transitioning into Kinesiology and placing greater emphasis on the diverse subdisciplinary contributions within the field. This transition has provided an opportunity to highlight the diverse subdisciplinary contributions within Kinesiology. Through this transition, various subdisciplines, such as exercise physiology, motor control, sports psychology, biomechanics, and sociocultural studies, have emerged as essential components of the field. By familiarizing themselves with the principles, theories, and methodologies of relevant subdisciplines, teachers can enhance their instructional practices and address specific student needs. For example, integrating sports psychology principles can improve motivation and performance, while applying biomechanics can refine movement techniques and prevent injuries. Building a strong foundation in subdisciplinary knowledge enables physical education teachers to design effective and evidence-based lessons, tailor instruction to individual abilities, and foster a lifelong commitment to physical activity.

In terms of Recommendations of subdisciplinary concepts, the existing literature explored to examine the importance of two key subdisciplines, exercise physiology and motor development, and their implications for the preparation of future physical education teachers. Exercise physiology is a critical subdiscipline that focuses on the physiological responses and adaptations to exercise. Understanding exercise physiology concepts equips PE teachers with the knowledge to design appropriate physical training programs, monitor and evaluate students' physical fitness levels, and effectively address individual differences in exercise capacity. Motor development is another essential subdiscipline that explores the progression of motor skills and coordination throughout an individual's lifespan. A solid understanding of motor development theories and concepts enables PE teachers to design developmentally appropriate activities, facilitate skill acquisition, and identify potential motor delays or challenges in their students. The incorporation of kinesiology subdisciplinary knowledge into the preparation of prospective PE teachers has significant implications for their instructional practices. In this scoping review, two studies were reviewed, exploring the essential and practical knowledge within the subdisciplines of exercise physiology and motor development. While this review highlights the importance of exercise physiology and motor development, it is crucial to recognize that Kinesiology encompasses a wide range of subdisciplines. Each subdiscipline holds the potential for unique essential and practical knowledge that can contribute to the professional growth of physical education teachers. Therefore, future research should explore these subdisciplines, such as biomechanics, sports psychology, sociocultural studies, and others, to identify the specific knowledge and skills that are essential and practical for physical education teachers.

In this literature, there were relatively more practical studies related to the topics of Assessing knowledge, Perceptions, and Intervention. While the majority of research on

subdisciplinary knowledge in physical education relied on literature reviews, a few empirical research studies were conducted specifically addressing Assessing knowledge, Perceptions, and Intervention. These studies shared a common focus on empirically examining the impact of actual subdisciplinary knowledge on physical education teachers or students, providing practical insights. Considering the existing body of literature on subdisciplinary knowledge in physical education, there is a need for more empirical research in future studies. Particularly, research on Perceptions has been predominantly limited to literature reviews, and there is a demand for studies that incorporate the perspectives of in-service physical education teachers to encompass a broader range of viewpoints.

Descriptive Review

Based on the results of this scoping review, subdisciplinary knowledge has received more attention in the past two decades for various reasons. The studies conducted between the 1960s and 1970s focused on academic legitimacy to justify the field of physical education as an academic discipline during this transition period from physical education to Kinesiology. Physical education has undergone a significant transformation from a program aimed at training physical education professionals to a disciplinary program that emphasizes the preparation of students with the ability to apply their knowledge in a broader context than the traditional secondary school physical education classroom setting. As noted previously, physical education as a discipline at the college level was criticized for lacking a solid academic foundation (Conant, 1959), which resulted in the transition from physical education to kinesiology.

The significance of disciplinary knowledge, including motor learning, biomechanics, and exercise physiology, has been a subject of ongoing discussion (Taliaferro et al., 2017). This ongoing debate not only contributes to advancing our understanding of these

subdisciplinary areas but also serves to enhance the quality of PETE programs and the effectiveness of physical education teachers. (Bulger et al., 2008). For instance, several researchers have proposed various strategies to effectively incorporate subdisciplinary knowledge into practical teaching approaches in physical education to provide valuable resources for both future PETE programs and teachers, enabling them to effectively incorporate and apply such knowledge (Bulger & Housner, 2007; Bulger et al.,2008).

However, little research about practitioners' (e.g., in-service physical education teachers) perceptions regarding the significance of exercise science knowledge in physical education teaching and its applications has been conducted. Since this debate regarding whether exercise science knowledge is important for physical education teachers may result in divergence between theory and practice, there is a need to reduce the gap between what scholars believe and what practitioners perceive in practice. Thus, further research should address practitioners' perceptions and applications regarding subdisciplinary knowledge involved in their physical education teaching.

More research is required to examine the learning outcomes of K-12 students in interventions emphasizing science-based physical education lessons or taught by physical education teachers who effectively apply subdisciplinary knowledge. Unlike earlier studies that deliberated subdisciplinary knowledge and academic identity, recent subdisciplinary knowledge studies focused on teacher expertise and teaching effectiveness. According to Herold and Waring (2009), possessing subdisciplinary knowledge is significantly related to pre-service teachers' teaching confidence. For instance, pre-service teachers who have strong content knowledge feel more confident that they can perform as teachers. In particular, since physical education teachers play an essential role in increasing children's physical activity and

preventing chronic degenerative diseases, physical education teachers should have expertise in subdisciplinary areas to promote such activities (Bulger & Housner, 2007). Nevertheless, the studies in this review showed that research conducted related to K-12 student outcomes is lacking.

An essential component of education is the interaction between teaching and learning, and this relationship ought to be dealt with in future study. It is plausible to evaluate the efficiency of various instructional strategies and designs and ascertain their effects on student learning by conducting research on student learning outcomes. The results from this type of research will contribute to a better understanding of the variables that affect student accomplishment and guide the development of more effective teaching strategies. Additionally, it is crucial to conduct more intervention-based and quantitative research since such can provide a more in-depth understanding of the ways in which teaching, and learning are related. The quality of education can then be raised and the requirements of the students can be better met using this information. Additionally, focusing more emphasis on quantitative research can support the conclusions of conventional review studies and provide a knowledge of how various educational approaches affect students learning.

Furthermore, standardization of nomenclature for subdisciplinary knowledge in the field of physical education should be importance focus in future studies. This is due to many previous studies' lack of a precise definition of the terminology, concepts, and scope of the subdisciplinary knowledge within physical education and kinesiology, as well as the disciplines that are included and excluded. The author of this review used the term subdisciplinary knowledge based on specific criteria accepted by Schwab (1964). The term 'subdisciplinary knowledge' is used primarily to indicate the knowledge teachers can learn

from subcategory courses within the kinesiology department. Other terms, such as 'subject matter knowledge' and 'exercise science knowledge,' have been interchangeably used. Although they were used similarly, definitions of terms were not presented in most cases. There was also a lack of consistency regarding the disciplines included or excluded (i.e., humanities courses, such as history and sociology) in each study. In research on physical education knowledge, studies have focused on pedagogical knowledge rather than content knowledge (Reuker, 2017). More specifically, physical education content knowledge studies addressed syntactic knowledge (rules and tactics for sport and activity) instead of substantive knowledge (scientific principles and concepts). One potential reason for the lack of substantive knowledge research is, as Reuker (2017) noted, that subject matter knowledge (i.e., subdisciplinary knowledge) has not been identified in physical education. In addition, uncertainty regarding what subdisciplinary knowledge includes still exists. Considering this, additional research on terms, definitions, and concepts of subdisciplinary knowledge is needed for consistency.

A hypothesis was formulated that the instructional efficacy of pre-service physical education teachers could be influenced by the perceived gap between theory and practice (Wiegand et al., 2004). Additionally, this discrepancy may also be linked to the instructional approaches commonly employed for imparting subdisciplinary knowledge to pre-service teachers. Previous studies (Morford, 1972; O'Hanlon & Wandzilak, 1980) have suggested that the enhancement of physical education teaching could be maximized by effectively establishing the potential relationships between subdisciplinary knowledge and instructional practices. Unfortunately, there may be a disconnect between theory and practice in PETE programs (Bulger et al., 2008). Despite one of the national standards for eligible physical

education teachers provided by SHAPE America (2017) stating that "Physical education candidates demonstrate an understanding of common and specialized content, and scientific and theoretical foundations for the delivery of an effective pre-K-12 physical education program," in reality, many physical education teacher programs exhibit a divide between theory and practice. The challenge that teacher educators encounter concerning this issue is converting inert subdisciplinary knowledge into practical value in physical education by redesigning PETE courses to include four aspects: course content, instructional methods, teaching-learning environments, and interdisciplinary collaborations (Newell & Rovegno, 1990). As per Bulger et al. (2008), subdisciplinary courses in PETE programs are being delivered with a more traditional approach (e.g., content delivery-focused approach), which hinders PETE students from actively participating in classes. Also, since instructors who teach subdisciplinary courses often lack an understanding of physical education, it has been challenging to incorporate subdiscipline and pedagogical concepts. A novel approach is therefore needed to develop practical subdisciplines courses for teaching physical education.

Limitations

There are some limitations to this study. First, the reader should remember that this review study is based on specific inclusion and exclusion criteria akin to other scoping reviews. For instance, peer-reviewed articles published in English were included, meaning it is beyond this study's scope to examine non-English studies and dissertation papers. Thus, this study does not represent the overall trend of all studies written in all languages. Also, due to terminology regarding the topic of subdisciplinary knowledge being used interchangeably, studies related to this topic might have been missed because of the search keywords selected.

Another potential problem this study presents is that the scope of years may be too broad (1964~2020). It may not provide a comprehensive or detailed picture of research trends and insights into research gaps. It may also be difficult to analyze and interpret the trends derived from the results as a result of the broad scope, which includes irrelevant or outdated studies. In addition, this scoping study was not intended to evaluate the worthiness or quality of research or the importance of the studies used (Arksey & O'Malley, 2005). The author of this review primarily provided research trends and insights related to research gaps based on tendencies derived from the results.

Conclusion

To the author' knowledge, this is the first report of a scoping review of subdisciplinary knowledge. The findings of this review provide research trends and the agendas of subdisciplinary knowledge studies. The results show the debate on needing subdisciplinary knowledge and suggested future directions on the issue, as discussed in the discussion section above. Also, the author of this review indicated that "subdisciplinary knowledge" is ambiguous terminology. On the basis of this, it indicates that there is a lack of clarity and well-defined language in the research field, which can lead to confusion and misunderstandings between researchers and practitioners. As a result, the validity and reliability of research results and conclusions can be compromised. The definition of terms and clarity of the language is crucial for advancing knowledge and understanding in any field. Lastly, the author mentioned the need for a connection between theory and practice in PETE programs. Accordingly, this scoping review study confirmed that numerous studies have been conducted on subdisciplinary knowledge and discussed essential issues. The author of this scoping review hope it provides a valuable roadmap for researchers to conduct future studies on subdisciplinary knowledge.

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CHAPTER 5: COMPARATIVE ANALYSIS OF NBC AND NON-NBC PHYSICAL EDUCATION TEACHERS' KINESIOLOGY SUBDISCIPLINARY KNOWLEDGE IN SECONDARY SCHOOLS

Physical education, as a field of study, had a much clearer focus before the 1960s; its main goal was to train physical education teachers to teach physical education in public schools (Rikli, 2006). However, the field of physical education was criticized as an academic field of study in higher education (e.g., college or university) in a report written by James B. Conant, the former president of Harvard University, because of its insufficient scientific foundation and intellectual significance (Rikli, 2006). Conant stated, "I am far from impressed by what I have heard and read about graduate work in the field of physical educations ... to my mind, a university should cancel graduate programs in this area" (Conant, 1963, p. 201). Henry (1964) responded immediately, pointing out that the field of physical education did indeed have a scientific body of knowledge encompassing a wide range of subdisciplines including exercise physiology, biomechanics, sport psychology, motor learning and development, sport sociology, philosophy, and history. From this perspective, physical education ought to be an academic discipline that is designed to produce and disseminate expert knowledge, not just a program that trains future educators and coaches (Henry, 1964). Several physical education leaders, including Henry (1964) and Zeigler and McCristal (1967), influenced the scientific foundation of physical education by increasing attention paid to research and enhancing scholarly productivity. As an academic subject at colleges and universities, physical education gained higher status through this "subdisciplinary movement," which may have prevented its extinction (Rikli, 2006). As physical education became increasingly specialized in the 1960s and 1970s, the title "physical

education" no longer seemed appropriate (Oglesby et al., 2017). Consequently, many departments of physical education were gradually renamed departments of exercise science, sport science, sport studies, human movement, human kinetics, or kinesiology (Newel1, 1990).

The historical evolution of physical education as a field of study and its subsequent transformations in response to criticisms and the emphasis on kinesiology subdisciplinary knowledge have paved the way for exploring the connection between teachers' expertise and the attainment of physical education goals, as well as its alignment with established content standards (Rikli, 2006; Conant, 1963). The field of physical education has undergone significant transformations in response to criticisms and the need for academic legitimacy (Conant, 1963). As Bahneman (1996) emphasized, "The nature and quality of future physical education programs will depend largely on the insights and commitments of professionals responsible for future curricular decision making" (p. 198). These insights have instilled in physical education professionals an awareness of the need for reform about criticism of a lack of intellectual and scientific foundation within physical education programs (Conant, 1963). In response to these criticisms, a significant change to physical education teacher education (PETE) curricula occurred during the 1960s and 1970s as kinesiology subdisciplinary knowledge became more prominent in PETE to promote the academic legitimacy and respectability of physical education at the higher education level (Corbin, 1993, 1994). To be specific, a wide range of subdisciplinary courses, including biomechanics, anatomy, physiology, motor learning, history/philosophy of movement, and sociocultural factors of movement, began to be offered in teacher education programs (Bahneman, 1996; Estes, 1994). By successfully connecting kinesiology subdisciplinary knowledge with physical education teaching, it was hypothesized that pre-service physical education teachers would be more effective in their instruction

(Morford, 1972; O'Hanlon & Wandzilak, 1980). It is true, therefore, that there have been significant developments in curricular development in the field of physical education globally (O'Sullivan, 2013). In particular, the focus was directed towards three primary content domains, namely exercise physiology, biomechanics, and motor learning. These content areas were identified as crucial subdisciplinary courses within PETE programs, as highlighted by the scholarly work of Hetland and Strand (2010). Furthermore, previous research has frequently emphasized the significance of these subdisciplines in physical education. For example, the National Association for Sport and Physical Education (1998) acknowledged that exercise physiology is currently recognized as an essential component of the PETE curriculum. In the study titled "Preparing Prospective Physical Educators in Exercise Physiology," the authors highlighted the importance of exercise physiology by explaining that understanding the body's physiological response to different forms of physical activity serves as a significant theoretical foundation for the field of physical education (Bulger et al., 2000). Additionally, Santiago et al. (2012) observed that pre-service physical education teachers have the opportunity to acquire knowledge on physical activity and health-related fitness through coursework in exercise physiology. Bulger and Housner (2007) emphasized the significance of functional anatomy and biomechanics in relation to physical activity, exercise, and sport performance. In the study "Modified Delphi Investigation of Motor Development and Learning in Physical Education Teacher Education," Ross et al. (2014) proposed that information from motor learning research supports the notion, as suggested by Magill (1990), that motor development and learning continue to play a vital role in the preparation of physical education teachers. Therefore, by narrowing the focus to these three prominent subdisciplinary contents, the study sought to explore the connection between physical education teachers' kinesiology subdisciplinary

knowledge and the attainment of physical education goals, as well as the alignment with established content standards in the field However, when considering the relevance of disciplines to PETE programs, two areas must be taken into account: (a) "identifying the role the disciplines play in the curriculum of the K–12 program" and (b) "knowledge that teachers need in order to better teach the content" (Rink, 2007, p. 102).

National Board Certification for Physical Education

With the historical evolution of physical education as a field of study and its subsequent transformations emphasizing kinesiology subdisciplinary knowledge, the focus now shifts to the significance of National Board Certification (NBC) for Physical Education and its potential impact on teachers' expertise and the attainment of physical education goals. The National Board for Professional Teaching Standards (NBPTS) was established in 1987 with the aim of improving teaching quality in the United States (Berliner, 2001). NBC is a voluntary certification program for K–12 educators. Evaluation is based on the NBPTS Five Core Propositions, indicating that certified teachers (a) are committed to students and their learning, (b) know the content they teach and how to teach it to students, (c) are responsible for managing and monitoring student learning, (d) reflect on their practice and learn from experience, and (e) are members of learning communities (NBPTS, 2021). The second core proposition from the NBPTS, regarding improving teachers' knowledge, should be emphasized in the design of PETE programs. Specifically, qualified teachers should possess and apply knowledge of the subject matter of physical education, including exercise science, motor development and motor learning, movement forms in context, physical activity and wellness, sociology and psychology of movement, legal and safety issues, technology, and current issues and trends in physical education (NBPTS, 2014).

To that point, several studies have examined the impact of NBC for physical education teachers on various aspects of teaching and student outcomes. For instance, Phillips (2008) conducted the first study in this area and found that students of NBC physical education teachers performed better on the South Carolina Physical Education Assessment Program (SCPEAP) assessments than students of non-NBC physical education teachers. Subsequently, Woods and Rhoades (2010) conducted an investigation into the demographic characteristics, subjective warrants, and motivational factors of physical education teachers holding NBC. The findings of their study revealed that a significant proportion of NBC physical education teachers during that period were females of Caucasian ethnicity, possessing advanced academic degrees with an average age of 45 years. NBC physical education teachers pursued certification for reasons such as the desire to advance professionally, take on challenges, and obtain financial incentives. Rhoades and Woods (2012) suggested that NBC physical education teachers had the ability to positively impact student achievement through appropriate task presentations and proper use of class time. Similarly, Gaudreault and Woods (2012a, 2012b) highlighted that the certification process had the potential to enhance teachers' confidence, credibility, and professional opportunities, while also fostering a sense of assertiveness and readiness for leadership roles, and a study by Woods and Rhoades (2013) found that NBC physical education teachers displayed strong self-efficacy. Most recently, Richards et al. (2021) compared the perceived workplace experiences of NBC physical education teachers and non-NBC physical education teachers. They found that NBC physical education teachers reported feeling less isolated and perceived that they mattered more than non-NBC physical education teachers. However, NBC physical education teachers reported higher degrees of role conflict and role overload than non-NBC physical education teachers (Richards et at., 2021).

Although no existing research directly compares the kinesiology subdisciplinary knowledge of NBC physical education teachers and non-NBC physical education teachers, there is substantial evidence supporting the contention that kinesiology subdisciplinary knowledge enhances teachers' expertise (Iserbyt et al., 2017; Siedentop, 2002; Ward et al., 2015). Moreover, SHAPE America (2017) and NBPTS (2014) both underscore the significance of scientific and theoretical knowledge for effective teaching among physical education teachers. As such, the NBPTS emphasizes the significance of kinesiology subdisciplinary knowledge in the training of qualified teachers. As outlined in Standard 2, qualified teachers should possess and apply knowledge in various areas by stating the importance of subject matter knowledge such as exercise science, motor development, motor learning, movement forms in context, physical activity and wellness, sociology and psychology of movement in physical education. During the certification process, candidates must complete three portfolio entries and undergo a content proficiency evaluation. The former contains visual evidence, such as video recordings and student work samples, showing the teacher's expertise in authentic educational settings. This process involves the practical application of kinesiology subdisciplinary knowledge as well. Finally, candidates demonstrate their kinesiology subdisciplinary knowledge understanding through an assessment comprising open-ended and multiple-choice questions. This offers candidates the chance to exhibit knowledge and skills that are not assessed within the portfolio. As previously mentioned, despite the research that has been conducted on NBC physical education teachers' expertise, there seems to be a concerning lack of attention given to physical education teachers' content knowledge, specifically kinesiology subdisciplinary knowledge. Therefore, the purpose of this study is to investigate the disparities in kinesiology subdisciplinary knowledge such as exercise physiology, biomechanics, and motor learning between NBC

physical education teachers and non-NBC physical education teachers using quantitative research methods.

Method

Study Design

In this study, a knowledge test survey was completed by selected physical education teachers in the U.S. to examine their level of kinesiology subdisciplinary knowledge. The subdisciplines examined were exercise physiology, biomechanics, and motor learning. This study was conducted as a quantitative study. This approach is essential because it allows for causal explanations, hypothesis testing, manipulation and control of variables, and the use of structured instruments (Creswell, 2013). By employing deductive reasoning and component analysis, quantitative research provides a systematic framework (Yilmaz, 2013) to compare and analyze the kinesiology subdisciplinary knowledge between NBC and non-NBC physical education teachers in secondary schools.

Participant Recruitment

To ensure a representative sample, secondary-level physical education teachers were deliberately selected, excluding elementary-level teachers. This was because the NBC physical education certification is categorized into “Early Adolescence Through Young Adulthood” (i.e., secondary level) and “Early and Middle Childhood” (i.e., elementary level). To facilitate a meaningful comparison between NBC and non-NBC teachers, both groups were chosen from the secondary level. Additionally, considering the potential impact of students’ age-related learning abilities on teacher variations, it was deemed more appropriate to focus on the secondary level, where students are expected to comprehend and incorporate the scientific aspects of physical education more comprehensively. NBC physical education teachers were recruited from the

NBCT (National Board for Professional Teaching Standards) website directory. Likewise, the non-NBC physical education teacher participants were selected from the National Center for Education Statistics (NCES) online public-school database. In order to establish contact with potential participants, their contact information, such as email addresses, was manually retrieved from official school websites. Following the collection of contact details, email invitations were sent to 987 NBC members, and 2,353 non-NBC physical education teachers to encourage participation. From these outreach efforts, a total of 48 NBC physical education teachers and 47 non-NBC physical education teachers agreed to participate in the kinesiology subdisciplinary knowledge test. This corresponds to a response rate of approximately 4.86% for NBC participants (48 out of 987) and 1.99% for non-NBC participants (47 out of 2,353).

Instrument

The study employed a carefully designed knowledge test,the Assessment of Subdisciplinary Knowledge in Physical Education (ASK-PE), which was developed by Ayers (2001). ASK-PE is widely recognized for its validity and reliability in assessing the breadth and depth of kinesiology subdisciplinary knowledge in the field of physical education. Originally devised to evaluate seven distinct content areas delineated by Mohnsen (1998), including aesthetic experience, biomechanics, exercise physiology, historical perspectives, motor development, motor learning, and social psychology, ASK-PE provided a comprehensive framework for gauging teachers' expertise in various aspects of kinesiology subdisciplines.

The three subdisciplines employed in the study instrument of this study were exercise physiology, biomechanics, and motor learning. Each of these subdisciplines encompassed a range of questions that delved into specific aspects of the respective fields. The exercise physiology component in this assessment focused on investigating the physiological effects of

exercise on the human body. It encompassed inquiries into fundamental training principles, nutritional requirements necessary for optimal performance, as well as strategies for preventing injuries related to physical activity. Second, biomechanics explored the mechanical aspects of human movement. It involved the examination of key concepts such as lift, buoyancy, gravity, and force, shedding light on how these factors influence human motion and performance. Lastly, motor learning investigated the intricate processes underlying behavioral change resulting from practice and experience. It delved into various topics, including techniques for enhancing motor performance and the role of physical activity in improving overall fitness levels. By incorporating these three subdisciplines, the study aimed to comprehensively explore different facets of physical education and provide valuable insights into the interplay between exercise physiology, biomechanics, and motor learning.

The ASK-PE (Assessment of Subdisciplinary Knowledge in Physical Education) knowledge test was administered online via email, allowing participants to complete it at their convenience. The estimated time required to complete the survey was approximately 30-40 minutes based on pilot testing. To ensure a comprehensive evaluation of teachers' knowledge and application of subdisciplinary concepts, a combination of multiple-choice and case-based questions was employed for each of the three content areas. These question formats had been shown to effectively elicit a nuanced understanding of subdisciplinary concepts. Table 5.1 provides examples of such questions.

Table 5.1

Example Questions of ASK-PE (See Appendix D for Full Version)

Exercise Physiology

(Multiple-choice question)

Q4. 12. Consuela has been riding the stationary bike for eight weeks in an effort to improve her cardiovascular fitness. She started riding at level one and is still riding at that level. Which fitness principle is she ignoring?

A. Interest
B. Progression
C. Regularity
D. Specificity

(Case-based questions)

Directions: Read the following comments about Nikki then answer questions 8-11 by marking the letter of the best answer on your answer sheet.

Nikki has never done cardiorespiratory exercise or lifted weights before, but she stretches twice a week. She is going to try out for her high school track team next semester, so as part of her training, she has asked a friend to teach her how to lift weights correctly.

Q4. 8. When Nikki adds more weight to her exercises as she gets stronger she is ____

A. risking injury
B. using the principle of specificity
C. using the principle of progression
D. ignoring a major principle of lifting

Q4. 10. Nikki's strength-training program should be set up ____

A. based on her starting abilities
B. based on the fitness scores for her age group
C. differently than a boy who has never lifted before
D. according to the work-out Muscle and Fitness magazine recommends for the women's national body building champion

Biomechanics

(Multiple-choice question)

Q5. 4. If a weight is held further away from the body, it will feel ____

A. bulkier
B. heavier
C. lighter
D. none of the above

(Case-based questions)

Directions: Read the following comments about Jamaal then answer questions 6-8 by marking the letter of the best answer on your answer sheet.

Jamaal's family is moving to another state, and he is helping pack the truck. He is the oldest of his brothers and sisters, so he is helping load the big items such as dressers and appliances. Jamaal has never played on any of his school's sport teams and he does not work out regularly.

Table 5.1 (cont.)

Q5. 6. When moving bulky things like large mirrors and bed mattresses, what is the best way for Jamaal to lift these types of things?

A. Use only his arms.
B. Bend at the waist with his knees locked.
C. Hold the item as far away from his body as possible.
D. Lift with his arms and legs, bend his knees, and keep his back straight.

Q5. 8. What is one way Jamaal can generate more force to pick up a heavy item?

A. Pick it up very slowly
B. Pick it up while running
C. Forcefully stretch his muscles just before lifting the item
D. Avoid stretching his muscles before lifting something heavy

Motor Learning

(Multiple-choice questions)

Q6. 14. When first learning how to do a set shot in basketball, your attention should be on ____

E. perfecting the skill.
F. how to shoot against a defender.
G. figuring out how to do the skill.
H. none of the above.

(Case-based question)

Directions: Read the following comments about Sarah then answer questions 2-4 by marking the letter of the best answer on your answer sheet.

Sarah has been challenged by her best friend to learn how to play soccer without instruction from anyone else. After getting some books from the school library, she has decided to start by teaching herself how to dribble.

Q6. 2. Which would be the best way for Sarah to start learning how to play soccer?

A. Run as fast as possible while trying to control the ball.
B. Dribble slowly until she gets used to moving with the ball.
C. Ask a friend to try and take the ball from her while she is learning how to dribble.
D. None of the above

Q6. 4. Once Sarah can dribble down the field without losing control of the ball, which would be the best way for her to get better?

A. Ask a friend to try to take the ball away from her.
B. Ask three people to try to take the ball from her at the same time
C. Keep practicing the same way she did when she started learning how to dribble
D. Change the way she practices by gradually adding more difficult objects to avoid

Data Analysis

Upon completion of the data collection process, the data were coded and entered to ensure accuracy and reliability. Data analysis was conducted using IBM SPSS software version 27.0, which is a widely recognized statistical analysis tool. Frequency analysis was performed to examine the distribution of variables. This analysis provided insights into the occurrence and prevalence of different response categories within each variable. To assess significant differences, independent t-tests were conducted on four key variables: exercise physiology, biomechanics, motor learning, and total scores. A power analysis, specifically utilizing Cohen's d effect size, was conducted to determine the statistical power of the study and ascertain the required sample size for detecting meaningful effects. Additionally, a one-way analysis of variance (one-way ANOVA) was conducted to investigate the impact of the NBC status on various factors, considering the following variables: gender (male, female), years of teaching (0-5, 5-10, 10 or more years), grade level of students (middle school, high school), education level (bachelor's, master's, doctorate), and class size (0-20, 21-30, 31-40, 41 or more students).

Results

Participants' Demographic Characteristics

The characteristics of the sample used in this study are shown in Table 5.2. Among the total 95 participants, 6.5% were in their 20s, 21.7% were in their 30s, 32.6% were in their 40s, 29.3% were in their 50s, 9.8% were in their 60s; 54.8% were female, and 45.5% were male; 84.6% were White/Caucasian. Table 5.2 provides additional characteristics for years of teaching, grades of teaching, education, and class size of total samples, and the characteristics of the sample according to whether or not NBC was achieved.

Table 5.2

Demographic Characteristics

Classification		Non-NBC (N=47)		NBC (N=48)		Total (N=95)	
		N	%	N	%	N	%
Age	20s	5	10.9	1	2.2	6	6.5
	30s	15	32.6	5	10.9	20	21.7
	40s	17	37.0	13	28.3	30	32.6
	50s	6	13.0	21	45.7	27	29.3
	60s	3	6.5	6	13.0	9	9.8
Gender	Female	23	50.0	28	59.6	51	54.8
	Male	23	50.0	19	40.4	42	45.2
Race	Asian	1	2.3	0	0.0	1	1.1
	Black/Africa	2	4.5	1	2.1	3	3.3
	Hispanic	1	2.3	3	6.4	4	4.4
	Middle Eastern	1	2.3	-	-	1	1.1
	Multiple Races	2	4.5	3	6.4	5	5.5
	White/Caucasian	37	84.1	40	85.1	77	84.6
Teaching years	0 ≤ years < 5	7	14.9	1	2.1	8	8.4
	5 ≤ years < 10	6	12.8	4	8.3	10	10.5
	10 < years	34	72.3	43	89.6	77	81.1
Teaching grades	Middle school	15	32.6	19	42.2	34	37.4
	High school	27	58.7	23	51.1	50	54.9
	Multiple Levels	4	8.7	3	6.7	7	7.7
Education	Bachelor's degree	9	19.1	5	10.6	14	14.9
	Master's degree	36	76.6	35	74.5	71	75.5
	Doctoral degree	2	4.3	7	14.9	9	9.6
Class size	0 ~ 20	3	6.4	7	14.6	10	10.5
	21 ~ 30	14	29.8	19	39.6	33	34.7
	31 ~ 40	20	42.6	18	37.5	38	40.0
	41 ~	10	21.3	4	8.3	14	14.7

Level of Knowledge According to NBC Achievement

The purpose of this study was to examine potential differences between NBC and Non-NBC physical education teachers' ASK-PE scores in the areas of exercise physiology, biomechanics, motor learning, and total ASK-PE scores. To this end, an independent t-test was

conducted (see results in Table 5.3). Overall, the mean motor learning score of those who achieved NBC was statistically higher than that of those who did not (t (93) = -2.26, p = .03). This indicates that the NBC process had a significant effect on improving motor learning scores.

Table 5.3

Level of knowledge according to NBC achievement

Domain	Non-NBC (N=47)		NBC (N=48)		*t*	*df*	*p*
	M	SD	M	SD			
Exercise Physiology	29.02	1.93	28.90	1.90	.32	93	.75
Biomechanics	25.00	4.13	24.98	3.08	.03	93	.98
Motor Learning	17.13	3.11	18.40	2.32	-2.26*	93	.03
Total Score	71.15	7.67	72.27	5.50	-.82	93	.41

Note. *p<.05,

Effect Size

This study further considered the effect size of the mean difference in order to demonstrate the validity of the study results. Cohen's d was examined (not significant: $d < .20$; small: $.20 \leq d < .50$; medium: $.50 \leq d < .80$; large $.80 < d$). Based on the results (see Table 5.4), the mean differences in exercise physiology, biomechanics, motor learning, and total scores between those with and without NBC resulted in the effect size of .06, .01, -.46, and -.17, respectively. The effect size of motor learning score difference exceeded the threshold of .20, so the effect size is considered to be small and significant. However, the effect size of exercise physiology, biomechanics, and the total score did not exceed the threshold of .20.

Table 5.4

Results of Cohen's d

Domain	Cohen's *d*
Exercise Physiology	.06
Biomechanics	.01
Motor Learning	-.46
Total Score	-.17

Note. Cohen's d criteria: Not significant <.20, .20 ≤ Small < .50, .50 ≤ Medium <.80, .80 ≤ Large

Level of Subdisciplinary Knowledge According to Sociodemographic Characteristics

This study further examined the difference in the level of knowledge of participants according to sociodemographic characteristics. For each of those who achieved NBC and those who did not, differences in knowledge levels according to gender, years of teaching, grades of teaching, education, and class size were analyzed.

Table 5.5 lists the t-test and ANOVA results of non-NBC participants. Regarding gender, the exercise physiology score ($t(44) = 2.33$, $p = .03$) showed significant differences according to gender. This means that the exercise physiology score of females was statistically higher than males.

For the year of teaching, statistical differences were not confirmed. The ANOVA results for grades of teaching were also not significant. Additionally, results of the level of education were not significant. Finally, the mean score differences based on the size of the class were not statistically significant. This series of ANOVA results indicate that the overall level of knowledge as well as the scoring in the content areas of exercise physiology, biomechanics, and motor learning of non-NBC participants were similar regardless of the year of teaching, grades of teaching, level of education, and class size.

Table 5.5

Level of kinesiology subdisciplinary knowledge according to sociodemographic variables of Non-NBC participants (N=47)

Variables		N	Exercise Physiology		Biomechanics		Motor Learning		Total Score	
			M	SD	M	SD	M	SD	M	SD
Gender	Female	23	29.61	1.37	23.83	3.71	17.35	2.92	70.78	6.31
	Male	23	28.35	2.21	26.00	4.33	16.91	3.41	71.26	9.02
	t		2.33*		-1.82		.47		-.21	
	df		44		44		44		44	
	p		.03		.07		.64		.84	
Teaching year	0 ≤ years < 5	7	29.14	2.19	23.14	6.12	16.43	4.86	68.71	11.29
	5 ≤ years < 10	6	28.67	2.58	24.17	3.25	17.67	1.63	70.50	4.68
	10 < years	34	29.06	1.81	25.53	3.78	17.18	2.94	71.76	7.33
	F (Tukey)		.12		1.11		.26		.47	
	df (between/within)		2/44		2/44		2/44		2/44	
	p		.89		.34		.77		.63	
Teaching grades	Middle school	15	28.73	2.09	25.47	3.46	16.80	1.42	71.00	5.69
	High school	27	29.04	1.83	24.44	4.64	16.96	3.89	70.44	8.95
	Multiple Levels	4	29.25	2.06	25.75	2.63	19.00	1.15	74.00	2.94
	F (Tukey)		.17		.38		.82		.37	
	df (between/within)		2/43		2/43		2/43		2/43	
	p		.85		.68		.45		.69	
Education	Bachelor's degree	9	28.89	1.76	24.22	5.38	16.00	4.06	69.11	9.53
	Master's degree	36	29.00	2.01	25.19	3.96	17.42	2.83	71.61	7.41
	Doctoral degree	2	30.00	1.41	25.00	0.00	17.00	4.24	72.00	2.83
	F (Tukey)		.27		.19		.74		.39	
	df (between/within)		2/44		2/44		2/44		2/44	
	p		.76		.83		.48		.68	
Class size	0 ~ 20	3	27.67	3.06	25.33	1.53	15.67	2.08	68.67	4.16
	21 ~ 30	14	29.21	2.12	25.64	2.98	17.57	1.34	72.43	5.06
	31 ~ 40	20	29.50	1.10	24.85	4.12	17.45	3.12	71.80	6.53
	41 ~	10	28.20	2.44	24.30	6.07	16.30	4.83	68.80	12.57

Table 5.5 (cont.)

F (Tukey)	1.62	.21	.61	.58
df (between/within)	3/43	3/43	3/43	3/43
p	.20	.89	.61	.63

Note. $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$.

The results of the t-test and ANOVA of NBC participants are provided in Table 5.6. Regarding gender, results indicated no significant score differences according to gender. The ANOVA results for grades of teaching were also not significant. Additionally, results of the level of education represented that there were no statistical differences dependent on the academic backgrounds of participants. Hence, this study confirmed that NBC participants' overall level of knowledge and specific knowledge of exercise physiology, biomechanics, and motor learning did not differ according to gender, grades of teaching, and level of education.

However, for years of teaching, there were significant differences in exercise physiology ($F(2, 45) = 3.88$, $p = .03$) and total ($F(2, 45) = 3.53$, $p = .04$) scores. Although post hoc analysis could not be conducted because the sample size of a certain group was one, this study found that NBC participants tend to have a higher level of overall and exercise physiology knowledge than other NBC participants when the years of teaching were more than 10 years. Lastly, for class size, motor learning ($F(3, 43) = 2.90$, $p = .04$) had a statistically significant difference according to the size of the class. These results indicate that there was no difference in the overall and exercise physiology and biomechanics knowledge of NBC participants depending on the number of students, but there was a meaningful difference in the knowledge level of motor learning. Specifically, as a result of post hoc analysis using the Tukey method, the motor learning knowledge level of NBC participants was significantly higher when the class size was 31 to 40

than when the size was 0 to 20. Class size between 21-30 and class size above 40 groups were not statistically different from other class size groups.

Table 5.6

Level of kinesiology subdisciplinary knowledge according to sociodemographic variables of NBC participants (N=48)

Variables		N	Exercise Physiology		Biomechanics		Motor Learning		Total Score	
			M	SD	M	SD	M	SD	M	SD
Gender	Female	28	28.79	1.99	24.25	3.27	18.46	2.32	71.50	5.30
	Male	19	29.11	1.85	25.89	2.56	18.16	2.36	73.16	5.80
	t		-.56		-1.84		.88		.91	
	df		45		45		45		45	
	p		.58		.07		.66		.32	
Teaching year	0 ≤ years < 5 [a]	1	25.00		20.00		21.00		66.00	
	5 ≤ years < 10 [b]	4	27.50	1.29	22.50	4.65	16.50	1.91	66.50	7.51
	10 < years [c]	43	29.12	1.83	25.33	2.79	18.51	2.29	72.95	5.02
	F (Tukey)		3.88*		3.13		2.11		3.53*	
	df (between/within)		2/45		2/45		2/45		2/45	
	p		.03		.05		.13		.04	
Teaching grades	Middle school [a]	19	29.32	1.53	24.68	2.91	18.32	2.00	72.32	4.45
	High school [b]	23	28.48	2.17	25.57	3.15	18.91	2.48	72.96	6.02
	Multiple Levels [c]	3	28.33	2.31	22.67	4.93	16.00	2.00	67.00	8.54
	F (Tukey)		1.08		1.28		2.26		1.52	
	df (between/within)		2/42		2/42		2/42		2/42	
	p		.35		.29		.12		.23	

Table 5.6 (cont.)

Education	Bachelor's degree [a]	5	28.20	2.49	23.60	3.05	18.40	2.70	70.20	6.14
	Master's degree [b]	35	29.03	1.74	24.86	3.08	18.34	2.20	72.23	5.01
	Doctoral degree [c]	7	28.71	2.56	26.14	3.13	18.29	2.98	73.14	7.69
	F (Tukey)		.43		1.02		.01		.42	
	df (between/within)		2/44		2/44		2/44		2/44	
	p		.65		.37		.99		.66	
Class size	0 ~ 20 [a]	7	29.00	1.83	24.43	1.90	16.71	1.70	70.14	4.63
	21 ~ 30 [b]	19	29.00	2.03	25.21	3.21	18.11	2.00	72.32	5.50
	31 ~ 40 [c]	18	29.11	1.84	25.44	3.42	19.44	2.23	74.00	5.58
	41 ~ [d]	4	27.25	1.50	22.75	2.22	18.00	3.56	68.00	4.40
	F (Tukey)		1.11		.94		2.90* (a<c)		1.84	
	df (between/within)		3/43		3/43		3/43		3/43	
			.36		.43		.04		.15	

Note. $^{*}p<.05$, $^{**}p<.01$, $^{***}p<.001$.

Discussion

To summarize, the results of this study indicate a potential positive influence of attaining NBC on performance of the motor learning portion of the ASK-PE knowledge test. The findings demonstrate a statistically significant difference in motor learning scores between physical education teachers who possess NBC accreditation and those who do not. However, no notable disparities were observed in the overall scores, exercise physiology, or biomechanics between the two groups. Effect size analysis provides additional support for the small yet significant effect of NBC on motor learning scores. In contrast, no significant effect size was observed for exercise physiology, biomechanics, and total scores.

Several factors could explain the higher scores observed in NBC participants. One possible explanation is that the NBC process may imply an inherent emphasis on improving

techniques and strategies for teaching motor learning concepts. This specialized training may have equipped certified individuals with a deeper understanding of effective instructional methods for motor skill acquisition, leading to improved motor learning test scores compared to non-certified individuals.

However, the lack of significant differences between NBC physical education teachers and non-NBC physical education teachers in terms of total scores, exercise physiology, and biomechanics raises interesting questions about the scope and focus of the NBC process. This finding aligns with previous research that the NBC process, in actuality, primarily emphasizes pedagogical aspects such as effective teaching practices (Woods & Rhoades, 2013) even though physical education standards officially mention both pedagogical and content knowledge as a focus in this certification process (NBPTS, 2014). Given that motor learning, which involves the acquisition and improvement of new skills through practice, incorporates both educational and scientific elements in its study of how individuals develop and enhance motor abilities (Nieuwboer et al., 2009), it is reasonable that NBC teachers who possess both pedagogical experience, knowledge, and experience in the NBC process would achieve higher scores in the motor learning section. Consequently, it is plausible that individuals with and without NBC accreditation may possess similar levels of knowledge and understanding in the non-pedagogical content areas of exercise physiology and biomechanics. This can be attributed to the insufficient emphasis placed on developing content knowledge in exercise science focused within the NBC process.

It is crucial to examine the actual training process provided by the NBC process in developing and applying content knowledge for physical education teachers. This is especially important considering their official documentation that highlights the significance of applying

content knowledge, such as exercise physiology, biomechanics, and motor learning, in their teaching practices (NBPTS, 2014). To meet the expectations outlined in the NBC's official document and the instructional practices within the NBC certification process, the process should equip physical education teachers with the skills and competencies necessary to enhance their teaching practices and ultimately, improve student learning outcomes by providing comprehensive training in the application of content knowledge in teaching. This certification should emphasize labs, classroom observations, and reflective teaching practices as a means of preparing for the real world. Teachers are encouraged to apply acquired content knowledge to real-world teaching situations, receive feedback from experienced mentors, and continuously improve their teaching approach through self-reflection. By integrating content knowledge application throughout the certification process, teachers can develop the skills necessary to effectively translate theoretical concepts into practical teaching strategies (NBPTS, 2014). Thus, further research is necessary to determine the gap between what is actually included in the curriculum and what is taught in the NBC certification program as physical education teachers through in-depth qualitative investigation.

One intriguing aspect from the results of this study is that it is speculated that individuals holding NBC certification have a higher awareness of the importance of kinesiology subdisciplinary knowledge compared to non-NBC certified individuals. The NBC physical education teachers may make greater efforts to incorporate kinesiology subdisciplinary knowledge into their teaching. This was demonstrated among NBC physical education teachers with over 10 years of teaching experience having a higher total score. This may be attributed to their heightened interest and commitment to continuous learning of kinesiology subdisciplinary knowledge. The emphasis on kinesiology subdisciplinary knowledge, particularly in the domain

of exercise physiology, suggests that physical education teachers with NBC possess a greater inclination towards learning and applying physiology-related concepts in physical education teaching. Positioning exercise physiology as a core subdisciplinary subject suggests the potential influence of NBC certification on teachers' professional development. NBC physical education teachers may actively seek opportunities to enhance their understanding of physiology and explore its practical applications in their teaching contexts. However, to fully comprehend the underlying causes of these results, further research is necessary.

Although this study offers valuable insights, it has some limitations. First, the sample size was relatively small which may have limited the generalizability of the findings to a broader population. Increasing the sample size and diversity of the sample could provide a better understanding of the research topic, allowing for a more comprehensive generalization. The second limitation of this study included the narrow focus on only three aspects of kinesiology subdisciplines, including exercise physiology, biomechanics, and motor learning. This study did not encompass the entirety of knowledge within the field of kinesiology, a broad applied science that explores various facets of human movement. While the measurement of these three specific areas aligned with the emphasis of most PETE programs, it failed to account for other domains of kinesiology subdisciplines such as exercise nutrition, exercise psychology, sports medicine and additional related subdisciplines. Therefore, generalizability of the findings of this study may be limited, given the existence of other important areas of knowledge within the broader field of kinesiology.

Conclusion

In conclusion, this study examined the impact of NBC certification on the level of knowledge of physical education teachers in the subdisciplines of exercise physiology, biomechanics, and motor learning. The results indicated that NBC certification has a small yet significant effect on motor learning scores but does not have a meaningful impact on exercise physiology, biomechanics, or total scores. The findings suggest that the NBC certification process may equip certified individuals with deeper understanding of effective instructional methods for motor skill acquisition, leading to improved motor learning scores compared to non-certified individuals. However, the lack of significant differences between NBC and non-NBC physical education teachers in the areas of exercise physiology and biomechanics suggests that the NBC certification program may be more focused on pedagogical aspects rather than content knowledge. Future research should investigate the gap between what is actually required in the NBC certification program and the content knowledge application skills of physical education teachers. Although this study has limitations, the findings provide valuable insight into how NBC certification affects teachers' knowledge in exercise physiology, biomechanics, and motor learning.

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CHAPTER 6: PHYSICAL EDUCATION TEACHERS' PERCEPTIONS OF KINESIOLOGY SUBDISCIPLINARY KNOWLEDGE AND ITS APPLICATIONS

Teachers' content knowledge plays a vital role in effective teaching, which promotes student learning (Siedentop, 2002; Ward, 2009). Substantial research (Ingersoll et al., 2014; Miller & Housner, 1998; Siedentop, 2002; Ward, 2009) and the professional organization National Association of Sport and Physical Education (2008) indicate that teachers should acquire "scientific and theoretical knowledge" of physical activity and that Physical Education Teacher Education (PETE) programs should include coursework related to the subdisciplines of kinesiology. Ingersoll et al. (2014) note that the limited subject matter knowledge of pre-service teachers can limit their teaching flexibility. This is mainly because physical education teachers who have sufficient subdisciplinary knowledge can provide high-quality programming to develop students' physical activity, positive attitudes, and skills that promote the development of healthy lifetime habits (Miller & Housner, 1998).

Nevertheless, uncertainty remains about the role and importance of subdisciplinary knowledge in practice (Herold & Waring, 2009). Herold and Waring (2009) contend that an overemphasis on subdisciplinary knowledge can decrease students' concentration. According to Tinning (2002), subdisciplinary knowledge is an essential factor but insufficient in the improvement of teachers' teaching quality. He also notes that because content knowledge (i.e., subdisciplinary knowledge) is not a sufficient factor for effective teaching, other factors, such as the teacher's attitude, ability to connect with students, and proficiency of facilitating the general purposes of physical education should be considered as important as content knowledge.

Furthermore, Capel (2007) argues that an overemphasis on subdisciplinary knowledge potentially hinders the emergence of effective, pupil-centered pedagogies.

As noted, the measurement of teaching proficiency is complex. To recognize highly qualified teachers who adhere to rigorous standards, the National Board for Professional Teaching Standards (NBPTS) initiated its certification process in 1994. This initiative aims to recognize highly qualified teachers who adhere to rigorous standards. Covering 25 distinct subject areas (NBPTS, 2014; NBPTS, 2021), the standards for physical education were developed based on five central tenets comprised of commitment, knowledge, responsibility, systematic thinking, and learning communities (NBPTS, 2014). Specifically, Standard 2 for the subject area of physical education, as specified by the National Board for Professional Teaching Standards (NBPTS, 2014), requires that certified teachers possess an understanding of and the ability to apply knowledge in relevant subject matter domains, including exercise physiology, biomechanics, and motor learning.

In addition to the competencies addressed by the NBPTS, factors related to the socialization process can also contribute to teachers' application of knowledge. Occupational socialization theory (Lawson, 1983a, 1983b) has been the dominant perspective in investigating careers in physical education for prospective, pre-service, and in-service teachers (Richards et al., 2019). This process includes acculturation or pretraining socialization, professional socialization in university teacher education programs, and organizational socialization within the school environment (Templin & Schempp, 1989).

Because the theory has provided a wealth of information on why physical education teachers think and act as they do (Curtner-Smith, 2009), this framework, for the current study, will help to provide an understanding of physical education teachers' perceptions and application

of subdisciplinary knowledge in kinesiology. Based on occupational socialization theory (Richards et al., 2019; Templin & Schempp, 1989) and knowledge as a grounding framework, the goal of the study was to investigate the extent to which subdisciplinary knowledge is valued by physical education teachers and how crucial it is to their teaching of physical education, as well as how they use this knowledge in their instructional strategies.

Theoretical Framework

Knowledge

In the mid-1980s, a new area of investigation was the concept of teacher content knowledge, and Shulman (1987) presented teacher knowledge in seven categories: (a) content knowledge, (b) general pedagogical knowledge, (c) curriculum knowledge, (d) pedagogical content knowledge, (e) knowledge of learners, (f) knowledge of educational contexts, and (g) knowledge of educational aims, purposes, and values. The first category, referred to as content knowledge, pertains to the quantity and organization of knowledge of a teacher. Shulman presented various perspectives, such as Bloom's cognitive taxonomy, Gagne's varieties of learning, Schwab's distinction of content knowledge (substantive and syntactic knowledge), and Peter's conceptualizations of content knowledge, to interpret this concept. The second category, known as general pedagogical knowledge, encompasses broad principles and strategies for managing a classroom. Essentially, it encompasses "knowledge about teaching methods that are applicable to all subjects and situations" (Metzler, 2011, p. 46). The next category, curriculum knowledge, involves understanding the materials and programs available to teachers (Shulman, 1987). Specifically, it refers to knowledge of how to organize and teach a specific curriculum to a particular group of students at a specific level (Shulman, 1986). Pedagogical content knowledge, the fourth category, represents a unique blend of content and pedagogy that is exclusive to

teachers and their specialized professional understanding (Shulman, 1987). The fifth category, knowledge of learners, pertains to a teacher's understanding of their students' characteristics and backgrounds (Shulman, 1987). The sixth category, knowledge of educational contexts, encompasses "the knowledge of the contexts from the workings of the group or classroom, the governance and financing of school districts, to the character of communities and cultures" (Shulman, 1987, p. 8). The final category, knowledge of educational purposes, and values, encompasses a teacher's philosophical and historical underpinnings (Shulman, 1987).

Subdisciplinary Knowledge

According to Shulman (1986), content knowledge encompasses the concepts, principles, and skills specific to a particular subject area. While the categorization of subdisciplinary knowledge in physical education research lacks precision, previous studies have conducted on the assumption that subdisciplinary knowledge, including areas such as physiology, biomechanics, and sport psychology, falls within the scope of content knowledge (Castelli & Williams, 2007; Fernéndez-Balboa et al., 1996; Solmon, 2021). In this study, using Schwab's (1964) perspective of substantive knowledge as a basis, subdisciplinary knowledge is defined as principles and concepts specific to the subject area. Exercise physiology, biomechanics, motor learning, and other subdisciplines in kinesiology are included in physical education as examples of subdisciplinary knowledge in kinesiology (Hetland & Strand, 2010).

Occupational Socialization Theory

A theory of workplace socialization, called occupational socialization theory (OST) (Lawson, 1986), is used to examine "all the kinds of socialization that initially influence persons to enter the field of physical education and that later are responsible for their perceptions and actions as teacher educators and teachers" (Lawson, 1986, p. 107). As such, physical education

scholars employ occupational socialization theory as a perspective through which to comprehend how individuals are recruited, trained, and socialized into the physical education profession (Templin & Schempp, 1989). More recently, Richards and Gaudreault (2017) described how OST has become a theoretical foundation for the development of PETE programs and provides an explanation of the recruitment, education, and ongoing socialization of physical education teachers. Scholars who utilize OST typically use a dialectical approach to examine the socialization process (Richards & Templin, 2019). This positions individuals as proactive agents in their own socialization because it acknowledges that recruits into the physical education field can use their voices or perceptions of agency to oppose the influence of those whose goal is to socialize them into the profession. Contrary to structural-functionalist viewpoints, the dialectical view acknowledges the capacity of individuals to resist the influence of others and of the institutions that strive to socialize them (Schempp & Graber, 1992). Occupational socialization theory can be divided into the three phases: acculturation, professional socialization, and organizational socialization with a time-oriented continuum (Lawson, 1986; Richards et al., 2019). These phases are detailed in the following sections.

Acculturation

Acculturation represents the pretraining socialization that takes places prior to formal training for job roles (Curtner-Smith, 2017). Through interactions with significant socializing agents, including teachers, coaches, counselors, and family members, individuals learn what it means to be a physical education teacher before entering PETE programs (Lawson, 1983a; Valtonen et al., 2015). In other words, through interactions with their own teachers and coaches, prospective recruits gain their first impressions of the job (Curtner-Smith et al., 2008). This process is known as an apprenticeship of observation (Lortie, 1975) and distinguishes

recruitment into the teaching profession from other fields (Richards & Templin, 2019). Throughout this formative education, students observe the practices of their teachers for more than 13,000 hours (Lortie, 1975). As recruits interact with their own teachers and coaches during their apprenticeship of observation, these experiences ultimately form their subjective theories or initial impressions concerning teachers' responsibilities for the education of primary and secondary school students in physical education (Curtner-Smith, 2017; Richards et al., 2013). The term "subjective theories" was coined by Grotjahn (1991) to refer to "complex cognitive structures that are highly individual, relatively stable, and relatively enduring, and that fulfill the task of explaining and predicting such human phenomena as action, reaction, thinking, emotion and perception" (p. 188). Ultimately, these are firmly ingrained through the acculturation process, yet because they are exclusively dependent on student experiences rather than teacher experiences, they do not give recruits with a deep understanding of the technical aspects of teaching (Templin & Schempp, 1989).

In addition, during this experience, students form preferences for the positions of physical education teacher and athletic coach as part of their subjective theories (Richards & Templin, 2012). Individuals who are more coaching-oriented frequently adopt custodial teaching concepts while possessing a low commitment to teaching, and they consider physical education teaching to be a career contingency for their genuine enthusiasm for coaching (Curtner-Smith, 2017; Curtner-Smith et al., 2008; Millslagle & Morley, 2004). Furthermore, males who focus on coaching are more likely to have substantial experience in team sports at elite levels and to have had poor school physical education experiences (Curtner-Smith, 2001; Stran & Curtner-Smith, 2009). In contrast, those who are more interested in teaching view teaching physical education as their main professional goal. These recruits are more likely to be females who engaged in

recreational individual sports or other forms of exercise and had access to high-quality physical education throughout acculturation (Curtner-Smith, 1997).

Professional Socialization

Following acculturation, the professional socialization phase begins when individuals enroll in their teacher education programs with the goal of becoming physical education teachers (Lawson, 1983a). During this stage of socialization, individuals acquire knowledge, skills, and dispositions that teacher educators deem important in the teacher education program (Richards et al., 2014). Based on the subjective theories they have acquired through acculturation, recruits enter PETE programs with their own beliefs regarding what these programs should provide (Graber et al., 2017). Student resistance to the socialization process occurs among those whose subjective theories conflict with the objectives expressed by PETE faculty members (Richards et al., 2013). However, Schempp and Graber (1992) stress that recruits cannot be expected to accept all of the knowledge, values, and beliefs communicated by teacher educators because all socialization, including professional socialization, is dialectical, and pre-service teachers' subjective theories are not easily changed (Graber, 1989). Additionally, due to their insufficient technical understanding of the profession, many of these subjective theories are inaccurate or incomplete (Templin & Richards, 2014). Thus, teacher educators must be willing to discuss and negotiate with recruits regarding their preexisting views and experiences to successfully socialize them into teacher education programs (Schempp & Graber, 1992).

Organizational Socialization

The third phase of occupational socialization theory is organizational socialization, which occurs when individuals begin their teaching careers (Lawson, 1983a). According to Van Maanen and Schein (1979), "organizational socialization is a jejune phase used by social

scientists to refer to the process by which one is taught and learns the ropes of a particular organizational role" (p. 211). This phase of occupational socialization places an emphasis on continued socialization throughout a teacher's career (Woods & Lynn, 2014). In other words, within a particular school context, teachers create a culture that influences the actions, behaviors, and philosophical orientations of their teaching (Feiman-Nemser & Folden, 1984). Despite Lawson's (1989) prediction that the shift from student to teacher should be generally smooth, some new teachers actually encounter a challenging transition that is marked by frustration and discontent (Stroot & Ko, 2006; Veenman, 1984). Given that school cultures frequently uphold the status quo rather than embracing innovation (Curtner-Smith et al., 2008), many physical education teachers confront the additional difficulty of marginalization because the subject of physical education is frequently perceived as a marginal subject within the school curriculum (Ensign et al., 2017). For this reason, physical education teachers may find the shift from student to teacher much more challenging than general education teachers due to the marginalization of their subject matter (Lux & McCullick, 2011).

Relationship Between Teacher Socialization and Subdisciplinary Knowledge

To summarize, socialization is the overarching process of learning the skills, knowledge, values, and norms of the social group or institution to which an individual aspires to belong (Billingham, 2007) while teacher socialization is the complex process in which "people selectively acquire the values and attitudes, the interests, skills and knowledge—in short the culture—current in groups to which they are, or seek to become, a member" (Merton et al., 1957, p. 287). Accordingly, OST is the framework that guides the current study. This provides an explanation of how teachers are trained and how subdisciplinary knowledge is acquired through the three phases of socialization. It is reasonable to examine teacher knowledge though the lens

of OST because the definition involves the process of individuals learning about "knowledge." The next several sections will describe the acquisition and application of subdisciplinary knowledge during the various phases of OST.

Subdisciplinary Knowledge in Acculturation

Physical education involves addressing the cognitive domain of students along with the psychomotor and affective domains because students' performances are closely related to the knowledge they possess in the cognitive domain (Ayers, 2002). According to Curtner-Smith et al. (2008), acculturation is "the most potent type of socialization experienced by PE teachers" (p. 99). Because acculturation has a significant role to play in shaping future teachers' perspectives, it is an influential phase of socialization that must be understood (Richards et al., 2014). Although physical education pedagogy and theory have progressed over the years (e.g., Ennis, 2017; Kirk et al., 2006; Silverman & Ennis, 2003), many potential recruits continue to experience physical education that is characterized by inappropriate practices. These practices include delivering physical education as recess, punishing students with exercise, assessing effort and appropriate clothing, and failing to adhere to state and national standards (Barney & Leavitt, 2022). Interestingly, while research indicates that the students who develop high subjective warrants for physical education tend to have extensive backgrounds in sports and physical activity and enjoyed physical education as children (Curtner-Smith & Sofo, 2004; Dodds et al., 1991), other evidence specifies that some recruits who have experienced low-quality school physical education select the physical education profession in an effort to educate in a better way than their own teachers (Stran & Curtner-Smith, 2009). Thus, it is valuable to examine how individuals' physical education experiences during acculturation effect their perceptions and applications of knowledge.

Subdisciplinary Knowledge in Professional Socialization

Similar to the acculturation phase, subdisciplinary knowledge as connects to next phase of socialization. Lawson (1983a, 1986) states that the process of professional socialization begins when new recruit enrolls a teacher education program, often in a college or university setting. PETE students are expected to obtain knowledge and develop a professional identity while thinking and acting as physical education teachers in a school setting (Pike & Fletcher, 2014; Templin & Schempp, 1989). A major goal of teacher education programs is to produce competent primary and secondary school teachers (Grant et al., 1999; Lewis et al., 1999). Despite the fact that academic studies have focused on a number of facets concerning what is required to be a competent teacher, four pertinent components have been identified and are frequently mentioned in the literature: (a) content knowledge, (b) pedagogical knowledge, (c) pedagogical skills, and (d) attitudes (Casey & Childs, 2007). Principally, in terms of content knowledge, according to Bulger et al. (2008), quality PETE programs provide PETE students with knowledge of the physiology, anatomy, and neuromuscular systems of the human body as well as an awareness of how these systems function. However, many PETE programs do not include appropriate subdisciplinary knowledge courses (Bulger et al., 2008). For example, according to the findings of Herold (2013)'s study, all participants expressed concerns about their limited content knowledge and highlighted that their undergraduate courses did not adequately equip them with the necessary content knowledge required for their teaching practice.

Subdisciplinary Knowledge in Organizational Socialization

Because of the lack of emphasis on subdisciplinary knowledge within PETE curricula, the teaching performance of physical education teachers is affected. The term "knowledge obsolescence" refers to a teacher's content knowledge being out of date to the extent that the

information they are providing to students is no longer adequate (Lawson, 1993). According to Templin et al. (2011), engaging in professional development during organizational socialization empowers teachers and better prepares them for their profession. To prevent knowledge obsolescence, professional development programs should encourage teachers to remain current in their field (Lawson, 1993). As noted by Templin et al. (2011), engaging in ongoing professional development may be one way that novice teachers can better avoid the challenges of organizational socialization. In many schools, however, teachers are not offered a wide variety of professional development opportunities and may not have access to the resources they need to participate in professional development (Doolittle & Schwager, 1989; Templin, 1989). The role of professional organizations in the continuous development of teacher's knowledge may be significant (Kneer, 1989), but little research has been conducted on the relationship between organizational socialization and professional organizations.

Given that OST provides a framework to identify individuals' values and subject warrants (Lawson, 1986), it is important to understand how in-service teachers' perceptions regarding application of subdisciplinary knowledge in physical education are formed by each phase of socialization, as well as how these perceptions affect their ability and desire to incorporate subdisciplinary knowledge into their teaching physical education.

Method

Design and Participants

In this study, a qualitative approach was employed to capture the perceptions of National Board Certification (NBC) and non-NBC physical education teachers regarding the application of kinesiology subdisciplinary knowledge. Qualitative research method, as a systematic and empirical strategy, aims to answer questions about people within a specific social context

(Locke, 1989). It excels in clarifying situations with unclear variables, explaining unexpected intervention effects, offering new perspectives on familiar problems, and understanding participant perceptions of tasks, policies, roles, and systemic elements (Locke, 1989). As such, by adopting a qualitative approach, this study seeks to delve into the subjective experiences and perspectives of NBC and non-NBC physical education teachers, shedding light on how they perceive and apply the subdisciplinary knowledge of kinesiology.

The participants of this study consisted of both NBC and non-NBC physical education teachers who were currently employed as in-service physical education teachers at secondary-level schools (i.e., middle or high schools) in the United States. The number of participants were total 30, 15 NBC and 15 non-NBC physical education teachers. From the pool of participants who agreed to participate, a random sampling method was used to select 15 participants from each group. Then, they were invited to participate in a semi-structured interview via Zoom or phone according to the participant's preference. Participants were recruited by email. NBC physical education teacher participants were recruited from the directory available on the NBCT website (https://www.nbpts.org/nbct-search/). Meanwhile, non-NBC physical education teachers were selected from the National Center for Education Statistics (NCES) publicly accessible database of schools. The emails provided participants with a brief overview of the study and requested their agreement to participate. Then, participants who agreed were asked to take part in an interview to delve deeply into their perceptions and application of subdisciplinary knowledge in their teaching.

Data Collection

One individual semi-structured interview was conducted with those selected with random sampling and who agreed to participate. The purpose of it was to gain a deeper understanding of

how in-service physical education teachers perceive and use subdisciplinary knowledge in their teaching (Patton, 2015). The semi-structured interview was designed based on the theoretical framework of OST. Specifically, the interview guide focused on the following: (a) perceptions of subdisciplinary knowledge of kinesiology through the three phases of occupational socialization theory and (b) application of subdisciplinary knowledge of kinesiology in teaching physical education. Additionally, for teachers with NBC certification, questions related to experiences of subdisciplinary knowledge during the NBC certification process were included during the interview process. Each interaction lasted approximately 45 minutes and was audio-recorded and transcribed verbatim.

Data Analysis

A grounded theory approach was applied to the qualitative analysis of the data (Glaser & Strauss, 1967; Strauss & Corbin, 1998). The analysis of all interviews involved the application of open-ended and axial techniques as described by Corbin and Strauss (2008). The raw interview data were conceptualized and categorized during open coding procedures. Next, axial coding was used to reassemble "data that were fractured during open coding" (Strauss & Corbin, 1998, p. 124). This involved both inductive and deductive analysis (Glaser & Strauss, 1967; Patton, 2015), and the analyses were interpreted through the lens of the guiding framework, occupational socialization theory (Patton, 2015).

Trustworthiness

To establish the trustworthiness of this qualitative research, Guba's (1981) recommendations were applied. To accomplish this, the entire process of this study, including data collection and methods, were documented. A member check regarding the interview data and its interpretation was conducted (Lincoln & Guba, 1985; Patton, 2015); a detailed

methodological description was included, so readers can evaluate whether this study is confirmable (Shenton, 2004); and the non-numerical data were described in a rich, detailed, and comprehensive way to improve transferability (Lincoln & Guba, 1985). As part of the process to establish the trustworthiness of this research, triangulation was used through member checking, peer debriefing, and employing multiple interviewers as well (Patton, 2015).

Results

This research examined the perceptions of subdisciplinary knowledge and how physical education teachers applied this knowledge when teaching physical education. The goal of the study was to investigate the extent to which subdisciplinary knowledge is valued by physical education teachers and how crucial it is to their teaching of physical education, as well as how they use this knowledge in their instructional strategies. The findings of the study revealed three primary themes: *(a) perceptions of the presence of subdisciplinary knowledge in physical education contexts*, *(b)subdisciplinary knowledge enhances instruction*, and *(c)barriers facing the integration of subdisciplinary knowledge in physical education*. Furthermore, the study examined physical education teachers' barriers when they applied subdisciplinary knowledge in their teaching including both internal and external factors. The next several sections will address the three primary themes

Perceptions of the Presence of Subdisciplinary Knowledge in Physical Education Contexts

The study found that both NBC and non-NBC physical education teachers shared similar perceptions and understandings of subdisciplinary knowledge during the three socialization phases, except for organizational socialization.

Acculturation

Participants were asked to consider their experiences during their own K-12 physical education related to how subdisciplinary knowledge was used by their teachers. Most indicated that their K-12 education experiences were structured to prioritize the development of affective and psychomotor domains rather than cognitive outcomes. Both an NBC and a non-NBC reported:

> NBC, David: I don't know that I actually remember the game part of it, being exercise science-based. It was more of the affective domain and the behavioral domain and not so much the cognitive part of it. NBC, Matthew: I couldn't say it was science-based because I don't think any of the physical education classes in the 80's were science-based. Non-NBC, Douglas: I would say not having any guidance (learning kinesiology subdisciplinary knowledge) in retrospect has been a blessing because it has sparked my curiosity and my hunger to learn…. I did not become interested in health or exercise and fitness because of my negative experience. The writing was on the wall that movement, muscles, fitness, that's the direction I was going to go. My lack of education didn't fuel the passion but my lack of education fueled my passion for learning about it maybe.

These narratives provide insight into the experiences and motivations of individuals in the field of physical education. Results indicate that most participants' physical education teachers did not directly design their classes based on exercise science principles and did not explicitly incorporate exercise science theories into the physical education curriculum. However, both the NBC and non-NBC participants demonstrated a high level of motivation towards the value of physical education, regardless of whether they received subdiscipline-based physical education experiences during their acculturation stage.

Professional Socialization

Dorothy, classified as NBC, and Ellis, classified as non-NBC, shared their perspectives on the subject matter taught in their PETE programs. The narrative indicated that the participants, both NBC and non-NBC, had positive experiences acquiring knowledge in subdisciplinary knowledge in kinesiology during their PETE program. However, they noted that the challenge of effectively applying this content in their physical education classes as teachers was difficult or often irrelevant. They stated the following:

> NBC, Dorothy: I think in the universities it can be a little bit too technical and too complicated. It's my thoughts. The Krebs cycle, glycolysis, I don't know if you need to know exactly everything about that. I think you just need more general teachable kid-friendly language.
>
> non-NBC, Ellis: The simpler stuff is what they're (pre-service physical education teachers) going to understand. They don't need to know about nerves. They don't need to know the meaning. Long muscles, short muscles, joints, they don't need to know that.

According to both of these physical education teachers, the PETE curriculum that they experienced was too complicated and technical for pre-service physical education teachers to properly comprehend and implement in curricula for K-12 students. In addition, both physical education teachers contended that their PETE programs might need to provide more opportunities for PETE candidates to apply concepts and principles of subdisciplinary courses in kinesiology during preparatory teaching experiences. The majority of participants felt that their PETE experiences were beneficial, but they also highlighted areas for improvement because of the reasons mentioned above.

Organizational Socialization

Through observation, it was noted that similarities and contrasts exist between the perceptions of NBC and non-NBC physical education teachers during organizational socialization. For example, both groups emphasized the importance of incorporating exercise science knowledge into specific units of physical education classes, such as fitness units, indicating a common understanding of its significance. NBC Debra and non-NBC Perry explained:

> NBC Debra: The reason, I just believe that's true that they need more information to be able to create their own personalized (fitness plan), so that individually, it helps them in their fitness, and as you said, nutrition, more than the movement.
>
> non-NBC Perry: I think it may depend on what you're teaching. If you are in weight training, then I think it's got to be central that you must be strong in exercise science. If you are a teacher on the outside, which is like mainly is teaching games and volleyball or football or tennis or whatever it is, then I don't think it is as important. I'm not saying it's not important. I don't think it is as important as if you are particularly in weight training because now, that's a totally different thing because now you're talking about safety.

The narratives provided by NBC Debra and non-NBC Perry reflect similar opinions on the importance of subdisciplinary knowledge of kinesiology in certain physical education teaching units. Although these views do not represent all participants, and conflicting opinions persist in the results analysis, both physical education teachers believed that teachers need more subdisciplinary knowledge of kinesiology in order to create personalized fitness and nutrition plans for their students, and they considered exercise science to be central to this process. In

particular, subdisciplinary knowledge may be particularly important for teachers in fitness units due to the focus on safety,

In contrast, a notable difference between NBC and non-NBC physical education teachers during organizational socialization was their perceptions of the application of subdisciplinary knowledge in their teaching of physical education. This distinction is derived from professional development experiences such as NBC. This process includes continued learning and application of necessary subdisciplinary knowledge of kinesiology, such as exercise physiology, biomechanics, and sports nutrition. NBC Dennis stated the following:

> NBC, Dennis: You had to film yourself and watch your own teaching and watch for certain things within your video. Noticing where in my own teaching, I explicitly explained exercise sports science type principles, versus where I either inferred or implicitly assumed students might have that knowledge. What I learned from the video is that I need to be even more explicit and clear and not assume that students know what I'm talking about or that they understand. That I need to spell it out more for them especially that I have a lot more academic knowledge than them through college and master's programs and everything, and they're just high school students.

On the other hand, non-NBC physical education teachers held a negative perspective regarding the application of subdisciplinary knowledge, attributing this to their students' limited attention span and their preference for more physically demanding activities during physical education classes. For example, non-NBC Perry described the following:

> non-NBC, Perry: At the same time, I don't tend to go as deep because when you're dealing with this generation of kids now, their attention span is very short because of, obviously, because of electronics and so on and so forth. This helps shorten their

attention span. Now, when I try to go through in-depth physiology, I don't go as deep. I touch on some things, so I can have a general knowledge. So they can, and then, they can progress from there.

This revealed that both NBC and non-NBC physical education teachers had similar perceptions and understandings of subdisciplinary knowledge during the three socialization phases, except for organizational socialization. They both stressed the importance of integrating exercise science knowledge into specific units of physical education classes, such as fitness units. Nevertheless, a noticeable disparity arose in their approaches to applying kinesiology subdisciplinary knowledge in their teaching, which was influenced by their National Board Certification. NBC physical education teachers demonstrated a stronger commitment to explicitly teach exercise science principles, whereas non-NBC physical education teachers tended to adapt their teaching depth due to students' limited attention spans and preference for more physically demanding activities.

Subdisciplinary Knowledge Enhances Instruction

The theme of "subdisciplinary knowledge enhances instruction" encompasses teaching approach, lesson plan approach, and integrated approach as subthemes.

Teaching Approach

To begin, the subtheme "teaching approach," pertains to the utilization of subdisciplinary knowledge in kinesiology by physical education teachers in their teaching practices. To begin, data obtained from NBC physical education teachers revealed their incorporation of subdisciplinary knowledge into their instructional strategies for the purpose of providing a conceptual understanding of the physical activities performed in the physical education classroom. For example, NBC teachers Andy and Howard stated the following:

NBC, Andy: I spend a lot of time showing (throwing the ball) them and putting their action, placing their opposite foot and their arm and showing them and just turning them. That to me is a very basic example of the mechanics that somebody should be knowing that and should be teaching that at a young age, and they're not, or the kid doesn't practice it.

NBC, Howard: With the stretching, we talked about the difference between dynamic and static stretching. The warmup routine had only dynamic stretches in it. Then, we talked to kids about that current research shows that it's better to do dynamic stretching before a game or an event.

These NBC physical education teachers offered insights into the challenges they face in imparting fundamental skills to their students. The first narrative highlighted the difficulty in teaching basic concepts like throwing with the opposition hand and foot, a result of inadequate exposure in earlier grades. The second narrative focused on the importance of proper stretching and the differentiation between dynamic and static stretching. Together, these narratives emphasize the need for teachers to go beyond traditional classroom instruction and use integrative strategies by utilizing subdisciplinary knowledge to better engage students and enhance their learning experiences.

Other data collected from National Board Certified (NBC) physical education teachers provided insight into the execution aspect. The NBC physical education teachers reported incorporating subdisciplinary knowledge of kinesiology into their instructional practices to provide clear and concise directions to students during physical education classes.

NBC, Tilda: I'll say we, the teachers I teach with here in our school apply all of those (kinesiology subdisciplinary knowledge concepts). Probably, what we apply the least is

> the biomechanics of throwing and talking about angle of release. We focus our physiology principles that we focus on more and involve just direct fitness. Our focus is much more on the fitness, so we teach the FITT principle. We have the students practice the FITT principle. We talk to them about the frequency of exercise, intensity, time, and types of exercise.

Similarly non-NBC Michael provided the following information:

> non-NBC, Michael: If they put too much weight in the bar and the bar slows down, I could tell them, Hey, you got to take some of the weight off to the bar to make sure that you're making the velocity range. On the other hand, if the bar is moving really fast, that's an indicator to me that they need more weight on the bar. Those are ways that I apply some basic exercise science in my classes.

This approach to teaching emphasizes the importance of effectively conveying information and demonstrating techniques to students, ensuring that they understand the physical activities they are engaged in and how to perform them correctly. This not only supports student learning but also promotes safe and effective physical education experiences. By using subdisciplinary knowledge in kinesiology, physical education teachers are able to bring a scientific and evidence-based approach to their teaching, demonstrating a commitment to improving student outcomes.

Tilda, an NBC physical education teacher, highlighted his focus on "Technology Integration purpose" in her teaching practices. Specifically, he emphasized the importance of cardiovascular conditioning and monitoring heart rate during physical education classes. To achieve this goal, he utilized technology such as heart rate monitors and charts displaying heart rate information by stating the following:

NBC Tilda: We talk a lot about cardiovascular conditioning and the importance of your heart rate. We've got charts up that show them the examples of heart rate, either perceived exertion rate, or we actually get them on heart rate monitor watches. And, we either have track their heart rate on how long they're in the zone, or we have them track calories burned during the workout.

These tools allowed the teachers to track students' heart rates and measure their physical exertion, helping to promote cardiovascular fitness and safe physical activity. The use of technology in this context not only enriches students' physical education experiences, but also provides valuable data for teachers to use in evaluating student progress and making informed decisions about future instructional practices. The integration of technology into physical education classes highlights a commitment to using cutting-edge tools to enhance student learning and health outcomes.

Lesson Plan Approach

The second subtheme refers to the application of subdisciplinary knowledge from kinesiology by physical education teachers in developing their lesson plans for physical education classes. The lesson plans are based on scientific evidence and emphasize the importance of evidence-based practices in physical education.

NBC, Debra: Then, the other third more classroom-type, making the plan of how to work out. I use the exercise science a lot because I teach what the components of fitness are and using the FITT principle to be able to create your own personal work fitness plan. Then, that exercise science comes into play, so they know that they don't want to lift and work the same muscle two days in a row and things like that.

non-NBC, Jonathan: We do look at the FITT principles. We try to create a workout plan or an activity plan for the students to use, focusing on the frequency, intensity, time, and type so that they can rebuild into what they are going to be specifically focusing on.

Integrated Approach

The NBC physical education teachers suggested that they use an "Integrated Approach" that combines subdisciplinary knowledge of kinesiology and pedagogical knowledge to strengthen their teaching effectiveness. Cameron provided one example of how she integrated subdisciplinary knowledge of kinesiology with pedagogical theory using one biomechanics concept. For example, NBC Cameron stated:

> NBC, Cameron: I always explain concentric and eccentric contractions in my weightlifting class. But instead of using those terms, I use "positive" and "negative" movements. It's just easier for students to understand. And the reason I teach this concept before we jump into weightlifting is so students can get a good grasp on proper breathing techniques. When they're lifting, always exhale on the positive movement, and inhale on the negative movement.

Barriers Facing the Integration of Subdisciplinary Knowledge in Physical Education

Both NBC physical education teachers and non-NBC physical education teachers experienced similar barriers to applying subdisciplinary knowledge to their teaching. In terms of common barriers, qualitative content analysis resulted in the generation of two main categories related to the barriers of applying subdisciplinary knowledge in teaching physical education: *internal barriers and external barriers*.

Internal barriers

Lack of time is one of the barriers identified that prevented most teachers from effectively applying subdisciplinary knowledge in their lessons. Teachers also noted that lack of knowledge could be a barrier, especially if they are unfamiliar with resources or lack the skills to find what they need. NBC Howard described the following:

> NBC, Howard: Time is definitely a barrier. Well, and I think knowledge can be a barrier depending on-- If you don't have the knowledge and you don't know how to find it, time and (the difficulty in accessing) resources probably a barrier.
>
> non-NBC, Benjamin: It takes a little more preparation… You have to do a little bit on the back end as far as personal education of it because there's not a lot out there that you're getting, again, maybe through your education courses or through localized professional development may not have that much.

Most participants spoke of the students' low motivation with several factors regarding subdisciplinary knowledge of Kinesiology. Both NBC and non-NBC teachers mentioned that most students were not interested in obtaining subdisciplinary knowledge during physical education class time. For example, NBC Ava explained the following:

> NBC, Ava: Probably the biggest barrier is finding ways to motivate students to use it (kinesiology subdisciplinary knowledge), to apply it themselves because for a majority of students, especially for students that are not interested in athletics or fitness coming in, motivating them to do it can be difficult.

Similarly non-NBC Nancy provided the following information:

> non-NBC Nancy: They don't need to know necessarily the science behind it, they're just interested in learning how to and making sure that they can do whatever it is. For

example, if I'm teaching the barbell squat in the weight room, the kids really don't care. At least it's been my experience, the kids really don't care what muscles are working, they don't really care about eccentric and concentric muscle action. They just want to squat. They just want to learn how to do a squat. I would say that that's probably the biggest barrier would be the kids. They're just really not motivated to understand the exercise science aspect of a skill in P.E.

Perry had a similar experience with students' lack of interest related to subdisciplianry knowledge. When asked during the interview about his experience and perception, Perry had this to offer:

non-NBC, Perry: You have a small portion of kids that do care about the in-depth stuff when it comes to exercise science, but that's a small few. You may have a couple of kids that had a concern about that, but most of them are not.

In addition, NBC Dennis also mentioned how much his students like to move during his class time. For example, he described this:

NBC, Dennis: Because it is PE, they want to move. They want to run. They don't want to sit and take in a lesson or learn. Even just literally today in my last class right before I joined you, one of the students was like, "I need a brain break. Can we just run around for five minutes?" The fact that, on the one hand, I get frustrated. I'm like, "No, this is so important", but on the other hand, I'm like, "This student is clearly expressing their need in a very clear way, so I need to respond to that." Yes, a barrier of that gap between their attention span and their age versus me and my passion and my pedagogy and remembering that they don't have fully developed frontal cortexes yet and not knowing what's going to get through.

Dennis's quote highlighted the challenges he faces in trying to engage students who have a strong desire to be physically active particularly when introducing more in-depth cognitive content. He expressed frustration not only with this situation but also recognized that the students are simply expressing their needs in a clear way. Dennis noted the challenge of balancing his passion for delivering science-based teaching with the limited attention span of the students.

External barriers

Some physical education teachers faced challenges in sharing space and resources with colleagues. Anthony and Cassidy described how having a shared space with another physical education teacher who may not prioritize the same teaching methods can be problematic. NBC Anthony stated the following:

> NBC, Anthony: Often phys. ed. teachers share space. Here's a good one for me. I share space with other PE teachers. If I believe it's important, and the other teacher does not, it's difficult for me to find the space to teach when I have the other teacher sharing that space. If we have separate spaces, the noise from the other space can be problematic. Let's say I have a barrier between the two gyms like a dividing wall. It's very distracting when students in the other gym are bouncing basketballs, and I want to deliver some type of content science instruction. Because of that, a lot of teachers might be turned off to delivering that type of instruction in that environment.

This highlighted the challenges of sharing the gym space with other physical education teachers who may have different views on the importance of subdisciplinary knowledge-based instruction. The teacher noted that the noise from the other gym can be distracting and could discourage teachers from delivering content science instruction in that environment. Similarly, non-NBC Cassidy described barriers in her work environment by stating the following:

non-NBC, Cassidy: Other barriers I would say is colleagues. When your colleagues don't teach things the same way you do or don't put emphasis or don't find it to be as important, it's tough because, again, especially at the high school level, kids talk amongst one another or you're trying to do something one way that another colleague is trying to do another way or is maybe just doing something surface level. That can be challenging as well because you're sharing space. You're sharing students. Students go from one semester to another, one teacher to another. It really helps if you're all on the same page. That could be a barrier as well.

To summarize, this non-NBC teacher also raised the issue of colleagues as a barrier to utilizing content-based teaching. The teacher noted that it can be challenging when colleagues have different teaching methods or do not place the same emphasis on certain topics.

In addition to issues with time and space, others highlighted challenges faced by physical education teachers in terms of funding and resources. For example, NBC Andy described the following:

NBC, Andy: A big barrier is no one really respects the importance of a healthy body, and that's bottom line. They don't respect it. They think academics are more important, so they don't fund us well, and they don't give us enough space or enough teachers, and it's very frustrating. You can't do as much as you want to do because you don't have the equipment, and you don't have the resources like the other teachers in the space, and so, it's frustrating at times. You'd like to give them so much more. I'd like to teach tennis, I'm a tennis coach, but I'm not bringing 55 kids on to two courts. I can't.

This NBC teacher highlighted the lack of respect for the importance of physical education as a barrier to applying subdisciplinary knowledge in teaching physical education. The teacher noted

that inadequate funding and resources limited their ability to provide science-based instruction and create frustration. Similarly, non-NBC Ellis provided the following response:

> non-NBC, Ellis: Then, PE doesn't get a budget…. We run out of equipment, or we run out of money, or if something's too expensive, we can't buy it… I think that's a barrier too. Money is a barrier. All-inclusive classes with the large amount of students, I think, is a barrier.

The non-NBC teacher identified the issue of limited funding as a significant barrier in their teaching role. The teacher noted that money also posed barriers to applying subdisciplinary knowledge in physical education.

Both NBC and non-NBC physical education teachers expressed their concerns about class sizes and its impact on their capacity to provide individualized feedback based on scientific evidence and support for their students. To that point, NBC Tracy suggested that class size is an important factor in her ability to effectively teach and support her students when she stated the following.

> NBC, Tracy: I could tell you one is class size. I like to give individual information feedback. As the class sizes get larger and larger, I feel like I don't get to spend as much time giving feedback or positive reinforcement or just making connections with the students for mental and social health. I try my best, but if you have 50 minutes and you have 30 students, it becomes more difficult. I do like smaller class sizes.

Non-NBC Jackson shared a similar understanding with regard to the challenge of the size of classes. He expressed his personal experience in the following:

> non-NBC, Jackson: You're only given a limited amount of time with a large amount of students. Now, if the class size was a little bit smaller, and you had a little bit more

> resources, then oh, being able to introduce more and more exercise science principles into what you're teaching will be much easier. It would probably be a joy to teach, but in saying that, it would require more time than what is allotted and more resources than what is allotted.

He emphasized the difficulties faced in giving individualized feedback based on scientific-based teaching to promote students learning. In summary, the result of this study explored the experiences and perspectives of physical education teachers with regard to the integration of kinesiology subdisciplinary knowledge in their teaching practices. Through a comprehensive analysis, three primary themes emerged: (a) perceptions of the presence of subdisciplinary knowledge in physical education contexts, (b) subdisciplinary knowledge enhances instruction, and (c) barriers facing the integration of subdisciplinary knowledge in physical education. These findings highlight the significance of adopting scientific, evidence-based methodologies in physical education teaching, as well as shed light on the barriers teachers confront when striving to integrate kinesiology subdisciplinary knowledge into their physical education teaching.

Discussion

This study compared the perception and application of subdisciplinary knowledge in teaching physical education between NBC and non-NBC physical education teachers to explore how their experiences affect their perceptions of the importance of subdisciplinary knowledge for physical education and how physical education teachers apply subdisciplinary knowledge in their teaching experiences. These research findings suggest that NBC physical education teachers hold more favorable views regarding the importance of subdisciplinary knowledge for physical education instruction compared to their non-NBC counterparts. The study sheds light on the perceptions of physical education teachers and underscores the need to consider these

perspectives in discussions regarding the integration of subdisciplinary knowledge into physical education curricula. Furthermore, findings indicate that NBC physical education teachers employ a diverse range of strategies for incorporating subdisciplinary knowledge into their teaching, in contrast to their non-NBC counterparts. Both NBC and non-NBC teachers reported facing numerous barriers to implementing subdisciplinary knowledge in the actual classroom setting, highlighting the need for continued efforts to address these barriers and support the integration of subdisciplinary knowledge in physical education teaching.

According to Solmon et al. (1993), four main issues are associated with occupational socialization - Subject alienation (when physical education is seen as less important than other subjects), role conflict (when teachers find themselves with other responsibilities besides teaching), reality shock (when they realize they are not in the best teaching environment with highly motivated students), and the wash-out effect (when novices discard what they learned at the university and revert to teaching in a way they themselves were taught). The following discussion of student's motivation relates to the concept of reality shock.

The results of the study reveal a marked inconsistency in students' motivation for participation in class when subdisciplinary knowledge is incorporated into the teaching approach. Although this finding highlights the need for further research into the impact of subdisciplinary knowledge integration on student motivation in physical education, the authors contend applying subdisciplinary knowledge in teaching can result in different results regarding students' motivation level depending on their characteristics. As an illustration, the study found that students who possess a strong motivation to learn the reasons behind an activity or how to perform it effectively exhibit a higher level of motivation for learning the principles and theories of subdisciplines of kinesiology. Conversely, students who are primarily motivated by physical

movement and increased activity exhibit lower levels of motivation for engaging in theory learning experiences in their physical education class. This suggests that students' motivations for learning principles or theories of subdisciplines of kinesiology may impact their level of engagement with subdisciplinary knowledge learning during class time.

The wash-out effect is in relation to the teacher's application of subdisciplinary knowledge in teaching physical education. The result found that NBC physical education teachers offered more comprehensive examples of the application of subdisciplinary knowledge in teaching physical education, likely due to their exposure to the NBC process that included the practical application of exercise science. Conversely, some non-NBC teachers neglected the application of subdisciplinary knowledge, mentioning the challenge of applying the subdisciplinary knowledge into the practical classroom setting, given students' limited attention spans. These findings highlight the need for effective approaches that bridge the gap between academic learning and real-world application in physical education classrooms.

While there has been some controversy regarding the requirement of subdisciplinary knowledge for all physical education lessons, the findings of this study have consistently indicated a need for subdisciplinary knowledge within the domain of fitness units in physical education. Given that fitness units, such as weight training and strength and conditioning, involves specific techniques (i.e., biomechanics), intensities (i.e., exercise physiology), and types of movements (i.e., human autonomy) that can have a significant impact on the musculoskeletal system, it is important for physical education teachers to understand subdisciplinary knowledge of kinesiology which provides a scientific basis for understanding the effects of physical activity on the human body.

Conclusion

This study aims to explore the perceptions and applications of subdisciplinary knowledge among physical education teachers using the lens of occupational socialization theory. Because there is still some uncertainty and debate regarding the role and importance of subdisciplinary knowledge in practice among scholars, this study focused on gaining insight into physical education teachers' perceptions and applications of subdisciplinary knowledge by comparing NBC and non-NBN physical education teachers. Using the three primary themes of perceptions of the presence of subdisciplinary knowledge in physical education contexts, subdisciplinary knowledge enhances instruction, and barriers facing the integration of subdisciplinary knowledge in physical education, the study provides valuable insight into the perceptions and challenges physical education teachers face in incorporating subdisciplinary knowledge into their teaching.

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APPENDIX A: INSTITUTIONAL REVIEW BOARD APPROVAL LETTER

Sun, Justin Alexander June 24, 2021 at 4:28 PM
IRB #22039 Exempt Determination
To: Woods, Amelia Mays

Dear Dr. Woods,

Attached is the exempt determination letter and a bookmarked PDF of the protocol, IRB #22039. The exempt amendment policy effective August 1, 2019 is also attached for your future reference. Should you have a question or concern, please do not hesitate to contact the Office for the Protection of Research Subjects at irb@illinois.edu or 217-333-2670.

Respectfully,
-Justin

Justin Sun
Human Subjects Research Specialist

Office for the Protection of Research Subjects
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ILLINOIS

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN

Office of the Vice Chancellor for Research & Innovation
Office for the Protection of Research Subjects
805 W. Pennsylvania Ave., MC-095
Urbana, IL 61801-4822

Notice of Exempt Determination

June 24, 2021

Principal Investigator	Amelia Woods
Protocol Title	*A Comparison of National Board Certified and Non-National Board Certified Physical Education Teachers' Levels, Perceptions, and Applications of Subdisciplinary Knowledge*
Protocol Number	22039
Funding Source	Illinois Association for Health, Physical Education, Recreation and Dance
Review Category	Exempt 2 (ii)
Determination Date	June 24, 2021
Closure Date	June 23, 2026

This letter authorizes the use of human subjects in the above protocol. The University of Illinois at Urbana-Champaign Office for the Protection of Research Subjects (OPRS) has reviewed your application and determined the criteria for exemption have been met.

The Principal Investigator of this study is responsible for:

- Conducting research in a manner consistent with the requirements of the University and federal regulations found at 45 CFR 46.
- Requesting approval from the IRB prior to implementing major modifications.
- Notifying OPRS of any problems involving human subjects, including unanticipated events, participant complaints, or protocol deviations.
- Notifying OPRS of the completion of the study.

Changes to an **exempt** protocol are only required if substantive modifications are requested and/or the changes requested may affect the exempt status.

APPENDIX B: INTERVIEW RECRUITMENT LETTER

Recruitment Script Email

Subject line: An exploration into exercise science knowledge in secondary physical education

Hello,

My name is YOUR NAME and I am working with a research team from the University of Illinois at Urbana-Champaign on a research study related to physical education teachers' levels, perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge). I am contacting you because you have been recognized as an in-service physical education teacher for early adolescence through young adulthood.

We are in need of present Nationally Board Certified teachers and in-service physical education teachers that currently teach physical education in a secondary school. The information you give us will help us drive research in physical education forward and impact how physical education teacher education programs prepare teachers to apply to exercise science knowledge into physical education teaching.

Participation in the study involves one 30 minutes online knowledge test survey and one 45-60-minute Zoom or telephone interview (optional). In appreciation for your time and help, we will provide a compensation (Amazon gift). If you are interested in participating or would like to know more about the study, please contact Jeongkyu Kim at jk26@illinois.edu for additional information and to schedule an interview.

Thank you for your time and we hope to hear from you.

Sincerely,
YOUR NAME

APPENDIX C: INFORMED CONSENT FORM

Informed Consent for Participation

You are being asked to participate in a voluntary research study. The purpose of this study is to explore in-service physical education teachers' levels, perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge). Risks related to this research include nothing beyond those of everyday life; benefits related to this research include helping design professional and physical education teacher education programs to support physical education teachers for gaining exercise science knowledge to apply in physical education. The alternative to participating in this study is to choose not to participate in this study.

Principal Investigator Name and Title: Dr. Amelia Mays Woods
Department and Institution: Department of Kinesiology and Community Health at the University of Illinois at Urbana-Champaign
Contact Information: Email at amywoods@illinois.edu or by phone at (217) 333-9602
Sponsor (if applicable): Illinois Association for Health, Physical Education, Recreation and Dance (IAHPERD)

This study is being conducted by Dr. Amelia Mays Woods of the Department of Kinesiology and Community Health at the University of Illinois at Urbana-Champaign. This study will investigate in-service physical education teachers' levels, perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge) in physical education.

Purpose and Procedures

The purpose of this study is to explore in-service physical education teachers' levels, perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge) in physical education. If you agree to participate in this study, you will be asked to complete an online survey. At the end of this survey, you will be asked to indicate whether or not you would also be willing to participate in a follow-up interview to delve more deeply into your experiences and perception of exercise science. If you are asked to participate in the interview, it will be scheduled at a time convenient for you and conducted over Zoom or phone. With your consent, the interview will also be audio recorded. Participants in the survey are estimated to take 30 minutes, and the interview will last 45-60 minutes.

Participation is Voluntary

Participation in this study is completely voluntary. You may refuse to participate in the study or may discontinue your participation at any time with absolutely no repercussions. There is no penalty for not participating, and you may drop out of the interview at any point. While the risk associated with this study is low, it is possible that some of the questions could make you feel uncomfortable. If that occurs, feel free to say that you do not want to answer those questions. In addition, if you say something during the interview and decide later that you do not want us to use it, we can delete these comments. Breach of confidentiality is always a risk in research, but we have safeguards in place to protect against your identification.

Benefits and Risks

This study will allow researchers to understand in-service physical education teachers' levels, perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge) in physical education. The benefits related to this research include helping design professional development to support PE teachers' effective teaching for their professionalism. You will be offered compensation for being in this study ($10 Amazon Gift for Test Survey participants, $20 Amazon Gift for Interview participants). There are no foreseeable risks of participating in this study beyond those of everyday life.

Confidentiality

You will be given a pseudonym for interviews and reflection data that you provide. All documents will be kept in a locked filing cabinet. All data that is collected will be kept for a period no less than five years and then will be destroyed. Your de-identified information could be used for future research without additional informed consent.

We will use all reasonable efforts to keep your personal information confidential, but we cannot guarantee absolute confidentiality. When this research is discussed or published, no one will know that you were in the study. But, when required by law or university policy, identifying information (including your signed consent form) may be

seen or copied by: a) The Institutional Review Board that approves research studies; b) The Office for Protection of Research Subjects and other university departments that oversee human subjects research; c) University and state auditors responsible for oversight of research.

Research Subject Rights
If you feel you have not been treated according to the descriptions in this form, or if you have any questions about your rights as a research subject, including questions, concerns, complaints, or to offer input, you may call the Office for the Protection of Research Subjects (OPRS) at 217-333-2670 or e-mail OPRS at irb@illinois.edu

Remember:
Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University. If you decide to participate, you are free to withdraw at any time without affecting that relationship.

I have read (or someone has read to me) the above information. I have been given an opportunity to ask questions and my questions have been answered to my satisfaction. I agree to participate in this research. I will be given a copy of this signed and dated form.

Contact Information
Questions, concerns, or complaints related to this research should be directed to Dr. Amelia Mays Woods. He can be reached by email at amywoods@illinois.edu or by phone at (217) 333-9602.

What are my rights as a research subject?

If you have any questions about your rights as a participant in this study, please contact the University of Illinois at Urbana-Champaign Office for the Protection of Research Subjects at 217-333-2670 or irb@illinois.edu.

I have read the above information. I have been given an opportunity to ask questions and my questions have been answered to my satisfaction. I agree to participate in this research. I will be given a copy of this signed and dated form.

_____
Date

_____
Printed Name

_____ _____
Signature of Person Obtaining Consent Date (must be same as subject's)

_____
Printed Name of Person Obtaining Consent

APPENDIX D: ASSESSMENT OF SUBDISCIPLINARY KNOWLEDGE IN PHYSICAL EDUCATION (ASK-PE) KNOWLEDGE TEST

Knowledge Test Survey

Start of Block: Informed Consent

Q1.1 **Informed Consent for Research Study Interview Participation Physical Education Teachers' Level, Perceptions, and Application of Subdisciplinary Knowledge Study** You are invited to participate in a research study conducted by Drs. Amelia Mays Woods and K. Andrew R. Richards at the University of Illinois at Urbana-Champaign. This study is focused on understanding physical education teachers' level, perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge). You are being asked to participate because our records indicate that you are an in-service physical education teacher. **Purpose and Procedures** The objective of this study is to understand level, perceptions, and applications of exercise science knowledge as either a National Board Certified physical education teacher or a in-service physical education teacher. If you agree to participate in this study, you will be asked to complete an online survey. At the end of this survey, you will be asked to indicate whether or not you would also be willing to participate in a follow-up interview to delve more deeply into your experiences. If you agree to participate in the interview, it will be scheduled at a time convenient for you and conducted over the phone. With your consent, the interview will also be audio recorded. Participation in the survey is estimated to take 30 minutes, and the interview will last 45-60 minutes **Participation is Voluntary** Participation in this research study is completely voluntary. You may refuse to participate in the study or may discontinue your participation at any time during the survey or interview with absolutely no repercussion. The decision to engage in this research, declining to answer questions or withdrawing from the study will have no effect on your relationship with the University of Illinois at Urbana-Champaign, nor will your participation or lack thereof be shared with anyone at any time. **Compensation** You will be provided compensation for participating in this study ($10 Amazon Gift for Test Survey, $20 Amazon Gift for Interview) **Benefits and Risks** This study will allow researchers to better understand about physical education teachers' level, perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge). There are no risks to individuals participating in this study beyond those that exist in everyday life. There is compensation for study participation, and we also hope that what is learned through the study will lead to recommendations for physical education teacher education programs.

Confidentiality Only Drs. Woods and Richards and their research associates will analyze audio recordings of the interviews. The information will be kept in a secure location at all times. None of your personally identifiable information will ever be disclosed and under no circumstances will your individual survey responses or audio recordings ever be made public. Your participation in this study will remain confidential at all times.

In general, we will not tell anyone any information about you. When this research is discussed or published, no one will know that you were in the study. However, laws and university rules

might require us to disclose information about you. For example, if required by laws or University Policy, study information which identifies you and the consent form signed by you may be seen or copied by the following people or groups: The University committee and office that reviews and approves research studies, the Institutional Review Board (IRB) and Office for Protection of Research Subjects; University and state auditors, and Departments of the University responsible for oversight of research. **Contact Information** If you have any questions related to this research, please contact Dr. Amelia Mays Woods by email at amywoods@illinois.edu and by phone at (217)-333-9602. If you feel you have not been treated according to the descriptions in this form, or if you have any questions about your rights as a research subject, including questions, concerns, complaints, or to offer input, you may call the Office for the Protection of Research Subjects (OPRS) at 217-333-2670 or e-mail OPRS at irb@illinois.edu. **Remember** Your participation in this research is voluntary. Your decision whether or not to participate will not affect your current or future relations with the University. If you decide to participate, you are free to withdraw at any time without affecting that relationship. **Informed Consent** By clicking "Next" you confirm your willingness to participate in this investigation and will advance into the survey. If you are not interested in participating, please close out of your web browser to exit the survey. A copy of this informed consent document can be downloaded below as a .pdf document and saved for your records.

Click Here to Download a Copy of the Consent Form

End of Block: Informed Consent

Start of Block: Survey Directions

Q2.1 Thank you for agreeing to participate in this investigation. The following survey includes a background questionnaire and a series of questions related to exercise science knowledge (Exercise physiology, Biomechanics, and Motor learning). Please review each item carefully and respond honestly. As a reminder, no one outside of the research team, including your administrators, will have access to how you individually answer these questions. The entire survey is expected to take between 30 minutes to complete. If you have any questions or challenges in completing the survey, please contact Amelia Mays Woods (amywoods@illinois.edu; 217-333-9602).

End of Block: Survey Directions

Start of Block: Demographic Questionnaire

Q3.1 I certify that I am currently located in the United States

- ○ Yes (1)
- ○ No (2)

Skip To: End of Survey If I certify that I am currently located in the United States = No

Q3.2 I currently teach physical education in a K-12 school environment

- ○ Yes (1)
- ○ No (2)

Skip To: End of Survey If I currently teach physical education in a K-12 school environment = No

Q3.3 I have achieved National Board Certification as a physical education teacher

- ○ Yes (4)
- ○ No (5)

Skip To: End of Survey If I have achieved National Board Certification as a physical education teacher = No

Q3.4 What is your date of birth (MM/DD/YYYY)?

_____

Q3.5 What is your gender?

- ○ Male (1)
- ○ Female (2)
- ○ Other (Please explain) (3) _____

Q3.6 Which of the following best describes your race or ethnicity?

- African American (1)
- Asian American (2)
- Caucasian (3)
- Hispanic (4)
- Native American Indian (5)
- Multiple Races/Ethnicities (6)
- Other (Please Explain) (7) _____

*

Q3.7 How many years have taught in total (enter only a number, for example, “15”)?

_____

Q3.8 How would you best describe your current career stage as a physical education teacher?

- I have only been teaching for a few years (1)
- I have been teaching for a few years and am striving to improve my teaching skills and abilities by seeking out new materials, methods, and strategies (2)
- I have reached a high level of competency in my job, and am constantly seeking new ways to enrich my teaching (3)
- I am not really satisfied with my job, and I question my choice of entering the profession (4)
- I am at a point of career stability (5)
- I am preparing to leave the profession (6)

Q3.9 Highest level of degree attained

- ○ Bachelor's degree (1)
- ○ Some Master's-level work (2)
- ○ Completed Master's degree (3)
- ○ Some doctoral-level work (4)
- ○ Educational Specialist (5)
- ○ Doctoral degree (6)

Q3.10 In which of the following US States or Territories do you teach?

▼ Alabama (1) ... Wyoming (56)

Q3.11 At which level do you currently teach?

- ○ Elementary school (K-5) (1)
- ○ Middle school (6-8) (2)
- ○ High school (9-12) (3)
- ○ K-8 school (4)
- ○ K-12 school (5)
- ○ Multiple Levels (6)

Display This Question:

If At which level do you currently teach? = Multiple Levels

Q3.12 If you teach across multiple school levels, which of the following is the level of your primary teaching assignment?

- Elementary school (K-5) (1)
- Middle school (6-8) (2)
- High school (9-12) (3)
- K-8 school (4)
- K-12 school (5)

Q3.13 Approximately what percentage of students who attend your school (or the school to which you are primarily assigned) receive free or reduced cost lunch?

- 0-25% (1)
- 26-50% (2)
- 51-75% (3)
- 76-100% (4)

Q3.14 Which descriptor best describes the area in which your school is located (i.e., what population is served by the school district in which you work)?

- Urban (1)
- Suburban (2)
- Rural (3)

End of Block: Demographic Questionnaire

Start of Block: EXERCISE PHYSIOLOGY (Ayers, 2001)

Q4. EXERCISE PHYSIOLOGY

Q4. I. What is the minimum number of days per week should you exercise within your target heart rate range to develop cardiorespiratory fitness?

- 1
- 3
- 5
- 7

Q4. 2. What does the acronym F.I.T.T., as it refers to fitness, stand for?

- Fun, Interest, Tension and Tone
- Frequency, Intensity, Time and Type
- Fatness, Isolation, Thinness and Technique
- Flexibility, Intuition, Tightness and Thought

Q4. 3. What principle(s) is/are related to improving fitness?

- How hard you exercise
- How long you exercise
- How often you exercise
- All of the above

Q4. 4. Which of the following is most likely to contribute to good physical and mental health?

- Working out a gym once a week
- Shopping regularly in a large mall
- Regular moderate to vigorous physical activity
- All of the above

Q4. 5. Which exercises could be included in a safe stretching and strengthening program?

- Fast head circles
- Fast deep knee bends
- Slow crunches/curl-downs
- Slow straight-legged toe touches

Q4. 6. Which activity will result in the biggest improvement in cardiorespiratory fitness?

- Archery
- Bowling
- Walking
- Weight lifting

Q4. 7. Which of the following activities contributes to fitness?

- Strength training
- Flexibility training
- Cardiorespiratory training
- All of the above

Directions: Read the following comments about Nikki then answer questions 8-11 by marking the letter of the best answer on your answer sheet.

Nikki has never done cardiorespiratory exercise or lifted weights before, but she stretchestwice a week. She is going to try out for her high school track team next semester, so as part of her training, she has asked a friend to teach her how to lift weights correctly.

Q4. 8. When Nikki adds more weight to her exercises as she gets stronger she is ____

- risking injury
- using the principle of specificity
- using the principle of progression
- ignoring a major principle of lifting

Q4. 9. What should Nikki always do when lifting weights?

- Lock her elbows and knees at the end of a lift
- Limit her range of motion to avoid getting hurt
- Move weights rapidly through her full range of motion
- Stretch the muscles she strengthens before and after each session

Q4. 10. Nikki's strength-training program should be set up ____

- based on her starting abilities
- based on the fitness scores for her age group
- differently than a boy who has never lifted before
- according to the work-out Muscle and Fitness magazine recommends for the women's national body building champion

Q4. 11. When stretching the major muscle groups, Nikki should hold all stretches for seconds.

- 1 - 5
- 10 - 15
- 20 - 25
- 30 - 60+

Q4. 12. Consuela has been riding the stationary bike for eight weeks in an effort to improve her cardiovascular fitness. She started riding at level one, and is still riding at that level. Which fitness principle is she ignoring?

- Interest
- Progression
- Regularity
- Specificity

Q4. 13. The muscles and joints of the elbows function similarly to those of the ____

- ankles
- knees
- shoulders
- wrists

Q4. 14. What do you need for both normal daily activities and hard physical activity?

- ○ Endurance
- ○ Power
- ○ Basic strength
- ○ All of the above

Q4. 15. Muscles that are not used for a long time usually ____

- ○ are stronger
- ○ become longer
- ○ get weaker
- ○ stay firm

Q4. 16. The best way to know when you should add weight to an exercise is when ____

- ○ you cannot complete one full lift
- ○ your lifting partner adds more weight
- ○ you can complete the exercise with little effort
- ○ the weight you started with is lighter than everyone else's

Q4. 17. Intensity refers to ____

- how hard you exercise
- how long you exercise
- how often you exercise
- what kind of exercise you do

Q4. 18. What helps motivate people to maintain a regular fitness program? Opportunities to __.

- Interest
- Progression
- Regularity
- Specificity

Directions: Read the following comments about Wade then answer questions 19-21 by marking the letter of the best answer on your answer sheet.

Wade is 16 years old who wants to lose weight and improve his cardiorespiratory fitness.He has never played organized sports and he works after school, so he will have to exercise before school and in his physical education class.

Q4. 19. What type of exercise(s) should Wade do the first few weeks of his fitness program?

- Stretching
- Brisk walking
- Lifting weights
- Gradually include all of the above

Q4. 20. After Wade has been exercising for several months, how often should he be exercising?

- Once a week
- Twice a week
- Three times a week
- Most days of the week

Q4. 21. When Wade first begins his program, what would be an appropriate training heart rate?

- In his target heart rate range
- As high as he can possibly get it
- The same as his resting heart rate
- Low enough so he does not breathe hard

Q4. 22. Which of the following is true about muscles? They usually ___

- attach directly to bones
- work individually to move bones
- prevent ligaments from working properly
- contract and relax in opposite sets around joints

Q4. 23. How often should you lift weights to improve your strength?

- Twice daily
- Every two days
- Once a week
- Every other week

Q4. 24. As you age, you should ___

- limit your participation in physical activity to weekends
- increase the difficulty of your participation in physical activity
- adapt your fitness needs to the changes in your physical ability and interests
- all of the above

Q4. 25. To improve your cardiorespiratory fitness, what is the minimum number of minutes you must keep your heart rate increased?

- 10
- 20
- 35
- 50

Q4. 26. Which activity will produce the greatest increase in overall muscle size (hypertrophy)?

- Downhill skiing
- Playing tennis
- Skateboarding
- Weight lifting

Q4. 27. Target heart rate is the range ___

- in which you should start exercising
- that is the same for all high school students
- that you should avoid reaching during exercise
- in which it is ideal for you to reach and stay in during exercise

Q4. 28. What is true regarding the joints in your body?

- Most are protected by muscles.
- Their size determines their function.
- They allow different types of movement.
- Most of them work in the exact same ways.

Q4. 29. How can reading current information about fitness help you the most? It tells you ____

- the latest trends
- how to break records
- how to apply research to everyday needs
- about unusual injuries that can happen when exercising

Q4. 30. Regular cardiorespiratory exercise releases brain chemicals that _____

- help you feel good during and after exercise
- cause increased muscle damage and soreness
- can be harmful if allowed to build up over time
- cause your heart rate to get faster during exercise

Q4. 31. Whose attitudes can help you remain commitment to staying physically active?

- Your family
- Your friends
- People in the community
- All of the above

Q4. 32. Dynamic, isometric, and isokinetic (isostatic) weight training exercises ____

- are useful mainly for athletes
- are dangerous and should be avoided
- are each useful for a variety of activities
- do not improve cardiorespiratory fitness

Q4. 33. Nerve cells send and receive messages to and from ____

- lungs
- muscles
- skin
- all of the above

End of Block: EXERCISE PHYSIOLOGY (Ayers, 2001)

Start of Block: BIOMECHANICS (Ayers, 2001)

Q5. BIOMECHANICS

Q5. 1. Why does a ball move when you kick it?

- ○ The force of your kick is less than the ball's mass.
- ○ The force of your kick is greater than the ball's mass.
- ○ The pull of gravity is working with the ball's movement.
- ○ The pull of gravity is working against the ball's movement.

Q5. 2. If two wrestlers of the same body weight are standing in an arm lock during a match but not moving, ____

- ○ one has greater mass than the other
- ○ both must be pushing with the same force
- ○ one must be pushing harder than the other
- ○ there is not enough information to answer this question

Q5. 3. How do you produce spin (backspin or topspin) when hitting a ball? Hit the ball ____

- ○ at its center
- ○ as hard as possible
- ○ away from its center
- ○ with a lighter bat or stick

Q5. 4. If a weight is held further away from the body, it will feel ____

- bulkier
- heavier
- lighter
- none of the above

Q5. 5. When lifting heavy weights, one should ____

- never use a spotter
- always use a spotter
- use a spotter only on your first set
- use a spotter if you have never done an exercise before

Directions: Read the following comments about Jamaal then answer questions 6-8 by marking the letter of the best answer on your answer sheet.

Jamaal's family is moving to another state and he is helping pack the truck. He is the oldest of his brothers and sisters, so he is helping load the big items such as dressers andappliances. Jamaal has never played on any of his school's sport teams and he does not**work** out regularly.

Q5. 6. When moving bulky things like large mirrors and bed mattresses, what is the best way for Jamaal to lift these types of things?

- Use only his arms.
- Bend at the waist with his knees locked.
- Hold the item as far away from his body as possible.
- Lift with his arms and legs, bend his knees, and keep his back straight.

Q5. 7. If Jamaal has to help carry something very heavy, what should he do? Use ____

- only his back
- only his upper body
- as many body parts as possible
- he should not help carry heavy items

Q5. 8. What is one way Jamaal can generate more force to pick up a heavy item?

- Pick it up very slowly
- Pick it up while running
- Forcefully stretch his muscles just before lifting the item
- Avoid stretching his muscles before lifting something heavy

Q5. 9. Bending your knees and spreading your feet apart will ____

- increase your balance
- decrease your balance
- raise your center of gravity
- decrease your base of support

Q5. 10. Which of the following is a general guide to follow when lifting weights?

- Complete exercises as fast as you can.
- Complete exercises slowly and with control.
- Moving fast is ok if you have done an exercise before.
- Moving with control is necessary only the first time you do an exercise.

Q5. 11. If you are trying to kick a ball as far as possible, you should run up to the ball a few steps and move your leg ____

- with no backswing and no follow through
- with no backswing and a full follow through
- with a full backswing and no follow through
- with a full backswing and a full follow through

Q5. 12. Hitting a ball at the far end of the bat (away from your hands) will usually cause the ball to go ____ than if you hit the ball closer to your hands.

- a greater distance
- a shorter distance
- the same distance
- straight up into the air

Q5. 13. A ball in a balanced state ____

- is not moving
- gradually slows down to a stop
- increases its speed and changes directions slightly
- either does not move or moves at a constant speed in a given direction

Q5. 14. When trying to hit a ball as hard as possible, you should try to swing the racket ____

- as fast as possible
- as slowly as possible
- with a short backswing
- with a slow, long backswing

Q5. 15. After you wind up, to throw a ball as far as possible you should release the ball ____

- when it is level with your chest
- when it is still behind your shoulder
- when it is just in front of your shoulder
- with your arm pointing straight over your head

Q5. 16. When trying to produce maximum force, you should use ____ body parts than when maximum force is not the goal.

- fewer
- more
- the same number of
- number of body parts does not matter when producing force

Q5. 17. How can you decrease the amount of friction between two surfaces?

- Make both surfaces rougher.
- You cannot decrease friction.
- Add a layer of fluid between the surfaces.
- Add a layer of sand between the surfaces.

Q5. 18. The muscle(s) in which area of the body would be able to produce the most force?

- Abdominals (stomach)
- Biceps (front of upper arm)
- Triceps (back of upper arm)
- Quadriceps (front of upper leg)

Q5. 19. A tennis ball with topspin will rebound off the court ____ a ball without spin.

- lower than
- higher than
- the same as
- none of the above

Q5. 20. A person's buoyancy is most directly related to which of the following quantities?

- Density
- Mass
- Volume
- Weight

Q5. 21. Which clothing will limit the drag on a swimmer the most?

- Blue jeans
- Gym shorts
- Loose shorts
- Form-fitting shorts

Q5. 22. Which of the following will experience the most drag while airborne?

- Badminton shuttlecock (birdie)
- Basketball
- Discus
- Frisbee

Q5. 23. When lifting a heavy object, you should ____

- bend your knees
- hold the object close to your body
- avoid bending or twisting your upper body
- all of the above

Q5. 24. If we ignore air resistance and drop a bowling ball and a tennis ball from the same height, gravity causes the tennis ball to ____

- fall faster than the bowling ball
- fall slower than the bowling ball
- fall at the same speed as the bowling ball
- it depends on the weather when the balls are dropped

Q5. 25. Muscular tension may be produced by which of the following?

- Shortening a muscle
- Lengthening a muscle
- Maintaining a muscle at a constant length
- All of the above

Q5. 26. Your body moves when muscles contract producing joint forces. What contributes to these joint forces?

- Muscle forces
- Resistance forces
- Both muscle and resistance forces
- None of the above

Q5. 27. Which softball bat should a tall, strong person choose when hitting for maximum distance?

- Long and light
- Short and light
- Long and heavy
- Short and heavy

Q5. 28. How can you hit a ball harder if you are already using as much force as you can produce? Hit it ____

- With no backswing
- with no follow through
- with lighter, shorter hat
- with a heavier, longer bat

Q5. 29. Which of the following is least likely to produce lift when thrown?

- Boomerang
- Discus
- Frisbee
- Shot put

Q5. 30. If all else is equal, who should be able to punt a football further? Someone who is ____

- 3 feet tall
- 4 feet tall
- 5 feet tall
- 6 feet tall

Q5. 31. Which of the following has the most effect on the time that an object thrown into the air for maximum distance remains in the air?

- Mass
- Release height
- Release speed
- Weight

Q5. 32. What is usually the most important thing to consider when releasing an object for maximum distance? The ball's ____ of release.

- direction
- force
- height
- speed

Q5. 33. Which of the following characterize(s) a force?

- Size
- Direction
- Where it is applied
- All of the above

Q5. 34. For a platform diver to get as much spin/rotation as possible during a back summersault dive, his arms should be ____ and his legs should be ____.

- tucked, tucked
- tucked, extended
- extended, tucked
- extended, extended

End of Block: BIOMECHANICS (Ayers, 2001)

Start of Block: MOTOR LEARNING (Ayers, 2001)

Q6. MOTOR LEARNING

Q6. 1. What type(s) of training program(s) can be helpful in improving a soccer midfielder's physical ability to play the game?

- The force of your kick is less than the ball's mass.
- The force of your kick is greater than the ball's mass.
- The pull of gravity is working with the ball's movement.
- The pull of gravity is working against the ball's movement.

Directions: Read the following comments about Sarah then answer questions 2-4 by marking the letter of the best answer on your answer sheet.

Sarah has been challenged by her best friend to learn how to play soccer without instruction from anyone else. After getting some books from the school library, she hasdecided to start by teaching herself how to dribble.

Q6. 2. Which would be the best way for Sarah to start learning how to play soccer?

- Run as fast as possible while trying to control the ball.
- Dribble slowly until she gets used to moving with the ball.
- Ask a friend to try and take the ball from her while she is learning how to dribble.
- None of the above

Q6. 3. While Sarah is learning to dribble, how much time should she spend practicing?

- Everyday
- Every 2 days
- Once a week
- Once a month

Q6. 4. Once Sarah can dribble down the field without losing control of the ball, which would be the best way for her to get better?

- Ask a friend to try to take the ball away from her.
- Ask three people to try to take the ball from her at the same time.
- Keep practicing the same way she did when she started learning how to dribble.
- Change the way she practices by gradually adding more difficult objects to avoid.

Q6. 5. A person who is good at fielding and throwing a ball during a baseball game ____

- has never practiced the skills separately
- is able to combine the skills in a smooth fashion
- limited their practice to a changing environment
- practiced the skills only in game-like settings where score is kept

Q6. 6. You are good at a volleyball overhead pass when you ____

- can do the skill during practice
- play on the team that wins the game
- can use the overhead pass effectively in a game
- know how to do the skill even if you cannot do it

Q6. 7. You are good at a tennis serve when your ____

- serves are smooth and usually land where you aim.
- serves are hit hard but usually do not stay in the court.
- attention is still on how to toss the ball before you hit it.
- serves are smooth and the ball sometimes goes where you aim.

Q6. 8. Which of the following can influence performance?

- alertness
- attention
- readiness
- all of the above

Q6. 9. A person who is good at dribbling a basketball in a game has the ability to ____

- choose how to dribble
- execute the dribble well
- choose when to dribble
- all of the above

Q6. 10. A person with which of the following body builds would be better as a gymnast?

- Short, muscular, little fat
- Tall, long limbs, muscular
- Tall, long limbs, lots of fat
- Short, muscular, lots of fat

Q6. 11. Who are more likely to succeed at a physical activity, no matter what they look like? People who ____

- have a great desire to practice
- save their energy for the games
- practice because the coach said to
- only participate to have fun with their friends

Q6. 12. If you are good at racquetball, which of the following skills should be easiest for you to learn?

- Badminton
- Frisbee
- Softball
- Tennis

Q6. 13. If you have learned a motor skill, you should be able to ____

- beat everyone you play against.
- consistently repeat your performance.
- teach it to someone else in your class.
- perform the skill correctly 100% of the time.

Q6. 14. When first learning how to do a set shot in basketball, your attention should be on ____

- perfecting the skill.
- how to shoot against a defender.
- figuring out how to do the skill.
- none of the above.

Q6. 15. Which of the following kinds of practice should follow initial learning and practice of a basketball set shot?

- Play against two defenders.
- Try to shoot against light defensive pressure.
- Avoid having anyone guard you during a game.
- Play in games without worrying about skill performance.

Q6. 16. Which of the following would be the best way to keep your balance while practicing the toe spin in ice skating (or the 360 in skateboarding/in-line skating)?

- Close your eyes to limit your distractions.
- Watch everything around you as you spin.
- Focus on a single non-moving point as you spin.
- Look at a single object that moves with you as you spin.

Q6. 17. Who will get the most help from very specific comments about skill performance?

- People who have never performed a skill.
- Nobody likes to hear comments about their performance.
- People who have developed regular (consistent) performance.
- None of the above.

Q6. 18. If you have the same physical qualities as another person and you are equally smart, what factor can make the difference in who is better?

- Experience
- Interest
- Practice
- All of the above

Q6. 19. When learning how to hit a golf drive off the tee, one of the best ways to practice at first is to ____

- use imagery to practice without actually swinging a golf club.
- hit into a net to help you focus on learning how to swing correctly.
- go to the golf course and play a game of golf with several of your friends.
- go to the practice range and swing as hard as you can to see how far you can hit.

Q6. 20. What influences the kind of practice that is best for you?

- The skill you are practicing.
- How good you are at the skill.
- How long you have performed the skill.
- All of the above.

Q6. 21. If you do not practice long enough to store performance in long-term memory, ____

- no improvement in performance will happen.
- short-term improvement in performance can happen.
- how long you practice does not matter relative to improving performance.
- none of the above.

Q6. 22. When learning a new complex skill, like the tennis serve, it is best to ____

- practice the serve in a game situation.
- practice all parts of the serve together as a whole.
- practice the whole serve first and then each separate part.
- practice the parts of the serve first and then the whole skill.

Q6. 23. Which of the following contributes to your learning and improvement of a motor skill? How much ____

- you practice that skill.
- you have played the game.
- physical skill your parents possess.
- All of the above.

Q6. 24. The best way to see if you have learned a new motor skill is to test yourself ____

- The force of your kick is less than the ball's mass.
- The force of your kick is greater than the ball's mass.
- The pull of gravity is working with the ball's movement.
- The pull of gravity is working against the ball's movement.

Q5. 25. When learning the tennis serve, it is best to start practicing the serve

- so you have a high level of accuracy.
- easy at first until you get more accurate.
- as a courtesy serve (drop and hit the ball).
- as hard as you can until you get the feel for the skill.

End of Block: MOTOR LEARNING (Ayers, 2001)

Start of Block: Final Questions

Q11.1 Are you interested in participating in a telephone interview about your experiences as a physical education teacher? This interview will focus on your feelings of stress and how you are able to cope with these stressors in your daily life. The interview will last about 30 minutes.

- Yes (1)
- No (2)

Display This Question:

If Are you interested in participating in a telephone interview about your experiences as a physical... = Yes

Q11.2 Please provide an email address at which we can contact you to schedule a Zoom interview

_____

Q11.3 This is the final question on the survey. If you click the forward arrow button after this question, you will finish and submit the survey. Are you read to submit? If not, click the back arrow button to return to questions that you might want to finish

- ○ Finish and Submit (1)

End of Block: Final Questions

APPENDIX E: INTERVIEW GUIDE

Physical Education Teachers' Perceptions, and Applications of Subdisciplinary Knowledge Interview Consent Script

Hi [interviewee] my name is [interviewer] it's nice to meet you. Thank you for your willingness to participate in the research study. Before we begin, I want to take a minute to review the purpose of this interview: We are interested in talking with you about the ways in which National Board Certified physical education teachers and in-service physical education teachers' perceptions, and applications of subdisciplinary knowledge. We hope to better understand physical education teachers' perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge). The information we gather will be possibly used in future research publications. The interview should take between 45 and 60 minutes.

Anything you say will be kept strictly confidential. That is, we will transcribe this conversation and then remove your name and any identifying information from the interview and replace it with a pseudonym. Following transcription, the audio file from the interview will be destroyed. The resulting text file will also be de-identified.

I also want you to know that your participation in this interview is entirely optional. There is no penalty for not participating, and you may drop out of the study at any point. While the risk associated with this study is low, it is possible that some of the questions could make you feel uncomfortable. If that occurs, feel free to say that you do not want to answer those questions. In addition, if you say something during the interview and decide later that you do not want us to use it, we can delete these comments. Breach of confidentiality is always a risk in research, but we have safeguards in place to protect against your identification. Also, note that the insights we gain from your experiences may help us to better understand physical education teachers' perceptions, and applications of exercise science knowledge (Subdisciplinary knowledge) and have implications on how future physical educators are trained in exercise science knowledge.

Can you please state for the record whether or not you agree to participate in the study? [wait for response]

We would also like to record the interview with the understanding that the recording will be deleted after we have transcribed our conversation. Do I have your permission to audio record the conversation? [wait for response; If "yes", proceed to the next paragraph. If "no", ask if the participant would like to continue in the interview if it is not audio-recorded. If "yes", explain that notes will be taken throughout the discussion in place of the audio-recording, if "no", thank the participant and end the interview]

Before we begin with the interview questions, do you have any questions about the interview or any of the other information I have given to you before we begin? [wait for response] Okay, If any of the questions I ask sound redundant or like you've already addressed it, please just say so and we will move on to the next question.

Semi-Structured Interview Guide
Physical Education Teachers' Perceptions, and Applications of Subdisciplinary Knowledge

1. Do you have any questions or concerns before we begin the interview? [wait for a response and answer any questions asked].
2. Please tell me a little about yourself as a teacher
    a. How many years have you been teaching secondary physical education?
        i. What grades do you teach?
        ii. How many sections do you have each day?
    b. Age, and degree?
    c. What was your college major?
    d. When did you complete your National Board Certification?
        i. Is your certification up to date?
3. K-12 experience and science-based physical education
    a. Have you experienced or observed science-based physical education in your K-12?
    b. If so, what was your perception of it.
4. College (or graduate school) curriculum and exercise science courses
    a. What did you learned in the college related to exercise science that help you to apply it into your teaching?
    b. Did you apply the exercise science knowledge that you learned into real teaching situations?
    c. In what ways does college curriculum help for applying exercise science knowledge content?
5. Teaching experience and applied exercise science based physical education
    a. In your current school, in what ways does your teaching experience help to apply exercise science knowledge into teaching physical education?
    b. If so, how did you learn?
    c. What strategies did you use to apply exercise science concepts? Did the strategies effective?
6. National Board Certification curriculum and exercise science knowledge
    a. What did you learned in National Board Certification curriculum related to exercise science that help you to apply it into your teaching?
    b. Did you apply the exercise science knowledge that you learned into real teaching situations?
    c. In what ways does National Board Certification curriculum help for applying exercise science knowledge content?
7. Peers, administration, school, parent and exercise science knowledge
    a. What did you learned from Peer teachers for applying exercise science knowledge into physical education class?
    b. If so, how did you learn?
    c. In what ways does peer teachers help for applying exercise science knowledge into physical education class?
8. Professional development and exercise science knowledge
    a. Have you attended any professional developments learning how to apply exercise science concepts for teaching physical education?

    b. How did you apply what you learned to your actual teaching?
9. What other factors influence to build your exercise science knowledge?
10. If you determine the ranking these (College curriculum, National Board Certification curriculum, Peer teachers, Teaching Experience, others) to acquire exercise science knowledge to apply physical education class, how can you determine the ranking and why?
11. Barrier
    a. Have you encountered any barriers while applying exercsie science knowledge into teaching physical education? What supports do you expect to receive?
12. Before we conclude, is there anything else you would like to share me about organizing physical education class content?