Technology Integration in School-Based Physical Activity

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ABSTRACT

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The purpose of this study was to understand the current practice of technology use for physical activity promotion in K-12 schools in the United States by conducting two studies. Using a quantitative research design, study one aimed to identify the current practice of technology use in school-based physical activity promotion. Study two investigated what attributes contribute to the use of technology in schools for physical activity facilitation and promotion. A sequential explanatory mixed-methods study design was used for study two, and Rogers' (2003) diffusion of innovations theory served this study as a theoretical framework. A total of 367 registered Active Schools Champions completed the Comprehensive School Physical Activity Program Technology Practice Questionnaire (CSPAP-TPQ) and the Diffusion of Innovations Questionnaire for studies one and two, respectively. Semi-structured interviews were additionally conducted with ten purposefully selected participants for study two. For study one, the data were analyzed using several statistical analyses, including descriptive statistics, cross-tabulation analysis with χ^2 test, and multiple regression. For study two, quantitative data (i.e., survey data) were analyzed using descriptive statistics and multiple regression analysis, while qualitative data (i.e., results from semi-structured interviews) were analyzed inductively using open and axial coding.

The results of study one showed that various technologies are currently used in school-based physical activity, and physical education is the timeslot where technology is most used by

school staff for physical activity facilitation and promotion in K-12 schools. Among various personal characteristics, race and certified/licensed teacher status were significant predictors of technology use among various school staff for physical activity promotion in schools, while school characteristics did not predict the school use of technology for school-based physical activity promotion. Study two found that school staff are more likely to use technology when they see the ease and simplicity of new technology and after testing out new technology before committing to using it. Furthermore, personal experiences with technology greatly affect their perceptions of using technology in school-based physical activity facilitation and promotion. However, there are multiple barriers to using technology in school-based physical activity, and school staff, especially physical education teachers, believe that the barriers occur due to the marginalization of physical education in school communities. Although school staff see the benefits of technology use for school-based physical activity promotion in general, they also see some risk factors and concerns.

This dissertation generated findings that could contribute to the field of physical education teacher education (PETE) and public health in multiple ways. The generated data on the current practice of technology use in school-based physical activity facilitation and promotion can be used by schools, school districts, professional organizations for teachers (e.g., Society of Health and Physical Educators [SHAPE] America), and government agencies (e.g., U.S. Department of Education) to enhance resources, equipment, and facilities for the use of technology in schools. Furthermore, this dissertation fills an existing knowledge gap by investigating and determining what characteristics of schools and their staff predict the use of technology for school-based physical activity promotion and what attributes and experiences contribute to the same. This information can be used to inform professional development efforts and better support student physical activity in school communities. PETE and public health researchers, practitioners, and decision-makers will be able to use the results of this dissertation to better understand technology use in school-based physical activity promotion.

DEDICATION

This dissertation is dedicated to my mom and dad, who never said "no” and supported my choices and decisions for me to keep following my dreams throughout my life.

I love you two very much.

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INTRODUCTION

Sedentary behavior and physical inactivity in school-aged children and adolescents have been troublesome public health concerns for many years in the United States (Datar, 2017; Guthold et al., 2010; Mitchell & Byun, 2014; Pandita et al., 2016; Williams et al., 2018). According to the recent edition of the *Physical Activity Guidelines for Americans* (U.S. Department of Health and Human Services, 2018), approximately three-quarters of children and adolescents (aged 6–17 years) in the United States are insufficiently active. Given that children and adolescents spend most of their time at school and that the school is a major learning environment, K–12 schools could play a greater role in supporting their students to live healthy lives by increasing the quality and quantity of physical activity among students (Chen & Gu, 2018; Corbin & McKenzie, 2008; Erwin et al., 2013). In fact, numerous studies have shown the positive effects that school-based physical activity programs and various interventions can have on the development of healthier school communities (Erwin et al., 2012; Fredriksen et al., 2017; Naylor et al., 2015; Pulling Kuhn et al., 2021; Russ et al., 2015; Watson et al., 2017).

Digital technologies have become an inextricable part of almost every aspect of life today, especially for younger people, who have been growing up with many different types of technologies (Blower et al., 2020; Chubb et al., 2021; Mantilla & Edwards, 2019). According to the Centers for Disease Control and Prevention (CDC; 2018), children and adolescents tend to spend a large proportion of their time with technology; children aged 8-10 and adolescents aged 11-14 spend nearly 6 hours and 9 hours a day, respectively, in front of a screen using entertainment media with televisions, tablets, smartphones, or other technologies. However, the American Academy of Pediatrics (AAP) has discouraged media use by children younger than 2 years old and has recommended limiting older children's screen time to no more than one or two hours a day through policy statements and technical reports (Hill et al., 2016).

With the data above, technology has been considered one of the leading causes of children's physical inactivity and sedentary behavior (Gao & Lee, 2019; Mustafaoğlu et al., 2018; Rosen et al., 2014). Nevertheless, various technologies significantly benefit the age group, especially in an educational environment, because schools are predominantly places of learning, socializing, and development for children and adolescents. In education, technology provides students with easy-to-access information, accelerated learning, and entertaining opportunities to practice and apply what they learn (Cheung & Slavin, 2012; Criollo-C et al., 2021; Delgado et al., 2015). Moreover, population-based physical activity programs continuously seek more creative, innovative, and unique ways to increase lifelong engagement and participation in physical activity (Bunn et al., 2018; Fomby et al., 2021; Page et al., 2020). As schools are theoretically an ideal setting for physical activity promotion for children and adolescents (Active Schools, 2022; Carson et al., 2014; CDC, 2014), many different types of technology can play substantial roles in better supporting, facilitating, and promoting physical activity in school communities (Casey & Jones, 2011; Evans et al., 2017; Lewis et al., 2017).

There are various ways to integrate technology into school-based physical activity. For example, the use of relevant technologies can be incorporated into a school's allocated physical activity sessions, such as physical education classes, recess and classroom physical activity, before and after school programs, and even in distance learning environments (Buchele Harris & Chen, 2018; Ha et al., 2022; Lewis et al., 2017; Martin & Zimmerman, 2014; Yu & Ha, 2021).

Research findings support the notion that technology integration into classroom physical activity (e.g., brain breaks) positively impacts attitudes and physical activity behavior (i.e., self-efficacy in learning with technology, exercise motivation and enjoyment, self-confidence in physical fitness, holistic health promotion, exercise habit, and attitude toward physical activity) in schoolchildren (Uzunoz et al., 2017). In addition, it has been shown that using technology in physical education has assisted teachers in creating more dynamic classes that better suit students with a wide range of physical activity and fitness levels (Keating et al., 2020). Evans et al. (2017) also highlighted that using wearable technology (e.g., pedometers or accelerometers) within the context of a school-based physical activity intervention for children is feasible for increasing student motivation for goal achievement.

It is clear that there are prospective benefits associated with integrating technology into the promotion of physical activity in schools. However, to actualize and support implementation, it is necessary to first examine the current practice of technology use in schools and the factors that influence the use of technology in school-based physical activity promotion. To date, there are no studies related to these specific topics, while few studies have examined physical education teachers' attitudes toward, perceptions of, and self-efficacy in technology integration (Gibbone et al., 2010; Hill & Valdez-Garcia, 2020; Krause, 2017). Therefore, the purpose of this dissertation, which consisted of two studies, was to understand the current practice of technology use for physical activity promotion in K-12 schools in the United States. A whole-of-school approach to physical activity promotion called a comprehensive school physical activity program (CSPAP; CDC, 2014), consisting of five components (i.e., physical education, physical activity during school, physical activity before and after school, staff involvement, and family and community engagement), served as a conceptual framework for this dissertation.

Participants for two studies in this dissertation were recruited from the national organization Active Schools, which includes members called Active Schools Champions, encompassing physical education teachers, classroom teachers, school administrators, and other school staff who contribute to creating an active school environment through school-based physical activity in the United States. Study one aimed to identify the current practice of technology use in school-based physical activity promotion. The research questions included:

Q1 What types of technology do schools currently use to facilitate or promote physical activity?

Q2 What personal and school characteristics predict the use of technology for school-based physical activity promotion?

This study utilized a quantitative research design, and numeric data were collected using the Comprehensive School Physical Activity Program Technology Practice Questionnaire (CSPAP-TPQ; Ha et al., in review). The data were analyzed using several statistical analyses, including descriptive statistics, cross-tabulation analysis with χ^2 test, and multiple regression, to answer the aforementioned research questions (Chatterjee & Hadi, 2013).

Study two investigated what attributes contribute to the use of technology in schools for physical activity facilitation and promotion. This work was based on Rogers' (2003) diffusion of innovations theory, which encompasses the following five attributes of innovations that affect adoption: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability (Kapoor et al., 2014; Lundblad, 2003; Sahin, 2006). The research questions included:

Q3 What attributes contribute to the use of technology in schools for the facilitation and promotion of physical activity?

Q4 What experiences contribute to perceptions of using technology to facilitate and promote physical activity in schools?

Using a sequential explanatory mixed-methods study design (Creswell & Creswell, 2017), study two used a survey adapted from the work of Moore and Benbasat (1991) and Ntemana and Olatokun (2012) to collect quantitative data, which was analyzed to determine what attributes contribute to the use of technology in schools for physical activity promotion. Semi-structured interviews (Creswell, 2009) were then conducted with purposefully selected participants (i.e., those who show positive perceptions of technology and those who show negative perceptions of technology) to explore what experiences contribute to their perceptions of using technology to promote physical activity in schools. Quantitative data (i.e., survey data) were analyzed using descriptive statistics and multiple regression analysis (Chatterjee & Hadi, 2013). Qualitative data (i.e., results from semi-structured interviews) were analyzed inductively using open and axial coding (Corbin & Strauss, 2014).

This dissertation generated findings that could contribute to the field of physical education teacher education (PETE) and public health in several ways. First, this dissertation generated data on the current practice of technology use in school-based physical activity facilitation and promotion, which could positively impact the health of school-aged children and adolescents. Schools, school districts, professional organizations for teachers (e.g., Society of Health and Physical Educators [SHAPE] America), and government agencies (e.g., U.S. Department of Education) will be able to use the data to enhance resources, equipment, and facilities for the use of technology in schools. Second, this dissertation fills an existing knowledge gap by investigating and determining what characteristics of schools and their staff predict the use of technology for school-based physical activity promotion and what attributes and experiences contribute to the same. Hence, this dissertation established and provided evidence of the influential factors of technology integration in school-based physical activity, and this information can be used to inform professional development efforts and better support student physical activity in school communities. Overall, PETE and public health researchers, practitioners, and decision-makers will be able to use the results of this dissertation to better understand technology use in school-based physical activity promotion.

CHAPTER II

LITERATURE REVIEW

This chapter discusses a comprehensive school physical activity program (CSPAP) and the diffusion of innovations theory based on various research studies and guidance documents. The CSPAP and the diffusion of innovations theory served as conceptual and theoretical frameworks for this dissertation, respectively. These two frameworks guided and supported this dissertation by structuring the research process, explaining the key concepts and phenomena, and drawing connections between the two studies (Leshem & Trafford, 2007; Osanloo & Grant, 2016). In addition, definitions of technology are discussed. Then, based on an extensive literature review on the current trend of technology use in physical activity, the ideas and visions for technology integration in school-based physical activity are also discussed under five crucial components of CSPAP.

Comprehensive School Physical Activity Program

In 2014, with quality physical education as its foundation, a CSPAP was recognized as the national framework for physical education and physical activity in the United States (Centers for Disease Control and Prevention [CDC], 2014). The CSPAP's aim is not just to educate school-aged children and adolescents in the knowledge and application of skills learned in physical education but also to enable them to meet the national recommendation of 60 minutes of physical activity daily (Society of Health and Physical Educators [SHAPE] America, 2015; U.S. Department of Health and Human Services, 2018). As a whole-of-school approach, the concept of CSPAP is aligned with various internationally accepted guidelines and initiatives, including

Finnish Schools on the Move in Finland, *Active School Flag* in Ireland, and *PE with Class* in Poland (McMullen et al., 2015). A CSPAP was conceptualized as part of public health efforts to address the rising prevalence of sedentary lifestyles and hypokinetic chronic diseases, including obesity, heart disease, and diabetes (Biddle et al., 2004; CDC, 2019a; van der Mars & Lorenz, 2020). Since then, CSPAP has been supported and advocated by multiple national, public, and private organizations, including CDC, the National Academy of Medicine, SHAPE America, and Active Schools. The foregoing organizations have stood by CSPAP by supporting the same public health goal, which aims at increased access and opportunities for youth to be physically active and to develop their ability to perform and enjoy day-to-day physical activity throughout their lifetimes.

The CSPAP movement has gained momentum in recent years; over 23,000 schools, 33,000 educators, and 12,000,000 students have been reached by the CSPAP model since 2013 (Active Schools, 2018). This phenomenon started with the guiding model of the former First Lady, Michelle Obama's *Let's Move!* Active Schools initiative. Accordingly, a large body of peer-reviewed research papers have investigated the effects of CSPAP, and multiple organizations, such as SHAPE America, have established a special interest group and web page in relation to CSPAP (van der Mars & Lorenz, 2020). Moreover, many physical education teacher education programs (e.g., Arizona State University, University of Idaho, University of Northern Colorado, University of South Carolina, West Virginia University) across the nation have included CSPAP as an essential component of teacher education (Bulger et al., 2017; Carson et al., 2017; Dauenhauer et al., 2017; Webster & Nesbitt, 2017; van der Mars et al., 2017).

A CSPAP emphasizes establishing the foundation of physical activity opportunities not only in physical education classes but also in all other school settings, such as before- and after-school programs and recess, as well as getting staff and family involved in physical activity. As a multi-component approach, the CSPAP consists of five different components (CDC, 2014): (a) physical education, (b) physical activity during school, (c) physical activity before and after school, (d) staff involvement, and (e) family and community engagement (see Figure 2.1). The components of CSPAP can be implemented by school districts and schools to maximize all possible physical activity opportunities throughout every school day.

Figure 2.1

Comprehensive School Physical Activity Program

Note. Centers for Disease Control and Prevention. (2019a). *Increasing physical education and physical activity: A framework for schools 2019*. https://www.cdc.gov/healthyschools/physicalactivity/pdf/2019_04_25_PE-PA-Framework_508tagged.pdf

Physical Education

Although each of the five components uniquely contributes to the goal of CSPAP, quality physical education is the foundation. Physical education takes place in the primary learning environment, where school-aged children and adolescents develop the necessary knowledge, skills, confidence, and disposition to be physically active for a lifetime (SHAPE America, 2014). A large body of literature has highlighted the benefit of physical education, including motor skill development, fitness improvements, self-esteem and social skill enhancement, and academic performance (Bailey, 2006; Dudley et al., 2011; Ericsson & Karlsson, 2014; Hills et al., 2015; McKenzie et al., 2010; Sallis et al., 1999). Moreover, when students have a physical education class, they engage in more moderate-to-vigorous physical activity (MVPA) than on the days they do not (Erwin et al., 2013; Hollis et al., 2017; Lonsdale et al., 2013). In order to provide students with quality physical education experiences, there are four essential components of such programs (SHAPE America, 2015): policy and environment, curriculum, appropriate instruction, and student assessment. For example, defining physical education expectations (e.g., instruction periods totaling 150 minutes per week in elementary and 225 minutes per week in middle and high school) through specific and clear policy and environmental support has long been recommended to school districts and schools across the country. A standards-based and -aligned curriculum, along with teachers' appropriate instruction and assessment practices, is also essential to support the overarching goals defined in the school district's or school's physical education curriculum (e.g., active engagement, modified activities, differentiated instruction). With a clear understanding of the four areas, physical education teachers can provide students with quality physical education that provides MVPA and develops appropriate knowledge of lifetime physical activity that can be applied to other components of CSPAP (Graber et al., 2020).

Physical Activity During School

According to the CDC (2019b), the variety of physical activities offered during the school day affects students' attitudes toward physical activity, their physical and mental health, and their behaviors, resulting in, for example, an increased level of physical activity, improved cardiovascular and metabolic health, reduced weight gain, reduced symptoms of anxiety, and reduced disruptive behavior in the classroom. Beyond physical education, physical activity during school takes place via multiple programs and experiences. Beighle et al. (2020) stated that physical activity during school at the elementary level commonly occurs during classroom physical activity integration and recess, while secondary-level students may have the chance to participate in physical activity during school not only through classroom physical activity integration and recess time but also via walking breaks and drop-in sessions. Physical education teachers and other school staff can organize programs, projects, or events that can potentially produce more physical activity opportunities for the school community based on the school context. A systematic review by Ridgers et al. (2012) found that physical activity during school recess periods has the potential to increase students' physical activity levels. Physical activity during the school day can make a meaningful contribution to the daily physical activity of school-aged children and adolescents in terms of achieving the goal of the CSPAP, eliciting various physiological and psychological benefits (Hills et al., 2015; Ridgers et al., 2006; Ridgers et al., 2012; Webster et al., 2015).

Physical Activity Before and After School

Despite physical education class time and physical activity during school, many children and adolescents still do not participate in the nationally recommended 60 minutes of physical activity per day (U.S. Department of Health and Human Services, 2018). In response to this concern, public health advocates have highlighted out-of-school time as an excellent opportunity to help school-aged children and adolescents meet this national recommendation (Dauenhauer et al., 2020). Notable examples of out-of-school time include before- and after-school programs that encompass various activities, programs, and events, such as walking or biking to and from such school programs; physical activity clubs; intramural programs (e.g., sports organized by the school or community); and interscholastic sports (e.g., competitive sports between schools). These programs can offer meaningful amounts of physical activity accumulation for children and adolescents. A systematic review and meta-analysis by Mears & Jago (2016) also highlighted that after-school physical activity programs have mixed effectiveness in increasing MVPA levels of school-aged children and adolescents. Physical activity before and after school can encourage students to be physically active by helping them identify activities they enjoy and can participate in in the long term with its multiple health benefits (Davison et al., 2008; D'Haese et al., 2015; Faulkner et al., 2009; Lee et al., 2008; Martin et al., 2016; McDonald et al., 2014; Wong et al., 2011).

Staff Involvement

A number of studies have shown that school professionals and staff can positively influence physical activity behavior among school-aged children and adolescents (Holt et al., 2013; Huberty et al., 2012; Weaver et al., 2014). According to Webster et al. (2020), a key component in the successful implementation of CSPAP in schools is possessing support from the school staff, and by extension, the ideal way of introducing CSPAP to staff is by working together to encourage physical activity in the whole school. The staff involvement component focuses on two aims: (a) increasing staff wellness and (b) the staff promotion of youth physical activity (Webster et al., 2020). In other words, school staff can be participants or physical activity leaders (PALs) regarding both their own health and wellbeing and students' physical activity participation. In order to better lead school-based physical activity programs with relevant knowledge and skills, having a trained PAL in a school has also been highlighted in multiple guidance documents, conceptual papers, and research studies (Brusseau & Burns, 2018; Dauenhauer et al., 2018; Stoepker et al., 2020; van der Mars & Lorenz, 2020). Moreover, the interaction between students and school staff, especially teachers, is an integral part of the school community. Staff should be involved in all the other components of CSPAP. They, as positive role models, can support recess activities, clubs, intramural programs, and other physical activity offerings throughout the whole school.

Family and Community Engagement

School staff typically take the lead in organizing and structuring youth physical activity programming; however, CSPAP is more successful when family and community members are involved with regard to its effectiveness and sustainability over time (Pulling Kuhn et al., 2021). Family and community engagement embraces collaborative work between parents, school staff, community members, and out-of-school time providers to maximize opportunities for physical activity before, during, and after the school day. As family and the surrounding community are influential for students' growth in terms of physical and mental development, family and community members also possess responsibility and accountability with regard to playing an important role in shaping the health and learning of students in multiple settings, including at home, in schools, in the community, and in out-of-school time programs. Developing school, family, and community partnerships benefits students by increasing physical activity, encouraging better student behavior, improving social skills, and enhancing grades and test scores (CDC, 2012). The CSPAP model cannot successfully be completed without support from family and the community (Brown et al., 2016; Erwin et al., 2013; Pulling Kuhn et al., 2021)

Many school districts and schools in the United States have their own programs that focus on promoting physical activity (SHAPE America, 2016). However, SHAPE America

(2015) and CDC (2019a) have consistently recommended that all schools across the nation implement CSPAP as a total school-based physical activity promotion program. As a conceptual framework, the CSPAP model could serve as a structure to examine the potential uses of technology for the facilitation and promotion of physical activity according to the five component areas.

Diffusion of Innovations Theory

The diffusion of innovations theory was introduced by Everett M. Rogers, a communication theorist at the University of New Mexico, in 1962. The theory was initially developed by integrating multiple sociological theories of behavioral change (Rogers, 1962). It is a wide-ranging social and psychological theory seeking to explain how humans make decisions to adopt a novel innovation and at what rate new ideas spread by finding their adoption patterns and understanding their structures and characteristics (Lundblad, 2003; Min et al., 2019; Rogers, 2003). Many studies across various disciplines have employed this theory as a framework to explain the adoption of innovation in contexts such as education, information technology, public health, management, organization development, and sociology (Al-Jabri & Sohail, 2012; Dearing, 2009; Dearing & Cox, 2018; Değerli et al., 2015; Lundblad, 2003; Ma et al., 2014; Sahin, 2006; Simin & Janković, 2014; Smith, 2012).

Importantly, the adoption of innovations is not sudden; a specific innovation is established after a sequence of thinking and thought making (Barnett, 1979). In 1995, Rogers outlined the process of adoption through five sequential stages: (a) knowledge (interchangeably called awareness), (b) persuasion, (c) decision, (d) implementation, and (e) confirmation. In the knowledge (awareness) stage, a person becomes aware of an innovation by having some ideas of what it is and what it does. Their attitude (positive or negative) toward the innovation develops, which leads them to seek more information about the innovation in the persuasion stage. If the innovation is considered valuable, the decision of whether to adopt or reject it is established in the decision stage. During the implementation stage, a person puts the innovation to use while still determining its usefulness. Finally, during the confirmation stage, the decision of whether to continue using the innovation is made after it is fully integrated. The abovementioned five stages show how individuals adopt or reject an innovation over time.

Rogers (2003) described the process of innovation diffusion as "an uncertainty reduction process" (p. 232) and identified five attributes of an innovation that help decrease uncertainty about its adoption: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability. Rogers (2003) argued that many studies over the decades have shown that these five attributes consistently influence the process of innovation adoption. These five attributes especially guided study two of this dissertation, which investigated what attributes contribute to the use of technology in schools for physical activity facilitation and promotion.

Relative Advantage

Relative advantage indicates "the degree to which an innovation is perceived as better than the idea it supersedes" (Rogers, 2003, p. 15). Under the topic of this study, this attribute suggests the need to understand the specific advantages of technology that can better facilitate or promote physical activity in school settings. For example, if a classroom teacher perceives that Microsoft PowerPoint slides are more convenient and visually beneficial than projector transparency slides to communicate the importance of physical activity, they will use the new technology while abandoning the use of the projector. A number of studies have shown that educators integrate technology into their instruction when they see its obvious value and benefits

(McKenzie, 2001; Spotts, 1999). Thus, individuals are more likely to adopt new technology when it offers increased effectiveness and/or efficiency (Rogers, 1995).

Compatibility

Rogers (2003) defined compatibility as “the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters” (p. 15). A tablet is an excellent example of explaining compatibility. Many educators have replaced other tools and systems with tablets (e.g., iPad) for checking student attendance, writing notes, creating presentations, and multiple activities which they currently were doing on their desktop or laptop. However, if innovation requires a considerable change from existing rules or additional products to make it work, it is likely to fail (Rogers, 1995). According to Sahin (2006), compatibility and relative advantage were viewed as similar in much literature related to diffusion research even though they are conceptually different. Research by Sherry (1997) supports the idea that a lack of compatibility with individual needs in technology use negatively influences the performance of that technology.

Complexity

Complexity refers to “the degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers, 2003, p. 16). The level of complexity in usage influences the diffusion process (Rogers, 1995). For example, although the effectiveness of emerging motion analysis technology for students’ motor skill learning has been shown to be effective (Yu et al., 2021), and a school may have a sufficient budget, physical education teachers may not invest much time in learning to use it because, despite teachers’ awareness of the advantages of the innovation, the level of effort required to use such a technology would be prohibitive. Rogers (2003) argued that complexity is negatively correlated with the rate of adoption, in contrast to the other attributes; therefore, excessive complexity of an innovation is a significant obstacle to its adoption.

Trialability

Trialability indicates “the degree to which an innovation may be experimented with on a limited basis” (Rogers, 2003, p. 16). It is important for potential adopters to clearly see what the new innovation can do for their work. Therefore, they need to test it before committing to adopting it because the results affect their final decision regarding its adoption. For example, before a school integrates sports video games (e.g., Nintendo Olympics) to improve its after-school physical activity program, it might implement a one-month testing period to see if sports video games are productive and effective at increasing students’ physical activity levels. Trialability contributes to the decision as to whether a new innovation will be adopted or rejected by potential adopters. Thus, more trials of innovation lead to its faster adoption (Sahin, 2006).

Observability

Rogers (2003) defined observability as “the degree to which the results of an innovation are visible to others” (p. 16). For example, if a physical education teacher sees other classroom teachers effectively using a learning management system (e.g., Google Classroom) to monitor student learning progress, this can create a sense of assurance of the potential of using this technology in the context of physical education. If the outcomes and benefits of an innovation are observable, it gives potential adopters a clear rationale for adopting the innovation. Conversely, if many disadvantages are shown, potential adopters may decide against adopting the innovation. Parisot (1997) highlighted that peer observation as role modeling is a key motivational factor in the adoption and diffusion of technology.

The literature on the diffusion of innovations theory offers insights into the factors that may affect the use of technology among various school staff members for physical activity promotion purposes, especially the five attributes of innovations. Rogers (2003) reported that these five attributes determine between 49% and 87% of the variation in innovation adoption. Rogers also highlighted how innovations offering relative advantage, compatibility, less complexity, trialability, and positive observability could be adopted faster than other innovations, while relative advantage is the most potent predictor of an innovation's rate of adoption (Rogers, 2003).

Defining Technology

Although most people use technology in the current era, it may not be easy to clearly define technology because the term *technology* can be differently defined, depending on the context of its use (Matthews & Greenspan, 2020). For example, the term *information technology*, also known as IT, indicates the use of any computers, networking, and other physical devices to create, process, store, secure, and exchange all forms of electronic data in the context of business operations (Dewett & Jones, 2001). On the other hand, according to the Definition and Terminology Committee from the Association for Educational Communications & Technology (2022), the term *educational technology* can be defined as "the study and ethical application of theory, research, and best practices to advance knowledge as well as mediate and improve learning and performance through the strategic design, management and implementation of learning and instructional processes and resources." These aforementioned definitions can also be changed as time goes on because new ideas and innovations affect the practices of their fields in many different ways to elicit more productive and beneficial outcomes. In this dissertation, technology was defined as all the existing digital, mobile, electronic, and physical tools and devices that can be used by teachers, school staff, families, community members, and related professionals to better support, facilitate, and promote physical activity in school communities.

Technology Integration in School-Based Physical Activity

Technology is everywhere in the present age, and schools are no exception. Various advanced and innovative technologies have affected today's classrooms. According to a recent report on the results of the U.S. national survey titled *Use of Educational Technology for Instruction in Public Schools* (National Center for Education Statistics, 2021), over 70 percent of schools in the United States stated that their teachers use technology for activities typically done in the classroom (47 percent of the schools reported moderate technology use in classrooms and 24 percent reported extensive technology use, respectively). Moreover, the report titled *Reimagining the Role of Technology in Education: 2017 National Education Technology Plan Update from the Office of Educational Technology* (Office of Educational Technology, 2017) claimed that multiple aspects of the technology landscape in school communities have changed dramatically across the United States over the years. These technological change factors encompass the rapid increase of broadband access in the classroom setting, the availability of more types of technology and more grants for technology, increased attention toward technological leadership in education, a greater focus on data security and digital citizenship, and an increased emphasis of preservice teachers' technology competency in accordance with the advent of new research on technology use by early learners (Office of Educational Technology, 2017).

In this climate, technology also has the potential to contribute to the field of public health. Physical inactivity among American school-aged children and adolescents is a salient public health issue (Datar, 2017; Guthold et al., 2010; Mitchell & Byun, 2014; Pandita et al., 2016; Williams et al., 2018), despite the fact that CDC (2020) and the U.S. Department of Health and Human Services (2018) have long recommended that young people engage in a minimum of 60 minutes of physical activity every day. In recent days, as nearly all school-aged children and adolescents have grown up with extensive daily technology use, the excessive use of technology can cause a sedentary lifestyle that may increase the risk of developing various physical, physiological, and social health hazards (Akindutire & Olanipekun, 2017; Loveday et al., 2015; Odiaga & Doucette, 2017). On the other hand, however, as children and adolescents spend most of their time in school, technology can play a significant role in facilitating physical activity among students in school communities. Therefore, technology integration should be carefully considered in the design of school-based physical activity programs. Reviewing both research-based and practitioner-focused articles, the following sections will discuss the ideas and visions for technology integration in school-based physical activity in accordance with the CSPAP model. As many technology tools overlap in the CSPAP context, this section discusses technology practices under the following three categories: (a) technology for "physical education," (b) technology for "physical activity during school" and "physical activity before and after school," and (c) technology for "staff involvement" and "family and community engagement."

Technology for "Physical Education"

The goal of physical education is to develop physically literate individuals who have the knowledge, skills, confidence, and disposition to participate in and enjoy healthy physical activities throughout their lives (SHAPE America, 2015). Accordingly, technology can be a vehicle to foster a learning environment in which students can have engaging, challenging, motivating, and enjoyable learning experiences that provide them with positive perceptions of physical activity. For example, appropriate use of music can create a more exciting and fun learning atmosphere (Barney & Prusak, 2015), and YouTube video clips can be used to lead health-related fitness workouts in an enjoyable environment (Quennerstedt, 2013), as health-related fitness is one of the core national standards (Standard #3) to be achieved in physical education (SHAPE America, 2014). Countless video clips created by physical and health education professionals are available on YouTube and involve fitness challenges or fitness-related games with various concepts (e.g., “would you rather” workouts).

Technology can play an important role in enhancing teachers’ pedagogical practices in physical education. The use of software, such as Microsoft Office (e.g., Word, PowerPoint, and Excel) and Google Workspace (e.g., Docs, Slides, and Forms), is ubiquitous among educators when creating documentation and slideshow presentations, organizing data, and managing the classroom (Jenny et al., 2020). Creating and using various instructional materials by employing the aforementioned applications can help engage multiple learning styles among students due to the increased visual impact of the materials; by extension, this helps students make sense of their physical experiences in the gymnasium. Moreover, there are many web-based graphic design tools (e.g., Canva, Piktochart) that allow educators to easily create visuals, such as presentations, posters, flyers, and infographics, by choosing from a wide range of templates. Researchers have also found that in physical education, the use of visual materials improved student skill learning compared to traditional teaching methods that are not accompanied by visual materials (Oudat, 2015).

There are also advanced technological options for maximizing visual learning. For example, video technology is highly effective in supporting the teaching of various motor skills and movements (i.e., Standard #1; SHAPE America, 2014), and a number of studies have proved the effectiveness of video technology in teachers' pedagogical practices (Kretschmann, 2017; Palao et al., 2015; Weir & Connor, 2009; Yu et al., 2021). For teachers to easily and effectively use video technology, there are many mobile applications for conducting video analysis for sports-specific purposes (e.g., myDartfish Express) that have functions such as video recording, slow-motion, frame-by-frame scrubbing, and superior playback. Using these functions, teachers can provide students with more detailed and meaningful visual feedback, and the recorded videos can be used for student assessment, an essential component of quality physical education (SHAPE America, 2015). Research by Palao et al. (2015) found that teacher feedback that incorporated video technology resulted in a significant improvement in students' skill execution, technique, knowledge learning, and level of practice. Watching recorded videos of students or professionals playing sports can also help students learn concepts, principles, strategies, and tactics related to these sports games (i.e., Standard #2; SHAPE America, 2014). In addition, research by Weir and Connor (2009) showed that the use of video technology enhances not only student engagement but also teacher motivation.

Motivation significantly affects students' physical activity behavior in physical education (Ward et al., 2008). The concept of game-based learning can be an effective approach to improving students' motivation and engagement. In the context of physical education, game-based learning is a technique that uses games to help students meet grade-level physical education standards (Brooks & McMullen, 2021). There are many free and ready-to-use online game-based learning platforms, including Kahoot!, Plickers, and Gimkit, which allow educators to create live quizzes, card-based exercises, and many more activities that include fun elements such as reward systems (e.g., badges, points). Activities involving game-based learning offer multiple advantages, including greater student participation with increased motivation, alignment with students' digital learning styles, formative assessment options, and customization options (Erhel & Jamet, 2013; Jenny et al., 2020).

Considering the nature of physical education, which mainly focuses on student physical movements, futuristic technologies, such as augmented reality (AR) and virtual reality (VR), hold tremendous potential as instructional and motivational tools in physical education classes. AR can be described as an interactive method of presenting relevant digital information in the context of the real-world environment (e.g., Pokémon GO in AR), while VR signifies the virtual world where users can have simulated experiences (e.g., Beat Saver in VR) (Aukstakalnis, 2017). Research by Chang et al. (2020) supports that AR-assisted instruction is more effective than video-assisted instruction, especially for motor skill-related content, for students in secondary-level school physical education. The positive effects of the application model of VR as a novel learning method in physical education have also been proven in several studies, highlighting that VR could enhance student learning outcomes by creating a more enjoyable and creative environment (Kang & Kang, 2019; Wang et al., 2022; Wang & Wei, 2020; Yang & Meng, 2019).

Online physical education (OLPE) is an important topic in contemporary physical education research. Recently, many studies have highlighted the significance and future prospects of OLPE, as the Coronavirus Disease 2019 (COVID-19) has significantly impacted education all over the world (Reimers, 2022). An article by Webster et al. (2021) has described OLPE as a possible means of promoting equitable physical activity among school-aged children and adolescents in the current climate by highlighting OLPE's synergy with the CSPAP model. As many people have been made aware of the benefits of distance learning, OLPE has become a promising alternative for students to remain active even after the COVID-19 pandemic. However, scholars have argued that a lack of interaction between teachers and students in OLPE leads to lower student engagement and poorer learning outcomes (Daum & Buschner, 2014; Daum et al., 2022; Kim et al., 2021). Accordingly, several studies have highlighted the importance of and proposed ideas for effective pedagogical practices in OLPE (Goad et al., 2019; Kooiman et al., 2017; Yu & Ha, 2021). For example, Daum et al. (2022) argued that physical education teachers can achieve effective learning outcomes regarding health-related fitness and motor skills in distance learning environments via different forms of technology use (e.g., video sharing, exergaming, virtual classrooms) and alternative types of at-home equipment (e.g., rolled-up socks, toilet paper tubes, water bottles, balloons).

Technology for "Physical Activity During School" and "Physical Activity Before and After School"

According to *Comprehensive School Physical Activity Programs: Putting Research into Evidence-Based Practice* (Carson & Webster, 2020), physical activity during school typically occurs during recess, physical activities integrated into classroom lessons, lunch-time clubs, walking breaks, intramural programs, or drop-in events, while physical activity before and after school takes place on campus through school-sponsored programs or off-campus in partnership with various community organizations (e.g., recreation centers). For students to achieve the nationally recommended 60 minutes of physical activity every day, the time allocated to physical education in schools may not be enough, as many schools invest more time in other core academic subjects (e.g., mathematics; Richards et al., 2018). It is important to understand how technology can be used before, during, and after school to effectively facilitate physical activity among students by enhancing active experiences in creative ways.

Most schools in the United States set their own required amount of time for physical education or physical activity (SHAPE America, 2016). Consequently, monitoring students' physical activity and physical fitness can support them in meeting school requirements. Beyond physical education, wearable technology can be used in the monitoring process. Wearable technology includes smart electronic devices that can be worn on one's body (e.g., smartwatches) or integrated into clothing, shoes, or accessories (e.g., belts). Such technology can track information and collect data on students' health behaviors. For example, a pedometer can count students' daily steps, and a heart rate monitor can measure and display students' heart rates in real-time. Actigraphy and Fitbit are also notable examples of widely used wearable technology for monitoring students' physical activity before, during, and after school. Wearable technology has been frequently used in various research projects to measure physical activity levels of K-12 students (e.g., Brusseau & Kulinna, 2015; Burns et al., 2017; Kahan & McKenzie, 2018); however, few studies have directly examined the effectiveness of wearable technology in school settings by focusing on the technology itself. McCaughtry et al. (2008) found that teachers' use of pedometers as instructional technology in physical education revealed a significant shift in their technology-related thinking and values; the teachers believe that wearable technology, specifically the pedometer, can support pedagogical practice, especially assessment, and can better help motivate lower-performing students. Many studies have found that before, during, and after school times are great for promoting students' physical activity (Brusseau et al., 2016; McMullen et al., 2014; Pulling Kuhn et al., 2021; Stylianou et al., 2016), and wearable technology can play a significant role in supporting school-based physical activity promotion (Conger et al., 2022; Lindberg et al., 2016; Phillips et al., 2018).

Recently, exergaming has become a popular approach to encouraging students to be more motivated and engaged in the learning process (Benzing & Schmidt, 2018). An emerging fitness trend, exergaming is a form of video gaming that incorporates various elements of exercise and physical activity by tracking body movements and reactions during certain activities (Zhao et al., 2020). In other words, the benefits of exercising and gaming are combined in a single activity—students can achieve fitness outcomes while enjoying gaming activities. A review by Sween et al. (2014) identified 27 studies on the effects of exergaming, with the overall findings of these studies showing a strong correlation between exergaming and increased energy expenditure, which helps meet the health and fitness guidelines provided by the American College of Sports Medicine (2012). Exergaming can be a motivational technological tool that organically encourages students to be more physically active and can be used not only in physical education classes but also during recess or before-and-after physical activity programs (Krause & Jenny, 2020). Research by Kooiman et al. (2017) showed that exergaming can be implemented in the OLPE environment as well.

Technology for "Staff Involvement" and "Family and Community Engagement"

CSPAP, as a whole-of-school approach, has a greater chance of success in terms of effectiveness and sustainability over time when school professionals, family, and community members are involved (Dauenhauer & Stoepker, 2022; Webster et al., 2020; Welk & Lee, 2020). Therefore, staff involvement in and family and community engagement within CSPAP encourages collaborative work between school staff, parents, and various community members to create an active school environment through not only physical education but also before, during, and after school physical activity. When it comes to collaborative work between school stakeholders, group management software can help teachers, school staff, family, and community members communicate, collect data, share resources, and manage schedules and tasks. Connecteam, Blink, and Microsoft Teams are some prime examples of software for improving productivity and enhancing the quality of team tasks, activities, and projects.

Like group management software, a learning management system (e.g., ClassDojo, Google Classroom) can help students learn more about physical activity with support from staff, family, and community. A learning management system is an online integrated software application that offers a large set of features for supporting educational activities, including both classroom learning and distance education (Falvo & Johnson, 2007). Therefore, a learning management system can be an assistive tool to provide students with compensatory learning opportunities. For example, physical education does not merely teach students how to move without thinking; it also fosters skills and knowledge that can be used to lead healthier lives. Therefore, a learning management system can be used by teachers to manage student health and fitness information generated during fitness assessments or by wearable technology (e.g., pedometers) and to prepare online examinations or quizzes and administer them out of class time. Using a system like this, other school staff, such as physical activity leaders and school wellness coordinators, can collaboratively support and manage student health and physical activity beyond physical education, and parents can also monitor student learning progress in real time (Killian et al., 2021).

According to Jenny et al. (2020), technology can be used in the physical education teaching profession not only for teaching and learning but also for professional development and advocacy. Social media (e.g., Twitter) can be used as a channel for teachers, school staff, and families to obtain information from and communicate with professionals in the field. Social media can be defined as virtual platforms that enable users to create online communities to share and exchange information, ideas, personal messages, and other content, including documents, photos, and videos. Accordingly, for a professional learning community, social media allows teachers to explore and obtain various teaching ideas and resources to improve their teaching practices (Brooks & McMullen, 2020). Moreover, school staff (e.g., physical activity leaders and school wellness coordinators), family, and community members can advocate and promote physical activity and related events in their schools, as school-aged youth are increasingly turning to social media for health-related information, including unique physical activity, diet, and nutrition (Goodyear et al., 2018). A recent scoping review by Jackson et al. (2021) found that over the past 10 years, more than 20 works have discussed the use of social media in the public health community for public policy advocacy related to human health issues. Overall, social media offers multiple benefits in terms of professional development and advocacy.

M-learning (or mobile learning) is another widely used form for educators to engage in professional development. M-learning can be defined as learning across multiple contexts via the internet or network using personal mobile devices, such as tablets (e.g., iPad) and smartphones (Kumar Basak et al., 2018). Podcasts, webinars, virtual conferences, and online certificate courses are typical examples of M-learning. Through these platforms, school staff, including physical education teachers, can develop their knowledge and skills in terms of school-based physical activity promotion in a more flexible environment because M-learning is time-efficient, cost-effective, and location-accessible (Evans, 2008; Kumar Basak et al., 2018; Matzavela & Alepis, 2021). With these apparent benefits, other community members can also use M-learning as a platform to continue their education related to physical activity and health to better support school-based physical activity programs. Research also supports that M-learning, especially podcasts, are very effective in physical education to improve learners' examination performance and their motivations if used in conjunction with traditional teaching methods (Myers, 2013).

Technology continues to evolve, and many novel technologies have emerged over the past few decades. As it is impossible to imagine rising and future generations living without technology, there are also negative impacts of using technology among school-aged children and adolescents, such as addiction (extreme dependability of technology), social isolation, and degradation of memory (Dere, 2022; Plowman & Stephen, 2003). Moreover, several studies highlighted that technology is one of the biggest causes that leads to children's physical inactivity and sedentary behavior (Mustafaoğlu et al., 2018; Rosen et al., 2014). Nevertheless, it is an undeniable fact that a variety of technologies can help many aspects of human lives; therefore, technology integration is indispensable to education in the current era. With the known benefits and importance of school-based physical activity, integrating technology into physical education and physical activity programs in school settings is a promising strategy for increasing the daily physical activity levels of school-aged children and adolescents. The above-stated ideas and visions of technology integration in school-based physical activity based upon extensive review under the concept of CSPAP provide insights into directions for future research and initiatives in the field of physical education teacher education (PETE) and public health.

CHAPTER III

METHODOLOGY

The purpose of this chapter is to describe the methodology for the two studies included in this dissertation. Each study encompasses several subdivided sections such as research design, participants and setting, research instrument, data collection, data analysis, and trustworthiness in accordance with the methods being adopted.

Methodology for Study One: Technology Use in School-Based Physical Activity Promotion

Study one aimed to identify the current practice of technology use in school-based physical activity promotion. The research questions included:

Q1 What types of technology do schools currently use to facilitate and promote physical activity?

Q2 What personal and school characteristics predict the use of technology for school-based physical activity promotion?

Research Design

Numerical data were collected through an online survey created in Qualtrics to answer the research questions stated above. Therefore, a quantitative research design was utilized for this study. According to Black (1999), for the study employing a quantitative research design to observe situations or events that affect people through numerical data, surveys are often used to make predictions, test causal relationships, and establish statistically significant conclusions about a sample of the population.

Participants and Setting

Participants were recruited from the national organization Active Schools, which includes members called Active Schools Champions, encompassing various school stakeholders such as physical education teachers, classroom teachers, health education teachers, and other school staff who contribute to school-based physical activity promotion in the United States. Following Institutional Review Board (IRB) approval (see Appendix A), the Executive Director and Manager of the organization supported the data collection for this dissertation by sending out a survey invitation to Active Schools Champions. An online version of the survey, encompassing the Comprehensive School Physical Activity Program (CSPAP) Technology Practice Questionnaire (CSPAP-TPQ; Ha et al., in review) for study one and the Diffusion of Innovations Questionnaire for study two, was included in the Active Schools' newsletter, which was sent out to all the members on the list (approximately 40,000 Active Schools Champions) via email multiple times in three weeks (see Appendices B & C). A total of 367 Active Schools Champions completed the survey, with a higher than 95% survey completion rate for those who initiated the survey. A $10 Amazon gift card was awarded to the first 250 Active Schools Champions who completed the survey. Everyone after that was entered into a lottery for a $50 Amazon gift card, and ten of them won the $50 Amazon gift card.

Research Instrument: Comprehensive School Physical Activity Program Technology Practice Questionnaire (CSPAP-TPQ)

In order to identify the current practice of technology use for physical activity promotion in K-12 schools in the United States, the CSPAP-TPQ was used to collect related data on the topic (see Appendix D). The CSPAP-TPQ was developed to investigate the use of technology among various school staff who can potentially contribute to the promotion of physical activity in the school community. The instrument encompasses six sections and 41 unique technologies with items related to respondent demographics, school characteristics, and technology experience, including (a) Technology Use in Physical Education (39 technologies), (b) Technology Use in Physical Activity During School and Physical Activity Before and After School (27 technologies), (c) Technology Use in Staff Involvement and Family and Community Engagement (23 technologies), (d) Personal Characteristics (8 items), (e) School Characteristics (7 items), and (f) Technology Experience (5 items; Ha et al., in review).

The first three sections of technology use under CSPAP components ask respondents whether their schools, including themselves, use specific technologies on the list to facilitate and promote student physical activity. For example, respondents first answer the question, “Does anyone at your school, including you, use the following technologies in Physical Education? - Bluetooth” with three options, including “Yes,” “No,” and “I don’t know.” Then if a respondent responds with “Yes,” they move on to the sub-question, “Check the circle if YOU are the one who uses this technology” If not, they move on to the next technology on the list. The fourth and fifth sections ask about respondents’ personal and school characteristics, such as years of teaching or working experience in education and an approximate number of students in their schools. The last section asks five questions associated with respondents’ technology experience, including the level of confidence in using technology both outside of the classroom and in their teaching and/or educational practices. In order to establish its validity and reliability, the CSPAP-TPQ underwent two rounds of the Delphi method (n = 24 experts) and test-retest among 43 registered Active Schools Champions (85 technology items showed “good to excellent” agreement [≥ 75%], while four technology items showed “moderate” agreement [60-74%] with a value of $p < .001$), respectively (Ha et al., in review).

Data Analysis

The data (i.e., results of CSPAP-TPQ) were first screened thoroughly prior to conducting any data analysis to examine the accuracy of the data and to assess statistical assumptions, including multivariate normality, independence of observation, homoscedasticity, linearity, and multicollinearity (Garson, 2012). The data screening process identified missing values and univariate outliers through the observation of a descriptive table and plots (DeSimone et al., 2015). Then descriptive statistics, including frequency distribution, were used to present a summary of the data characteristics, including measures of central tendency and measures of variability. A frequency table identified the distribution of overall data, which addressed the Q1.

In order to answer the Q2, two separate cross-tabulation analyses with χ^2 tests for personal characteristic variables and school characteristic variables were first conducted, respectively, to see the relationships between the variables and to see the distributions within categorical variables (Momeni et al., 2018). For the cross-tabulation analyses with χ^2 tests, the top 50^{th} percentile and the bottom 50^{th} percentile of technology use were treated as high-tech practitioners (or schools) and low-tech practitioners (or schools), respectively. Multiple regressions (Chatterjee & Hadi, 2013) were utilized with only the independent variables that showed significance in the previous step (i.e., cross-tabulation analyses with χ^2 tests). Two separate multiple regression analyses were run for both personal and school characteristics. In one model, the independent variables included personal characteristics such as age, current position, and years of experience, and the dependent variable was a total score of personal technology use. In the second model, the independent variables were school characteristics, including public school status, locale, and level of school, and the dependent variable was a total score of school technology use.

Response options of several categorical variables in both regression models were re-grouped to avoid unbalanced cell sizes within the regression analysis. For example, the two majorities of participants were bachelor's degree holders (107 out of 367) and master's degree holders (245 out of 367), with lower response rates for doctoral degree holders (10 out of 367); therefore, the master's degree and doctoral degree holders were consolidated as graduate degree holders for statistical analysis purposes. Moreover, if a response option included an extremely small number of responses (e.g., 2 for 2-year associate degree within the Highest Degree variable), cases were eliminated using listwise deletion because they would lead to unbalanced cell sizes (Zahn, 2010). All the analyses were conducted in R, a programming language for statistical computing and graphics (R Core Team, 2022).

Methodology for Study Two: Attributes Contributing to the Use of Technology in School-Based Physical Activity Promotion: A Diffusion of Innovations Theory Approach

Study two investigated what attributes contribute to the use of technology in schools for physical activity promotion. This work was based on Rogers' (2003) diffusion of innovations theory, which encompasses the following five attributes of innovations that affect adoption: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability (Kapoor et al., 2014; Lundblad, 2003; Sahin, 2006). The research questions included:

Q3 What attributes contribute to the use of technology in schools for the facilitation and promotion of physical activity?

Q4 What experiences contribute to perceptions of using technology to facilitate and promote physical activity in schools?

Research Design

For study two, a mixed-methods sequential explanatory research design was utilized to complement quantitative findings with qualitative data (Creswell & Creswell, 2017). The mixed-methods research approach encompasses the process of integrating both quantitative and qualitative data into data collection and data analysis within one study (Creswell, 2009). This process allows the researcher, through multiple data sources, to better understand the context, and by extension, the process creates and presents more evidence to support the findings than each single method itself (Ponce & Pagán-Maldonado, 2015). In this study, according to the procedure used for a mixed-methods sequential explanatory research design, quantitative data (survey results) were first collected and analyzed and then qualitative data (interview results) in two consecutive phases within a single study.

Participants

Quantitative Participants

Quantitative participants for this study were the same as study one (i.e., 367 Active Schools Champions) as they conducted an online survey that included both CSPAP-TPQ for study one and the Diffusion of Innovations Questionnaire for study two.

Qualitative Participants

There was a question at the end of the online survey asking survey respondents if they were willing to participate in a follow-up interview. Thus, for the qualitative phase of this study, an email was first sent to the participants who responded that they were willing to participate in a follow-up interview in the online survey in the first quantitative data collection phase (see Appendix E). Those participants were asked to participate in a semi-structured interview to obtain more in-depth qualitative data (Corbin & Strauss, 2014). With the list of participants who were willing to participate in the interview, purposeful, stratified sampling (Palinkas et al., 2015; Tipton, 2013) was used to equally select participants from two different groups (i.e., positive perceptions group and negative perceptions group).

The target number of participants for the qualitative portion of the study was 10, including five participants who showed positive perceptions of technology and the other five who showed negative perceptions of technology on the Diffusion of Innovations Questionnaire. Using the QUARTILE function in Microsoft Excel, only the participants of the top 25% (positive perceptions of technology) and bottom 25% (negative perceptions of technology) in the total questionnaire score were invited. In addition, according to the results of the frequency table, three physical education teachers, one classroom teacher, and one school administrator were recruited for each group to reflect the different roles that participants took on in schools. Stratified sampling is a method of sampling that selects representative samples from each stratum and ensures diversity in the population (Trost, 1986). Moreover, purposeful sampling allows the researcher to select key informants that are the most effective use of limited resources (Patton, 2014). Table 3.1 presents information about the 10 participants recruited using stratified and purposeful sampling techniques. A $20 Amazon gift card was awarded to those participants who completed the interview process.

Table 3.1

Participant Information for Qualitative Approach

	Name	Gender	Current position	Years of experience	Level of school
Positive perceptions of technology	Natalie	F	Physical education teacher	28	Elementary
	Angel	M	Physical education teacher	30	Combined (PK-8)
	Laura	F	Physical education teacher	29	Elementary
	Ava	F	School administrator	30	Middle
	James	M	Classroom teacher	15	Elementary
Negative perceptions of technology	Deborah	F	Physical education teacher	19	Middle
	Michelle	F	Physical education teacher	12	Elementary
	Elisa	F	Physical education teacher	37	Elementary
	Jose	M	School administrator	33	Elementary
	Julia	F	Classroom teacher	11	Elementary

Note. Names in the table are pseudonyms.

Data Collection and Research Instruments

Phase I: Quantitative Approach

The Diffusion of Innovations Questionnaire was utilized to identify the perceptions of technology use in school-based physical activity promotion among participants by determining their five attributes of innovations defined by Rogers (2003) (see Appendix F). The questionnaire was composed of 20 items adapted from the works of Moore and Benbasat (1991) and Ntemana and Olatokun (2012). All the survey items were adapted by changing only the object in a sentence. For example, the item, "Using a *personal workstation* enables me to accomplish tasks more quickly" (Moore & Benbasat, 1991) was adapted by "Using *technology* enables me to accomplish tasks more quickly" In this questionnaire, there were four questions for each attribute among five total attributes (i.e., relative advantage, compatibility, complexity, trialability, and observability), and a five-point Likert scale was used for responses ranging from Strongly Disagree to Strongly Agree (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree). All 20 items were tested by the original authors for reliability using Cronbach's alpha (see Table 3.2).

Table 3.2

Diffusion of Innovations Questionnaire Items, Sources, and Reliability

Attributes of innovations	Sources	Total items	Reliability (α)	# of items adapted
Relative Advantage	Moore & Benbasat (1991)	9	.90	4
Compatibility	Moore & Benbasat (1991)	4	.81	4
Complexity	Ntemana & Olatokun (2012)	5	.97	4
Trialability	Moore & Benbasat (1991)	5	.72	4
Observability	Ntemana & Olatokun (2012)	4	.92	4

Phase II: Qualitative Approach

Semi-structured individual interviews (Creswell, 2009) were used to explore what experiences contribute to perceptions of using technology to promote physical activity in schools (see Appendices G & H). As the Diffusion of Innovations Questionnaire in the previous phase (i.e., the quantitative approach) asked 20 questions to examine what attributes contributed to the use of technology in schools for physical activity promotion, more questions about "why" were asked to obtain more in-depth and detailed information about participants' perceptions on the topic (Merriam & Tisdell, 2015). As participants for this phase were purposefully selected (i.e., those who show positive perceptions of technology and those who show negative perceptions of technology), they offered meaningful information about what factors and experiences in their own life have led to their positive or negative perceptions of using technology to promote physical activity in schools. Participants were asked to respond to open-ended questions, such as “Can you tell me about your experience with technology in your personal life?” and “Can you tell me about any formal training you have obtained associated with technology?” Each individual interview was conducted by the researcher via a video-conferencing application (i.e., Zoom) and lasted approximately 40 to 60 minutes. All the interviews were audio recorded and subsequently transcribed.

Data Analysis

The data were analyzed according to the corresponding research questions specified for the quantitative and qualitative approaches.

Quantitative Data

Data screening was first conducted to check missing values and univariate outliers and to assess statistical assumptions, such as multivariate normality, independence of observation, homoscedasticity, linearity, and multicollinearity (Garson, 2012). Then Cronbach's alpha test was conducted before running the main analysis in order to establish the reliability of adapted items in the questionnaire by measuring internal consistency that shows how closely related a set of items is as a group in a single administration (Taber, 2018). Acceptable reliability for Cronbach’s alpha was set at > .70 for this study (Tavakol & Dennick, 2011). Finally, in order to answer the first research question in this study, multiple regression analysis was used to examine what attributes contributed to the use of technology in schools for the promotion of physical activity (Chatterjee & Hadi, 2013). Independent variables were five attributes of innovations; a total score of 4 items in each attribute was calculated before entering the regression model. The dependent variable was the sum score of personal use of technology in school-based physical activity promotion. R, a programming language for statistical computing and graphics, was used for the analyses (R Core Team, 2022).

Qualitative Data

Recorded audios were transcribed first, and then open and axial coding was utilized to inductively analyze the participants' responses to the interview questions (Corbin & Strauss, 2014). A general inductive approach for qualitative data analysis starts with data gathering and finalizes with a general conclusion (Thomas, 2006). With this concept, in the first open coding process, interview transcripts were read several times to identify noticeable phrases or sentences that involve or connote information showing school staffs' diverse experiences of technology-use that can potentially contribute to positive or negative perceptions of using technology to promote physical activity in schools. All the codes were noted in the margins. After the open coding was completed, the axial phase was implemented by identifying relationships among all the open codes, combining the same or similar meanings into categories, developing themes, and seeing whether the themes had connections with any existing theories (e.g., Rogers, 2003).

Researcher Positionality

Researcher positionality is a significant consideration in qualitative research because it directly influences the researcher's interpretation of the data collected and impacts the credibility of outcomes and results in the research (Holmes, 2020). As a person who is interested in exploring, studying, and learning emerging technologies and is currently studying as a doctoral student in the physical education and physical activity leadership program, I personally believe that technology can elicit multiple benefits in the context of education and by extension, it can also positively impact school-based physical activity promotion through various unique ways of its use. On the other hand, based on much literature I reviewed and my personal experience, I have also been exposed to people who have negative perceptions and views of technology use in educational contexts. Throughout the research process, I was cautious to honestly reflect on my own subjectivities that potentially affected the results and decisions of this study. Specific steps were carefully taken to ensure the trustworthiness of the data that were collected.

Trustworthiness

Data trustworthiness, including credibility and confirmability, was established using several overlapping techniques, such as member checking, peer debriefing, and an audit trail (Merriam & Tisdell, 2015). Member checking was employed to establish the tenet of credibility by sending all the transcripts back to their corresponding participants and sharing the established codebook to confirm their responses and the researcher's comprehension and obtain approval for using quotations (Creswell, 2009). In order to uncover bias and assumptions, peer debriefing was also conducted in three steps. The researcher and one qualified peer researcher first completed coding for several of the same transcripts independently, discussed the codes, and made decisions for keeping, revising, or eliminating codes. Then another independent peer researcher reviewed and assessed all the established codes to verify their connections with the raw data. Additionally, one experienced qualitative researcher reviewed the work of axial coding to assess the researcher's interpretation of the data. The peer debriefing strategy maintained the researcher's honesty by asking questions about methods, meanings, and interpretations (Creswell & Creswell, 2017). Moreover, the researchers reported all activities related to the study as an audit trail and discussed those activities with an experienced researcher regularly (Cutcliffe & McKenna, 2004).

CHAPTER IV

STUDY ONE: TECHNOLOGY USE IN SCHOOL-BASED PHYSICAL ACTIVITY PROMOTION

Contribution of Author and Co-Authors

Manuscript in Chapter IV

Author: Taemin Ha

Contributions: Taemin Ha conceived the research topic, developed and implemented the research design, collected and analyzed data, and wrote the manuscript.

Co-Author: Brian Dauenhauer

Contributions: Brian Dauenhauer assisted the lead author throughout the whole process of the research by providing feedback, verifying the research process, discussing the issues that occurred, and editing the manuscript.

Co-Author: Jennifer Krause

Contributions: Jennifer Krause contributed to reviewing every step of this research, especially focusing more on developing and implementing the research design.

Co-Author: Jaimie McMullen

Contributions: Jaimie McMullen contributed to reviewing every step of this research, especially focusing more on interpretation and discussion of results.

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Contributions: Matthew Farber contributed to reviewing every step of this research, especially focusing more on reviewing the manuscript.

Introduction

Sedentary behavior and physical inactivity in school-aged children and adolescents have been troublesome public health concerns for many years in the United States (Datar, 2017; Guthold et al., 2010; Mitchell & Byun, 2014; Pandita et al., 2016; Williams et al., 2018). According to the recent edition of the *Physical Activity Guidelines for Americans* (U.S. Department of Health and Human Services, 2018), approximately three-quarters of children and adolescents (aged 6–17 years) in the United States are insufficiently active. Given that children and adolescents spend most of their time at school and that the school is a major learning environment, K–12 schools could play a greater role in supporting their students to live healthy lives by increasing the quality and quantity of physical activity among students (Chen & Gu, 2018; Corbin & McKenzie, 2008; Erwin et al., 2013). Accordingly, the Centers for Disease Control and Prevention (CDC), in collaboration with the Society of healthy and Physical Educators (SHAPE) America, has developed, promoted, and disseminated a comprehensive school physical activity program (CSPAP) model as the national framework for physical education and physical activity in the United States (CDC, 2014).

A CSPAP emphasizes establishing the foundation of physical activity opportunities not only in physical education classes but also in all other school settings, such as before- and after-school programs and recess, as well as getting staff and family involved in physical activity. As a multi-component approach, the CSPAP consists of five different components: (a) physical education, (b) physical activity during school, (c) physical activity before and after school, (d) staff involvement, and (e) family and community engagement. The components of CSPAP can be implemented by school districts and schools to maximize all possible physical activity opportunities throughout every school day. In fact, numerous studies have shown the positive effects that school-based physical activity programs and various interventions can have on the development of healthier school communities (Erwin et al., 2012; Fredriksen et al., 2017; Naylor et al., 2015; Pulling Kuhn et al., 2021; Russ et al., 2015; Watson et al., 2017).

Digital technologies have become an inextricable part of almost every aspect of life today, especially for younger people, who have been growing up with many different types of technologies (Blower et al., 2020; Chubb et al., 2021; Mantilla & Edwards, 2019). According to CDC (2018), children and adolescents tend to spend a large proportion of their time with technology; children aged 8-10 and adolescents aged 11-14 spend nearly 6 hours and 9 hours a day, respectively, in front of a screen using entertainment media with televisions, tablets, smartphones, or other technologies. However, the American Academy of Pediatrics (AAP) has discouraged media use by children younger than 2 years old and has recommended limiting older children's screen time to no more than one or two hours a day through policy statements and technical reports (Hill et al., 2016).

With the data above, technology has been considered one of the leading causes of children’s physical inactivity and sedentary behavior (Gao & Lee, 2019; Mustafaoğlu et al., 2018; Rosen et al., 2014). Nevertheless, various technologies significantly benefit the age group, especially in an educational environment, because schools are predominantly places of learning, socializing, and development for children and adolescents. In education, technology provides students with easy-to-access information, accelerated learning, and entertaining opportunities to practice and apply what they learn (Cheung & Slavin, 2012; Criollo-C et al., 2021; Delgado et al., 2015). Moreover, population-based physical activity programs continuously seek more creative, innovative, and unique ways to increase lifelong engagement and participation in physical activity (Bunn et al., 2018; Fomby et al., 2021; Page et al., 2020). As schools are theoretically an ideal setting for physical activity promotion for children and adolescents (Active Schools, 2022; CDC, 2014; Carson et al., 2014), many different types of technology can play substantial roles in better supporting, facilitating, and promoting physical activity in school communities (Casey & Jones, 2011; Evans et al., 2017; Lewis et al., 2017).

There are various ways to integrate technology into school-based physical activity. For example, the use of relevant technologies can be incorporated into a school's allocated physical activity sessions, such as physical education classes, recess and classroom physical activity, before and after school programs, and even in distance learning environments (Buchele Harris & Chen, 2018; Ha et al., 2022; Lewis et al., 2017; Martin & Zimmerman, 2014; Yu & Ha, 2021). Research findings support the notion that technology integration into classroom physical activity (e.g., brain breaks) positively impacts attitudes and physical activity behavior (i.e., self-efficacy in learning with technology, exercise motivation and enjoyment, self-confidence in physical fitness, holistic health promotion, exercise habit, and attitude toward physical activity) in schoolchildren (Uzunoz et al., 2017). In addition, it has been shown that using technology in physical education has assisted teachers in creating more dynamic classes that better suit students with a wide range of physical activity and fitness levels (Keating et al., 2020). Evans et al. (2017) also highlighted that using wearable technology (e.g., pedometers or accelerometers) within the context of a school-based physical activity intervention for children is feasible for increasing student motivation for goal achievement.

It is clear that there are prospective benefits associated with integrating technology into the promotion of physical activity in schools. However, to actualize and support implementation, it is necessary to first examine the current practice of technology use in schools and the factors that influence the use of technology in school-based physical activity promotion. To date, there are no studies related to these specific topics, while few studies have examined physical education teachers' attitudes toward, perceptions of, and self-efficacy in technology integration (Gibbone et al., 2010; Hill & Valdez-Garcia, 2020; Krause, 2017). Therefore, the purpose of this study was to understand the current practice of technology use for physical activity promotion in K-12 schools in the United States by investigating what types of technology schools currently use to facilitate or promote physical activity and what personal and school characteristics predict the use of technology for school-based physical activity promotion. A CSPAP model served this study as a conceptual framework, and two research questions guided this study. The research questions included:

Q1 What types of technology do schools currently use to facilitate and promote physical activity?

Q2 What personal and school characteristics predict the use of technology for school-based physical activity promotion?

Method

Participants and Setting

A total of 367 registered Active Schools Champions (68.7% Female) completed the Comprehensive School Physical Activity Program Technology Practice Questionnaire (CSPAP-TPQ; Ha et al., in review). Active Schools Champions are registered members of the national organization called Active Schools, which promotes an active school culture in the United States. There are approximately 40,000 registered Active Schools Champions across the country, consisting of various school stakeholders, such as physical education teachers, classroom teachers, school administrators, and other school staff, who contribute to school-based physical activity promotion. Following Institutional Review Board (IRB) approval, a study invitation letter with the link to an online version of the CSPAP-TPQ was sent out to all the Active Schools

Champions multiple times in three weeks via an Active Schools' newsletter. The online survey also included the Diffusion of Innovations Questionnaire that subsequently examined what attributes contribute to the use of technology in schools for the facilitation and promotion of physical activity (results presented in Study 2). A $10 Amazon gift card was awarded to the first 250 Active Schools Champions who completed the survey. Moreover, everyone after that was entered into a gift card lottery, and ten of them were awarded a $50 Amazon gift card.

Research Instrument: Comprehensive School Physical Activity Program Technology Practice Questionnaire (CSPAP-TPQ)

In order to identify the current practice of technology use for physical activity promotion in K-12 schools in the United States, the CSPAP-TPQ was used to collect related data on the topic. The CSPAP-TPQ was developed, with the use of a CSPAP (CDC, 2014) as a conceptual framework, to investigate the use of technology among various school staff who can potentially contribute to the promotion of physical activity in school communities. The instrument encompasses six sections with 41 unique technologies and items related to respondent demographics, school characteristics, and technology experience, including (a) Technology Use in Physical Education (39 technologies), (b) Technology Use in Physical Activity During School and Physical Activity Before and After School (27 technologies), (c) Technology Use in Staff Involvement and Family and Community Engagement (23 technologies), (d) Personal Characteristics (8 items), (e) School Characteristics (7 items), and (f) Technology Experience (5 items; Ha et., in review).

The first three sections ask respondents whether their schools, including themselves, use specific technologies on the list to facilitate and promote student physical activity under CSPAP component areas. For example, respondents first answer the question, "Does anyone at your school, including you, use the following technologies During School and/or Before and After School to facilitate or promote physical activity? - Wearable Technology (e.g., pedometer, accelerometer, Fitbit, heart rate monitor)" with three options, including "Yes," "No," and "I don't know." Then, if a respondent answers "Yes," they move on to the sub-question, "Check the circle if YOU are the one who uses this technology" If not, they move on to the next technology on the list. The fourth and fifth sections ask about respondents' personal and school characteristics, such as certified/licensed teacher status and school type (e.g., public school). The last section asks five questions associated with respondents' technology experience, including the level of confidence in using technology both outside of the classroom and in their teaching and/or educational practices. In order to establish its validity and reliability, the CSPAP-TPQ underwent two rounds of the Delphi method (n = 24 experts) and test-retest among 43 registered Active Schools Champions (85 technology items showed "good to excellent" agreement [≥ 75%], while four technology items showed "moderate" agreement [60-74%] with a value of $p < .001$), respectively (Ha et al., in review).

Data Analysis

After the completion of data screening and statistical assumptions assessment, frequency tables were used to identify the distribution of overall data, which presented what types of technology K-12 schools currently use to facilitate and promote physical activity. To investigate what personal and school characteristics predict the use of technology for school-based physical activity promotion, two separate cross-tabulation analyses with the χ^2 tests for both personal characteristic variables and school characteristic variables were first conducted, respectively, to see the relationships between the variables and to see the distribution across categorical variables. For the cross-tabulation analyses with χ^2 tests, the top 50th percentile and the bottom

50^{th} percentile of technology use were treated as high-tech practitioners (or schools) and low-tech practitioners (or schools), respectively. Then two separate multiple regressions were utilized with only the independent variables that showed significance in the previous step (i.e., cross-tabulation analyses with the χ^2 tests). In one model, the independent variables included personal characteristics, such as age, current position, and years of experience, and the dependent variable was a total score of personal technology use. In a second model, the independent variables were school characteristics, including public school status, locale, and level of school, and the dependent variable was a total score of school technology use. All the analyses were conducted in R, a programming language for statistical computing and graphics (R Core Team, 2022), and statistical significance was set prior at $p < .05$.

Results

Frequency tables showed what types of technology K-12 schools currently use to facilitate and promote physical activity (see Table 4.1). Audio systems (e.g., speaker, compact disc [CD], audio cassette, MP3 player), computer (desktop or laptop), and email were the most-used technology in physical education practice, in physical activity before, during, and after school, and under the components of staff involvement and family and community engagement, respectively. Augmented reality (AR) (e.g., Pokémon GO in AR), virtual reality (VR) (e.g., Beat Saver in VR), and podcast were shown as the least-used technology in physical education practice, in physical activity before, during, and after school, and under the components of staff involvement and family and community engagement, respectively.

Table 4.1

The Use of Technology under CSPAP Components in K-12 Schools

Unique technology	CSPAP component area PE (%)	PADS & PABAS (%)	SI & FCE (%)
Audio system (e.g., speaker, compact disc [CD], audio cassette, MP3 player)	95.10	68.70	N/A
Online video clips (e.g., YouTube)	91.80	64.60	52.30
Email	91.00	N/A	79.00
Computer (desktop or laptop)	89.40	79.00	76.00
Stopwatch	88.00	56.90	N/A
Bluetooth	83.70	67.80	50.10
Google workspace (e.g., Docs, Sheets, Slides, Forms)	79.80	58.90	58.60
Smartphone	79.30	69.20	65.70
Cloud-based file sharing tools/apps. (e.g., Google Drive, Dropbox)	73.00	46.90	43.60
Microsoft office (e.g., Word, PowerPoint, Excel)	71.90	48.00	49.90
Video conferencing software/apps. (e.g., Zoom, Google Hangouts)	65.40	40.60	41.10
Learning management system (LMS) software/apps. (e.g., Google Classroom, Team Shake, Teacher Kit)	63.20	42.80	35.10
Tablet (e.g., iPad)	61.60	54.20	49.90
Wearable technology (e.g., pedometer, accelerometer, Fitbit, heart rate monitor)	59.70	42.00	27.80
Online video recording/creating/sharing platforms (e.g., YouTube, Vimeo, TeacherTube, Flipgrid)	56.40	34.60	29.70
Wireless microphones	54.20	42.00	26.70
Data storage (e.g., flash memory, hard drive, removable memory card)	54.20	N/A	26.20
Social media (e.g., Facebook, Twitter, Instagram)	51.80	46.30	51.50
Interactive touchscreen display (e.g., Smartboard)	46.30	40.60	
Game-based learning platforms (e.g., Kahoot!, Gimkit)	46.00	27.80	N/A
FitnessGram software for data organization	41.40	N/A	N/A
Assistive technology for individuals with disabilities (e.g., talking device, text to speech device, color identifier, screen reader software, paramobile device, video remote interpreting platforms)	39.80	26.40	21.30

Table 4.1, continued

Unique technology	CSPAP component area		
	PE (%)	PADS & PABAS (%)	SI & FCE (%)
Quick response (QR) code	37.30	28.30	27.00
Video editing software/apps. (e.g., iMovie, Final Cut Pro)	34.60	N/A	N/A
Webinar	29.20	N/A	16.10
Infographic development tools/apps. (e.g., Piktochart, Canva)	21.80	16.90	16.30
Digital video camcorder	20.40	17.20	N/A
Audience response system (e.g., iClicker, Plickers)	19.60	N/A	N/A
Motion-based video games (e.g., Wii Fit)	16.30	14.40	N/A
Still image editing tools/apps. (e.g., PicArt, Snapseed)	14.70	N/A	N/A
Website development tools/apps. (e.g., Wix, Squarespace)	12.50	N/A	N/A
Podcast	12.30	N/A	9.80
Bioelectric impedance analyzer (measures body composition)	12.00	N/A	N/A
Sports video games (e.g., Nintendo Olympics)	11.40	9.50	N/A
Global positioning system (GPS)	9.00	N/A	N/A
Video analysis apps. (e.g., myDartfish Express, Hudl)	8.20	N/A	N/A
Audio editing tools/apps. (e.g., Adobe Audition CC, Audacity)	7.60	N/A	N/A
Virtual reality (VR) (e.g., Beat Saver in VR)	4.60	4.40	N/A
Augmented reality (AR) (e.g., Pokémon GO in AR)	4.10	4.90	N/A
Digital scheduling tools/Apps. (e.g., Doodle, SignUp Genius)	N/A	19.90	27.00
Text messaging	N/A	N/A	56.70

Note. PE: physical education; PADS: physical activity during school; PABAS: physical activity before and after school; SI: staff involvement; FCE: family and community engagement; N/A indicates the technology was not included as an option within the CSPAP-TPQ for that component.

Two separate cross-tabulation analyses with χ^2 tests for personal characteristic variables and school characteristic variables showed the distributions within categorical variables and associations with current technology use (see Tables 4.2 and 4.3). According to the results, race (χ^2[5, N = 367] = 11.34, p = .045), position (χ^2[3, N = 367] = 19.58, p = .000), and certified/licensed teacher status (χ^2[1, N = 367] = 28.52, p = .000) among personal characteristic variables were statistically significant, and the percentage of students for free or reduced lunch (χ^2[3, N = 367] = 12.67, p = .005) and budget for technology (χ^2[4, N = 367] = 9.81, p = .044) among school characteristic variables were statistically significant.

Table 4.2

Results of Cross-Tabulation Analysis with χ^2 Test for Personal Characteristic Variables (N = 367)

Personal characteristics	*n*	Current practice of personal technology use: High-tech practitioners (%)	Current practice of personal technology use: Low-tech practitioners (%)	χ^2	*df*	*p*
Gender				.09	2	.955
Female	252	50.40	49.60			
Male	113	48.67	51.33			
Other	2	50.00	50.00			
Hispanic status				3.42	1	.064
Yes	25	32.00	68.00			
No	342	51.17	48.83			
Race				11.34	5	.045*
American Indian or other Native American	7	100.00	0.00			
Pacific Islander	2	100.00	0.00			
Asian	3	33.33	66.67			
Black/African American	28	60.71	39.29			
White/Caucasian	311	47.59	52.41			
Other	16	50.00	50.00			
Highest degree				2.12	4	.714
High school diploma/GED	2	50.00	50.00			
2-year associate degree	3	66.67	33.33			
Bachelor's degree	107	48.60	51.40			
Master's degree	245	51.02	48.98			
Doctoral degree	10	30.00	70.00			
Position				19.58	3	.000**
Physical education teacher	253	56.92	43.08			
Classroom teacher/health education teacher	36	22.22	77.78			
School administrator	46	36.96	63.04			
Other	32	43.75	56.25			
Certified/licensed teacher status				28.52	1	.000**
Yes	307	56.03	43.97			
No	60	18.33	81.67			

Table 4.2, continued

Personal characteristics	*n*	Current practice of personal technology use: High-tech practitioners (%)	Current practice of personal technology use: Low-tech practitioners (%)	χ^2	*df*	*p*
Age				7.17	4	.127
25-34	43	44.19	55.81			
35-44	129	50.39	49.61			
45-54	121	57.85	42.15			
55-64	65	40.00	60.00			
65 or older	9	33.33	66.67			
Years of experience				6.73	3	.081
1-14 years	86	39.53	60.47			
15-21 years	88	47.73	52.27			
22-28 years	93	58.06	41.94			
29+ years	100	53.00	47.00			

*$p < 0.05$; **$p < 0.01$

Table 4.3

Results of Cross-Tabulation Analysis with χ^2 Test for School Characteristic Variables (N = 367)

School characteristics	n	Current practice of School's technology use: High-tech schools (%)	Current practice of School's technology use: Low-tech schools (%)	χ^2	df	p
Locale				4.74	3	.192
City	173	43.35	56.65			
Suburban	75	54.67	45.33			
Town	56	57.14	42.86			
Rural	63	50.79	49.21			
Type of school				5.90	3	.116
Public School	329	50.76	49.24			
Private School	20	25.00	75.00			
Charter School	11	36.36	63.64			
Other	7	57.14	42.86			
Level of school				10.30	5	.067
Elementary (PK-5)	201	45.77	54.23			
Middle (6-8)	64	56.25	43.75			
High (9-12)	24	70.83	29.17			
Combined (PK-8)	18	27.78	72.22			
Combined (PK-12)	26	53.85	46.15			
Other	34	47.06	52.94			
Number of students				7.043	4	.134
1-300	79	40.51	59.59			
301-600	168	51.79	48.21			
601-900	60	41.67	58.33			
901-1200	36	61.11	38.89			
1200+	24	58.33	41.67			
Percentage of students for free or reduced lunch				12.67	3	.005**
0-24%	104	47.12	52.88			
25-49%	63	68.25	31.75			
50-74%	69	49.28	50.72			
75-100%	131	41.22	58.78			
Budget for technology				9.81	4	.044*
No budget	176	41.48	58.52			
$1-999	133	57.14	42.86			
$1,000-1,999	29	55.17	44.83			
$2,000-2,999	9	33.33	66.67			
3,000+	20	60.00	40.00			

*$p < 0.05$; **$p < 0.01$

The result of the multiple regression model for personal characteristics (Table 4.4) indicated that the three significant variables from the χ^2 test explained 38.1% of the variance ($R^2 = .381$, $F(5,361) = 12.24$, $p < .001$) in personal technology use for school physical activity promotion. Among the three predictors, race and certified/licensed teacher status were significant predictors; it was found that the non-White/Caucasian group was 6.6 times more likely to use technology for physical activity promotion in schools compared to other racial groups ($\beta = 6.591$, $p < .01$). Moreover, non-certified/licensed teachers were 13 times less likely to use technology for school-based physical activity promotion compared to certified/licensed teachers ($\beta = -12.975$, $p < .001$). The result of the multiple regression model for school characteristics showed that the two significant predictors from the χ^2 test did not predict school use of technology for physical activity promotion in schools ($R^2 = .044$, $F(12,354) = 1.35$, $p = .189$).

Table 4.4

Results of Multiple Regression Analysis for Personal Characteristics

Dependent variable	Independent variable	*β*	*SE*	*t*	*p*
Current practice of personal technology use	Race (White/Caucasian–ref.)				
	Other Race	6.5910	2.28	2.8955	0.004
	Position (Physical education teacher–ref.)				
	Classroom teacher/ health education teacher	-6.2568	3.26	-1.9213	0.055
	School administrator	-0.7697	2.59	-0.2969	0.767
	Other positions	-0.0802	2.98	-0.0269	0.979
	Certified/licensed teacher status (Yes–ref.)				
	No	-12.9750	2.62	-4.9568	< .001

Note. β: standardized coefficient; *SE*: standard error

Discussion

Descriptive statistics revealed that physical education is the CSPAP component where technology is used most by school staff for physical activity facilitation and promotion in schools. In physical education, the technologies showing a high percentage of use (higher than 80%) were computers (desktop or laptop), Bluetooth, email, audio systems (e.g., speaker, compact disc [CD], audio cassette, MP3 player), online video clips (e.g., YouTube), and stopwatch. These findings empirically confirm previous literature that described those technologies as commonplace in physical education classrooms in the current era (Jenny et al., 2020; Suherman et al., 2019; Quennerstedt, 2013). On the other hand, advanced technologies, such as augmented reality (AR) (e.g., Pokémon GO in AR) and virtual reality (VR) (e.g., Beat Saver in VR), were shown to be the two least-used technologies (4.1% and 4.6%, respectively). It may be because those advanced technologies are costly; research studies have shown that budget is one of the most profound and troublesome barriers to technology integration in physical education among teachers (Gibbone et al., 2010; Krause et al., 2017; Wyant & Baek, 2019), and more than 84% of schools of participants in this study had a technology budget under $1,000.

In physical activity before, during, and after school and under the components of staff involvement and family and community engagement, no technology showed higher than 80% use among school staff in the results, while computer (desktop or laptop) was the most-used technology in the abovementioned two areas (79% and 76%, respectively). In these two areas, however, social media (e.g., Facebook, Twitter, Instagram) showed a relatively high percentage of use (46.3% and 51.5%, respectively), which is a notable finding. Evidence shows that social media can be widely and effectively used as an online learning community for physical education teachers to reflect on their teaching and highlight gaps in their knowledge (Brooks & McMullen, 2020; Goodyear et al., 2019). Not only teachers but also other school staff (e.g., wellness coordinators), family, and community members can advocate and promote physical activity and related events in their schools, as school-aged youth are increasingly turning to social media for health-related information, including unique physical activity, diet, and nutrition information (Goodyear et al., 2018).

Results of the multiple regression analyses showed that personal characteristics, including race and certified/licensed teacher status, predicted the use of technology among various school staff for physical activity promotion in schools. In contrast, school characteristics did not predict the school use of technology for school-based physical activity promotion. Among those personal characteristics, certified/licensed teacher status should be addressed because this is significantly connected to teachers' competencies related to pedagogical and technological proficiency. Research by Phelps et al. (2021) highlighted that pre-service physical education teachers' pedagogical knowledge associated with planning, instruction, assessment, and management should be the foundation of the appropriate technology use in physical education. Moreover, a number of research studies found that physical education teachers' technology proficiency and their actual use of technology in educational practices are strongly correlated (Gibbone et al., 2010; Kretschmann, 2015).

In order to enhance pedagogical and technological knowledge, quality training should be provided for not only in-service physical education teachers but also pre-service physical education teachers. Research by Gibbone et al. (2010) found that teachers were more likely to hold a positive attitude about technology use in their educational practices when their technology-related training experiences were positive. On the other hand, there is also research showing that insufficient professional development opportunity is one of the biggest barriers for teachers to appropriately and effectively use technology in their educational practices (Gibbone et al., 2010; Hill & Valdez-Garcia, 2020; Krause et al., 2017). It is well documented that teacher preparation programs have the responsibility to prepare future teachers to successfully teach their students in their future professions (Krause et al., 2020; Russell et al., 2003). Thus, physical education teacher education (PETE) programs should design and deliver quality training that helps pre-service teachers develop relevant knowledge to implement technology in their educational practices in the future. Accordingly, SHAPE America (2017) has infused technology-related pedagogy, knowledge, and skills as essential capabilities of physical education teachers in the *National Standards for Initial Physical Education Teacher Education* (e.g., standards 3.e., 4.e, and 6.c.). Schools and school districts should also find realizable ways to provide in-service teachers with more quality professional development opportunities related to not only pedagogical practices but also appropriate technology implementation in physical education programs.

For successful school-based physical activity promotion, quality training is important not just for physical education teachers but for other school staff who are currently and can potentially fulfill the role of physical activity leaders in school communities because a whole-of-school approach (e.g., CSPAP) is more successfully implemented when school staff, family, and community members are involved working together (Dauenhauer & Stoepker, 2022; Pulling Kuhn et al., 2021). For example, classroom teachers, school principals, members of wellness committees, and after-school program directors should have the appropriate knowledge to lead physical activity programs in schools and can implement relevant technology to better facilitate the programs. Besides the field of physical education, the International Society for Technology in Education (ISTE) has developed and promoted ISTE Standards to provide the competencies for teaching, coaching, learning, and leading in the digital age, offering a comprehensive roadmap according to evidence-based practices for the effective and appropriate use of technology in schools worldwide (ISTE, n.d.). This indicates that classroom teachers and administrative personnel (e.g., school principals and administrators) should be aware of the importance and necessity of technology competency among teachers. Research shows that administrative personnel have a critical role to play in physical activity and health promotion in school communities (Dauenhauer et al., 2022; Orendorff et al., 2021). Therefore, the increased implementation of technology-in-physical activity-specific professional development for various school staff is an area of great need.

Although the result of multiple regression analysis showed that school characteristics did not predict the school use of technology for school-based physical activity promotion, with the cross-tabulation analysis and χ^2 test for school characteristic variables, it was found that the socioeconomic status of the school (percentage of students for free or reduced lunch) may play a meaningful role in technology use. More robust access to and use of more options of technology are more typical among people of more advantaged socioeconomic status; evidence shows that schools in low socioeconomic status areas unfortunately have limited equipment and resources in terms of technology access and use, with relatively a lower level of schools' efforts to deploy new technologies for academic preparation (Araque et al., 2013; Cruz, 2021; Warschauer et al., 2004). However, a systematic review by Western et al. (2021) highlighted that enriching access to various technologies for physical activity creates an attractive and appealing prospect for supporting people of low socioeconomic status to live more active, energetic, and healthier lives.

Multiple national organizations, including Active Schools (2022), CDC (2014), and SHAPE America (2015), have emphasized that other timeslots beyond allotted physical education time in schools (e.g., before and after school, recess) should effectively be used to maximize physical activity opportunities for school-aged children and adolescent. To date, even though there have been a number of research studies that investigate the effectiveness of specific technologies (e.g., mobile applications) for pedagogical practices in physical education classes (Jastrow et al., 2022), research on technology use for school-based physical activity promotion in other CSPAP component areas beyond the physical education class (e.g., staff involvement and family and community engagement) is very limited. Thus, research on these specific topics should actively be conducted to find more creative and productive ways to better support healthful daily physical activity among school-aged children and adolescents.

The limitation of this study was primarily related to the participants. As this study employed multiple regression analysis with a maximum of 7 predictors, power analysis indicates a target number of participants of 721 for a small effect size, 103 for a medium effect size, and 49 for a large effect size ($p < .05$; 80% power; Maxwell, 2000). A sample size larger than 721 for a small effect size would lead to a lower risk of making a Type II error, but the sample size of this study (367 participants) was larger than 103 for a medium effect size, which is acceptable (Aguinis et al., 2005). Moreover, among many registered Active Schools Champions, those who decided to participate in this study may be relatively more interested in the specific topic of technology than others who did not, and it can elicit self-selecting bias. However, this may also positively impact the study because those participants intelligently respond to the survey questions with a good level of competency on the topic. A considerable portion of participants in this study were white/Caucasian (84.7%) and working at public schools (89.6%), which might limit the generalizability of the findings. Lastly, it is important to note that technology use was self-reported rather than directly observed, which may have introduced some level of bias in the data, and it is unknown the extent to which schools were implementing each component of a CSPAP, so low technology use could have been indicative of limited program implementation.

Conclusion

To date, this is the first study that investigated what types of technology schools currently use to facilitate or promote physical activity and what personal and school characteristics predict the use of technology for physical activity promotion in K-12 schools in the United States. The findings indicated that various technologies are currently used in school-based physical activity, and physical education is the timeslot where technology is most used by school staff for physical activity facilitation and promotion in K-12 schools. Among various personal characteristics, race and certified/licensed teacher status were significant predictors of technology use among school staff for physical activity promotion in schools, while school characteristics did not predict the school use of technology for physical activity promotion. Based on the findings, future research examining technology use for school-based physical activity promotion in other CSPAP component areas besides physical education (e.g., staff involvement and family and community engagement) is recommended to find more creative and productive ways of using technology to better support and promote physical activity among school-aged children and adolescents. To better integrate technology in school-based physical activity, school staff should obtain more professional development opportunities with better support from school administrators. Moreover, teacher education programs should be responsible for preparing physical education teacher candidates along with relevant curricula because those candidates may potentially fulfill the role of physical activity leaders in their future professions.

CHAPTER V

STUDY TWO: ATTRIBUTES CONTRIBUTING TO THE USE OF TECHNOLOGY IN SCHOOL-BASED PHYSICAL ACTIVITY PROMOTION: A DIFFUSION OF INNOVATIONS THEORY APPROACH

Contribution of Author and Co-Authors

Manuscript in Chapter V

Author: Taemin Ha

Contributions: Taemin Ha conceived the research topic, developed and implemented the research design, collected and analyzed data, and wrote the manuscript.

Co-Author: Brian Dauenhauer

Contributions: Brian Dauenhauer assisted the lead author throughout the whole process of the research by providing feedback, verifying the research process, discussing the issues that occurred, and editing the manuscript.

Co-Author: Jaimie McMullen

Contributions: Jaimie McMullen contributed to reviewing every step of this research, especially focusing more on qualitative data analysis and interpretation.

Co-Author: Jennifer Krause

Contributions: Jennifer Krause contributed to reviewing every step of this research, especially focusing more on developing and implementing the research design.

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Contributions: Matthew Farber contributed to reviewing every step of this research, especially focusing more on reviewing the manuscript.

Introduction

Technology is everywhere in the present age, and schools are no exception. Not only commonplace technologies (e.g., desktop computer) but also various advanced and innovative technologies (e.g., artificial intelligence) have affected today's classrooms (Chen et al., 2020; Hill et al., 2016; Lai & Bower, 2019). According to the results of the U.S. national survey titled *Use of Educational Technology for Instruction in Public Schools* (National Center for Education Statistics, 2021), over 70 percent of schools in the United States stated that their teachers use technology for activities typically done in the classroom (47 percent of the schools reported moderate technology use in classrooms and 24 percent reported extensive technology use). Moreover, the report titled *Reimagining the Role of Technology in Education: 2017 National Education Technology Plan Update from the Office of Educational Technology* (Office of Educational Technology, 2017) claimed that multiple aspects of the technology landscape in school communities have changed dramatically across the United States over the years. These technological change factors encompass the rapid increase of broadband access in the classroom setting, the availability of more types of technology and more grants for technology, increased attention toward technological leadership in education, a greater focus on data security and digital citizenship, and an increased emphasis of pre-service teachers' technology competency in accordance with the advent of new research on technology use by early learners (Office of Educational Technology, 2017).

In this climate, technology also has the potential to contribute to the field of public health. Physical inactivity among American school-aged children and adolescents is a salient public health issue (Datar, 2017; Guthold et al., 2010; Mitchell & Byun, 2014; Pandita et al., 2016; Williams et al., 2018), despite the fact that the Centers for Disease Control and Prevention

(CDC; 2020) and the U.S. Department of Health and Human Services (2018) have long recommended that young people engage in a minimum of 60 minutes of physical activity every day. In more recent times, however, as nearly all school-aged children and adolescents have grown up with extensive daily technology use, the excessive use of technology has likely contributed to a sedentary lifestyle that may increase the risk of developing various physical, physiological, and social health hazards (Akindutire & Olanipekun, 2017; Loveday et al., 2015; Odiaga & Doucette, 2017). As technology keeps evolving, this issue may continue for some time.

On the other hand, as children and adolescents spend most of their time in school, which is a primary learning environment for the age group, technology can play a significant role in better facilitating and promoting physical activity among students in school communities (Casey & Jones, 2011; Evans et al., 2017; Lewis et al., 2017). For example, various mobile applications, such as game-based learning platforms (e.g., *Kahoot!),* can be a motivational tool for both teachers and students in the physical education class, which is the center of school-based physical activity (Ha et al., 2022). Moreover, many different types of wearable technology, including pedometers, smartwatches, and smart shoes, can be used to monitor and assess the level of physical activity in multiple school settings, such as before and after school. A recent systematic review by Sousa et al. (2023) supports that wearable technology is a great motivational tool to improve physical activity behavior among school-aged children and adolescents.

For these reasons, technology integration should be carefully considered in the design of school-based physical activity programs, and by extension, there is a need to investigate what factors affect the use of technology among school staff, including physical education teachers, in schools to facilitate and promote physical activity. The purpose of this study was, therefore, to examine what attributes contribute to the use of technology in schools for the facilitation and promotion of physical activity and what experiences contribute to perceptions of technology use among teachers and school staff. The diffusion of innovations theory was employed as a theoretical lens for this study, and two research questions guided this study. The research questions included:

Q1 What attributes contribute to the use of technology in schools for the facilitation and promotion of physical activity?

Q2 What experiences contribute to perceptions of using technology to facilitate and promote physical activity in schools?

Diffusion of Innovations Theory

The diffusion of innovations theory was initially developed by integrating multiple sociological theories of behavioral change (Rogers, 1962). It is a wide-ranging social and psychological theory seeking to explain how humans make decisions to adopt a novel innovation and at what rate new ideas spread by finding their adoption patterns and understanding their structures and characteristics (Lundblad, 2003; Min et al., 2019; Rogers, 2003). Many studies across various disciplines have employed this theory as a framework to explain the adoption of innovation in contexts such as education, information technology, public health, management, organization development, and sociology (Al-Jabri & Sohail, 2012; Dearing, 2009; Dearing & Cox, 2018; Değerli et al., 2015; Lundblad, 2003; Ma et al., 2014; Sahin, 2006; Simin & Janković, 2014; Smith, 2012). Rogers (2003) described the process of innovation diffusion as “an uncertainty reduction process” (p. 232) and identified five attributes of an innovation that help decrease uncertainty about its adoption: (a) relative advantage, (b) compatibility, (c) complexity, (d) trialability, and (e) observability. Rogers (2003) argued that many studies over the decades have shown that these five attributes consistently influence the process of innovation adoption.

Relative Advantage

Relative advantage indicates “the degree to which an innovation is perceived as better than the idea it supersedes” (Rogers, 2003, p. 15). Under the topic of this study, this attribute suggests the need to understand the specific advantages of technology that can better facilitate or promote physical activity in school settings. For example, if a classroom teacher perceives that Microsoft PowerPoint slides are more convenient and visually beneficial than projector transparency slides to communicate the importance of physical activity, they will use the new technology while abandoning the use of the projector. A number of studies have shown that educators integrate technology into their instruction when they see its obvious value and benefits (McKenzie, 2001; Spotts, 1999). Thus, individuals are more likely to adopt new technology when it offers increased effectiveness and/or efficiency (Rogers, 1995).

Compatibility

Rogers (2003) defined compatibility as “the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters” (p. 15). A tablet is an excellent example of explaining compatibility. Many educators have replaced other tools and systems with tablets (e.g., iPad) for checking student attendance, writing notes, creating presentations, and multiple activities which they currently were doing on their desktop or laptop. However, if innovation requires a considerable change from existing rules or additional products to make it work, it is likely to fail (Rogers, 1995). According to Sahin (2006), compatibility and relative advantage were viewed as similar in much literature related to diffusion research even though they are conceptually different. Research by Sherry (1997) supports the idea that a lack of compatibility with individual needs in technology use negatively influences the performance of that technology.

Complexity

Complexity refers to “the degree to which an innovation is perceived as relatively difficult to understand and use” (Rogers, 2003, p. 16). The level of complexity in usage influences the diffusion process (Rogers, 1995). For example, although the effectiveness of emerging motion analysis technology for students’ motor skill learning has been shown to be effective (Yu et al., 2021), and a school may have a sufficient budget, physical education teachers may not invest much time in learning to use it because, despite teachers’ awareness of the advantages of the innovation, the level of effort required to use such a technology would be prohibitive. Rogers (2003) argued that complexity is negatively correlated with the rate of adoption, in contrast to the other attributes; therefore, excessive complexity of an innovation is a significant obstacle to its adoption.

Trialability

Trialability indicates “the degree to which an innovation may be experimented with on a limited basis” (Rogers, 2003, p. 16). It is important for potential adopters to clearly see what the new innovation can do for their work. Therefore, they need to test it before committing to adopting it because the results affect their final decision regarding its adoption. For example, before a school integrates sports video games (e.g., Nintendo Olympics) to improve its after-school physical activity program, it might implement a one-month testing period to see if sports video games are productive and effective at increasing students’ physical activity levels. Trialability contributes to the decision as to whether a new innovation will be adopted or rejected by potential adopters. Thus, more trials of innovation lead to its faster adoption (Sahin, 2006).

Observability

Rogers (2003) defined observability as "the degree to which the results of an innovation are visible to others" (p. 16). For example, if a physical education teacher sees other classroom teachers effectively using a learning management system (e.g., Google Classroom) to monitor student learning progress, this can create a sense of assurance of the potential of using this technology in the context of physical education. If the outcomes and benefits of an innovation are observable, it gives potential adopters a clear rationale for adopting the innovation. Conversely, if many disadvantages are shown, potential adopters may decide against adopting the innovation. Parisot (1997) highlighted that peer observation as role modeling is a key motivational factor in the adoption and diffusion of technology.

Method

A mixed-methods sequential explanatory research design was utilized for this study. This design allowed researchers to better understand the context, and by extension, the process creates and presents more evidence to support the findings than each single method itself (Creswell & Creswell, 2017). According to the procedure used for a mixed-methods sequential explanatory research design, quantitative data (survey results) were first collected and analyzed, and then qualitative data (interview results) were collected in two consecutive phases within a single study.

Participants and Setting

Quantitative Participants

A total of 367 Active Schools Champions (68.7% Female), encompassing various school staff, such as physical education teachers, classroom teachers, school administrators, and other positions contributing to school-based physical activity promotion in the United States, completed the Comprehensive School Physical Activity Program Technology Practice Questionnaire (CSPAP-TPQ; Ha et al., in review) and the Diffusion of Innovations Questionnaire. An Active Schools Champion is a registered member of Active Schools, which is a national organization that aims to promote an active school culture to help school-aged children and adolescents meet the national recommendation of 60 minutes of physical activity per day in the United States (Active Schools, 2022; U.S. Department of Health and Human Services, 2018). In order to recruit participants, an online version survey, including the CSPAP-TPQ and the Diffusion of Innovations Questionnaire, was sent via Active Schools' newsletter multiple times in three weeks. The first 250 Active Schools Champions who completed the survey received a $10 Amazon gift card, and every one after that was entered into a lottery to win one of ten $50 Amazon gift cards.

Qualitative Participants

Qualitative participants for this study included a total of 10 school staff, encompassing five participants who showed positive perceptions of technology and the other five who showed negative perceptions of technology on the Diffusion of Innovations Questionnaire. An email was sent to the participants who indicated they were willing to participate in an interview. In the email, those participants were asked to participate in a semi-structured interview to obtain more in-depth qualitative data (Corbin & Strauss, 2014). With the list of participants who wanted to participate in the interview, stratified sampling was used to equally select participants from two different groups (i.e., positive perceptions group and negative perceptions group), while purposeful sampling was also applied as participants were purposefully identified from the phase of quantitative data analysis (Palinkas et al., 2015; Tipton, 2013). Using the QUARTILE function in Microsoft Excel, only the participants of the top 25% (positive perceptions of technology) and bottom 25% (negative perceptions of technology) in the total questionnaire score were invited. In addition, according to the results of a frequency table, three physical education teachers, one classroom teacher, and one school administrator were recruited for each group to reflect the different roles that participants took on in schools. Table 5.1 presents information about the 10 participants recruited using stratified and purposeful sampling techniques. A $20 Amazon gift card was awarded to those participants who completed the interview process.

Table 5.1

Participant Information for Qualitative Approach

	Name	Gender	Current position	Years of experience	Level of school
Positive perceptions of technology	Natalie	F	Physical education teacher	28	Elementary
	Angel	M	Physical education teacher	30	Combined (PK-8)
	Laura	F	Physical education teacher	29	Elementary
	Ava	F	School administrator	30	Middle
	James	M	Classroom teacher	15	Elementary
Negative perceptions of technology	Deborah	F	Physical education teacher	19	Middle
	Michelle	F	Physical education teacher	12	Elementary
	Elisa	F	Physical education teacher	37	Elementary
	Jose	M	School administrator	33	Elementary
	Julia	F	Classroom teacher	11	Elementary

Note. Names in the table are pseudonyms.

Data Collection and Research Instruments

Phase I: Quantitative Approach

The CSPAP-TPQ was employed to investigate personal technology use among various school staff in school-based physical activity promotion. The tool was developed to examine the current practice of technology use for physical activity promotion in K-12 schools and has completed its validity and reliability test through two rounds of the Delphi method (n = 24 experts) and test-retest among 43 registered Active Schools Champions (85 technology items showed "good to excellent" agreement [≥ 75%], while four technology items showed "moderate" agreement [60-74%] with a value of $p < .001$), respectively (Ha et al., in review). Moreover, the Diffusion of Innovations questionnaire identified the perceptions of technology use in school-based physical activity promotion among participants by determining their five attributes of innovations defined by Rogers (2003). The questionnaire was composed of 20 items adapted from the works of Moore and Benbasat (1991) and Ntemana and Olatokun (2012). All the survey items were adapted by changing only the object in a sentence. For example, the item, "Using a *personal workstation* enables me to accomplish tasks more quickly" (Moore & Benbasat, 1991) was adapted by "Using *technology* enables me to accomplish tasks more quickly" In this questionnaire, there were four questions for each attribute among five total attributes (i.e., relative advantage, compatibility, complexity, trialability, and observability), and a five-point Likert scale was used for responses ranging from Strongly Disagree to Strongly Agree (Strongly Disagree, Disagree, Neutral, Agree, Strongly Agree). All 20 items were tested by the original authors for reliability using Cronbach's alpha (see Table 5.2).

Table 5.2

Diffusion of Innovations Questionnaire Items, Sources, and Reliability

Attributes of innovations	Sources	Total items	Reliability (α)	# of item adapted
Relative advantage	Moore & Benbasat (1991)	9	.90	4
Compatibility	Moore & Benbasat (1991)	4	.81	4
Complexity	Ntemana & Olatokun (2012)	5	.97	4
Trialability	Moore & Benbasat (1991)	5	.72	4
Observability	Ntemana & Olatokun (2012)	4	.92	4

Phase II: Qualitative Approach

Semi-structured individual interviews were used to explore what experiences contribute to perceptions of using technology to promote physical activity in schools. As the Diffusion of Innovations Questionnaire in the previous phase asked 20 questions to examine what attributes contributed to the use of technology in schools for physical activity promotion, more questions about "why" were asked to obtain more in-depth and detailed information about participants' perceptions on the topic (Merriam & Tisdell, 2015). As participants for this phase were purposefully selected, they offered meaningful information about what factors and experiences in their own life have led to their positive or negative perceptions of using technology to promote physical activity in schools. Participants were asked to respond to open-ended questions such as "Can you tell me about your experience with technology in your personal life?" and "Can you tell me about any formal training you have obtained associated with technology?" Each individual interview was conducted by the researcher via a video-conferencing application (i.e., Zoom) and lasted approximately 40 to 60 minutes. All the interviews were audio recorded and subsequently transcribed.

Data Analysis

Quantitative Data

After the data screening process, a Cronbach's alpha test was first conducted to establish the reliability of adapted items in the Diffusion of Innovations questionnaire by measuring internal consistency that showed how closely related a set of items is as a group in a single administration (Taber, 2018). According to Tavakol and Dennick (2011), acceptable values of Cronbach's alpha can range from 0.70 to 0.95 depending on the number of questions in an instrument. Multiple regression analysis was used to examine what attributes contribute to the use of technology in schools for the promotion of physical activity. Independent variables were five attributes of innovations; a total score of 4 items in each attribute was calculated before entering the regression model. The dependent variable was the sum score of personal technology use in school-based physical activity promotion. R, a programming language for statistical computing and graphics, was used for all the analyses (R Core Team, 2022). The alpha level was set a priori at $p < .05$ for all statistical analyses.

Qualitative Data

Recorded audios were transcribed first, and then open and axial coding was utilized to inductively analyze the participants' responses to the interview questions (Corbin & Strauss, 2014; Thomas, 2006). In the first open coding process, interview transcripts were read several times to identify noticeable phrases or sentences that involve or connote information showing school staffs' diverse experiences of technology-use that can potentially contribute to positive or negative perceptions of using technology to promote physical activity in schools. All the codes were noted in the margins. After the open coding was completed, the axial phase was implemented by identifying relationships among all the open codes, combining the same or similar meanings into categories, developing themes, and seeing whether the themes had connections with any existing theories.

Trustworthiness

Throughout the research process, the researcher was cautious to honestly reflect on his own subjectivities that potentially affected the results and decisions of this study; specific steps were carefully taken to ensure the trustworthiness of the data that were collected. Trustworthiness, including credibility and confirmability, was established using several overlapping techniques, such as member checking, peer debriefing, and an audit trail (Merriam & Tisdell, 2015). Member checking was employed to establish the tenet of credibility by sending all the transcripts back to their corresponding participants, sharing the established codebook to confirm their responses and the researcher's comprehension, and obtain approval for using quotations (Creswell, 2009). In order to uncover bias and assumptions, peer debriefing was also conducted in three steps. The researcher and one qualified peer researcher first completed coding for several of the same transcripts independently, discussed the codes, and made decisions for keeping, revising, or eliminating codes. Then another independent peer researcher reviewed and assessed all the established codes to verify their connections with the raw data. Additionally, one experienced qualitative researcher reviewed the work of axial coding to assess the researcher's interpretation of the data. The peer debriefing strategy maintained the researcher's honesty by asking questions about the methods, meanings, and interpretations (Creswell & Creswell, 2017). Moreover, the researchers reported all activities related to the study as an audit trail and discussed those activities with an experienced researcher regularly (Cutcliffe & McKenna, 2004).

Results

The result of Cronbach's alpha test indicated that all five attributes of innovations were in the range from 0.70 to 0.95, which is considered acceptable (Tavakol & Dennick, 2011; see Table 5.3). The result of the multiple regression model indicated that five attributes of innovations explained 26.4% of the variance ($R^2 = .264$, $F(5,361) = 5.42$, $p < .001$) in personal technology use for school physical activity promotion. Among the five attributes, complexity ($\beta = 3.909$, $p = < .01$) and trialability ($\beta = 2.687$, $p = < .05$) were significant predictors (see Table 5.4).

Table 5.3

Reliability Statistics for the Diffusion of Innovations Questionnaire

Attributes of innovations	Number of items	Reliability (α)
Relative advantage	4	.93
Compatibility	4	.90
Complexity	4	.73
Trialability	4	.87
Observability	4	.78

Table 5.4

Results of Multiple Regression Analysis

Dependent variable	Independent variable	*β*	*SE*	*t*	*p*
Personal use of technology	Relative advantage	0.313	1.40	0.223	.824
	Compatibility	1.294	1.46	0.888	.375
	Complexity	3.909	1.19	3.292	.001**
	Trialability	2.687	1.10	2.436	.015*
	Observability	0.426	1.68	0.253	.800

Note. β: standardized coefficient; *SE*: standard error; $^*p < 0.05$; $^{**}p < 0.01$

The qualitative data analysis revealed three themes regarding school staff's experiences contributing to perceptions of using technology to facilitate and promote physical activity in schools. The three themes include the following: (a) the impact of personal experiences, (b) the marginalization of physical education, and (c) the double-edged sword of using technology in school-based physical activity.

The Impacts of Personal Experiences

The interview data analysis found that school staff's perceptions of using technology for school-based physical activity promotion are greatly influenced by their personal experiences with technology. In other words, participants who obtained a high score on the Diffusion of Innovations Questionnaire showed more extensive experience with technology use in their personal life regardless of their position. For example, they ordinarily use tablets for multiple reasons, including managing schedules, reading e-books, watching movies, sharing photos, and more personal, educational, or professional purposes (Laura, Ava, and James). Furthermore, they expressed that they enjoy using various wearable technology, such as Fitbit, to monitor their physical activity for their daily lives. One of the participants in the positive perception group emphasized that she loves and enjoys using technology in her personal life and noted the following:

> I'm pretty comfortable around technology. I have technology all around my own personal experience. I use them every day between my laptops, my smartboards, my smartwatch, and my smart TV. (Ava)

On the other hand, participants who obtained a low score on the Diffusion of Innovations Questionnaire expressed that they use very basic technology in their personal life. One of the participants in the negative perception group stated:

> I don't own anything but a cheap cellphone because I'm not computer motivated. Super personally, I was raised without a television. I am 56, and I still do not own a television. If I want to watch something, I do have a DVD player on my computer. That's pretty much it. (Deborah)

Participants in the group frequently said, “I use minimal technology” or “I use basic technology,” however, they interestingly tended to perceive themselves as having moderate technology competency. For example, a school administrator in the group stated:

> I'm not an expert by any stretch of the imagination. Using technology has been tough for me, and I've always trusted pen and paper better than typing something up or sending it off. I need some time [to adapt to new technology], so I use minimal tech and always rely on some young staff members because I know they're good at it. I think I would be able to do it, but I don't have the time to get into it, so I'd say I'm like a five out of 10, maybe. (Jose)

Participants' personal experiences with technology well reflected their perceptions regarding the use of technology for school-based physical activity promotion that was found from the result of the Diffusion of Innovations Questionnaire.

The Marginalization of Physical Education

In addition to personal experience with technology, participants also talked about their experience with technology in their professional life and many expressed that they have faced some barriers to using technology in school-based physical activity. The barriers were stated with several noticeable keywords, including large class size, accessibility, limited budget, and insufficient training. Many participants, especially in the negative perception group, believed that those barriers came up because physical education is considered an undervalued and marginalized subject compared to other subjects and programs in schools. For example, a physical education teacher in the negative perception group talked about large class size as a barrier to using technology and connected it to the status of physical education in her school; she stated:

> Too many kids, too many kids. And then you can't have enough equipment because even the heart rate monitor watches that we got, we only got 15, and when you got 150 kids, everybody's mad because only those 15 got it. It's because PE is an afterthought. (Deborah)

Other physical education teachers in the group also highlighted the marginalization of physical education with issues of limited budget and funding for equipment and professional development as significant barriers. Michelle said:

> This is the only school out of seven that I've taught in the last 30 years that I actually got a budget of more than $500 for a school year. $500 doesn't buy even 10 basketballs. $500 is not going to buy very much technology. Until the administration realizes that PE is important, you're going to live in this body for the rest of your life. PE is always one of the first classes to get thrown to the wayside. You understand?

Elisa also stated:

> We don't get any funding. I'm being honest with you. We have no funding at all. Um, basically physical Ed doesn't get any funding. When I want to go to a professional development meeting, I have to pay for it out of my own pocket. Physical Ed is nothing but a planning period or babysitter for some of the teachers.

Despite being placed in the positive perception group, several participants also stressed the marginalization of physical education. One physical education teacher talked about it and emphasized advocacy for physical education; she said:

> For PE class, unfortunately, I think it's not supported as much as in the regular classroom. So as PE teachers, we have to work harder and advocate for it and push for it and seek it ourselves, right? Grants and do all that to ensure that we are keeping up with everybody else and that our students are getting the best opportunities possible. (Natalie)

When participants talked about their experiences associated with the marginalization of physical education, they seemed to be very emotional.

The Double-Edged Sword of Using Technology in School-Based Physical Activity

Without reference to the position and the score on the Diffusion of Innovations Questionnaire, almost every participant expressed that they see benefits of using technology for physical activity promotion in school communities, but they also see some risks, disadvantages, or concerns. In terms of the benefits, they highlighted improving work efficiency, incorporating different learning styles, and creating a more engaged environment. One physical education teacher shared her experience using technology in her class; she said:

> Technology in schools has come so far, and it's amazing how much more we can do and how much more we can ensure student learning and provide support for them, like visuals and different, a variety of learning opportunities. And then our tracking of things, our planning for things, our advocating for things. So, there are so many different ways we use technology that is valuable in schools nowadays, and students are capable and competent. (Natalie)

Moreover, although one classroom teacher was placed in the negative perception group in terms of the score on the Diffusion of Innovations Questionnaire, she talked about multiple advantages of using technology; she noted:

> I think that technology is fantastic for teaching so many things that it's how our kids are learning now. Like really sitting down and turning on a video or having them play a game. I see kids find that engaging and exciting, and that's more fun than staring at a teacher talking to them. (Julia)

At the same time, she also highlighted the risk factor of using technology in school-based physical activity. Julia stated:

> But equally, I feel like at that point, they're losing their ability to stop and to slow down and think and engage interpersonal, so I can argue both sides from kindergarten through 12th to college. As adults, I think technology is fantastic, maybe for physical activity too, but I think that technology really needs to be limited because I think if we start relying on technology to teach in school too much, then we're losing it.

One school administrator also talked about various benefits of using technology for school-based physical activity, but she shared some concerns about using technology in schools. As a school administrator and a former physical education teacher, Ava said:

> Overall, technology is good, but the only problem with technology in schools is [that] it's so expensive, and sometimes it lags behind because it takes so much to upgrade or add to the technology that you have.

When participants were asked about overall perceptions of using technology in school-based physical activity promotion as a last question, most of their responses showed both benefits and concerns; some were even open to interpretation.

Discussion

Quantitative results showed that complexity and trialability were significant predictors of technology use among school staff for physical activity facilitation and promotion in a school setting. According to Rogers (1995), the level of complexity in usage influences the diffusion process; therefore, the comfort level for learning and practicing certain technologies among teachers may meaningfully affect their technology integration in school-based physical activity facilitation and promotion. Evidence shows that the ease of technology use among teachers is a substantial factor in their intention to use and actual use in their pedagogical practices (Holden & Rada, 2011; Shiue, 2007; Yuen & Ma, 2008). Moreover, Rogers (2003) also emphasized that trialability significantly contributes to the decision to adopt innovation. This notion relates to previous research results showing that educators decide to adopt new technology when they can try it and clearly see its benefits in advance for their educational practices (Hsbollah & Idris, 2009; Kebritchi, 2010; Oluyinka & Cusipag, 2021). The quantitative results of this study confirmed that school staff are more likely to use technology when they see the ease and simplicity of new technology and after being able to test out new technologies before committing to using them. This finding suggests that schools and school districts should provide school staff, as potential technology adopters, with more opportunities to participate in technology-related seminars, workshops, and training to explore various technologies, develop relevant knowledge, and see for themselves which technology is feasible and appropriate for physical activity promotion in their schools.

Qualitative results revealed that school staff's experiences with technology in their personal lives are influential to their perceptions of using technology for school-based physical activity promotion. Previous research shows that there is a strong relationship between personal experience and job performance (Sjølie et al., 2013). With that said, school staff who have sufficient experience of using technology in their personal life with a good comfort level with technology may use more technology in their teaching or educational practices, and by extension, this may lead them to have more positive perceptions of using technology in school-based physical activity promotion. The result of this study clearly showed that participants who expressed that they enjoy using technology in their personal life obtained a high score on the Diffusion of Innovations Questionnaire. However, it should not be overlooked that some barriers (e.g., a lack of resources) were revealed from the interview data, and those barriers may affect the use of technology among school staff in school-based physical activity regardless of their experience with technology in their personal life.

Among multiple barriers revealed in interviews, the cost of technology and limited budgets were the most often-mentioned barriers to the use of technology by school staff in school-based physical activity. Traditional campus funding allocated to physical education is typically limited, and a limited budget was frequently claimed as a profound barrier to technology integration into physical education classes between teachers (Gibbone et al., 2010; Krause et al., 2017; Wyant et al., 2015). In an effort to address this concern, Wyant and Baek (2019) suggested that framing technology as a budget-friendly pedagogical tool is a practical strategy to overcome the preconceived notion that technology is costly. For example, school physical activity leaders can apply the Bring Your Own Device (BYOD) concept to their programs (Hockly, 2012). A physical activity leader in school can create an environment where students can bring their own smartphones and use various mobile applications that can support activities in school-based physical activity programs. For example, the physical activity leader lets students download and use mobile applications of the audience response system (e.g., *iClicker*) and game-based learning platform (e.g., *Kahoot!*) to participate in fitness-infused interactive quiz activities. However, they should be aware of an equity issue; some students may not have smartphones. In this case, for example, students who do not have smartphones can partner with those who do to complete the tasks that may even enhance the social aspects of the learning activities.

When participants talked about the limited budget for technology, they stressed that it came up due to the marginalization of physical education. In the past year, a large body of research has discussed the marginalization of physical education along with various reasons, regardless of technology. For example, research by Richards et al. (2018) supported that physical education teachers feel marginalized during social interaction with other school staff in the school communities. In connection with the research, several physical education teachers in the interview indicated that if other school staff, especially administrative personnel (e.g., principals), do not recognize the value of physical education, it would be challenging for teachers to obtain appropriate resources for technology integration in school-based physical activity. Thus, building good relationships with other school staff and advocating physical education programs are essential competencies for physical education teachers to obtain suitable support, such as funding for equipment (technology) and professional development, for school-based physical activity programs, including allocated physical education classes. Physical education teachers and other physical activity leaders in school communities should continuously demonstrate how their program positively impacts not only students' health and well-being but also their academic performance (Pennington et al., 2023). Conversations on the topic with other school staff and administrators should occur on a regular basis and not just at budget-related meeting times. There is the case that some physical education teachers have experienced success with relationships and advocacy that enhanced the status and value of physical education in their schools (Lux & McCullick, 2011).

As the *Every Student Succeeds Act* (ESSA) was authorized in 2015, identifying school health and physical education as part of a student's "well-rounded education," physical education programs in public schools have better potential to have access to more resources, including technology. Section 4109 of Title IV, Part A Statute of ESSA clearly indicates that each local educational agency or consortium of such agencies "shall use a portion of such funds to improve the use of technology to improve the academic achievement, academic growth, and digital literacy of all students" (National Center on Safe Supportive Learning Environment, n.d.). Thus, it is imperative that physical education teachers and other school staff who contribute to promoting physical activity in school communities should be aware of the act that can help them obtain or increase the budget to purchase technology to improve the quality of their programs that directly impact the health and well-being of school-aged children and adolescents.

Despite the barriers due to the marginalization of physical education, almost every participant expressed that they see the benefits of using technology in school-based physical activity. Much research has shown and highlighted the benefits of technology and the potential integration of technology in school-based physical activity. For example, as participants stated, various technologies support teachers to perform pedagogical practices in more creative ways to better elicit student engagement in physical education classes (Jastrow et al., 2022). Moreover, beyond physical education classes, technology, such as wearable physical activity monitors, was recognized as an effective tool for increasing the level of physical activity among students within a coordinated school-based physical activity program (Evans et al., 2017). In contrast, as the interview data showed, several risk factors, disadvantages, or concerns about using technology in school communities still exist. As one of the participants pointed out, technology can decrease human interaction among students in school communities (Hertlein & Ancheta, 2014). Using technology may be a double-edged sword; however, it is critical to discuss strategies for using technology in accordance with its purposes and advantages. Research by Jeffs and Banister (2006) supported that the appropriate use of technology could enhance students' collaboration skills along with personal and social responsibility in schools.

Some connections between qualitative results and attributes of the diffusion of innovations theory were also found. First, when school staff talked about the benefits of using technology in school-based physical activity, they described how the use of technology helped and promoted their tasks better than working without technology. For example, a few teacher participants shared their experience using YouTube video clips as visual resources for their teaching, and they emphasized that the technology-infused teaching better-enticed students' engagement and excitement in the classroom rather than teaching class verbally without any visual resources. This case connects to the concepts of relative advantage and compatibility. Much literature on diffusion research viewed relative advantage and compatibility as similar ideas and underlined that the concepts play a significant role in making a decision for an individual to employ a new product (Sahin, 2006). Thus, when school staff acknowledge that using technology can replace existing practices, bring evident advantages, such as cost-effectiveness or time-saving properties, or see compatibility with legacy knowledge, they may be more likely to integrate the technology into their work associated with physical activity promotion in school communities.

Moreover, several participants expressed concerns about the rapid development of technology, leading them to hesitate to implement new technology in their work for school-based physical activity. This phenomenon is linked with the concept of complexity, which is negatively correlated with the rate of adoption (Rogers, 2003). According to Call and Herber (2022), a high level of complexity causes individuals to adopt innovation based on only their relative advantage and compatibility alone, and subsequent iterations of the innovation can decrease the level of complexity of innovation, fostering more user-friendly innovation. In other words, if school staff see a high level of complexity for some specific technology, it substantially hinders its adoption even though they see the advantages of using it for school-based physical activity promotion. Moreover, in order to decrease the level of complexity, school staff need more practice and training to develop relevant knowledge with sufficient experience. As quantitative results showed complexity as a significant predictor of perceptions about using technology among school staff, this finding indicates the importance of continuing professional development opportunities for school staff.

There were a number of limitations to this study. First, seven of the 10 participants were females, and seven were working in elementary schools, while no one was working in high schools (two staff in middle schools and one staff in PK-8 school). Moreover, most participants were experienced teachers or administrators; the average years of experience among them was 24.4 years. A participant with the least experience was an 11 years-experienced elementary classroom teacher. This composition of participants might limit exploring the experience of school staff who had a shorter career in the educational field. Reversely, as they are younger participants, they may also have more familiarity with and exposure to technology in their personal life or be more likely to have experienced training in their teacher preparation programs related to technology. The inexperienced professionals may share some other valuable and meaningful information according to the focus of this study; therefore, an equal distribution and wider range of participants is recommended for future studies. Furthermore, using technology in other areas of school-based physical activity (e.g., before and after school, recess) beyond the physical education classroom could be relatively lower as it was not sure participants' schools were implementing a whole-of-school approach for physical activity promotion (e.g., Comprehensive school physical activity program [CSPAP] model); therefore, participants' responses in the survey and interview might overemphasize technology practice in physical education.

Conclusion

Using a mixed-methods sequential explanatory research design with the diffusion of innovations theory as a theoretical lens, this study examined what attributes contribute to the use of technology in schools for the facilitation and promotion of physical activity and explored what experiences contribute to perceptions of technology use. Quantitative results showed that complexity and trialability were significant predictors of technology use among school staff. In other words, school staff are more likely to use technology when they see the ease and simplicity of new technology and after testing out new technology before committing to using it. Qualitative results showed that personal experiences with technology greatly affect their perceptions of using technology in school-based physical activity facilitation and promotion. However, there are multiple barriers to using technology, and school staff, especially physical education teachers, believe that the barriers occur due to the marginalization of physical education in school communities. Although school staff see the benefits of technology use in school-based physical activity promotion in general, they also see some risk factors and concerns. These findings suggest that physical education teachers and other school staff who contribute to promoting physical activity in school communities should be aware of the ESSA, which can help them obtain or increase the budget to purchase technology to improve the quality of their programs. Furthermore, those who perform the role of a physical activity leader in school communities should build good relationships with other school staff, especially administrative personnel, frame technology as a budget-friendly pedagogical tool, and make a continuous effort to advocate for school-based physical activity that positively impacts health and well-being and academic performance among school-aged children and adolescents.

CHAPTER VI

GENERAL SUMMARY AND CONCLUSIONS

Technology has the potential to better facilitate, support, and promote physical activity in school communities, which could result in multiple benefits associated with physical, mental, and social well-being among school-aged children and adolescents. The purpose of this dissertation was to understand the current practice of technology use for physical activity promotion in K-12 schools in the United States by conducting two studies titled "Technology use in school-based physical activity promotion" and "Attributes contributing to the use of technology in School-Based Physical Activity Promotion: A diffusion of innovations theory approach." A whole-of-school approach to physical activity promotion called a comprehensive school physical activity program (CSPAP; CDC, 2014) served as a conceptual framework for this dissertation. Using a quantitative research design, study one aimed to examine what types of technology schools currently use to facilitate or promote physical activity and what personal and school characteristics predict the use of technology for school-based physical activity promotion. Study two investigated what attributes contribute to the use of technology in schools for the facilitation and promotion of physical activity and explored what experiences contribute to perceptions of using technology to facilitate and promote physical activity in schools. For study two, the diffusion of innovations theory was employed as a theoretical framework, and a sequential explanatory mixed-methods study design was used in accordance with the research focus.

The results of study one showed that various technologies are currently used in school-based physical activity, and physical education is the timeslot where technology is most used by school staff for physical activity facilitation and promotion in K-12 schools. Among various personal characteristics of school staff, race and certified/licensed teacher status were significant predictors of technology use, while school characteristics did not predict the school use of technology for school-based physical activity promotion. Study two found that school staff are more likely to use technology when they see the ease and simplicity of new technology and after testing out new technology before committing to using it. Furthermore, personal experiences with technology greatly affect their perceptions of using technology in school-based physical activity facilitation and promotion. However, there are multiple barriers to using technology in school-based physical activity, and school staff, especially physical education teachers, believe that the barriers occur due to the marginalization of physical education in school communities. Although school staff see the benefits of technology use in school-based physical activity promotion in general, they also see some risk factors and concerns.

With the above-stated findings from two studies, this dissertation suggests that school staff should obtain more professional development opportunities to appropriately and effectively integrate technology in school-based physical activity. In order to obtain more satisfactory support from schools, those who perform the role of a physical activity leader in school communities should build good relationships with other school staff, especially administrative personnel, frame technology as a budget-friendly pedagogical tool, and make a continuous effort for advocacy for school-based physical activity that positively impacts health and well-being among students. Moreover, as certified/licensed teacher status was found as a significant predictor of technology use among school staff, pre-service physical education teachers who potentially fulfill the physical activity leader roles in their future professions should have relevant training from their teacher education programs. Accordingly, more quality training related to technology integration in school-based physical activity should be developed and provided by national and professional organizations, such as state-level departments of education and the Society of Health and Physical Educators (SHAPE) America. Physical education teacher education (PETE) programs are also responsible for developing curricula that can support teacher candidates to be able to demonstrate a good level of technology competency in their future profession. Future research examining technology use for school-based physical activity promotion in other CSPAP component areas besides physical education (e.g., staff involvement and family and community engagement) is recommended to find more creative and productive ways along with the effective use of technology to better support school-aged children and adolescents to meet the national recommendation of 60 minutes of physical activity per day.

This dissertation generated valuable findings that could contribute to the field of PETE and public health in several ways. First, this dissertation generated data on the current practice of technology use in school-based physical activity facilitation and promotion, which could positively impact the health of school-aged children and adolescents. Schools, school districts, professional organizations for teachers (e.g., SHAPE America), and government agencies (e.g., U.S. Department of Education) will be able to use the data to enhance resources, equipment, and facilities for the use of technology in schools. Second, this dissertation fills an existing knowledge gap by investigating and determining what characteristics of schools and their staff predict the use of technology for school-based physical activity promotion and what attributes and experiences contribute to the same. Hence, this dissertation established and provided evidence of the influential factors of technology integration in school-based physical activity, and this information can be used to inform professional development efforts and better support student physical activity in school communities. Overall, PETE and public health researchers, practitioners, and decision-makers will be able to use the results of this dissertation to better understand technology use in school-based physical activity promotion.

REFERENCES

Active Schools. (2018). *About us*. https://www.activeschoolsus.org/about

Active Schools. (2022). *Active schools guiding framework*. Chicago, IL: Action for Healthy Kids.

Aguinis, H., Beaty, J. C., Boik, R. J., & Pierce, C. A. (2005). Effect size and power in assessing moderating effects of categorical variables using multiple regression: A 30-year review. *Journal of Applied Psychology*, *90*(1), 94-107.

Akindutire, I. O., & Olanipekun, J. A. (2017). Sedentary life-style as inhibition to good quality of life and longevity. *Journal of Education and Practice,* 8(13), 39-43.

Al-Jabri, I. M., & Sohail, M. S. (2012). Mobile banking adoption: Application of diffusion of innovation theory. *Journal of Electronic Commerce Research, 13*(4), 379-391.

American College of Sports Medicine. (2012). *ACSM's health/fitness facility standards and guidelines fourth edition.* Champaign, IL: Human Kinetics.

Araque, J. C., Maiden, R. P., Bravo, N., Estrada, I., Evans, R., Hubchik, K., Kirby, K., & Reddy, M. (2013). Computer usage and access in low-income urban communities*. Computers in Human Behavior, 29*(4), 1393-1401.

Association for Educational Communications and Technology. (2022). *The definition and terminology committee*. https://aect.org/news_manager.php?page=17578#:~:text='Educational%20technology%20is%20the%20study,and%20instructional%20processes%20and%20resources

Aukstakalnis, S. (2017). *Practical augmented reality: A guide to the technologies, applications, and human factors for AR and VR*. London, United Kingdom: Pearson Education Inc.

Bailey, R. (2006). Physical education and sport in schools: A review of benefits and outcomes. *Journal of school health, 76*(8), 397-401.

Barnett, T. (1979). Why are bureaucrats slow adopters? The case of water management in the Gezira scheme. *Sociologia Ruralis, 19*(1), 60- 70.

Barney, D., & Prusak, K. A. (2015). Effects of music on physical activity rates of elementary physical. *The Physical Educator, 72*, 236-244.

Beighle, A., Erwin, H., Webster, C. A., & Webster, M. A. (2020). Physical activity during school. In Carson, R., & Webster, C. A. (Eds.), *Comprehensive school physical activity programs: Putting evidence-based research into practice* (pp. 99-110). Champaign, IL: Human Kinetics.

Benzing, V., & Schmidt, M. (2018). Exergaming for children and adolescents: Strengths, weaknesses, opportunities and threats. *Journal of Clinical Medicine, 7*(11), 422.

Biddle, S. J., Gorely, T., & Stensel, D. J. (2004). Health-enhancing physical activity and sedentary behaviour in children and adolescents. *Journal of Sports Sciences*, *22*(8), 679-701.

Black, T. R. (1999). *Doing quantitative research in the social sciences: An integrated approach to research design, measurement and statistics*. Thousand Oaks, CA: Sage Publications.

Blower, S., Swallow, V., Maturana, C., Stones, S., Phillips, R., Dimitri, P., Marshman, Z., Knapp, P., Dean, A., Higgins, S., Kellar, I., Curtis, P., Mills, N., & Martin-Kerry, J. (2020). Children and young people's concerns and needs relating to their use of health technology to self-manage long-term conditions: A scoping review. *Archives of Disease in Childhood, 105(*11), 1093-1104.

Brooks, C. C., & McMullen, J. M. (2020). Using social media: One physical education teacher's experience. *Journal of Teaching in Physical Education, 39*(4), 464-471.

Brooks, C., & McMullen, J. (2021). Level Up: Strategies to increase student engagement using gamification in physical education. *Strategies, 34*(6), 3-10.

Brown, H. E., Atkin, A. J., Panter, J., Wong, G., Chinapaw, M. J., & Van Sluijs, E. M. F. (2016). Family-based interventions to increase physical activity in children: A systematic review, meta-analysis and realist synthesis. *Obesity Reviews, 17*(4), 345-360.

Brusseau, T. A., & Burns, R. D. (2018). The physical activity leader and comprehensive school physical activity program effectiveness. *Biomedical Human Kinetics, 10*(1), 127-133.

Brusseau, T. A., Hannon, J., & Burns, R. (2016). The effect of a comprehensive school physical activity program on physical activity and health-related fitness in children from low-income families. *Journal of Physical Activity and Health, 13*(8), 888-894.

Brusseau, T. A., & Kulinna, P. H. (2015). An examination of four traditional school physical activity models on children's step counts and MVPA. *Research Quarterly for Exercise and Sport, 86*(1), 88-93.

Buchele Harris, H., & Chen, W. (2018). Technology-enhanced classroom activity breaks impacting children's physical activity and fitness. *Journal of Clinical Medicine, 7*(7), 165.

Bulger, S., Illg, K., & Jones, E. (2017). Achieving alignment in the preparation of CSPAP leaders in PETE programs. *Journal of Physical Education, Recreation & Dance, 88*(2), 37-42.

Bunn, J. A., Navalta, J. W., Fountaine, C. J., & Reece, J. D. (2018). Current state of commercial wearable technology in physical activity monitoring 2015–2017. *International Journal of Exercise Science, 11*(7), 503-515.

Burns, R. D., Fu, Y., Hannon, J. C., & Brusseau, T. A. (2017). School physical activity programming and gross motor skills in children. *American Journal of Health Behavior, 41*(5), 591–598.

Call, D. R., & Herber, D. R. (2022). Applicability of the diffusion of innovation theory to accelerate model-based systems engineering adoption. *Systems Engineering*, *25*(6), 574-583.

Carson, R. L., Castelli, D. M., Beighle, A., & Erwin, H. (2014). School-based physical activity promotion: A conceptual framework for research and practice. *Childhood Obesity, 10*(2), 100-106.

Carson, R. L., Castelli, D. M., & Kulinna, P. H. (2017). CSPAP professional preparation: Takeaways from pioneering physical education teacher education programs. *Journal of Physical Education, Recreation & Dance*, *88*(2), 43-51.

Carson, R., & Webster, C. A. (Eds.). (2020). *Comprehensive school physical activity programs: Putting evidence-based research into practice*. Champaign, IL: Human Kinetics.

Casey, A., & Jones, B. (2011). Using digital technology to enhance student engagement in physical education. *Asia-Pacific Journal of Health, Sport and Physical Education, 2*(2), 51-66.

Centers for Disease Control and Prevention. (2012). *Parent engagement: Strategies for Involving parents in school health*. Atlanta, GA: US Department of Health and Human Services.

Centers for Disease Control and Prevention. (2014). *National framework for physical activity and physical education.* Atlanta, GA: U.S. Department of Health and Human Services.

Centers for Disease Control and Prevention. (2018). *Screen time vs. lean time infographic.* https://www.cdc.gov/nccdphp/dnpao/multimedia/infographics/getmoving.html

Centers for Disease Control and Prevention. (2019a). *Increasing physical education and physical activity: A framework for schools 2019*. https://www.cdc.gov/healthyschools/physicalactivity/pdf/2019_04_25_PE-PA-Framework_508tagged.pdf

Centers for Disease Control and Prevention. (2019b). *Recess.* https://www.cdc.gov/healthyschools/physicalactivity/recess.htm

Centers for Disease Control and Prevention. (2020). *Physical activity prevents chronic disease.* https://www.cdc.gov/chronicdisease/resources/infographic/physical-activity.htm

Chang, K. E., Zhang, J., Huang, Y. S., Liu, T. C., & Sung, Y. T. (2020). Applying augmented reality in physical education on motor skills learning. *Interactive Learning Environments, 28*(6), 685-697.

Chatterjee, S., & Hadi, A. S. (2013). *Regression analysis by example*. New York, NY: John Wiley & Sons.

Chen, L., Chen, P., & Lin, Z. (2020). Artificial intelligence in education: A review. *IEEE Access*, *8*, 75264-75278.

Chen, S., & Gu, X. (2018). Toward active living: Comprehensive school physical activity program research and implications. *Quest, 70*(2), 191-212.

Cheung, A. C., & Slavin, R. E. (2012). How features of educational technology applications affect student reading outcomes: A meta-analysis. *Educational Research Review, 7*(3), 198-215.

Chubb, L. A., Fouché, C. B., Agee, M., & Thompson, A. (2021). 'Being there': Technology to reduce isolation for young people with significant illness. *International Journal of Inclusive Education*. Advance online publication. https://doi.org/10.1080/13603116.2021.1916106

Conger, S. A., Toth, L. P., Cretsinger, C., Raustorp, A., Mitáš, J., Inoue, S., & Bassett, D. R. (2022). Time trends in physical activity using wearable devices: A systematic review and meta-analysis of studies from 1995 to 2017. *Medicine & Science in Sports & Exercise, 54*(2), 288-298.

Corbin, C. B., & McKenzie, T. L. (2008). Physical activity promotion: A responsibility for both K-12 physical education and kinesiology. *Journal of Physical Education, Recreation & Dance*, *79*(6), 47-56.

Corbin, J., & Strauss, A. (2014). *Basics of qualitative research: Techniques and procedures for developing grounded theory* (4th ed.). Thousand Oaks, CA: Sage publications.

Creswell, J. W. (2009). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage Publications.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: Sage publications.

Criollo-C, S., Guerrero-Arias, A., Jaramillo-Alcázar, Á., & Luján-Mora, S. (2021). Mobile learning technologies for education: Benefits and pending issues. *Applied Sciences, 11*(9), 4111.

Cruz, C. (2021). From digital disparity to educational excellence: Closing the opportunity and achievement gaps for low-income, Black and Latinx students. *Harvard Latinx Law Review., 24*, 13-32.

Cutcliffe, J. R., & McKenna, H. P. (2004). Expert qualitative researchers and the use of audit trails. *Journal of Advanced Nursing*, *45*(2), 126-133.

Datar, A. (2017). The more the heavier? Family size and childhood obesity in the US. *Social Science & Medicine*, *180*, 143-151.

Dauenhauer, B., Carson, R. L., Krause, J., Hodgin, K., Jones, T., & Weinberger, C. (2018). Cultivating physical activity leadership in schools: A three-tiered approach to professional development. *Journal of Physical Education, Recreation & Dance, 89*(9), 51-57.

Dauenhauer, B., Krause, J., Douglas, S., Smith, M., & Stellino, M. B. (2017). A newly revised master's degree in physical education and physical activity leadership at the University of Northern Colorado. *Journal of Physical Education, Recreation & Dance, 88*(2), 14-19.

Dauenhauer, B., Stellino, M. B., Webster, C. A., & Steinfurth, C. (2020). Physical activity before and after school. In Carson, R., & Webster, C. A. (Eds.), *Comprehensive school physical activity programs: Putting evidence-based research into practice* (pp. 111-126). Champaign, IL: Human Kinetics.

Dauenhauer, B., Ha, T., Webster, C., Erwin, H., Centeio, E., Papa, J., & Burgeson, C. (2022). Predicting the presence of active schools: A national survey of school principals in the United States. *Journal of Physical Activity and Health, 19*(11), 771-776.

Dauenhauer, B., & Stoepker, P. (2022). Physical education and physical activity within a whole school, whole community, whole child approach. *Journal of Physical Education, Recreation & Dance, 93*(2), 12-19.

Daum, D. N., & Buschner, C. (2014). Research on teaching blended and online physical education. In Ferdig R. E., & Kennedy K. (Eds.), *Handbook of research on K-12 online and blended learning* (pp. 201-222). ETC Press.

Daum, D. N., Goad, T., Mosier, B., & Killian, C. M. (2022). Toward quality online physical education: Research questions and future directions. *International Journal of Kinesiology in Higher Education, 6*(4), 199-211.

Davison, K. K., Werder, J. L., & Lawson, C. T. (2008). Peer reviewed: Children's active commuting to school: Current knowledge and future directions. *Preventing Chronic Disease, 5(*3), A100.

Dearing, J. W. (2009). Applying diffusion of innovation theory to intervention development. *Research on Social Work Practice, 19*(5), 503-518.

Dearing, J. W., & Cox, J. G. (2018). Diffusion of innovations theory, principles, and practice. *Health Affairs, 37*(2), 183-190.

Değerli, A., Aytekin, Ç., & Değerli, B. (2015). Analyzing information technology status and networked readiness index in context of diffusion of innovations theory. *Procedia-Social and Behavioral Sciences, 195*, 1553-1562.

Delgado, A. J., Wardlow, L., McKnight, K., & O'Malley, K. (2015). Educational technology: A review of the integration, resources, and effectiveness of technology in k-12 classrooms. *Journal of Information Technology Education, 14*, 397-416.

Dere, Z. (2022). Analyzing technology addiction and challenging behaviors of young children: Technology addiction of young children. *International Journal of Curriculum and Instruction, 14*(1), 243-250.

DeSimone, J. A., Harms, P. D., & DeSimone, A. J. (2015). Best practice recommendations for data screening. *Journal of Organizational Behavior, 36*(2), 171-181.

Dewett, T., & Jones, G. R. (2001). The role of information technology in the organization: A review, model, and assessment. J*ournal of Management, 27*(3), 313-346.

D'Haese, S., Vanwolleghem, G., Hinckson, E., De Bourdeaudhuij, I., Deforche, B., Van Dyck, D., & Cardon, G. (2015). Cross-continental comparison of the association between the physical environment and active transportation in children: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity, 12*(1), 1-14.

Dudley, D., Okely, A., Pearson, P., & Cotton, W. (2011). A systematic review of the effectiveness of physical education and school sport interventions targeting physical activity, movement skills and enjoyment of physical activity. *European Physical Education Review, 17*(3), 353-378.

Erhel, S., & Jamet, E. (2013). Digital game-based learning: Impact of instructions and feedback on motivation and learning effectiveness. *Computers & Education, 67*, 156-167.

Ericsson, I., & Karlsson, M. K. (2014). Motor skills and school performance in children with daily physical education in school–a 9-year intervention study. *Scandinavian Journal of Medicine & Science in Sports, 24*(2), 273-278.

Erwin, H., Beighle, A., Carson, R. L., & Castelli, D. M. (2013). Comprehensive school-based physical activity promotion: A review. *Quest, 65*(4), 412-428.

Erwin, H., Fedewa, A., Beighle, A., & Ahn, S. (2012). A quantitative review of physical activity, health, and learning outcomes associated with classroom-based physical activity interventions. *Journal of Applied School Psychology, 28*(1), 14-36.

Evans, C. (2008). The effectiveness of m-learning in the form of podcast revision lectures in higher education. *Computers & Education*, *50*(2), 491-498.

Evans, E. W., Abrantes, A. M., Chen, E., & Jelalian, E. (2017). Using novel technology within a school-based setting to increase physical activity: A pilot study in school-age children from a low-income, urban community. *BioMed Research International, 2017*, 4271483.

Falvo, D. A., & Johnson, B. F. (2007). The use of learning management systems in the United States. *TechTrends*, *51*(2), 40-45.

Faulkner, G. E., Buliung, R. N., Flora, P. K., & Fusco, C. (2009). Active school transport, physical activity levels and body weight of children and youth: A systematic review. *Preventive Medicine*, *48*(1), 3-8.

Fomby, P., Goode, J. A., Truong-Vu, K. P., & Mollborn, S. (2021). Adolescent technology, sleep, and physical activity time in two US cohorts. *Youth & Society, 53*(4), 585-609.

Fredriksen, P. M., Hjelle, O. P., Mamen, A., Meza, T. J., & Westerberg, A. C. (2017). The health oriented pedagogical project (HOPP)-a controlled longitudinal school-based physical activity intervention program. *BMC Public Health, 17*(1), 1-14.

Gao, Z., & Lee, J. E. (2019). Emerging technology in promoting physical activity and health: Challenges and opportunities. *Journal of Clinical Medicine, 8*(11), 1830.

Garson, G. D. (2012). *Testing statistical assumptions*. Asheboro, NC: Statistical Associates Publishing.

Gibbone, A., Rukavina, P., & Silverman, S. (2010). Technology integration in secondary physical education: Teachers' attitudes and practice. *Journal of Educational Technology Development and Exchange, 3*(1), 27-42.

Goad, T., Towner, B., Jones, E., & Bulger, S. (2019). Instructional tools for online physical education: Using mobile technologies to enhance learning. *Journal of Physical Education, Recreation & Dance, 90*(6), 40-47.

Goodyear, V. A., Armour, K. M., & Wood, H. (2018). Young people and their engagement with health-related social media: New perspectives. *Sport, Education and Society, 24*(7), 673-688.

Goodyear, V. A., Parker, M., & Casey, A. (2019). Social media and teacher professional learning communities. *Physical Education and Sport Pedagogy, 24*(5), 421-433.

Graber, K. C., Killian, C. M., & Woods, A. M. (2020). Quality physical education. In Carson, R., & Webster, C. A. (Eds.), *Comprehensive school physical activity programs: Putting evidence-based research into practice* (pp. 89-98). Champaign, IL: Human Kinetics.

Guthold, R., Cowan, M. J., Autenrieth, C. S., Kann, L., & Riley, L. M. (2010). Physical activity and sedentary behavior among schoolchildren: A 34-country comparison. *The Journal of Pediatrics, 157*(1), 43-49.

Ha, T., Dauenhauer, B., & Krause, J. (2022). Facilitating alternative assessment with technology in physical education. *Strategies, 35*(2), 36-39.

Hertlein, K. M., & Ancheta, K. (2014). Advantages and disadvantages of technology in relationships: Findings from an open-ended survey. *The Qualitative Report, 19*(11), 1-11.

Hill, D., Ameenuddin, N., Chassiakos, Y. L. R., Cross, C., Radesky, J., Hutchinson, J., Levine, A., Boyd, R., Mendelson, R., Moreno, M., & Swanson, W. S. (2016). Media use in school-aged children and adolescents. *Pediatrics, 138*(5), e20162592.

Hill, G. M., & Valdez-Garcia, A. (2020). Perceptions of physical education teachers regarding the use of technology in their classrooms. *Physical Educator, 77*(1), 29-41.

Hills, A. P., Dengel, D. R., & Lubans, D. R. (2015). Supporting public health priorities: Recommendations for physical education and physical activity promotion in schools. *Progress in Cardiovascular Diseases, 57*(4), 368-374.

Hockly, N. (2012). Tech-savvy teaching: BYOD. *Modern English Teacher, 21*(4), 44-45.

Holden, H., & Rada, R. (2011). Understanding the influence of perceived usability and technology self-efficacy on teachers' technology acceptance. *Journal of Research on Technology in Education, 43*(4), 343-367.

Hollis, J. L., Sutherland, R., Williams, A. J., Campbell, E., Nathan, N., Wolfenden, L., Morgan, P. J., Lubans, D. R., Gillham, K., & Wiggers, J. (2017). A systematic review and meta-analysis of moderate-to-vigorous physical activity levels in secondary school physical education lessons. *International Journal of Behavioral Nutrition and Physical Activity, 14*(1), 1-26.

Holmes, A. G. D. (2020). Researcher positionality -A consideration of its influence and place in qualitative research - A new researcher guide. *Shanlax International Journal of Education, 8*(4), 1-10.

Holt, E., Bartee, T., & Heelan, K. (2013). Evaluation of a policy to integrate physical activity into the school day. *Journal of Physical Activity and Health*, *10*(4), 480-487.

Hsbollah, H. M., & Idris, K. M. (2009). E-learning adoption: The role of relative advantages, trialability and academic specialisation. *Campus-Wide Information Systems, 26*(1), 54-70.

Huberty, J., Dinkel, D., Coleman, J., Beighle, A., & Apenteng, B. (2012). The role of schools in children's physical activity participation: Staff perceptions. *Health Education Research, 27*(6), 986-995.

International Society for Technology in Education. (n.d.). *The ISTE Standards*. https://www.iste.org/iste-standards

Jackson, M., Brennan, L., & Parker, L. (2021). The public health community's use of social media for policy advocacy: a scoping review and suggestions to advance the field. *Public Health, 198*, 146-155.

Jastrow, F., Greve, S., Thumel, M., Diekhoff, H., & Süßenbach, J. (2022). Digital technology in physical education: A systematic review of research from 2009 to 2020. *German Journal of Exercise and Sport Research, 52*(4), 504-528.

Jeffs, T., & Banister, S. (2006). Enhancing collaboration and skill acquisition through the use of technology. *Journal of Technology and Teacher Education, 14*(2), 407-433.

Jenny, S. E., Krause, J. M., & Armstrong, T. (2020). *Technology for physical educators, health educators, and coaches: Enhancing instruction, assessment, management, professional development, and advocacy*. Champaign, IL: Human Kinetics.

Kahan, D., & McKenzie, T. L. (2018). Physical activity and psychological correlates during an after-school running club. *American Journal of Health Education, 49*(2), 113-123.

Kang, S., & Kang, S. (2019). The study on the application of virtual reality in adapted physical education. *Cluster Computing, 22*(1), 2351-2355.

Kapoor, K. K., Dwivedi, Y. K., & Williams, M. D. (2014). Exploring diffusion of innovation adoption attributes: A cross-disciplinary literature analysis. *International Journal of Indian Culture and Business Management, 8*(3), 300-328.

Keating, X., Liu, X., Stephenson, R., Guan, J., & Hodges, M. (2020). Student health-related fitness testing in school-based physical education: Strategies for student self-testing using technology. *European Physical Education Review, 26*(2), 552-570.

Kebritchi, M. (2010). Factors affecting teachers' adoption of educational computer games: A case study. *British Journal of Educational Technology, 41*(2), 256-270.

Killian, C. M., Daum, D. N., Goad, T., Brown, R., & Lehman, S. (2021). How do we do this? Distance learning in physical education—part 2. *Journal of Physical Education, Recreation & Dance, 92(*4), 11-17.

Kim, M., Yu, H., Park, C. W., Ha, T., & Baek, J. H. (2021). Physical education teachers' online teaching experiences and perceptions during the COVID-19 pandemic. *Journal of Physical Education and Sport, 21*(S3)*,* 2049-2056.

Kooiman, B. J., Sheehan, D. P., Wesolek, M., & Retegui, E. (2017). Moving online physical education from oxymoron to efficacy. *Sport, Education and Society, 22*(2), 230-246.

Krause, J. M. (2017). Physical education student teachers' technology integration self-efficacy. *Physical Educator, 74*(3), 476-496.

Krause, J. M., Franks, H., & Lynch, B. (2017). Current technology trends and issues among health and physical education professionals. *Physical Educator, 74*(1), 164.

Krause, J. M., & Jenny, S. E. (2020). Exergaming effects on physical activity beliefs and intention among at-risk Hispanic youth. *International Journal of Technology in Teaching & Learning, 16*(2), 93-105.

Krause, J. M., O’Neil, K., & Jones, E. (2020). Technology in physical education teacher education: A call to action. *Quest, 72*(3), 241-259.

Kretschmann, R. (2015). Effect of physical education teachers' computer literacy on technology use in physical education. *The Physical Educator, 72*(5), 261-277.

Kretschmann, R. (2017). Employing tablet technology for video feedback in physical education swimming class. *Journal of e-Learning and Knowledge Society, 13*(2), 103-115.

Kumar Basak, S., Wotto, M., & Belanger, P. (2018). E-learning, M-learning and D-learning: Conceptual definition and comparative analysis. *E-learning and Digital Media, 15*(4), 191-216.

Lai, J. W., & Bower, M. (2019). How is the use of technology in education evaluated? A systematic review. *Computers & Education, 133*, 27-42.

Lee, M. C., Orenstein, M. R., & Richardson, M. J. (2008). Systematic review of active commuting to school and children's physical activity and weight. *Journal of Physical Activity & Health, 5*(6), 930-949.

Leshem, S., & Trafford, V. (2007). Overlooking the conceptual framework. *Innovations in Education and Teaching International, 44*(1), 93-105.

Lewis, B. A., Napolitano, M. A., Buman, M. P., Williams, D. M., & Nigg, C. R. (2017). Future directions in physical activity intervention research: Expanding our focus to sedentary behaviors, technology, and dissemination. *Journal of Behavioral Medicine, 40*(1), 112-126.

Lindberg, R., Seo, J., & Laine, T. H. (2016). Enhancing physical education with exergames and wearable technology. *IEEE Transactions on Learning Technologies, 9*(4), 328-341.

Lonsdale, C., Rosenkranz, R. R., Peralta, L. R., Bennie, A., Fahey, P., & Lubans, D. R. (2013). A systematic review and meta-analysis of interventions designed to increase moderate-to-vigorous physical activity in school physical education lessons. *Preventive Medicine, 56*(2), 152-161.

Loveday, A., Sherar, L. B., Sanders, J. P., Sanderson, P. W., & Esliger, D. W. (2015). Technologies that assess the location of physical activity and sedentary behavior: A systematic review. *Journal of Medical Internet Research, 17*(8), e4761.

Lundblad, J. P. (2003). A review and critique of Rogers' diffusion of innovation theory as it applies to organizations. *Organization Development Journal,* 21(4), 50-64.

Lux, K., & McCullick, B. A. (2011). How one exceptional teacher navigated her working environment as the teacher of a marginal subject. *Journal of Teaching in Physical Education, 30*(4), 358-374.

Ma, L., Lee, C. S., & Goh, D. H. L. (2014). Understanding news sharing in social media: An explanation from the diffusion of innovations theory. *Online Information Review, 38*(5), 598-615.

Mantilla, A., & Edwards, S. (2019). Digital technology use by and with young children: A systematic review for the Statement on Young Children and Digital Technologies. *Australasian Journal of Early Childhood, 44*(2), 182-195.

Martin, A., Kelly, P., Boyle, J., Corlett, F., & Reilly, J. J. (2016). Contribution of walking to school to individual and population moderate-vigorous intensity physical activity: Systematic review and meta-analysis. *Pediatric Exercise Science, 28*(3), 353-363.

Martin, M. R., & Zimmerman, R. (2014). Technology in action: Developing school-wide activity programs. *Journal of Physical Education, Recreation and Dance, 85*(7), 44-45.

Matthews, P., & Greenspan, S. (2020). Technology Definitions. In *Automation and collaborative robotics* (pp. 45-67). Berkeley, CA: Apress.

Matzavela, V., & Alepis, E. (2021). M-learning in the COVID-19 era: Physical vs digital class. *Education and Information Technologies, 2*6(6), 7183-7203.

Maxwell, S. E. (2000). Sample size and multiple regression analysis. *Psychological methods, 5*(4), 434-458.

McCaughtry, N., Oliver, K. L., Dillon, S. R., & Martin, J. J. (2008). Teachers' perspectives on the use of pedometers as instructional technology in physical education: A cautionary tale. *Journal of Teaching in Physical Education, 27*(1), 83-99.

McDonald, N. C., Steiner, R. L., Lee, C., Rhoulac Smith, T., Zhu, X., & Yang, Y. (2014). Impact of the safe routes to school program on walking and bicycling. *Journal of the American Planning Association, 80*(2), 153-167.

McKenzie, J. (2001). How teachers learn technology best. *The Educational Technology Journal, 10*(6).

McKenzie, T. L., Sallis, J. F., Prochaska, J. J., Conway, T. L., Marshall, S. J., & Rosengard, P. (2010). Evaluation of a two-year middle-school physical education intervention: M-SPAN. *People, 25*(8), 2-6.

McMullen, J., Ni Chroinin, D., Tammelin, T., Pogorzelska, M., & van der Mars, H. (2015). International approaches to whole-of-school physical activity promotion. *Quest, 67*(4), 384-399.

McMullen, J., Kulinna, P., & Cothran, D. (2014). Physical activity opportunities during the school day: Classroom teachers' perceptions of using activity breaks in the classroom. *Journal of Teaching in Physical Education, 33*(4), 511-527.

Mears, R., & Jago, R. (2016). Effectiveness of after-school interventions at increasing moderate-to-vigorous physical activity levels in 5-to 18-year olds: A systematic review and meta-analysis. *British Journal of Sports Medicine, 50*(21), 1315-1324.

Merriam, S. B., & Tisdell, E. J. (2015). *Qualitative research: A guide to design and implementation*. Hoboken, NJ: John Wiley & Sons.

Min, S., So, K. K. F., & Jeong, M. (2019). Consumer adoption of the Uber mobile application: Insights from diffusion of innovation theory and technology acceptance model. *Journal of Travel & Tourism Marketing, 36*(7), 770-783.

Mitchell, J. A., & Byun, W. (2014). Sedentary behavior and health outcomes in children and adolescents. *American Journal of Lifestyle Medicine, 8*(3), 173-199.

Momeni, A., Pincus, M., & Libien, J. (2018). Cross tabulation and categorical data analysis. In *Introduction to statistical methods in pathology* (pp. 93-120). Springer, Cham.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation*. Information Systems Research, 2*(3), 192-222.

Mustafaoğlu, R., Zirek, E., Yasacı, Z., & Özdinçler, A. R. (2018). The negative effects of digital technology usage on children's development and health. *Addicta: The Turkish Journal on Addictions, 5*(2), 13-21.

Myers, E. J. (2013). ICT and physical literacy: The use of podcast as an educational tool to promote motivation and raise attainment in development knowledge and understanding in physical education*. ICSSPE, 65*.

National Center for Education Statistics. (2021). *Use of educational technology for instruction in public schools: 2019-20*. U.S. Department of Education. https://nces.ed.gov/pubs2021/2021017.pdf

National Center on Safe Supportive Learning Environment. (n.d.). *Title IV, part A statute*. *https://safesupportivelearning.ed.gov/title-iv-part-a-statute#Sec%204109*

Naylor, P. J., Nettlefold, L., Race, D., Hoy, C., Ashe, M. C., Higgins, J. W., & McKay, H. A. (2015). Implementation of school based physical activity interventions: A systematic review. *Preventive Medicine, 72*, 95-115.

Ntemana, T. J., & Olatokun, W. (2012). Analyzing the influence of diffusion of innovation attributes on lecturers' attitude towards information and communication technologies. *Human Technology: An Interdisciplinary Journal on Humans in ICT Environments, 88*(2), 179-197.

Odiaga, J. A., & Doucette, J. (2017). Technological media and sedentary behavior in pediatrics. *The Journal for Nurse Practitioners, 13*(1), 72-78.

Office of Educational Technology. (2017). *Reimagining the role of technology in education: 2017 national education technology plan update from the office of educational technology.* U.S. Department of Education. https://tech.ed.gov/files/2017/01/NETP17.pdf

Oluyinka, S., & Cusipag, M. (2021). Trialability and purposefulness: Their role towards Google classroom acceptance following educational policy. *Acta Informatica Pragensia, 10*(2), 172-191.

Orendorff, K., Webster, C. A., Mîndrilă, D., Cunningham, K. M., Doutis, P., Dauenhauer, B., & Stodden, D. F. (2021). Principals' involvement in comprehensive school physical activity programmes: A social-ecological perspective. *European Physical Education Review, 27*(3), 574-594.

Osanloo, A., & Grant, C. (2016). Understanding, selecting, and integrating a theoretical framework in dissertation research: Creating the blueprint for your "house". *Administrative Issues Journal: Connecting Education, Practice, and Research, 4*(2), 12-26.

Oudat, M. E. A. (2015). The effect of using visual aids on teaching volleyball skills to physical education students. *International Journal of Education Research, 10*(2), 22-30.

Page, E. J., Massey, A. S., Prado-Romero, P. N., & Albadawi, S. (2020). The use of self-monitoring and technology to increase physical activity: A review of the literature. *Perspectives on Behavior Science, 43*, 501-514.

Palao, J. M., Hastie, P. A., Cruz, P. G., & Ortega, E. (2015). The impact of video technology on student performance in physical education. *Technology, Pedagogy and Education, 24*(1), 51-63.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*, *42*(5), 533-544.

Pandita, A., Sharma, D., Pandita, D., Pawar, S., Tariq, M., & Kaul, A. (2016). Childhood obesity: Prevention is better than cure. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy, 9*, 83-89.

Parisot, A. H. (1997). Distance education as a catalyst for changing teaching in the community college: Implications for institutional policy. *New Directions for Community Colleges, 1997*(99), 5-13.

Patton, M. Q. (2014). *Qualitative research & evaluation methods: Integrating theory and practice*. Thousand Oaks, CA: Sage publications

Pennington, T., Prusak, K., & Beddoes, Z. (2023). Preparing successful advocates through PETE programs: A framework for advocacy in physical education. J*ournal of Physical Education, Recreation & Dance, 94*(2), 19-24.

Phelps, A., Colburn, J., Hodges, M., Knipe, R., Doherty, B., & Keating, X. D. (2021). A qualitative exploration of technology use among preservice physical education teachers in a secondary methods course. *Teaching and Teacher Education*, *105*, 103400.

Phillips, S. M., Cadmus-Bertram, L., Rosenberg, D., Buman, M. P., & Lynch, B. M. (2018). Wearable technology and physical activity in chronic disease: Opportunities and challenges. *American Journal of Preventive Medicine, 54*(1), 144-150.

Plowman, L., & Stephen, C. (2003). A 'benign addition'? Research on ICT and pre-school children. *Journal of Computer Assisted Learning, 19*(2), 149-164.

Ponce, O. A., & Pagán-Maldonado, N. (2015). Mixed methods research in education: Capturing the complexity of the profession. *International Journal of Educational Excellence*, *1*(1), 111-135.

Pulling Kuhn, A., Stoepker, P., Dauenhauer, B., & Carson, R. L. (2021). A systematic review of multi-component comprehensive school physical activity program (CSPAP) interventions. *American Journal of Health Promotion, 35*(8), 1129-1149.

Quennerstedt, M. (2013). PE on YouTube–investigating participation in physical education practice. *Physical Education and Sport Pedagogy, 18*(1), 42-59.

R Core Team. (2022). *What is R?* https://www.r-project.org/about.html

Reimers, F. M. (2022). Learning from a pandemic. The impact of COVID-19 on education around the world. In *Primary and secondary education during COVID-19* (pp. 1-37). New York, NY: Springer.

Richards, K. A. R., Gaudreault, K. L., Starck, J. R., & Mays Woods, A. (2018). Physical education teachers' perceptions of perceived mattering and marginalization. *Physical Education and Sport Pedagogy, 23*(4), 445-459.

Ridgers, N. D., Salmon, J., Parrish, A. M., Stanley, R. M., & Okely, A. D. (2012). Physical activity during school recess: A systematic review. *American Journal of Preventive Medicine, 43*(3), 320-328.

Ridgers, N. D., Stratton, G., & Fairclough, S. J. (2006). Physical activity levels of children during school playtime. *Sports Medicine, 36*(4), 359-371.

Rogers, E. M. (1962). *Diffusion of innovations*. New York, NY: Free Press.

Rogers, E. M. (1995). *Diffusion of innovations* (4th ed.). New York, NY: Free Press.

Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). New York, NY: Free Press.

Rosen, L. D., Lim, A. F., Felt, J., Carrier, L. M., Cheever, N. A., Lara-Ruiz, J. M., Mendoza, J. S., & Rokkum, J. (2014). Media and technology use predicts ill-being among children, preteens and teenagers independent of the negative health impacts of exercise and eating habits. *Computers in Human Behavior, 35*, 364-375.

Russ, L. B., Webster, C. A., Beets, M. W., & Phillips, D. S. (2015). Systematic review and meta-analysis of multi-component interventions through schools to increase physical activity. *Journal of Physical Activity and Health, 12*(10), 1436-1446.

Russell, M., Bebell, D., O'Dwyer, L., & O'Connor, K. (2003). Examining teacher technology use: Implications for preservice and inservice teacher preparation. *Journal of teacher Education, 54*(4), 297-310.

Sahin, I. (2006). Detailed review of Rogers' diffusion of innovations theory and educational technology-related studies based on Rogers' theory. *Turkish Online Journal of Educational Technology, 5*(2), 14-23.

Sallis, J. F., McKenzie, T. L., Kolody, B., Lewis, M., Marshall, S., & Rosengard, P. (1999). Effects of health-related physical education on academic achievement: Project SPARK. *Research Quarterly for Exercise and Sport, 70*(2), 127-134.

SHAPE America – Society of Health and Physical Educators. (2014*). National standards & grade-level outcomes for K-12 physical education*. Champaign, IL: Human Kinetics.

SHAPE America – Society of Health and Physical Educators. (2015). *The essential components of physical education.* https://www.shapeamerica.org/upload/TheEssentialComponentsOfPhysicalEducation.pdf

SHAPE America – Society of Health and Physical Educators. (2016). *2016 Shape of the nation.* https://www.shapeamerica.org/uploads/pdfs/son/Shape-of-the-Nation-2016_web.pdf

SHAPE America – Society of Health and Physical Educators. (2017). *National standards For initial physical education teacher education*. http://caepnet.org/~/media/Files/caep/accreditation-resources/national-standards-for-initial-physical.pdf?la=en

Sherry, L. (1997). The boulder valley internet project: Lessons learned. *The Journal, 25*(2), 68-72.

Shiue, Y. M. (2007). Investigating the sources of teachers' instructional technology use through the decomposed theory of planned behavior. *Journal of Educational Computing Research, 36*(4), 425-453.

Simin, M. T., & Janković, D. (2014). Applicability of diffusion of innovation theory in organic agriculture. *Economics of Agriculture, 61*(2), 517-529.

Smith, K. (2012). Lessons learnt from literature on the diffusion of innovative learning and teaching practices in higher education. *Innovations in Education and Teaching International, 49*(2), 173-182.

Sjølie, H., Karlsson, B., & Binder, P. E. (2013). Professionals' experiences of the relations between personal history and professional role. *Nursing Research and Practice, 2013*, 265247.

Sousa, A. C., Ferrinho, S. N., & Travassos, B. (2023). The use of wearable technologies in the assessment of physical Activity in preschool-and school-age youth: Systematic review. *International Journal of Environmental Research and Public Health, 20*(4), 3402.

Spotts, T. H. (1999). Discriminating factors in faculty use of instructional technology in higher education. *Educational Technology & Society, 2*(4), 92-99.

Stoepker, B. P., Dauenhauer, B., Carson, R. L., McMullen, J., & Moore, J. B. (2020). Becoming a physical activity leader (PAL): Skills, responsibilities, and training. *Strategies, 34*(1), 23-28.

Stylianou, M., van der Mars, H., Kulinna, P. H., Adams, M. A., Mahar, M., & Amazeen, E. (2016). Before-school running/walking club and student physical activity levels: An efficacy study. *Research Quarterly for Exercise and Sport, 87*(4), 342-353.

Suherman, A., Saptani, E., Setialengkana, A., & Nugraha, R. G. (2019). Understanding the teaching style of physical education teacher in primary school through audio visual media. *Journal of Physics: Conference Series, 1318*, 012122.

Sween, J., Wallington, S. F., Sheppard, V., Taylor, T., Llanos, A. A., & Adams-Campbell, L. L. (2014). The role of exergaming in improving physical activity: a review. *Journal of Physical Activity & Health, 11*(4), 864–870.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273-1296.

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education, 2*, 53-55.

Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation, 27*(2), 237-246.

Tipton, E. (2013). Stratified sampling using cluster analysis: A sample selection strategy for improved generalizations from experiments. *Evaluation Review*, *37*(2), 109-139.

Trost, J. E. (1986). Statistically nonrepresentative stratified sampling: A sampling technique for qualitative studies. *Qualitative Sociology*, *9*(1), 54-57.

U.S. Department of Health and Human Services. (2018). *Physical activity guidelines for Americans, 2nd edition.* Washington, DC: U.S. Department of Health and Human Services.

Uzunoz, F. S., Chin, M. K., Mok, M. M. C., Edginton, C. R., & Podnar, H. (2017). The effects of technology supported brain-breaks on physical activity in school children. In Dumon, D., Hofmann, A. R., Diketmüller R., Koenen K., Baily R., & Zinkler C. (Eds.), *Passionately inclusive: Towards participation and friendship in sport* (pp. 87-104). Münster, Germany: Waxmann.

van der Mars. H., & Lorenz., K. (2020). CSPAPs: History, foundations, possibilities, and barriers. In Carson, R., & Webster, C. A. (Eds.), *Comprehensive school physical activity programs: Putting evidence-based research into practice* (pp. 3-18). Champaign, IL: Human Kinetics.

van der Mars, H., Lorenz, K. A., & Kwon, J. (2017). Building CSPAP development into Arizona State University's PETE program: A work in progress. *Journal of Physical Education, Recreation & Dance, 88*(1), 11-19.

Watson, A., Timperio, A., Brown, H., Best, K., & Hesketh, K. D. (2017). Effect of classroom-based physical activity interventions on academic and physical activity outcomes: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity, 14*, 1-24.

Williams, A. S., Ge, B., Petroski, G., Kruse, R. L., McElroy, J. A., & Koopman, R. J. (2018). Socioeconomic status and other factors associated with childhood obesity. *The Journal of the American Board of Family Medicine*, *31*(4), 514-521.

Wang, F., & Wei, Z. (2020). Research on the application of VR technology in physical education. *Frontiers in Sport Research, 2*(6), 116-123.

Wang, N., Abdul Rahman, M. N., & Lim, B. H. (2022). Teaching and curriculum of the preschool physical education major direction in colleges and universities under virtual reality technology. *Computational Intelligence and Neuroscience, 2022*.

Ward, J., Wilkinson, C., Graser, S. V., & Prusak, K. A. (2008). Effects of choice on student motivation and physical activity behavior in physical education. *Journal of Teaching in Physical Education, 27*(3), 385-398.

Warschauer, M., Knobel, M., & Stone, L. (2004). Technology and equity in schooling: Deconstructing the digital divide. *Educational Policy, 18*(4), 562-588.

Weaver, R. G., Beets, M. W., Saunders, R. P., & Beighle, A. (2014). A coordinated comprehensive professional development training's effect on summer day camp staff healthy eating and physical activity promoting behaviors. *Journal of Physical Activity and Health*, *11*(6), 1170-1178.

Webster, C. A., D'Agostino, E., Urtel, M., McMullen, J., Culp, B., Loiacono, C. A. E., & Killian, C. (2021). Physical education in the COVID era: Considerations for online program delivery using the comprehensive school physical activity program framework. *Journal of Teaching in Physical Education, 40*(2), 327-336.

Webster, C. A., & Nesbitt, D. (2017). Expanded roles of physical education teachers within a CSPAP and implications for PETE. *Journal of Physical Education, Recreation & Dance, 88*(3), 22-28.

Webster, C. A., Russ, L., Vazou, S., Goh, T. L., & Erwin, H. (2015). Integrating movement in academic classrooms: Understanding, applying and advancing the knowledge base. *Obesity Reviews, 16*(8), 691-701.

Webster, C. A., Weaver, R. G., Carman, M., Marcheschi, L., Loulousis, A. T., Vazou, S., Goh, T. L., & Carson, R. L. (2020). Staff involvement. In Carson, R., & Webster, C. A. (Eds.), *Comprehensive school physical activity programs: Putting evidence-based research into practice* (pp. 127-142). Champaign, IL: Human Kinetics.

Weir, T., & Connor, S. (2009). The use of digital video in physical education. *Technology, Pedagogy and Education, 18*(2), 155-171.

Welk, G. J., & Lee, J. A. (2020). Family and community engagement. In Carson, R., & Webster, C. A. (Eds.), *Comprehensive school physical activity programs: Putting evidence-based research into practice* (pp. 143-156). Champaign, IL: Human Kinetics.

Western, M. J., Armstrong, M. E., Islam, I., Morgan, K., Jones, U. F., & Kelson, M. J. (2021). The effectiveness of digital interventions for increasing physical activity in individuals of low socioeconomic status: A systematic review and meta-analysis. *International Journal of Behavioral Nutrition and Physical Activity, 18*(1), 1-21.

Wong, B. Y. M., Faulkner, G., & Buliung, R. (2011). GIS measured environmental correlates of active school transport: A systematic review of 14 studies. *International Journal of Behavioral Nutrition and Physical Activity*, *8*(1), 1-22.

Wyant, J., & Baek, J. H. (2019). Re-thinking technology adoption in physical education. *Curriculum Studies in Health and Physical Education, 10*(1), 3-17.

Wyant, J. D., Jones, E. M., & Bulger, S. M. (2015). A mixed methods analysis of a single-course strategy to integrate technology into PETE. *Journal of Teaching in Physical Education, 34*(1), 131-151.

Yang, Y., & Meng, L. (2019). Physical education motion correction system based on virtual reality technology. *International Journal of Emerging Technologies in Learning, 14*(13), 105-116.

Yu, H., & Ha, T. (2021). Effective pedagogical practices in synchronous online physical education. *Journal of Physical Education, Recreation & Dance, 92*(9), 63-68.

Yu, H., van der Mars, H., Hastie, P. A., & Kulinna, P. H. (2021). Incorporating a motion analysis app in middle school badminton unit. *Journal of Teaching in Physical Education, 41*(4), 729-737.

Yuen, A. H., & Ma, W. W. (2008). Exploring teacher acceptance of e-learning technology. *Asia-Pacific Journal of Teacher Education, 36*(3), 229-243.

Zahn, I. (2010). Working with unbalanced cell sizes in multiple regression with categorical predictors. *Education, 112*(84), 1-18.

Zhao, Y., Feng, H., Wu, X., Du, Y., Yang, X., Hu, M., Ning, H., Liao, L., Chen, H., & Zhao, Y. (2020). Effectiveness of exergaming in improving cognitive and physical function in people with mild cognitive impairment or dementia: systematic review. *JMIR Serious Games, 8*(2), e16841.

APPENDIX A

INSTITUTIONAL REVIEW BOARD
APPROVAL

UNIVERSITY OF NORTHERN COLORADO

Institutional Review Board

Date:	06/30/2022
Principal Investigator:	Taemin Ha
Committee Action:	**IRB EXEMPT DETERMINATION – New Protocol**
Action Date:	06/30/2022
Protocol Number:	2205038578
Protocol Title:	Technology Integration in School-Based Physical Activity
Expiration Date:	

The University of Northern Colorado Institutional Review Board has reviewed your protocol and determined your project to be exempt under 45 CFR 46.104(d)(702) for research involving

Category 2 (2018): EDUCATIONAL TESTS, SURVEYS, INTERVIEWS, OR OBSERVATIONS OF PUBLIC BEHAVIOR. Research that only includes interactions involving educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual or auditory recording) if at least one of the following criteria is met: (i) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects cannot readily be ascertained, directly or through identifiers linked to the subjects; (ii) Any disclosure of the human subjects' responses outside the research would not reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, educational advancement, or reputation; or (iii) The information obtained is recorded by the investigator in such a manner that the identity of the human subjects can readily be ascertained, directly or through identifiers linked to the subjects, and an IRB conducts a limited IRB review to make the determination required by 45 CFR 46.111(a)(7).

You may begin conducting your research as outlined in your protocol. Your study does not require further review from the IRB, unless changes need to be made to your approved protocol.

As the Principal Investigator (PI), you are still responsible for contacting the UNC IRB office if and when:

UNIVERSITY OF
NORTHERN COLORADO

Institutional Review Board

- You wish to deviate from the described protocol and would like to formally submit a modification request. Prior IRB approval must be obtained before any changes can be implemented (except to eliminate an immediate hazard to research participants).
- You make changes to the research personnel working on this study (add or drop research staff on this protocol).
- At the end of the study or before you leave The University of Northern Colorado and are no longer a student or employee, to request your protocol be closed. *You cannot continue to reference UNC on any documents (including the informed consent form) or conduct the study under the auspices of UNC if you are no longer a student/employee of this university.
- You have received or have been made aware of any complaints, problems, or adverse events that are related or possibly related to participation in the research.

If you have any questions, please contact the Research Compliance Manager, Nicole Morse, at 970-351-1910 or via e-mail at nicole.morse@unco.edu. Additional information concerning the requirements for the protection of human subjects may be found at the Office of Human Research Protection website - http://hhs.gov/ohrp/ and https://www.unco.edu/research/research-integrity-and-compliance/institutional-review-board/.

Sincerely,

Nicole Morse
Research Compliance Manager

University of Northern Colorado: FWA00000784

Carter Hall 2008 I Campus Box 143 I Greeley, CO 80639 I Office 970-351-1910

APPENDIX B

STUDY INVITATION IN ACTIVE SCHOOLS' NEWSLETTER

UNIVERSITY OF NORTHERN COLORADO
Active Schools Institute

We invite you to participate in a study on technology integration in school-based physical activity promotion. The survey will take approximately 20-30 minutes.

A $10 Amazon gift card will be awarded to the first 250 Active Schools Champions who complete the survey, and everyone after that will be entered into a lottery for one of ten $50 Amazon gift cards.

If you voluntarily agree to participate in this study, please click the link below.

SURVEY LINK

If you have any questions about this study, please do not hesitate to contact Taemin Ha at taemin.ha@unco.edu. Thank you in advance for your valuable time participating in this study.

Survey Link

APPENDIX C

INFORMED CONSENT FOR SURVEY

CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH

Project Title: Technology Integration in School-Based Physical Activity
Researcher: Taemin Ha, M.A., taemin.ha@unco.edu
Research Advisor: Brian Dauenhauer, Ph.D., brian.dauenhauer@unco.edu

Good day,

My name is Taemin Ha, and I am a doctoral student in the School of Sport and Exercise at the University of Northern Colorado. I am currently working on my doctoral dissertation that aims to first examine the current practice of technology use in schools and the factors that influence the use of technology in school-based physical activity promotion. I became interested in this topic because technology has become a more integral part of the current rising generation and has a vast potential to better facilitate and support school-based physical activity programs, including physical education. To date, however, there has been no study on this topic conducted.

You were invited to this study because you were identified as an Active Schools Champion who is willing to contribute to creating an active school environment through school-based physical activity to promote school-aged children's and adolescents' physical activity. If you choose to participate, I will ask you to complete an online survey that encompasses various questions asking about your school's and your current technology practices and your perception of technology use in school-based physical activity promotion. I strongly believe your responses from the survey will generate valuable findings that will contribute to the field of physical education teacher education (PETE) and public health in various ways.

I believe that the survey will take approximately 20-30 minutes. **A $10 Amazon gift card will be awarded to the first 250 Active Schools Champions who complete the survey, and everyone after that will be entered into a lottery for one of ten $50 Amazon gift cards.**

Risks to you are minimal. You may feel uncomfortable sharing the details of your experience with technology in a school setting. There is no direct benefit from taking part in this study.

Participation is voluntary. You may decide not to participate in this study and if you begin participation, you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Please take your time to read and thoroughly review this document and decide whether you would like to participate in this research study. If you decide to participate, your completion of the research procedures indicates your consent. Please keep or print this form for your records. If you have any concerns about your selection or treatment as a research participant, please contact Nicole

Morse, Office of Research & Sponsored Programs, University of Northern Colorado, Greeley, CO; 970-351-1910 or nicole.morse@unco.edu.

If you voluntarily agree to participate in this study, please click the "NEXT" button below to proceed to the survey.

APPENDIX D

COMPREHENSIVE SCHOOL PHYSICALACTIVITY PROGRAM TECHNOLOGY PRACTICE QUESTIONNAIRE (CSPAP-TPQ)

Comprehensive School Physical Activity Program (CSPAP) Technology Practice Questionnaire (CSPAP-TPQ)

Thank you for taking your valuable time to complete the Comprehensive School Physical Activity Program (CSPAP) Technology Practice Questionnaire (CSPAP-TPQ). The purpose of this questionnaire is to investigate the current practice of technology use in school-based physical activity promotion under the five components of CSPAP.

The survey questions are presented in the following areas:
1. Technology use in physical education
2. Technology use in physical activity during school and physical activity before and after school
3. Technology use in staff involvement and family and community engagement
4. Personal characteristics
5. School characteristics
6. Technology experience

First, the following sections will ask you to indicate whether anyone at your school currently uses each of listed technologies under each CSPAP component area.

Comprehensive School Physical Activity Program (CSPAP)

"A Comprehensive School Physical Activity Program (CSPAP) is a multi-component approach by which school districts and schools use all opportunities for students to be physically active, meet the nationally-recommended 60 minutes of physical activity each day, and develop the knowledge, skills, and confidence to be physically active for a lifetime. A CSPAP reflects strong coordination and synergy across all of the components: quality physical education as the foundation, physical activity before, during, and after school, staff involvement, and family and community engagement." (CDC, 2013, p. 12).

Technology

All the existing digital, mobile, electronic, and physical devices that can be used by teachers, school staff, families, community members, and related professionals to better support, facilitate, and promote physical activity in school communities in any way.

SECTION I. Technology Use in Physical Education (39 technologies)

Physical Education: *"Physical education is an academic subject that serves as the foundation of the CSPAP by providing the opportunity for students to learn knowledge and skills needed to establish and maintain physically active lifestyles throughout childhood and adolescence and into adulthood."* (CDC, 2013, p. 12).

Does anyone at your school, including you, use the following technologies in **Physical Education** practice?	School Technology Use	Check the circle if YOU are the one who uses this technology
1. Computer (Desktop or laptop)	Yes / No / I don't know	○
2. Tablet (e.g., iPad)	Yes / No / I don't know	○
3. Smartphone	Yes / No / I don't know	○
4. Bluetooth	Yes / No / I don't know	○
5. Quick Response (QR) Code	Yes / No / I don't know	○
6. Email	Yes / No / I don't know	○
7. Audio System (e.g., speaker, compact disc [CD], audio cassette, MP3 player)	Yes / No / I don't know	○
8. Wireless Microphones	Yes / No / I don't know	○
9. Interactive Touchscreen Display (e.g., Smartboard)	Yes / No / I don't know	○
10. Microsoft Office (e.g., Word, PowerPoint, Excel)	Yes / No / I don't know	○
11. Google Workspace (e.g., Docs, Sheets, Slides, Forms)	Yes / No / I don't know	○
12. Online Video Clips (e.g., YouTube)	Yes / No / I don't know	○
13. Learning Management System (LMS) Software/Apps. (e.g., Google Classroom, Team Shake, Teacher Kit)	Yes / No / I don't know	○

14. Social Media (e.g., Facebook, Twitter, Instagram)	Yes / No / I don't know	○
15. Cloud-Based File Sharing Tools/Apps. (e.g., Google Drive, Dropbox)	Yes / No / I don't know	○
16. Game-Based Learning Platforms (e.g., Kahoot!, Gimkit)	Yes / No / I don't know	○
17. Website Development Tools/Apps. (e.g., Wix, Squarespace)	Yes / No / I don't know	○
18. Sports Video Games (e.g., Nintendo Olympics)	Yes / No / I don't know	○
19. Motion-Based Video Games (e.g., Wii Fit)	Yes / No / I don't know	○
20. Augmented Reality (AR) (e.g., Pokémon GO in AR)	Yes / No / I don't know	○
21. Virtual Reality (VR) (e.g., Beat Saver in VR)	Yes / No / I don't know	○
22. Wearable Technology (e.g., pedometer, accelerometer, Fitbit, heart rate monitor)	Yes / No / I don't know	○
23. Global Positioning System (GPS)	Yes / No / I don't know	○
24. Assistive Technology for Individuals with Disabilities (e.g., talking device, text to speech device, color identifier, screen reader software, paramobile device, video remote interpreting platforms)	Yes / No / I don't know	○
25. Stopwatch	Yes / No / I don't know	○
26. Bioelectric Impedance Analyzer (measures body composition)	Yes / No / I don't know	○
27. FitnessGram Software for Data Organization	Yes / No / I don't know	○
28. Audience Response System (e.g., iClicker, Plickers)	Yes / No / I don't know	○
29. Video Analysis Apps. (e.g., myDartfish Express, Hudl)	Yes / No / I don't know	○
30. Digital Video Camcorder	Yes / No / I don't know	○
31. Data Storage (e.g., flash memory, hard drive, removable memory card)	Yes / No / I don't know	○

32. Video Conferencing Software/Apps. (e.g., Zoom, Google Hangouts)	Yes / No / I don't know	○
33. Video Editing Software/Apps. (e.g., iMovie, Final Cut Pro)	Yes / No / I don't know	○
34. Online Video Recording/Creating/Sharing Platforms (e.g., YouTube, Vimeo, TeacherTube, Flipgrid)	Yes / No / I don't know	○
35. Still Image Editing Tools/Apps. (e.g., PicArt, Snapseed)	Yes / No / I don't know	○
36. Audio Editing Tools/Apps. (e.g., Adobe Audition CC, Audacity)	Yes / No / I don't know	○
37. Infographic Development Tools/Apps. (e.g., Piktochart, Canva)	Yes / No / I don't know	○
38. Podcast	Yes / No / I don't know	○
39. Webinar	Yes / No / I don't know	○

SECTION II. Technology Use in Physical Activity During School and Before and After School (27 technologies)

Physical Activity During School: *"In addition to physical education, schools can offer physical activity in a variety of settings during the school day. The main ways students can participate in physical activity during the school day are recess, physical activity integrated into classroom lessons, physical activity breaks in and outside the classroom, and lunchtime club or intramural programs."* (CDC, 2013, p. 14)

Physical Activity Before and After School: *"Before- and after-school physical activity programs offer students an opportunity to be physically active instead of waiting in a sedentary setting for the school day to begin or end. Before- and after-school physical activity offerings might include a walking and biking to school program, physical activity clubs and intramural programs (e.g., programs that are voluntary, student-centered, and give equal opportunity for all students to participate), informal recreation or play on school grounds, physical activity in school based childcare programs, integrating physical activity in homework during out of school hours, and interscholastic sports."* (CDC, 2013, p. 14)

Does anyone at your school, including you, use the following technologies **During School** and/or **Before and After School** to facilitate or promote physical activity?	School Technology Use	Check the circle if YOU are the one who uses this technology
1. Computer (Desktop or laptop)	Yes / No / I don’t know	○
2. Tablet (e.g., iPad)	Yes / No / I don’t know	○
3. Smartphone	Yes / No / I don’t know	○
4. Bluetooth	Yes / No / I don’t know	○
5. Quick Response (QR) Code	Yes / No / I don’t know	○
6. Audio System (e.g., speaker, compact disc [CD], audio cassette, MP3 player)	Yes / No / I don’t know	○
7. Wireless Microphones	Yes / No / I don’t know	○
8. Interactive Touchscreen Display (e.g., Smartboard)	Yes / No / I don’t know	○
9. Microsoft Office (e.g., Word, PowerPoint, Excel)	Yes / No / I don’t know	○
10. Google Workspace (e.g., Docs, Sheets, Slides, Forms)	Yes / No / I don’t know	○
11. Online Video Clips (e.g., YouTube)	Yes / No / I don’t know	○
12. Learning Management System (LMS) Software/Apps. (e.g., Google Classroom, Team Shake, Teacher Kit)	Yes / No / I don’t know	○
13. Social Media (e.g., Facebook, Twitter, Instagram)	Yes / No / I don’t know	○
14. Cloud-Based File Sharing Tools/Apps. (e.g., Google Drive, Dropbox)	Yes / No / I don’t know	○
15. Digital Scheduling Tools/Apps. (e.g., Doodle, SignUp Genius)	Yes / No / I don’t know	○
16. Game-Based Learning Platforms (e.g., Kahoot!, Gimkit)	Yes / No / I don’t know	○
17. Sports Video Games (e.g., Nintendo Olympics)	Yes / No / I don’t know	○

18. Motion-Based Video Games (e.g., Wii Fit)	Yes / No / I don't know	○
19. Augmented Reality (AR) (e.g., Pokémon GO in AR)	Yes / No / I don't know	○
20. Virtual Reality (VR) (e.g., Beat Saver in VR)	Yes / No / I don't know	○
21. Wearable Technology (e.g., pedometer, accelerometer, Fitbit, heart rate monitor)	Yes / No / I don't know	○
22. Assistive Technology for Individuals with Disabilities (e.g., talking device, text to speech device, color identifier, screen reader software, paramobile device, video remote interpreting platforms)	Yes / No / I don't know	○
23. Stopwatch	Yes / No / I don't know	○
24. Digital Video Camcorder	Yes / No / I don't know	○
25. Video Conferencing Software/Apps. (e.g., Zoom, Google Hangouts)	Yes / No / I don't know	○
26. Online Video Recording/Creating/Sharing Platforms (e.g., YouTube, Vimeo, TeacherTube, Flipgrid)	Yes / No / I don't know	○
27. Infographic Development Tools/Apps. (e.g., Piktochart, Canva)	Yes / No / I don't know	○

SECTION III. Technology Use in Staff Involvement and Family and Community Engagement (23 technologies)

Staff Involvement: *"Support for school employee wellness and leadership training contribute to the overall culture of physical activity at a school. Teachers and other school staff members can integrate physical activity into classroom academic instruction and breaks, and support recess, intramurals, and other physical activity offerings. Additionally, school employees can be positive role models for students by demonstrating active lifestyle choices in and out of school."* (CDC, 2013, p. 15)

Family and Community Engagement: *"Family and community engagement in school-based physical activity programs provides numerous benefits. Parents, guardians, or other family members can support a CSPAP by participating in evening or weekend special events, or by serving as physical education or physical activity volunteers. Community involvement allows maximum use of school and community resources and creates a connection between school and community-based physical activity opportunities.* (CDC, 2013, p. 16)

Does anyone at your school, including you, use the following technologies to facilitate or promote physical activity under the components of **Staff Involvement** and/or **Family and Community Engagement**?	School Technology Use	Check the circle if YOU are the one who uses this technology
1. Computer (Desktop or laptop)	Yes / No / I don't know	○
2. Tablet (e.g., iPad)	Yes / No / I don't know	○
3. Smartphone	Yes / No / I don't know	○
4. Bluetooth	Yes / No / I don't know	○
5. Quick Response (QR) Code	Yes / No / I don't know	○
6. Email	Yes / No / I don't know	○
7. Text messaging	Yes / No / I don't know	○
8. Wireless Microphones	Yes / No / I don't know	○
9. Microsoft Office (e.g., Word, PowerPoint, Excel)	Yes / No / I don't know	○
10. Google Workspace (e.g., Docs, Sheets, Slides, Forms)	Yes / No / I don't know	○
11. Online Video Clips (e.g., YouTube)	Yes / No / I don't know	○
12. Learning Management System (LMS) Software/Apps. (e.g., Google Classroom, Team Shake, Teacher Kit)	Yes / No / I don't know	○
13. Social Media (e.g., Facebook, Twitter, Instagram)	Yes / No / I don't know	○
14. Cloud-Based File Sharing Tools/Apps. (e.g., Google Drive, Dropbox)	Yes / No / I don't know	○
15. Digital Scheduling Tools/Apps. (Doodle, SignUp Genius)	Yes / No / I don't know	○

16. Wearable Technology (e.g., pedometer, accelerometer, Fitbit, heart rate monitor)	Yes / No / I don't know	○
17. Assistive Technology for Individuals with Disabilities (e.g., talking device, text to speech device, color identifier, screen reader software, paramobile device, video remote interpreting platforms)	Yes / No / I don't know	○
18. Data Storage (e.g., flash memory, hard drive, removable memory card)	Yes / No / I don't know	○
19. Video Conferencing Software/Apps. (e.g., Zoom, Google Hangouts)	Yes / No / I don't know	○
20. Online Video Recording/Creating/Sharing Platforms (e.g., YouTube, Vimeo, TeacherTube, Flipgrid)	Yes / No / I don't know	○
21. Infographic Development Tools/Apps. (e.g., Piktochart, Canva)	Yes / No / I don't know	○
22. Podcast	Yes / No / I don't know	○
23. Webinar	Yes / No / I don't know	○

SECTION IV. Personal Characteristics (8 items)

1. What is your gender?
   (a) Female (b) Male (c) Transgender (d) Non-Binary (e) Other
   (f) Prefer not to specify

2. Are you of Hispanic or Latino origin?
   (a) Yes (b) No

3. What is your race?
   (a) American Indian or other Native American (b) Pacific Islander
   (c) Asian (d) Black/African American (e) White/Caucasian
   (f) Other: ________________________

4. What is your age?
   (a) 18-24 (b) 25-34 (c) 35-44 (d) 45-54 (e) 55-64 (f) 65 or older

5. What is the highest degree you have earned?
   (a) Less than high school (b) High school diploma/GED (c) 2-year associate degree
   (d) Bachelor's degree (e) Master's degree (f) Doctoral degree

6. What is your current position? (Select all that apply)
   (a) Physical education teacher (b) Classroom teacher (c) Health education teacher
   (d) Adapted physical education teacher (e) Wellness coordinator
   (f) School administrator (e.g., principal, assistant principal)
   (g) Other: ____________________________

7. Are you a certified/licensed physical education teacher?
   (a) Yes (b) No

8. Counting this year, how many years of experience do you have teaching or working in education over your entire career? _____ years.

SECTION V. School Characteristics (7 items)

1. Which state is your school located? (e.g., CO) _____(drop down options)_______

2. What is your school locale?
   (a) City (b) Suburb (c) Town (d) Rural (e) I don't know

3. What is your school type?
   (a) Public school (b) Private school (c) Charter school (d) Other: ________________

4. At which school level do you currently teach or work?
    (a) Elementary (PK-5) (b) Middle (6-8) (c) High (9-12) (d) Combined (PK-8) \
    (e) Combined (PK-12) (f) Other: _________________

5. Approximately how many students attend your school?
    (a) 1-300 (b) 301-600 (c) 601-900 (d) 901-1200 (e) 1200+ (f) I don't know

6. Approximately what percentage of your school's student population is low-income and qualifies for free or reduced lunch?
    (a) 0-24% (b) 25-49% (c) 50-74% (d) 75-100% (e) I don't know

7. On average, how much money in the school budget is available for you to purchase technology for your educational practice each year??
    (a) No budget (b) $1-1,000 (c) $1,001-2,000 (d) $2,001-3,000 (e) $3,000+

SECTION VI. Technology Experience (5 items)

1. Do you have any educational technology-related certificates (e.g., ISTE certified educator, Google certified educator, educational technology certificate from a university, Quality Matters [QM] certificate)? If yes, please specify the name of the certificate.
    (a) Yes ____________________ (b) No

2. Did you complete any educational technology related coursework in your teacher preparation program?
    (a) Yes (b) No (c) Not applicable

3. Approximately how many hours of professional development have you received related to educational technology over the past 3 years?
    (a) None (b) 1-10 hours (c) 11-20 hours (d) 21-30 hours (e) 30+ hours

4. Please rate your level of confidence in using technology in your own life (i.e., outside of your job at school).

    Low High
    1 2 3 4 5 6 7 8 9 10

5. Please rate your level of confidence in using technology in your teaching/educational practice.

    Low High
    1 2 3 4 5 6 7 8 9 10

APPENDIX E

PARTICIPANT RECRUITMENT EMAIL FOR INTERVIEW

Dear [participant name],

Thank you very much for taking the time to complete the survey. Your Responses to the survey have provided me with valuable information to answer the research questions of my ongoing doctoral dissertation.

I am sending this email because you responded that you are interested in participating in an interview on the online survey, and your survey result offered interesting information; therefore, I would like to hear more about your experience with technology use in your profession. If you want to share your experience with me, I will ask you to participate in **a 45-minute interview** via a video-conferencing application (e.g., Zoom).

I totally understand you are very busy and want to be as accommodating to your schedule as possible. Please let me know your available days and times **by [date]** if you want to participate in the interview. I have availability most of the time, such as early morning, day, night, and on weekends.

To show my appreciation for your participation in this study, I will provide you with a **$20 Amazon gift card**.

Again, I appreciate your completion of the survey. I am sure that your participation will contribute to the field of physical education teacher education (PETE) and public health in various ways.

If you have any questions, please do not hesitate to contact me at taemin.ha@unco.edu.

I am looking forward to learning more about your experience with technology use!

Thank you.

APPENDIX F

DIFFUSION OF INNOVATIONS QUESTIONNAIRE

Diffusion of Innovations Questionnaire

For the following items, please consider technology use ***for facilitating or promoting physical activity in a school setting*** and select your level of agreement with the following statements.

Attribute #1: Relative Advantages

Using technology enables me to accomplish tasks more quickly.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Using technology improves the quality of work I do.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Using technology makes it easier to do my job.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Using technology gives me greater control over my work.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Attribute #2: Compatibility

Using technology is compatible with all aspects of my work

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Using technology is completely compatible with my current situation.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

I think that using technology fits well with the way I like to work.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Using technology fits into my work style.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Attribute #3: Complexity

Technology is complicated to learn.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Technology is difficult to understand and use.

(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Technology is confusing.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Technology is convenient to use.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Attribute #4: Trialability

I've had a great deal of opportunity to try various technologies.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

I know where I can go to satisfactorily try out various technologies.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Before deciding whether to use any technology, I am able to properly try it out.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

I am permitted to use technology on a trial basis long enough to see what it can do.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Attribute #5: Observability

I am influenced by what I observe as the benefits of using technology.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

I observe others using technology and see the advantages of doing so.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

I have seen how others use technology before using them.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

Observing technology users before using technology myself is unnecessary.
(1) Strongly Disagree (2) Disagree (3) Neither agree nor disagree (4) Agree (5) Strongly Agree

If we have further questions regarding your experiences and perceptions of technology use, would you be willing to participate in a follow-up interview?

If so, please provide your email address: ________________________________

APPENDIX G

INFORMED CONSENT FOR INTERVIEW

UNIVERSITY OF NORTHERN COLORADO

CONSENT FORM FOR HUMAN PARTICIPANTS IN RESEARCH

Project Title: Technology Integration in School-Based Physical Activity
Researcher: Taemin Ha, M.A., taemin.ha@unco.edu
Research Advisor: Brian Dauenhauer, Ph.D., brian.dauenhauer@unco.edu

Good day,

My name is Taemin Ha, and I am a doctoral student in the School of Sport and Exercise at the University of Northern Colorado. I am currently working on my doctoral dissertation that aims to first examine the current practice of technology use in schools and the factors that influence the use of technology in school-based physical activity promotion.

You were invited to this interview because you responded that you are interested in interview participation in the online survey you previously completed. Your survey result offered interesting information, and I would like to hear more about your experience with technology use in your profession.

Your responses to the interview will remain confidential, and pseudonyms will be used in any future reports. The interview will take approximately 45 minutes to complete. The interview will be audio and video recorded, according to participants' preferences.

To show my appreciation for your participation in this study, I will provide you with a **$20 Amazon gift card** after completing the interview.

Risks to you are minimal. You may feel uncomfortable sharing the details of your experience with technology in a school setting. There is no direct benefit from taking part in this study.

Participation is voluntary. You may decide not to participate in this study and if you begin participation, you may still decide to stop and withdraw at any time. Your decision will be respected and will not result in loss of benefits to which you are otherwise entitled. Please take your time to read and thoroughly review this document and decide whether you would like to participate in this research study. If you decide to participate, your completion of the research procedures indicates your consent. Please keep or print this form for your records. If you have any concerns about your selection or treatment as a research participant, please contact Nicole Morse, Office of Research & Sponsored Programs, University of Northern Colorado, Greeley, CO; 970-351-1910 or nicole.morse@unco.edu.

Sincerely,

Taemin Ha, M.A.
School of Sport and Exercise Science
University of Northern Colorado

____
Participant Full Name (please print)

______________________________________ ____________________
Participant Signature Date

______________________________________ ____________________
Researcher Signature Date

APPENDIX H

INTERVIEW GUIDE

Study Two Interview Guide

Name:

Date:

Context: Participants already have completed the Diffusion of Innovations Questionnaire, and the questionnaire results have provided the researcher with information regarding their perceptions of technology use in school-based physical activity promotion by determining the five attributes of innovations defined by Rogers (2003). Participants were purposefully recruited if their questionnaire results showed their perception of technology use significantly POSITIVE or NEGATIVE; however, **the researcher will not know the perceptions based on the survey result prior to the interview**. In this interview, the researcher will aim to explore their perceptions of technology use.

Introduction: Thank you for agreeing to speak with us about your experience with technology in school-based physical activity. I will be asking you some questions about your technology experience both in your personal life and in school settings for physical activity promotion. I ask that you answer questions as honestly as possible. Your responses will remain confidential. If, at any time, you want to pass on a question, or have us turn off the recorders, just simply ask. Pseudonyms will be used in any future report of the discussion. Again, thank you for your participation.

1. Tell me a little bit about yourself.
    a. What is your current position?
    b. What experience do you have with physical activity? Physical education? Technology?

2. Tell me about your experience with technology in your personal life.

3. Tell me about your experience with technology in your professional life?
    a. Do you have formal training in any aspect of technology (e.g., Google Classroom, etc.)? If so, can you tell me about your training?

4. Tell me about your experience of being involved in school-based physical activity programs.
    a. Were you formally trained to lead school-based physical activity programs? If so, can you tell me about your training?
    b. Do you use technology to promote or facilitate school-based physical activity program(s)?
        i. If so, what? how? why? was the integration helpful?

Closing Statement: Thank you for your time. I assure you that your responses will be kept completely confidential. We will be in touch to ask for you to confirm the transcriptions from this interview.