Technology Integration in Physical Education

Examining the Physical Education Teachers' Domain

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Rolf Kretschmann

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1. Gutachter: Prof. Dr. Robert Prohl, Frankfurt
2. Gutachter: Prof. Dr. Josef Wiemeyer, Darmstadt

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This cumulative dissertation consists of the following publications:

Publication I

Kretschmann, R. (2010). Physical Education 2.0. In M. Ebner & M. Schiefner (Eds.), *Looking Toward the Future of Technology-Enhanced Education: Ubiquitous Learning and the Digital Native* (pp. 432-454). Hershey, PA: IGI Publishing.

Publication II

Kretschmann, R. (2015). Physical Education Teachers' Subjective Theories about Integrating Information and Communication Technology (ICT) into Physical Education. *The Turkish Online Journal of Educational Technology, 14*(1), 68-96.

Publication III

Kretschmann, R. (2015). Effect of Physical Education Teachers' Computer Literacy on Technology Use in Physical Education. *The Physical Educator, 72*(5) [Special Issue], 261-277.

Additional publications on this dissertation's extended subject area:

Bittner, R., & Kretschmann, R. (2011). Medienverhalten und physisches Selbstkonzept bei Kindern. In F. Borkenhagen, S. Hafner, R. Heim & P. Neumann (Eds.), *Kinder- und Jugendsport zwischen Gegenwarts- und Zukunftsorientierung* (p. 31). Hamburg: Czwalina.

Hebbel-Seeger, A., Kretschmann, R., & Vohle, F. [alphabetical order] (2011). Bildungstechnologien im Sport – Forschungsstand, Einsatzgebiete und Praxisbeispiele. In M. Ebner & S. Schön (Eds*.), L3T. Lehrbuch für Lernen und Lehren mit Technologien* (pp. 425-434). Norderstedt: Books on Demand.

Hebbel-Seeger, A., Kretschmann, R., & Vohle, F. [alphabetical order] (2013). Bildungstechnologien im Sport – Forschungsstand, Einsatzgebiete und Praxisbeispiele. In M. Ebner & S. Schön (Eds.), *L3T. Lehrbuch für Lernen und Lehren mit Technologien* (2nd ed.) (pp. 319-329). Norderstedt: Books on Demand

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Heller, L., Kretschmann, R., & Linten, M. (2013). Literatur und Information – Datenbanken, Fachliteratur, Literaturrecherche und -verwaltung. In M. Ebner & S. Schön (Eds.), *L3T. Lehrbuch für Lernen und Lehren mit Technologien* (2nd. ed) (pp. 185-200). Norderstedt: Books on Demand.

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Kretschmann, R. (2011a). Evaluation of an Informal Introduction to Departmental Student's Life via an E-Learning Environment Performed by the Departmental Student Commission of a Department of Sport Science – Initiating a Digital Learning Culture. *International Journal of Health, Physical Education and Computer Science in Sports, 4*(1), 8-11.

Kretschmann, R. (2011b). Exergames and Health Promotion – Nintendo Wii Sports: Physiological Measures vs. Perceived Opinions. In J.A.s. Sánchez Molina, O. Carballo Iglesias & M.A.n. González Valeiro (Eds.), *Los profesionales de la educación física en la promoción de un estilo de vida activo: Actas del Congreso de la Asociación Internacional de Escuelas Superiores de Educación Física (AIESEP), A Coruña, 2010*. Alcoy: Alto Rendimiento.

Kretschmann, R. (2011c). Medien und körperliche Aktivität bei Kindern und Jugendlichen – Ein Blick auf die empirische Befundlage. In F. Borkenhagen, S. Hafner, R. Heim & P. Neumann (Eds.), *Kinder- und Jugendsport zwischen Gegenwarts- und Zukunftsorientierung* (p. 54). Hamburg: Czwalina.

Kretschmann, R. (2011d). "My Teaching in Physical Education Is Successful Without Integration Any Technology." – Integrating Technology in Physical Education From Physical Education Teachers' View. In J.A.s. Sánchez Molina, O. Carballo Iglesias & M.A.n. González Valeiro (Eds.), *Los profesionales de la educación física en la promoción de un estilo de vida activo: Actas del Congreso de la Asociación Internacional de Escuelas Superiores de Educación Física (AIESEP), A Coruña, 2010*. Alcoy: Alto Rendimiento.

Kretschmann, R. (2012a). Digital Sport-Management Games and Their Contribution to Prospective Sport-Managers' Competence Development. *Advances in Physical Education, 2*(4), 179-186.

Kretschmann, R. (2012b). Genetic Engeneering im Sport - Ansätze eines moralisch-kontraktualistischen Zugangs. In S. Körner & S. Schardien (Eds.), *Höher - Schneller - Weiter. Gentechnologisches Enhancement im Spitzensport. Ethische, rechtliche und soziale Perspektivierungen* (pp. 259-272). Münster: Mentis.

Kretschmann, R. (2012c). Pädagogische Facetten im E-Sport - ein heuristischer Aufriss pädagogischer Relevanz und Bedeutsamkeit. In M. Breuer (Ed*.), E-Sport - Perspektiven aus Wissenschaft und Wirtschaft* (pp. 65-89). Glückstadt: Verlag Werner Hülsbusch.

Kretschmann, R. (2012d). Physical Activity Levels during the School Day of German Secondary School Students. In R. Meeusen, J. Duchateau, B. Roelands, M. Klass, B. De Geus, S. Baudry & E. Tsolakidis (Eds.), *17th annual Congress of the European College of Sport Science. Book of Abstracts* (p. 95). Bruges: European College of Sport Science.

Kretschmann, R. (2012). What do Physical Education Teachers Think about Integrating Technology in Physical Education? *European Journal of Social Sciences, 27*(3), 444-448.

Kretschmann, R. (2013). Bewegung und Lernen. Lernpotenziale im Spannungsfeld motorischen und kognitiven Lernens. In G.S. Freyermuth, L. Gotto & F. Wallenfels (Eds.), *Serious Games, Exergames, Exerlearning. Zur Transmedialisierung und Gamification des Wissenstransfers* (pp. 323-350). Bielefeld: transcript.

Kretschmann, R. (2014a). Moving Into the Future: How Physical Education Teachers Can Use the Internet to Keep Up. *The Global Journal of Health and Physical Education Pedagogy, 3*(4), 281-289.

Kretschmann, R. (2014b). Objective Measurement of Physical Activity Levels in Everyday Physical Education. *Research Quarterly for Exercise and Sport, 85*(Supplement 1), A-143.

Kretschmann, R. (2014c). Physical Activity Levels during the School Day - Findings from a German Sample. *Research in Kinesiology, 42*(2), 188-190.

Kretschmann, R. (accepted). Employing Tablet Technology for Video Feedback in Physical Education Swimming Class. *The Turkish Online Journal of Educational Technology, xx*(x), xx-xx.

Kretschmann, R., Dittus, I., Lutz, I., & Meier, C. (2010). Nintendo Wii Sports: Simple Gadget or Serious "Measure" for Health Promotion? - A Pilot Study According to Energy Expenditure, Movement Extent, and Student Perceptions. In J. Wiemeyer & S. Göbel (Eds.), *Serious Games for Sports and Health. Proceedings - Game Days 2010* (pp. 145-159). Darmstadt: Institut für Sportwissenschaft, Technische Universität Darmstadt.

Kretschmann, R., Dittus, I., Lutz, I., & Meier, C. (2012). Nintendo Wii Sports Boxing - A Pilot Study According to Energy Expenditure, Observed Motion, and Sport Science Students' Perceptions. *International Quarterly of Sport Science,* 1, 19-30.

The following table illustrates the conncection of the additional publications to this dissertation's extended subject area:

Additional Publications	**Connection to Dissertation's Extended Subject Area**
Bittner & Kretschmann (2011), Kretschmann (2011c)	Bittner & Kretschmann (2011) and Kretschmann (2011c) empirically explore media behavior and consumption in relation to the physical self-concept in youth.
Hebbel-Seeger, Kretschmann, & Vohle (2011), Hebbel-Seeger, Kretschmann, & Vohle (2013)	Hebbel-Seeger, Kretschmann, & Vohle (2011) give an overview of educational technology in the realms of physical education, higher education, and sports coaching from a research and practice perspective. The article is a chapter in an acclaimed textbook on educational technology. Hebbel-Seeger, Kretschmann, & Vohle (2013) present an updated revision of the original article. Publication I of this publication partially served as a blueprint for the chapters' physical education portion.
Heller, Kretschmann, & Linten (2011), Heller, Kretschmann, & Linten (2013)	Heller, Kretschmann, & Linten (2011) give an overview of strategies to find, retrieve, and manage literature in the field of educational technology. The article is a chapter in an acclaimed textbook on educational technology. Heller, Kretschmann, & Linten (2013) present an updated revision of the original article.
Kretschmann (2010a)	Kretschmann (2010a) gives an overview of possible areas of competence development in digital sports games, including examples that allow a transfer to physical education.
Kretschmann (2010b)	Kretschmann (2010b) presents possible future developments of physical education, referring to and describing technology-enhanced distance education scenarios.

Kretschmann (2011a)	Kretschmann (2011a) presents evaluation results of a strategy to implement the learning management system (LMS) *Moodle* for beginner kinesiology/sports science/physical education teacher education students.
Kretschmann (2011b), Kretschmann, Dittus, Lutz, & Meier (2010), Kretschmann, Dittus, Lutz, & Meier (2012)	Kretschmann (2011b) presented a study that investigated energy expenditure while playing the *Nintendo Wii Sports Bundle* and compared objective measuring results with subjective observational measures. Results and methodology may be transferred to physical education settings. Kretschmann, Dittus, Lutz, & Meier (2010) objectively measured energy expenditure while playing the *Nintendo Wii Sport Bundle* boxing game. Again, results and methodology may be transferred to physical education settings. Kretschmann, Dittus, Lutz, & Meier (2012) is the revised version of the original preliminary proceedings article from the year 2010.
Kretschmann (2011d)	Kretschmann (2011d) and Kretschmann (2012) present preliminary results on physical education teachers' views on integrating technology in physical education. The sample was actually part of a pre-study for Publication II and Publication III of this dissertation.
Kretschmann (2012a)	Kretschmann (2012a) investigates the potential of a digital sports management game for developing competencies that may transfer to real life sport management tasks. Digital game-based learning approaches may as well be applied to physical education.
Kretschmann (2012b)	Kretschmann (2012b) presents an ethical model based on contractualism to discuss genetic engineering in elite sports, and gives and exemplifies this philosophical approach and methodology with an analogy to e-sports (electronic sports).
Kretschmann (2012c)	Kretschmann (2012c) gives an overview of possible learning outcomes and pedagogical implications for the youth culture in e-sports. E-sports may very well be an option for technology integration in physical education, as is shown in a future pedagogical scenario in Publication I of this dissertation.
Kretschmann (2012d), Kretschmann (2014b), Kretschmann (2014c)	Kretschmann (2012d), Kretschmann (2014b), and Kretschmann (2014c) present results of a study that has used technology, namely the combined heart rate monitor and pedometer measuring device *Actiheart*, to conduct research in the school and physical education setting. This illustrated the author's desire to transcend research methods using technology that may also be applied to school teaching scenarios. The Actiheart device has also been used in Kretschmann (2011b), Kretschmann, Dittus, Lutz, & Meier (2010), and Kretschmann, Dittus, Lutz, & Meier (2012).
Kretschmann (2013)	Kretschmann (2013) gives an overview of the learning outcomes of exergames in regard to motor learning.

Kretschmann (2014a)	Kretschmann (2015a) shows strategies for physical education teachers for managing their own professional development by employing Internet technology. This article can be regarded as a partial update of Publication I of this dissertation.
Kretschmann (accepted)	Kretschmann (accepted) presents positive learning outcomes regarding motor skill acquisition when applying tablet technology for video feedback to physical education swimming class.

1 STATEMENT OF THE PROBLEM

Information and Communication Technology (ICT) has become omnipresent in our everyday lives (Horst, 2012). Since the beginning of the so-called "digital age" (Rosenberg, 2001), technology has found its way in diverse educational settings, e.g., higher education, vocational training, and schools.

Children and adolescents nowadays are "digital natives" (Prensky, 2001), surrounded and "naturally" socialized by ubiquitous technology, demanding more widespread technology integration in schools as well (Dündar & Akçayır, 2014).

Physical education, in the meantime, has evolved as school subject that willingly adapts to technology trends to foster student learning (Mohnsen, 2012b; Wang, Myers, & Yanes, 2010). Several efforts to nurture and facilitate technology integration in physical education indicate the growth in interest in this topic over the past years: multiple physical education teacher education (PETE) programs, textbooks, and journal papers have adopted technology issues as a regular topic in the realm of physical education research and practice. Even curriculums on the national level have reacted to the on-going development in instructional technology, and published position statements and standards (Department for Education and Skills, 2004a, 2004b; National Association for Sport and Physical Education, 2004; 2009).

However, physical education may not necessarily be connected with technology at first sight, from the conventional understanding as movement subject and/or from the common sense perspective (Kretschmann, 2010). Moreover, there may exist a huge gap between conceptual theory and daily practice. The existence of technology well suited for physical education and best-practice examples integrating technology in physical education does not necessarily lead to technology-enhanced physical education classes on a regular basis.

Some physical education teachers may very well be aware of the latest technology and publications, but might not bring technology-enhanced teaching scenarios to life due to missing resources, lacking ICT literacy, or even technology aversion, vice versa. Physical education teachers may therefore be

regarded as the main arranger and deliverer of teaching methods, and driving (or hindering) force of innovation in the classroom, in terms of technology (Kretschmann, 2015b).

Although there are plenty of conceptual papers and technology teaching tips available in common publication outputs, empirical evidence on technology integration in physical education is still a rare sight (Kretschmann, 2010, 2012). The desire to systematically investigate this topic and to create some of the missing empirical evidence has driven this doctoral thesis project ever since.

The purpose of researching technology integration in physical education with an emphasis on physical education teachers infused the research that has been conducted in the three articles for this cumulative dissertation. Eventually, a total of 23 additional publications emerged out of these articles' research projects that relate to technology and physical education in the narrow or broader sense.

This framework paper is structured as follows: Chapter 2 presents the state and trends of current research and practice; pedagogical scenarios are described and empirical evidence is introduced (2). Chapter 3 highlights the theoretical framework that underlies this dissertation (3). Chapter 4 addresses the physical education teachers' perspectives by showing empirical evidence regarding their views on technology integration in physical education and the influencing factors on these views (4). Chapter 5 gives an overview of influencing factors of technology integration in physical education, emphasizing computer literacy. Empirical data on the effect of computer literacy on technology integration in PE is analyzed, and possible implications for physical education teachers' professional development and PETE programs are outlined (5). A discussion and recommendations for further study and practice conclude this framework paper (6).

Despite targeting a German physical education teacher sample, this dissertation attends to the English-speaking research and practice community, thereby featuring English-written literature as often as possible. Only in rare cases (e.g., highlighting the national perspective), German-written literature is referred to.

2 TECHNOLOGY INTEGRATION IN PHYSICAL EDUCATION – STATE AND TRENDS OF CURRENT RESEARCH AND PRACTICE[1]

The characteristic that makes physical education unique among school subjects is human movement and the understanding of the subject as a vehicle of physical activity. Hence, the human body may be regarded as the main media in physical education class, which may lead to a perceived missing link between technology and physical education from the common sense perspective. Two strands of argumentation can be identified that may explain this missing link perception.

Firstly, media and ICT may appear as a threat to children and adolescents, taking away precious physical activity from leisure. Mass media describes youth even as being "fat, stupid, and lazy", caused by excessive media consumption (Appel, 2008; Bastian, 2011). Several surveys are seemingly backing up this discussion (Marshall, Biddle, Gorely, Cameron, & Murdey, 2004; Common Sense Media, 2008; Mössle, Kleimann, & Rehbein, 2007). Media and technology is therefore perceived as some sort of counter measure against healthy physical activity, which [the latter] should be in the center of physical education and be promoted by it. In this argumentation, physical education compensates for the lack of physical activity in their daily lives outside school, whereas technology is held as a somewhat foreign object, which is contrary to physical activity.

Secondly, physical education may lack in importance and reputation, compared to other "major" school subjects. As physical education has not been included in big international technology studies, focus of global research and policy makers may have shifted to major subjects, leaving out physical education in the following. For instance, the impactful international study *SITES* (Second Informational Technology in Education Study) (Law, Pelgrum, & Plomp, 2008) is only concerned with natural sciences, mathematics, and language acquisition.

[1] This chapter is based on Publication I of this dissertation: Kretschmann, R. (2010). Physical Education 2.0. In M. Ebner & M. Schiefner (Eds.), *Looking Toward the Future of Technology-Enhanced Education: Ubiquitous Learning and the Digital Native* (pp. 432-454). Hershey, PA: IGI Publishing.

On the other hand, there is strong evidence in the form of published literature, media presence and on portals on the Internet that physical education and technology are a fruitful and beneficiary coupling.

Up to date, to the author's knowledge, there is no systematical and comprehensive review of publications in the field of technology and physical education in English-written literature, other than Kretschmann's (2010) one. As his paper is published in 2010, some areas have to be updated, which is the task on hand in the following.

For instance, the amount of textbooks concerning technology and physical education as well as chapters addressing this topic within general physical education pedagogy textbooks has risen in the meantime (eg., Rink, 2013). However, in terms of quantitative publication output, Kretschmann's (ebd.) statement, the topic of technology integration in physical education is underrepresented in physical education pedagogy literature, can be renewed. Table 1 shows the textbook monographs available in the field of technology integration in physical education at the moment.

Table 1. Textbooks: Physical Education and Technology

Author(s), Year, and Title	**Subject Area**
Castelli & Fiorentino (2008): Physical Education Technology Playbook	Technology Applications for Physical Education Teachers
Felker (2006): Integrating Technology into Physical Education and Health	Overview of Available Technology Applicable to Physical Education
Leight (2012): Technology for Physical Education Teacher Education: Student Handbook of Technology Skills Instruction & Assessment	Technology Applications for PETE Students
Mitchell & McKethan (2003): Integrating Technology and Pedagogy in Physical Education Teacher Education	Technology Applications for PETE Classes
Mitchell, McKethan, & Mohnsen (2004): Integrating Technology and Physical Education	Technology Applications for Physical Education Classes
Mohnsen (2012b): Using Technology in Physical Education	Comprehensive Overview of Available Technology Applicable to Physical Education
Sanders & Witherspoon (2012): Contemporary Uses of Technology in K-12 Physical Education. Policy, Practice, and Advocacy	Edited Book on Various Aspects of Technology Integration in Physical Education

With reference to Kretschmann (2010), literature analysis on technology and physical education reveals three categories publications focus on: a) PETE, b) higher education in general, and c) physical education.

a) PETE: Papers on PETE and technology feature diverse topics such as perception, attitude, technology competence, and/or use of technology in physical education teachers (e.g., Ince, Goodway, Ward, & Lee, 2006; M. Yaman, 2007b), and also the students' view (e.g., M. Yaman, 2007a).

b) Higher education in general: Papers on higher education in general address PETE and/or kinesiology/sports science programs within the higher education apparatus. The scope of papers concerns technology-enhanced classrooms and distance education (Bennett & Green, 2001), national higher education curriculums (Tearle & Golder, 2008), advice and information (Castelli & Fiorentino, 2008; Schell, 2004), and/or didactical arrangements (Bredel, Fischer, & Thienes, 2005; Leight & Nichols, 2012).

c) Physical education: With regard to technology integration in physical education, diverse topics have been covered throughout the literature. A wide range of technology has been applied to physical education classes, such as pedometers and heart rate monitors (e.g., Ladda, Keating, Adams, & Toscano, 2004), PDAs (Personal Digital Assistants) (DerVanik, 2005), and several software programs such as *Dartfish*, which is a software program for video analysis (Harris, 2009). Furthermore, online applications such as web quests (Woods, Shimon, Goc Karp, & Jensen, 2004) and portfolios (Hastie & Sinelnikov, 2007) as well as online physical education (Daum & Buschner, 2012) have been reported, respectively. In the meantime, portable devices such as laptops, projectors, and tablets have conquered the forefront of technology scenarios in physical education (Cummiskey, 2011; Dober, 2004, 2006; Robinson, 2012). A strong strand of integrating exergaming into the physical education classroom can also be identified (Barron & Chorney, 2014; Meckbach, Gibbs, Almqvist, Öhman, & Quennerstedt, 2013; Staiano & Calvert, 2011; Sun, 2013).

2.1 Pedagogical Scenarios

Kretschmann (2010) scanned through the various articles that described pedagogical scenarios for technology integration in physical education. He could posit four pedagogical scenarios that stand for a typical and most beneficiary use of technology integration in physical education classes in regard to student learning: a) homework and theory, b) informational Input, c) learning stations, and d) feedback. Again, as this categorization was published in the year 2010, some updates have to be made according to the rise of mobile devices, apps, and Internet applications. Meanwhile, physical activity tracking devices have become prominent in physical education (Nichols, Davis, McCord, Schmidt, & Slezak, 2009; Pangrazi, 2004). Hence, a new scenario that addresses these devices is added: e) physical activity tracking.

a) Homework and theory: Electronic textbooks, webpages and Internet portals, multimedia DVDs, podcasts, and/or smartphone/tablet apps may be distributed to the students in order to provide theoretical input to particular topics, either during class, or for preparation or post-processing as homework assignment. The Internet offers a wide realm of resources for information on physical activity related topics (Kretschmann, 2014; Mohnsen & Roblyer, 2013). In addition, online physical education resources and programs may offer best practice learning materials (Mohnsen, 2012a) and learning management systems (LMS). Exergaming consoles and pedometers, as well as activity tracking apps may serve as devices and software for physical activity induced homework, too (Cummiskey, 2012).

b) Informational input: Theoretical input can be distributed via any sort of screen big enough for the respective class size. Hardware such as portable or permanently installed projectors, portable or permanently installed (flat screen) TVs, laptop or desktop computer screens, tablet screens, or even smart phone screens for small groups may be used for informational input. Using wireless Internet if available, web content and videos can also be fetched “live” for informational input purposes.

c) Learning stations: The well known concept of learning stations in physical education (e.g., Schmoll, 2007) can easily be enhanced with technology by

planting technology infused tasks at one or multiple stations (Dober, 2006; Juniu, 2011). The emergence of mobile technology, namely smart phones and tablets, which are much cheaper than laptops and usually come with a larger battery life, makes technology integration much easier in terms of availability of resources, as students may bring their own devices themselves (Raths, 2012).

d) Feedback: Feedback to students regarding motor skill acquisition or sports game behavior can be delivered instantly, right after the respective motor action, using video delay software. Freeware software such as *VLC Player* and *Kinovea* provide this feature free of cost without the need to buy expensive professional software that a regular school most likely cannot afford. Post-processed and –edited video can also be distributed online via LMS or online video portals, even putting students into the role of the editor. In the meantime, multiple apps have been developed to master these feedback scenarios (e.g., *BaM Video Delay, Coach's Eye, Hudl*) (Kretschmann, 2015a; Robinson, 2012).

Using a digital camera, which may also be part of a tablet or integrated in a laptop chassis, the respective screen in use may also serve as a digital mirror that provides a live feed in real time of the student's movements. Especially in physical education teaching areas, mirrors for immediate self-feedback may be rare, so this extension of the original scenario (Kretschmann, 2010) adds an additional dimension to technology-enhanced feedback in physical education.

e) Physical activity assessment: The idea of this pedagogical scenario is that students wear mobile devices for physical activity assessment such as pedometers or heart rate monitors in-class while actively participating in physical education. From a health promotion perspective, monitoring students' physical activity levels during physical education class may deliver objective data on factual exertion for the student and for the teacher (Mears, 2012). The physical education teacher and also the students themselves therefore can control their physical and motor efforts. Cumulated student physical activity data may as well give an insight into the overall physical activity behavior outside physical education and school. As physical activity measurement devices have drastically dropped in prices, they are very well a realistic application for daily physical education classes.

2.2 Discussion of the Evidence

Looking for empirical evidence in regard to the afore-mentioned pedagogical scenarios, the original statement of little available empirical evidence by Kretschmann (2010; 2012) can be reinstated as well.

However, an up-to-date literature search revealed several studies that feature empirical methodology. The retrieved studies can be summarized into the following categories: a) digital video feedback, b) physical activity measurement devices, c) computer software, d) Internet assets, and e) exergaming.

a) Digital video feedback: Although video feedback may be considered a method for motor skill acquisition of utmost efficiency (Kretschmann, 2015a; Lees, 2002; Leon, 2006), it is kind of surprising that only four empirical studies could be found on digital video feedback, particularly using an authentic physical education setting (Table 2). All studies on digital video feedback in physical education reported positive results.

Table 2. Digital Video Feedback: Evidence

Study (Author, Date and Topic)	**Outcome Variable**	**Findings**
Brooker & Daley-James (2013): Gymnastics	Planning, performing, and evaluating tasks	The findings showed that ICT improved the plan, perform and evaluate stages, within gymnastics, and consequently, the children's technique improved.
Boyce, Markos, Jenkins, & Loftus (1996): Basketball (Overhead-Pass); Tennis (Forehand strike)	Skill acquisition	Performance scores of the video feedback group improved more than the scores of the teacher and peer feedback groups.
Casey & Jones (2011): Fundamental Movement Skills (Throwing and Catching)	Fundamental movement skills (throwing and catching)	The results highlighted the effectiveness of video technology in enhancing engagement and subsequently suggest that such a degree of commitment helped students to develop understanding beyond technical replication and towards rational and reasoned student investigations around their learning. Additionally, it helped students to feel less marginalized and enabled them to be more engaged in their learning.
Palao, Hastie, Cruz, & Ortega (2013): Track and Field (Hurdles)	Skill, knowledge (written test), teacher perception, quality and quantity of practice	The 'video and teacher feedback' condition provided the most positive overall results, with statistically significant improvements in skill execution, technique, and knowledge learning, as well as the highest level of practice. Nonetheless, while acknowledging the utility of video feedback as an instructional tool, the teacher felt overwhelmed by the demands of the technology on both his time commitments and in terms of his own technology.

b) Physical activity measurement devices: In sum, four studies could be found that investigated the use of either heart rate monitors or pedometers in physical education (Table 3). The studies tackled a variety of topics, nonetheless, leaving a mildly positive view of favoring the implementation of physical activity measurement devices in physical education.

Table 3. Physical Activity Measurement Devices: Evidence

Study (Author and Device)	Outcome Variable	Findings
Partridge, McClary, King, & Bian (2011): Heart Rate Monitors	Perceptions	Three major themes emerged from the data and indicated that 1) the use of heart rate monitors to determine physical education class grades, 2) students' perceptions of fitness levels, and 3) the consistency with which physical education instructors used heart rate monitors all impacted students' perceptions of heart rate monitor use in physical education classes.
Martin, McCaughtry, Kulinna, Cothran, & Faust (2009): Heart Rate Monitors	Pedometer and computer efficacy and anxiety	Both mentors and protégés significantly increased their computer efficacy compared with the control group. Finally, a significant interaction effect was also found for pedometer efficacy, again indicating that both groups significantly increased their efficacy compared with control teachers.
McCaughtry, Oliver, Dillon, & Martin (2008): Pedometers	Perspectives	At the beginning, the teachers predicted they would encounter few implementation challenges that they would not be able to overcome, but, after prolonged use, they voiced several limitations to implementing pedometers in physical education. They anticipated that pedometers would motivate primarily higher skilled students, but found that lesser skilled students connected with them more. They moved from thinking they could use pedometers to teach almost any content to explaining four areas of content that pedometers are best suited to assist in teaching. They shifted from seeing pedometers as potential accountability tools for student learning and their teaching to identifying key limitations to using pedometers for assessment.
Grissom, Ward, Martin, & Leenders (2005): Heart Rate Monitors	Technology/teacher effect (on physical activity)	There was no difference in activity counts between the two conditions. Boys had higher means than girls. The variance between more and less active boys was greater than the variance among the girls.

c) Computer software: Four studies could be found that involved specific software for physical education (Table 4). All, except for one, reported positive results.

Table 4. Computer Software: Evidence

Study (Author and Topic)	Outcome Variable	Findings
Everhart, Harhsaw, Everhart, Kernodle, & Stubblefield (2002): Nutritional and Physical Activity Guidance	Fitness, physical activity engagement	The intervention did not affect physical activity or nutritional patterns of students significantly.
Siskos, Antoniou, Papaioannou, & Laparidis (2005): Interactive Multimedia CD-ROM (Health Related Fitness)	Achievement (content knowledge)	The results of an analysis of covariance indicated that there was a significant increase in achievement post-test for the experimental groups when compared to the control groups.
Skinsley & Brodie (1990): Badminton Software	Knowledge (Badminton)	Positive outcomes, though no significant difference between groups.
Wilkinson, Pennington, & Padfield (2000): Interactive Guide to Volleyball (Skills)	Experiences	The students responded rather favorably to the CD. They offered 93 positive comments in response to the first question. Only 26 negative comments were made, and 27 percent of the students didn't mention anything negative about using the CD. 82 percent said that they would like to use other CDs in physical education classes.

d) Internet assets: In sum, six studies could be retrieved that included the distinctive uses of Internet applications in physical education (Table 5). Overall, the studies' findings display a positive trend toward technology adaption by students and physical education teachers. However, online physical education seems to be in danger of not reaching the minimum standards in regard to physical education time (Daum & Buschner, 2012). Furthermore, physical education teachers in the study by Cothran, McCaughtry, and Faust (2009) lacked chat performance quality probably due to the teachers' concerns regarding the computer-mediated communication channel.

Table 5. Internet Assets: Evidence

Study (Author and Asset)	Findings
Cothran et al. (2009): E-Mentoring (via Chat)	In general, teacher postings were minimal in frequency and quality. The limited use of the chat rooms was likely linked to the teachers' perceptions of electronic mentoring, which included several concerns with the technical and human dimensions of the process.
Daum & Buschner (2012): Online Physical Education	Three-fourths of the online physical education teachers focused on a fitness curriculum with emphasis on the cognitive domain. Likewise, it was found that almost three-fourths of the online physical education courses did not meet the national guidelines for secondary schools, of 225 min of physical education per week. Most of the courses required physical activity three days per week while six courses required no physical activity. Teachers expressed support, hesitation, and even opposition toward online physical education.

Hastie, Casey, & Tarter (2010): Wiki (Task of Creating a New Game in a Same Genre as Football, Hockey, Netball or Rugby)	24/7 classroom enabled by the ICT, together with an extended community of practice, resulted in a higher quality learning experience in physical education for the participants. Indeed, it was the belief of all concerned that the quality of the end game products would not have been possible without the ICT component.
Maheridou, Antoniou, Kourtessis, & Avgerinos (2011): Blogs (Blog Course for Physical Education Teachers)	Participants' responses in the perceived learning questions supported the benefits of using asynchronous web 2.0 tools in distance education programs. Their perception of learning using blogs appears to be positively increased regarding the regulation of the applied cooperative procedure.
Penney, Jones, Newhouse, & Cambell (2012): Digital Assessment	Students have perceived the assessment task to be authentic and meaningful for the *Physical Education Studies* course and have liked the way in which 'practical' and 'theoretical' aspects are combined in the task. Teachers have identified the task as aligning well with the pedagogic intent of the course and as providing a valid means of assessment of students' skills, knowledge and understandings relating to the aspects of course content that it was designed to address. Evaluation of the task implementation has utilized a feasibility framework, addressing technical, pedagogic, manageability, and functional feasibility.
Thornburg & Hill (2004): Web-Based Nutrition and Physical Activity Content and Assessment Tool	Students not only enjoyed working with computer technology but also preferred this interactive instructional method to a lecture method of instruction. The use of technology within the physical education program seemed to motivate students to engage with the material presented. After completing the web-based activities, students also seemed to be aware of their eating and physical activity habits and the changes that they needed to make in their lifestyles. They also expressed positive attitudes toward the use of technology in their physical education class.

e) Exergaming: A total of 13 studies could be retrieved that featured exergaming in physical education (Table 6). The results show overwhelmingly positive effects of exergaming on physical education students on several domains, almost deeming it a must-have in regular physical education classes.

Table 6. Exergaming: Evidence

Study (Author and Console)	**Outcome Variable**	**Findings**
Fogel, Miltenberger, Graves, & Koehler (2010): Multiple Platforms	Students' physical activity and opportunities to engage in physical activity, students' and physical education teacher's social validity	Exergaming produced substantially more minutes of physical activity and more minutes of opportunity to engage in physical activity than did the standard physical education program. Exergaming was socially acceptable.

Gao, Hannon, Newton, & Huang (2011): DDR (Dance Dance Revolution)	Students' situational motivation, Students' physical activity levels	Students spent significantly higher percentages of time in moderate to vigorous physical activity (MVPA) in fitness and football classes than they did in DDR class. Students reported higher intrinsic motivation (IM) and identified regulation (IR) toward fitness than DDR. Students displayed significantly lower amotivation (AM) toward fitness than football and DDR. IM was the only positive predictor for time in MVPA, whereas AM was the negative predictor.
Gao, Huang, Liu, & Xiong (2012): DDR	Self-efficacy, outcome expectancy, perceived social support, daily physical activity levels	The MANOVA (multivariate analysis of variance) with difference scores yielded a significant main effect for intervention. Follow-up tests indicated that the intervention children reported significantly greater increased self-efficacy, social support, and daily physical activity levels than the comparison children over time.
Gao, Zhang, & Stodden (2013): DDR	Physical activity levels, questionnaire	Children spent more MVPA time in aerobic dance than DDR. Children reported significantly higher self-efficacy and enjoyment in DDR than in aerobic dance.
Hansen & Sanders (2010): Multiple Platforms	Students' experiences	Analysis of data reveals a major theme of students' "Persistence to Game" when participating in active gaming during physical education. Seven subthemes associated with the major theme were identified. Both Play theory and Flow theory were used to explain the major theme and seven subthemes that emerged.
Lwin & Malik (2012): Nintendo Wii	Attitude, subjective norm, perceived behavioral control, intention, exercise behavior	Exergaming significantly influenced physical activity attitude, subjective norm, intention, and strenuous exercise behavior. Participants in the Wii-incorporated physical education lesson were more likely to emerge with more positive beliefs and behaviors. Age significantly influenced outcome variables, with the effect of exergaming more pronounced among children than pre-adolescents in attitude, moderate and mild exercise behaviors.
Meckbach et al. (2013): Multiple Platforms	Perceptions, use of exergames in teaching, potential obstacles and reasons for using exergames in teaching	80 percent are familiar with exergames, 17 percent are recreational exergamers, and a few (3%) have tried using exergames in physical education and health. The reasons for introducing exergames are generally as follows: encouraging physical activity, offering different types of movement, and having fun. The barriers to introducing exergames are mainly: financial, prioritizing other activities, and the teachers' own knowledge. The majority of the Physical education teachers are generally positive to introducing exergames as a teaching aid into their subject.
Perlman, Forrest, & Pearson (2012): Nintendo Wii	Potential learning outcomes for physical education students	Findings indicated that exergames provide opportunities to develop and work on the cognitive understanding of sport and games.

Sheehan & Katz (2012): Nintendo Wii	Balance (postural stability)	Students in improved their postural stability significantly compared to a control group (regular physical education class). The improvements in postural stability were also evident in a parallel intervention of children receiving more traditional training in agility, balance and coordination (gymnastics and dance). Gender did not have an effect on the changes in postural stability for either group; however, postural stability in the girls was better than the boys in all tests.
Sheehan & Katz (2013): Nintendo Wii	Balance (postural stability)	Exergaming students improved their postural stability significantly compared to those in the typical physical education class. Improvements in postural stability were also evident in the ABC class. Postural stability in the girls was better than the boys in all pre- and post-intervention tests.
Shayne, Fogel, Miltenberger, & Koehler (2012): Multiple platforms	Physical activity and opportunities to engage in physical activity	Exergaming produced substantially higher percentages of physical activity and opportunity to engage in physical activity. In evaluation of the exergaming equipment showed that exergaming stations were associated with differential levels of physical activity across participants.
Sun (2012): Multiple Platforms	In-class physical activity levels, motivation (perceived situational interest)	Students' situational interest in exergaming was significantly higher than in the fitness unit at the beginning and end of instruction. Children's interest declined significantly in both units and at the same rate.
Sun (2013): Multiple Platforms	In-class physical activity levels	Students' situational interest dropped dramatically over two semesters, but their physical activity intensity increased over time.

In conclusion, empirical evidence on technology integration in physical education is still limited. However, available studies reported vastly positive findings, favorably of a mutual linking of technology and physical education.

A major trend can be identified in the topic of exergaming in physical education, as well in research and in practice (Ennis, 2013). This may be partially explained by the growing interest of public health scientists and health economists in countermeasures against obesity and a sedentary lifestyle by employing new ubiquitous technology for this cause (Thompson, 2014).

Nevertheless, research and publication output on technology in physical education does not mirror the conceptual and practice paper output, as the trend in "theoretical" and practical publications clearly focuses on Internet technology (e.g., wikis, podcast, LMS, social networks), and mobile devices (smartphones and tablets) and associated apps.

3 THEORETICAL FRAMEWORK

In order to connect the three publications of this dissertation and to highlight their significance in regard to scientific contribution, this chapter shell give a brief and concise description of the theoretical framework that transcends this dissertation.

Interestingly, when revisiting the empirical evidence assessed in Chapter 2, only few studies employed an established theoretical framework in a broader sense. Although there are references to common (psychological) constructs such as attitudes (e.g., Lwin & Malik, 2012) or motivation (e.g., Sun, 2012), the bigger picture of a typical chain of how stand-alone technology assets may find its way to the actual classroom is not addressed theory-wise. This also accounts for conceptual and practical papers as well.

The underlying theoretical framework of this dissertation attempts to establish a comprehensive and cohesive understanding of how technology integration in the school classroom is shaped by confounding and benefiting factors and entities.

The framework consists of three building blocks: the a) significance of technology in everyday life and school, b) organizational development and agents of school development and change, and c) determinants of technology integration in schools and in the classroom – emphasizing the teacher as an agent of change. The to-be-posited theoretical framework may be applied to technology integration in schools in general, regardless of subject-area.

a) Significance of technology in everyday life and school: Technology has become omnipresent in our everyday lives (e.g., Vannini, 2009). Worksite as well as leisure is saturated by all kinds of ubiquitous technology. The so-called 21st century skills, that are supposedly needed to earn a living in modern societies, contain a mixed bag of competencies like media literacy, information retrieval competence or ICT competencies (e.g., Dede, 2010). The technology-savvy world requires its inhabitants to be tech-savvy, too. Hence, children and adolescents' technology skills have to be fostered by parents, teachers, educators, and policy makers to make sure that they become party of the technology-savvy society.

Schools may be assumed to be the primary institution for that purpose, as students spend the majority of their daytime in school and parents may not be tech-savvy enough to develop their children's technology competence (e.g., Law et al, 2008). Moreover, schools are mandated to carry out the task of educating students technology-wise as well (Anderson, 2008). Schools may also take advantage of implementing technology in classrooms that students are already used to from leisure (Gu, Zhu, & Guo. 2013).

Admittedly, the so-called digital natives (Prensky, 2001), that form today's youth, may not all be on a high proficiency level in regard to technology literacy, which may indeed suspend the latter argument of using known and already mastered technology from leisure in school classrooms (Kennedy, Judd, Dalgarno, & Waycott, 2013). However, the fact that students may have diverse technology literacy levels strengthens the need of school education in this area of learning and development.

b) Organizational development and agents of school development and change: School as an organizational entity has to adapt to contemporary developments in and requirements of society, politics, and students. Multiple organizational and school development theories and models have been posited to help schools to ease the process of adaption and change (e.g., Dalin, 2005). The common ground of these models is the agents that are supposed to administer any change, regardless whether the cause of change is school-driven or teacher-driven, or may be enforced by politics, policy makers, districts, or the curriculum. These agents are clearly predominantly the ones that spend most of their time face-to-face with the student learners, namely the teachers. Teachers may be regarded as the primary facilitator of true technology implementation in the classroom, as they decide the which, when and how in terms of using teaching methods and technology (Billig, Sherry, & Havelock, 2005; Dede, Honan, & Peters, 2005). Therefore, the teacher is of utmost importance in terms of a sensible technology integration and technology integration at all.

c) Determinants of technology integration in schools and in the classroom – emphasizing the teacher as an agent of change: There are multiple factors that influence teachers' technology integration (Afshari, Abu Bakar, Luan, Abu Samah,

& Say Fooi, 2009; Buabeng-Andoh, 2012). As teachers are a focus group that is hard to investigate in terms of recruitment, emphasis shell be put on the factors that may serve as an easier target regarding school development and organizational change in the short-term. Therefore external factors such as resources and institutional characteristics do not appear to be a feasible ad-hoc primary research target. In addition, it stands to reason that teachers' beliefs and own technology literacy may significantly influence the actual technology integration in their respective classroom (e.g., Afshari et al., 2009).

Admittedly, the other factors that have not been emphasized in this chapter do also account for determining technology integration in school classrooms. However, from the perspective of teachers as primary organizational change agents, teachers' technology beliefs and skills clearly appear to be addressed easier than areas such as technical support or budget issues, for instance. In line with this, multiple professional development interventions have been proven to positively change teachers' beliefs and skills regarding technology use and competence (e.g., Ertmer, 2005; Glazer, Hannafin, & Song, 2005).

Technology integration may also be regarded as an ongoing process that starts over once it is fulfilled, especially when taking professional development efforts into account (Kretschmann, 2014). On the one hand, teachers may further develop their current technology skills in terms of technology use in the classroom. On the other hand, contemporary technology development may also create a need for specific professional development that may directly alter teachers' technology beliefs and skills in the process.

The chain of argumentation in this theoretical framework illustrates the importance of teachers in the process of technology implementation in classrooms, as well as the possible change management and intervention targets in the process, namely teachers' technology beliefs and skills employing professional development.

Figure 1 illustrates the theoretical framework that has been posited in this chapter.

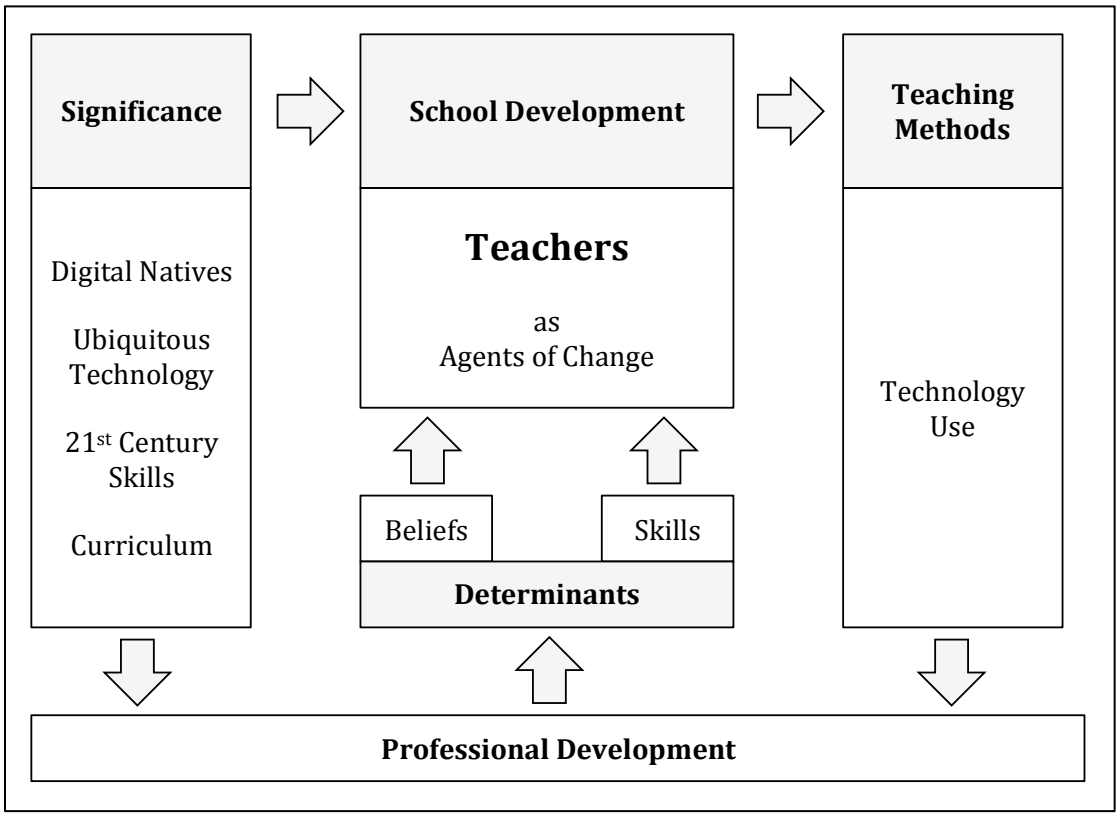

Figure 1. Theoretical Framework: The Process of Technology Integration in the Classroom - with an Emphasis on the Teachers

4 TECHNOLOGY INTEGRATION IN PHYSICAL EDUCATION FROM THE PERSPECTIVE OF PHYSICAL EDUCATION TEACHERS[2]

Several parties are involved and intertwined when it comes to systematically address the construct of teaching and learning in the school environment, as the science and practice of teaching and leaning is indeed a complex process (e.g., Hays, 2006). First of all, students are the main recipients of teaching efforts. Parents, students' and parents' peers, administrators, politicians, policy makers, and last but not least, the teachers themselves, are among factors that have to be considered as well.

Since the meta-study by Hattie (2009) has become viral in academic discussion and debate, the research and academic discussion trend towards teacher-orientation. In brief, as the evidence clearly suggests, the teacher is the main factor or successful student learning, the utmost relevance of the teacher's position is evident. The same accounts for physical education teachers, evidently as well (Dudley, Okely, Pearson, & Cotton, 2011).

Although there is plenty of research available that covers the physical education teachers' perspective (Hodges Kulinna, Scrabis-Fletcher, Kodish, Phillips, & Silverman, 2009; Kirk, Macdonald, & O'Sullivan, 2006), the technology topic is not a prominent one amongst the diverse research topics.

Empirical findings available in the field of technology mostly focus on pre-service physical education teachers and PETE students (e.g., Adamakis & Zounhia, 2013; Zorba, 2012). Only few studies focus on in-service physical education teachers (e.g., Gibbone, Rukavina, & Silverman, 2010; Ince et al., 2006). The majority of these studies emphasize physical education teachers' ICT-related skills and competences (e.g. Liang, Walls, Hicks, Clayton, & Yang, 2006; C. Yaman, 2008).

In regard to the theoretical framework of this dissertation (Chapter 3), *attitudes*, *perceptions*, *opinions*, and *subjective theories* may be subsumed under *views*, representing a specific form of beliefs.

[2] This chapter is based on Publication II of this dissertation: Kretschmann, R. (2015). Physical Education Teachers' Subjective Theories about Integrating Information and Communication Technology (ICT) into Physical Education. *The Turkish Online Journal of Educational Technology, 14*(1), 68-96.

4.1 Physical Education Teachers' Views toward Technology Integration in Physical Education

Over the last years, researching the teachers' perspective, especially teachers' beliefs has become one of the most important concepts in contemporary research efforts on teaching and teacher education (Tsangaridou, 2006).

Teachers' views are widely considered to be a crucial piece in understanding good teaching that is delivered by good teachers (Rovegno, 2003). Teachers' beliefs may serve as filters through which own learning and professional development emerges and should be treated as major determinants of their teaching practice and behavior (Borko & Putnam, 1996).

The same accounts as well for technology use as teaching method in educational settings, as teachers' attitudes towards technology determine their technology integration (Albirini, 2006; Baylor & Ritchie, 2002). The use and adoption of technology in the classroom is therefore largely influenced by teachers' attitudes toward technology (Teo, 2008).

Research studies on physical education teachers' views toward technology and technology integration in physical education reported mixed results regarding positive or negative attitudes toward technology (Kretschmann, 2015b). On the one hand, some samples provide positive views on technology in physical education teachers (e.g., Gibbone et al., 2010). On the other hand, some samples reported negative views on technology in physical education teachers (Kretschmann, 2012). In addition, some studies also presented mixed positive and negative views depending on topic or item (e.g., Ince et al., 2006). The current evidence does not show a clear picture. Therefore, it can be stated that physical education teachers have to be treated as a group that contains technology-aversive and technology-affirmative individuals to the same degree, although depending on particular sample.

In sum, literature search resulted in the retrieval of 13 empirical studies that examined physical education teachers' views on technology in general and technology integration in physical education (Table 7).

Table 7. Physical Education Teachers' Views on Technology Integration: Evidence

Study	Emphasis	Findings
Gibbone et al. (2010)	Technology use, attitudes toward technology use	Results suggest that teachers had positive attitudes, yet a limited use of technology. Teachers reported a number of barriers influencing technology use including budget, class size, and training. All attitude factors correlated with technology use. Physical educators may be willing to apply technology for teaching if given opportunities to prepare, practice and utilize appropriate resources.
Grigore, Stanescu, Bota, Mitrache, & Popescu (2007)	Technology use	The majority of the physical education teachers do not use ICT in physical education frequently.
Ince et al. (2006)	Technology competency, integration of technology competency, attitude (affinity) to technology	The technology intervention produced significant gains in total technology competency, integration of technology competency, and affinity to technology from pre- to post-intervention. There was a trend to a significant group by time interaction for total technology competency.
Koçak (2003)	Computer attitudes, computer competencies	The results of this study indicated that physical education teachers had positive attitudes toward computers.
Kretschmann (2012)	Attitudes toward technology integration in physical education	The majority of the Physical education teachers showed negative attitudes towards integrating technology in physical education.
Kretschmann (2015b)	Subjective theories toward technology integration	The results trend to negative views of physical education teachers toward technology integration. However, gender, computer literacy, household computer ownership, and professional experience (years in service) influence physical education teachers' views to different degrees.
Kul (2013)	Technology usage level, gender, age, marital status, work place, occupational level, educational level, occupational rank	There is no significant difference in technology usage of physical education and sport teachers in the educational activities based on age, gender, occupational rank, educational degree or marital status; but a statistically significant difference was found between work place and occupational levels. Physical education teachers state that they (44.5% - 268 teachers) "mostly" use class infrastructure other than chalk and blackboard; that they (40% -241 teachers) "mostly" choose their own computer software applied in the classroom; and that they (45.7% - 275 teachers) "mostly" try to prefer educational technologies, which motivate students. There is a statistically significant difference among the physical education and sport teachers' technology usage level in the educational activities based on their educational degree.

LaMaster (1998)	Attitudes toward computer technologies, self-efficacy for computer technologies, use of computers	Examination of their responses indicates that these teachers support the use of computer technologies in their day-to-day work. The results indicated that the teachers were fairly comfortable using word-processing programs but were less confident concerning their skills in e-mail and CD-ROM databases. Word processing seemed to account for a majority of these teachers' use of computers. The teachers' second most common use for the computer was to send and receive e-mail messages. However, more than 50 percent of the teachers said they never used the computer for e-mail, searching the Internet, or recording grades.
Perrotta (2013)	Perceptions of technology-related benefits	Physical education teachers have the highest prevalence of positive responses to the item, "Students are more attentive when using digital technology" (compared to all other school subjects). Teachers of specific subjects (e.g., physical education and special education) reported increased motivation and attention. Physical education teachers show highest scores for "digital technology gives students access to a wider range of learning content and resources".
Thomas & Stratton (2006)	Attitudes toward ICT in physical education, training, numbers of pieces of equipment and hardware owned, and its employment	The majority of physical education teachers felt that ICT was a valuable teaching tool. Parity of training and ownership of equipment were not standard across the range of schools or regions. The data suggest a growing trend in ICT use in physical education across England.
Woods, Goc Karp, Miao, & Perlman (2008)	Perceived technology competency, how and why they utilize technology, challenges they face in implementing technology, and where they learned to use technology	Results indicated a high level of perceived competency with many forms of technology but differences based on gender, teaching level, and years of experience. Low competency levels were shown for website creation, PDAs, heart rate monitors, and body composition analyzers. The teachers reported that student learning can be enhanced with technology because it aids the visual learner, facilitates individual development, and is useful for assessment purposes.
M. Yaman (2007b)	Computer ownership, MS office, computer laboratories, presence of computers at schools, computer use of relatives	Teachers who have personal computers at home are more competent in using office and multimedia programs when compared to the others. There is no relation between presence of computers at school and competence in computer skills. It is also found out that the teachers whose families are familiar with computers use 'Edit, Insert, View, Format and Window' menus of "Word"; 'Edit, View, Tools' menus of "Excel"; 'View, Tools and Table' menus of "Multimedia" programs more efficiently than the rest. Teachers who benefit from computer laboratories at their schools can use 'Insert and View' menus of "Power Point" more efficiently than the rest.

C. Yaman (2008)	Gender, age/years in service, educational background, in-service training, media assets, teaching approaches	It is found that physical education teachers' level of using educational technologies differs according to their gender and years in service. Female physical education teachers use educational technologies more than male teachers. Teachers who worked for 0-5 years were the group that used educational technologies most and those who worked for 21 years and more were the group that used them least.

4.2 Influencing Factors of Physical Education Teachers' Views toward Technology Integration in Physical Education

Several factors may influence teachers' views, beliefs, and attitudes toward technology integration into the classroom. For instance, the key study *Apple Classrooms of Tomorrow (ACOT)* (Dwyer, Ringstaff, & Sandholtz, 1991; Sandholtz, Ringstaff, & Dwyer, 1997) showed that there is a crucial relation between teachers' epistemological beliefs, pedagogical beliefs, and the technology use in the classroom. Availability of technology equipment and constant external expert support proved beneficial for teachers' positive perspective toward technology in the classroom.

Teachers' pedagogical beliefs, including their views on technology integration in classrooms, are formed based on previous beliefs and experience, which are basically bad or good experiences, perceptions, and prejudices regarding technology (Ertmer, 2005; Kagan, 1992). Teachers' beliefs can change through various experiences, observations, and also via arguments and reason (Cuban, Kirkpatrick, & Peck, 2001; Nespor, 1987; Windschitl & Sahl, 2002).

To the author's knowledge, to date, there are only two studies available, which provide empirical findings on influencing factors of physical education teachers' views on technology integration in physical education: Ince et al. (2006) and Kretschmann (2015b).

Ince et al. (2006) could show that a professional development program targeting technology competencies could impact physical education teachers views on technology: physical education teachers' technology aversion could be decreased and their technology affirmation could be increased by the professional development intervention.

Kretschmann (2015b) reported that a) computer literacy, b) household computer ownership, c) professional experience, as well as d) gender had an effect on physical education teachers' subjective theories toward technology integration in physical education. As each subjective theory may stand for an own research complex, it is not surprising that mixed results need a thorough addressing in detail. However, trends may be identified and will be exemplarily featured in the following.

a) Computer literacy: Results in detail were mixed, depending on the respective subjective theory. However, data analysis suggests a positive relation between physical education teachers' computer literacy proficiency and their computer literacy-related theories. A higher level of computer literacy therefore usually goes with a stronger agreement for computer literacy-related theories (e.g., "I use ICT frequently to prove my ICT skills").

b) Household computer ownership: Results in detail were mixed too, but only impact very few subjective theories. In regard to the fact that all physical education teachers of the study possessed at least one computer, computer ownership and accessibility can be treated as obligatory.

c) Professional experience (measured in years in service): Again, results in detail were mixed. Results of descriptive and few inferential-statistical data analyses suggest that physical education teachers showing fewer years in service tend to have more positive agreements for technology integration (e.g., "I would absolutely integrate ICT into my PE lessons, if it would be available").

d) Gender: Gender differences only showed in personal- or interpersonal-related subjective theories (e.g., "Not actively participating students can be mentors and advisors at PCs"). Teaching-related, equipment-related, and classroom management and organization-related subjective theories were not impacted by gender.

Conclusively, there is a mutual relation between physical education teachers' views on technology integration, their actual technology use and adoption, and general factors according to individual factors (socialization and personal

variables) and organizational structure (school and supportive environment) (Buabeng-Andoh, 2012).

5 INFLUENCING FACTORS OF TECHNOLOGY INTEGRATION IN PHYSICAL EDUCATION TEACHERS[3]

In general, multiple factors account for teachers' technology use in the classroom (Mumtaz, 2006). Afshari et al. (2009) distinguished between manipulative and non-manipulative factors. Non-manipulative factors are factors that cannot be manipulated by the school and lie within the individual teacher's realm. Manipulative factors are factors that can be directly influenced by external entities. Non-manipulated factors are a) teachers' characteristics (age, gender, and experience), and b) parent and community support. Manipulative factors are a) availability of vision and plan about the contribution of ICT in education, b) level of and accessibility to the ICT infrastructure, c) availability of time, to experiment, reflect and interact, d) availability support to computer-using teacher in the workplace, e) school culture, f) computer attributes, g) level and quality of training for teachers and school principals, h) attitude towards computer, i) computer competence, j) effective training program, and k) models for integrating technology into teacher training program.

In a more recent review, Buabeng-Andoh (2012) summarized the influencing factors of teachers' technology use in two concise main categories: personal characteristics and institutional characteristics. Personal characteristics contain, a) teachers' attitudes, b) ICT competence, c) gender, d) teaching experience, and d) teacher workload. Institutional characteristics consist of a) professional development, b) accessibility, c) technical support, and d) leadership support. A third independent category, namely technical characteristics, refers to technological innovations and development, and its appealing incentive.

The diverse factors appear to be intertwined when addressed in practice. In conclusion, teachers' attitudes and ICT literacy tend to have the strongest effect on technology integration in the classroom (Helena, 2006).

[3] This chapter is based on Publication III of this dissertation: Kretschmann, R. (2015). Effect of Physical Education Teachers' Computer Literacy on Technology Use in Physical Education. *The Physical Educator, 72*(5) [Special Issue], 261-277.

5.1 Influence of Computer Literacy on Technology Integration in Physical Education Teachers

The effect of teachers' computer and ICT literacy on technology use in the classroom has been covered in multiple studies and reviews, and has been identified as major factor for technology integration in the classroom (Afshari et al., 2009; Kreijns, Vermeulen, Kirschner, van Buuren, & Van Acker, 2013).

However, for physical education teachers, the evidence is very limited. Nevertheless, lower ICT skills have been identified as barrier for technology integration in physical education class (Tearle & Golder, 2008). Moreover, physical education teaching facilities may not serve a beneficial teaching and learning environment for the inclusion of technology, as power outlets and available technological equipment may be limited (Kretschmann, 2010; accepted).

Although some studies report physical education teachers' computer literacy independently (Thomas & Stratton, 2006; Woods et al., 2008), only Kretschmann (2015a), to the author's knowledge, examined the direct effect of computer literacy on technology use in physical education class so far.

Kretschmann (ebd.) surveyed physical education teachers' computer literacy, and instructional technology and media use in physical education. The majority of the physical education teachers seldom used technology in physical education classes. Physical education teachers' computer literacy had a statistically significant effect on their technology use in physical education class for ICT such as laptops, Internet, and digital cameras. Physical education teachers who showed higher levels of computer literacy were more likely to use technology in the classroom. However, the sample tended to consist of physical education teachers that do not use technology often. No statistical relation was found for the link of physical education teachers' computer literacy and the use of traditional media (e.g., printed images, chalkboard) in the classroom.

5.2 Professional Development and Physical Education Teacher Education Programs

ICT and computer literacy, and professional development programs have been identified as major factors influencing teachers' technology implementation in their respective classes (Afshari et al., 2009; Buabeng-Andoh, 2012).

Professional development programs that contain particular individual training for ICT and computer literacy blend two major factors in a single event, thereby multiplying potential effort. The same accounts for higher education study programs, as teacher education students are exposed to regular and pre-requisite study program classes on a mandatory regular basis.

Hence, for the subject of physical education and physical education teachers, professional development programs and interventions, and PETE programs appear as a sensible and promising target for directly influencing physical education teachers' technology integration in the classroom (via teachers' technology beliefs and skills).

On the one hand, professional development programs and PETE programs may themselves enhance their teaching methods with technology (e.g., LMS, distance learning applications, technology-enhanced assignments) (Ince et al., 2006; Leight & Nichols, 2012; Semiz & Ince, 2012).

The results of a professional development program targeting technology use by Ince et al. (2006) suggest that technology affirmation and ICT competence can be significantly boosted by well-constructed professional development program content and respective tasks.

For physical education teachers who are tech-savvy enough to employ a decent degree of Internet technology and information retrieval literacy, Kretschmann (2014) gives an overview of resources that are available on the World Wide Web free of cost. Additionally, he lists possible distance education options and e-learning materials that can be assessed simply through the Internet from any location in the world. The latest information on a) research findings, b) technology integration and developments, c) equipment, d) lesson plans and ideas, e) continuing education opportunities (e.g., online study programs,

webinars), and f) personal experience sharing (e.g., forums) can usually and easily be retrieved on the Internet, when knowing where and how to search for. The content of this given overview may also be eligible for inclusion in traditional face-to-face and virtual professional development programs featuring the technology topic.

For PETE programs, introducing ICT and systematically educating PETE students in the use of technology in physical education class may also lead to wider adaption of technology in general once they become in-service teachers. Technology covering and technology-enhanced PETE classes enable students to ask questions and interact with the respective instructor, and may ultimately lead to a transfer and adaption of teaching styles and methods, including technology-infused pedagogical scenarios, experienced in the higher education setting to the physical education school setting (Baert, 2012; Baert & Stewart, 2014).

The results from Wang et al. (2010) support the idea of a positive change in attitude toward ICT, ICT literacy growth, and a potential transfer to actual teaching in physical education in PETE students. The PETE students that were exposed to a technology-enhanced teaching scenario improved in technology-affirmation values, what eventually makes them more likely to keep technology in mind and to actually apply it in their prospective teaching careers.

Higher education teaching and learning environments may also not suffer from budget issues and lack of equipment, and may serve students who might as well already be labeled digital natives themselves (Kinash, Wood, & Knight, 2013).

Even more recently, Wyant, Jones, and Bulger (2015) implemented a single course strategy into a PETE program to realize the idea of a proper up-to-date education, in regard to technology, of pre-service teachers. Evaluation results showed that PETE students improved in technological and technological pedagogical knowledge. Their results further support the hypothesis that PETE courses may actually initiate a shift to technology-enhanced teaching in PETE classes, which may also transfer to technology integration in physical education as well.

6 DISCUSSION AND RECOMMENDATIONS FOR FURTHER STUDY AND PRACTICE

6.1 Possible Directions of Future Research

Literature analysis on technology integration in physical education revealed a decent body of publications, as well from the qualitative as from the qualitative standpoint. Although the majority of the articles consist of conceptual and practical articles, there is empirical evidence available, despite being limited in scope and quantity (Chapter 2).

However, after extracting pedagogical scenarios of typical and best-practice technology-enhanced physical education, only limited evidence can be employed to evaluate effectiveness or related evidence of these scenarios.

Future pedagogical scenarios are dependent of technology development and school- and educational system-related developments and may consist of technology, methods, and settings that we cannot image or deem ridiculous and science fiction nowadays (Kretschmann, 2010; Mohnsen, 2012b). For instance, the first *iPad* was released back in the year 2010 and the *World Wide Web* was "born" in the year 1999 (Gillies & Cailliau, 2000). The *Nintendo Wii* console was released in the year 2006, and today exergaming has conquered physical education and school classrooms as well as associated research. From the perspective of a physical education teacher, becoming tech-savvy and being ready for new developments may be the best preparation for what is yet to come (Mears, 2009).

Physical education research is still in need of more research findings from the field. Technology applications in physical education seem to be "out there", however, as it appears, not in sight and reach of capable researchers.

Since there is some evidence on physical education teachers' views on technology integration in physical education (Kretschmann, 2015b), there are still open questions to be answered. For instance, there is no evidence available on the possible difference of physical education teachers' views on technology integration in regard to different school levels (e.g., elementary school. secondary school). Most importantly, future research should focus on

intervention studies that target a positive change of technology-related views, beliefs, and attitudes in physical education teachers, eventually expanding to PETE students and longitudinal studies that transcend pre- and in-service physical education teachers.

Suitable research frameworks for the proposed attitude change studies may be found in the *Learning Theory of Attitude Change*, the *Elaboration Likelihood Theory of Attitude Change*, or the *Theory of Attitude Change*, as these theories have been prominent in social psychology research regarding attitude change (Smith & Mackie, 2007).

Concerning influencing factors on physical education teachers' technology use in physical education, there is almost no empirical evidence available (Kretschmann, 2015a). Future research needs to expand its efforts on creating more evidence on the multiple involved factors (e.g., personal characteristics such as gender or personal experience, and institutional factors such as administrational support or school culture).

The connection of physical education teachers' technology-related views, technology use in the classroom, and the diverse influencing factors is also unclear and needs further in-depth investigation using quantitative research methodology.

In terms of research methods, Humphries, Hebert, Daigle, & Martin (2012) have developed a questionnaire that assesses physical education teaching efficacy. The physical education teaching efficacy scale (PETES) contains a subscale that explicitly features efficacy for using technology. The items appear reasonable and up-to-date for contemporary pedagogical scenarios in physical education (e.g., "If my principal wants to see me use technology such as computer programs or audiovisual equipment in PE, I can do it").

Instruments assessing *Technological Pedagogical Content Knowledge* (TPACK) have also been proven to provide a valid research instrument and to create more empirical evidence in this field (Semiz & Ince, 2012). Therefore, the TPACK and PETES research instruments may be used in future studies, and are capable of creating a reliable data basis for multiple research questions and purposes.

Future research may also focus on technology-themed professional development intervention, as this concept has been proven successful in positively changing physical educators' technology competence and technology-related attitudes (Ince et al., 2006). Possibly focus might be put on enabling physical education teachers to take care of their own professional development employing technological resources such as the Internet themselves (Kretschmann, 2014). Internet resources and portals have popped up and grown ever since, providing valuable content for physical education teachers (e.g., www.thepegeek.com).

The implementation of technology in PETE programs still lacks in being widespread and systematical (Ayers & Housner, 2008; Baert & Stewart, 2014). Although literature provides conceptual proposals and plans to integrate technology into PETE programs (e.g., Leight & Nichols, 2012), empirical evidence is a rare sight. For instance, the studies by Baert and Stewart (2014), Wang et al., (2010), and Wyant et al. (2015) reported promising results that suggest further systematical research on the effect of technology-infused PETE programs. An instrument like the PETES might be the perfect fit for measuring such outcomes.

From the German national perspective, looking at the German national current state and developments regarding technology integration in physical education, the publication output is very limited compared to the international English-written publications available. Especially empirical studies are almost non-existent. However, the number of practical papers has been growing (e.g., Hebbel-Seeger, Krieger, & Vohle, 2014; Thienes, Fischer, & Bredel, 2005), a state-level program for pushing technology and physical education has been implemented and evaluated (Wiemeyer & Hansen, 2010), and a few physical education pedagogy or sport coaching textbooks have integrated a chapter on technology (Bösing, Bauer, Lau, & Remmert, 2014; Danisch & Friedrich, 2007; Hebbel-Seeger, Kretschmann, & Vohle [alphabetical order], 2013). The topic is still a developmental field in Germany, as the most urgent task, to the author's opinion, is to start receiving international English-written publications and material, as it is a fact that there is nearly no English-written publication cited in the reference sections of the respective German-written publications on technology and physical education.

Conclusively summing up the discussion, the developmental areas in the field of technology and physical education that have been posited by Kretschmann (2010, 2012) can still be reinstated, but receive an update or terminological adaption in some cases: a) curriculum development, b) media database, c) documentation, d) empirical research, e) physical education environment, f) dissemination, g) implementation strategies, g) professional development and PETE.

a) Curriculum development: For the United States and the United Kingdom, national curriculums have been updated to match technology issues in physical education (Department for Education and Skills, 2004a; National Association for Sport and Physical Education, 2004; 2009. For Germany, to the author's knowledge, there has been no explicit feature of technology in physical education curriculums on the national as well as on the state level. For non-English-speaking countries, a translated publication on the respective national curriculum and its technology covering would be essential in comparing, developing and discussing physical education curriculums and their technology portions globally.

b) Media database: An (international) database with commentaries to, and reviews of media products and offers that also provides evaluated usage documentary is still missing. Some web portals have established apps reviews for physical education in the meantime (e.g., www.pecentral.org/apps/). A comprehensive database that features all platforms and software would benefit physical education teachers, and would provide them pre-selection and guidance in available media products.

c) Documentation (of technology use): Multiple and various technology assets have been described throughout the literature in the meantime. However, lesson plans with in-depth descriptions for technology use in pedagogical scenarios are rare but still highly recommended (Mitchell et al., 2004).

d) Empirical research: To make it short, research on technology in physical education needs a boost to create more empirical findings. Collaborations among (international) researchers may also contribute positively.

e) Physical education environment: The relationship between technology and physical education environments such as gymnasiums, swimming pools, or track and field stadiums, still seems to be held as an alienated relationship. Architects, and facility and sport managers should address this issue and plan physical education and sports facilities accordingly.

f) Dissemination: Projects and media products, as well as best-practice reports have to be made public using scientific publications, mass media, and/or social networks (Polsgrove, Frimming, & Bower, 2012). A good example may be the *PE Central Facebook* group (www.facebook.com/groups/pecentral). It is a pity that elaborated media products such as multiple instructional software products such as the ones by *Bonnie's Fitware* (http://shop.pesoftware.com)[4] do not find their way into research projects and publications.

g) Implementation strategies: Strategies and concepts for the implementation process of technology into physical education are still in need to be developed on a systematical basis. Although there is some limited material available for technology implementation on the PETE level (e.g., Wyant et al., 2015), concepts on the school physical education level are still rudimentary (e.g., Ladda et al., 2004). Organizational change theories, for instance, may serve as a scaffold for this process (Lunenburg, 2010).

h) Professional development and PETE: As already stated above, professional development programs as well as PETE programs need further development concerning technology integration.

The empirical evidence, the literature analysis, and the argumentation and discussion pieces of this dissertation have contributed to partially fill the gap in these developmental areas. Future research and practice shell continue to build on empirical foundations for the topic of technology integration in physical education.

[4] I hereby declare that there is no conflict of interest concerning the company *Bonnie's Fitware.* I am not commercially associated with this company or any other company or brand mentioned in this framework paper or any part of this dissertation.

6.2 Critical Perspectives on Technology Integration in Physical Education

So far, this dissertation has been addressing and discussing technology integration in physical education from an affirmative and favorable perspective. Nonetheless, arguments and constraints against technology integration in physical education have to be at least considered to give the full picture of the subject area.

To the authors' knowledge, almost all available literature in technology in physical education proclaims an affirmative approach. In fact, despite critical discussion in mass media and among faculty, there is very little scientific literature to be found that addresses technology integration from a critical perspective (e.g., Bulfin, Johnson, & Bigum, 2015). However, several concerns against technology integration in physical education can be stated: a) Physical activity levels and physical activity time, b) sedentary lifestyle, c) empirical evidence, d) unfiltered experience and alienation, and e) preparation time and budget.

a) Physical activity levels and physical activity time: Integrating technology into physical education may lead to a decline in physical activity levels as well as physical activity time. When technology is used in a way that students stop being physically active, this might very well happen. Students may get distracted by devices and their functionalities or may have to do too many theoretical tasks that do not include physical activity.

b) Sedentary lifestyle: Technology may serve as a vehicle towards a sedentary lifestyle, as it is regarded as the opposite to physical activity and a physically active lifestyle (Kretschmann, 2010). This concern appears to be mainly focusing on sedentary video and computer games. As it is true that some technology can't be used while exercising, some can. For instance, physical activity monitors or GPS sensors only work properly when moving. Moreover, exergaming as a form of video gaming does explicitly and obviously provide physical activity and exercise (National Association for Sport and Physical Education, 2009).

c) Empirical evidence: Research does not provide a clear answer according to effectiveness of technology integration in regard to learning outcomes. In fact, as

this dissertation has shown, in the field of physical education, there is only little evidence available. However, the majority of research studies show positive outcomes so far, especially when implementing exergames. Admittedly, general educational subject-unspecific research shows mixed results in terms of learning outcomes, efficiency, and technology integration in the classroom (e.g., Hattie, 2009; Hew & Brush, 2007).

d) Unfiltered experience and alienation: Technology may prevent students from experiencing the world and physical activity first-hand and may also alienate them from reality. This concern is based on the fear that students may actually prefer "virtual" experience over "real" experience, which appears to be an argument driven by computer games, particularly online role playing games, as children and adolescents may indeed become kind of addicted to the virtual world (e.g., Wan & Chiou, 2006).

e) Preparation time and budget: Using technology in physical education is too time-consuming and there is no budget to do so. For the first part, especially in physical education, there is more time to prepare than for other classroom-located subject. As students need to change or may also be responsible for warming up via co-teaching, there is enough time for the teacher to set up technology equipment. Furthermore, there may also be physically passive students that can assist. However, as in any teaching scenario, when something goes wrong (e.g., power blackout), teachers have to have a Plan B.

For the second part, budgetary shortages are common in any educational system. Nevertheless, Bring-Your-Own-Device (BYOD) approaches have recently been prominent in academic and practice debate (Raths, 2012). Students as well as teachers may bring their own devices to class to enhance teaching and learning with technology. However, BYOD contains liability and insurance issues, as damaged private devices appear to remain in legal limbo. Especially in periods with flying objects, devices may be in serious danger of damage. Physical education teachers have to be aware of this and adapt by securing devices in danger and fostering awareness among the students.

Two additional concerns shell be mentioned that usually come up when discussing the topic with parents and technology-aversive faculty. The first one

is that teachers may not possess adequate technology literacy proficiency to implement technology. This argument is easily rejected referring to professional development, and to fellow tech-savvy colleagues and students who may assist when needed.

The second one expresses concern in regard to the lacking technology skills of the students. Students may lack technology skills to actually help in classes. Although research supports this concern partially (e.g., Bennett & Maton, 2010), a lack in student skill should not prevent teaching and learning efforts in a particular learning field, in this case technology literacy. Physical education teachers may employ their own information retrieval competence and may also seek out for external help via professional development (Kretschmann, 2014).

Admittedly, technology integration understood as simply integrating any technology in the classroom will most likely not lead to a better teaching and learning experience. The same accounts for throwing in a Basketball, for instance, as the Basketball itself will not provide a sure path to mastering the sport or quality teaching it. Having a computer in the gymnasium or having every student equipped with a tablet does not automatically result in positive learning outcomes. The actual way of using technology, the how, is what matters and what creates the so-called “didactical surplus” (Kretschmann, 2010).

Since quality physical education is supposed to involve technology in a sensible way “that will get the students moving” (United Nations Educational, Scientific and Cultural Organization, 2015), this does not mean that technology has to be implemented in each physical education period. There is plenty of evidence for serious learning outcomes in physical education without applying technology assets regularly (e.g., Bailey, 2006). Technology in physical education should not be used for the mere sake of technology use, “but rather [as] a tool or device to supplement instruction” (National Association for Sport and Physical Education, 2009).

However, there might be cases when a certain less effective technology asset may be used in favor of traditional teaching. This might be the case when students’ motivation is expected to raise by a somewhat innovative or especially engaging technology-enhanced teaching arrangement (e.g., exergaming) (e.g.,

Gao et al., 2011). Implementing new technology, new equipment, or new approaches in general may very well be used as motivational vehicle to engage students in physical education, despite being less effective in terms of learning outcomes.

Concluding the discussion about critical perspectives on technology use in physical education, the guidelines for an appropriate use of technology in physical education by the National Association for Sport and Physical Education (2009) provide physical education teachers a feasible framework to consider when applying technology to their classes:

> Guideline 1: The use of instructional technology in physical education is designed to provide a tool for increasing instructional effectiveness.
>
> Guideline 2: The use of technology in physical education is designed to supplement, not to substitute for, effective instruction.
>
> Guideline 3: The use of instructional technology in physical education should provide opportunities for all students, versus opportunities for few.
>
> Guideline 4: The use of instructional technology in physical education can prove to be an effective tool for maintaining student data related to standards-based curriculum objectives.

6.3 What does this Dissertation add?[5]

First of all, to the best of the author's knowledge, to date, this dissertation features the first comprehensive literature review in the field of technology integration and physical education (Chapter 2). This accounts for both empirical studies as well as conceptual and practice publications.

In addition, this dissertation contains a systematical display of pedagogical scenarios in regard to technology integration in physical education, which is derived from literature. Furthermore, an innovative outlook into possible future pedagogical scenarios is given that may alter traditional perspectives on future physical education developments (Publication I).

[5] This subchapter's title alludes to the very last paragraph of articles in the respected journal *Research Quarterly for Exercise and Sport* ("What does this article add?"). That paragraph has recently been added as a mandatory section for articles in order to highlight progression and advancement of scientific knowledge.

The most significant contribution of this dissertation is the addition of empirical evidence in the field of technology integration and physical education, particularly tackling the physical education teachers' perspective. The results add to the little empirical evidence that is available so far.

Referring to the posited scientific framework (Chapter 3), this dissertation provides empirical evidence for two major determinants of technology integration of physical education teachers: teachers' technology beliefs and skills (Publication II and Publication III).

Publication II gives insights in physical education teachers' beliefs (in form of subjective theories). The most striking results of Publication II are that a) computer literacy actually had an statistically significant impact on several subjective theories in physical education teachers, that b) physical education teachers' professional experience (years in service) did not statistically significantly effect their subjective theories on technology integration, which is contrary to previous studies' results, and c) household computer ownership significantly impacted computer literacy-related subjective theories in physical education teachers, which was expected.

Publication III presents results on the actual effect of physical education teachers' technology skills (in form of computer literacy) on technology integration in physical education.

The most striking result is that physical education teachers' computer literacy actually had an effect on the use of instructional media on a statistically significant level. Physical education teachers showing higher values of computer literacy significantly tended to use technology more often.

Despite providing expected results, the created empirical evidence may serve as an argumentation piece for technology-friendly research, practice, and policy-making efforts, also highlighting the important contribution of professional development in the process of technology integration in physical education.

From a global-scientific perspective, Publications II and Publication III are the first publications by a German author in the respective journals.

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PUBLICATIONS

PUBLICATION I

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Chapter 24
Physical Education 2.0

Rolf Kretschmann
University of Stuttgart, Germany

ABSTRACT

Thinking of subjects at school and integrating digital media and technology, one might not think of looking at physical education first. But the pedagogical potentials of digital media integrated in physical education can easily be outlined. Therefore, the concept of Physical Education 2.0 is developed that posits a framework for designing pedagogical scenarios after informing about the old-fashioned Physical Education 1.0, technical devices, software and internet offers, and categorizing pedagogical scenarios by literature review. The imagination of future pedagogical scenarios leads to a deeper awareness of possible physical education developments. Moreover, implementation premises for Physical Education 2.0 in different areas are displayed. Furthermore, future research directions in this special research field with almost tabula rasa character are given. Shortly, the aim of the paper is to give an introduction and overview of the wide scope of digital media within physical education.

INTRODUCTION

Scanning through subjects at school, while searching for fruitful and sensible application and implementation of digital media, one might not turn to look at physical education at first pick. Physical education is usually understood as a school subject that contains exercise content and takes place in the gymnasium, instructed by a former athlete or trainer from the field of sports, the so called physical education teacher. Students have to improve their fitness skills and learn various techniques of certain sports. The learning process is connected with sweat in the truest sense of the word. Due to this common connotation associated with human movement and physical activity, and actually doing sports and exercise, the notion of a pedagogical benefit of digital media (or media at all) comes not into mind at first sight. Hence, the human body is seen as main media in physical education. Media

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and informational technologies are not connected with physical education in the common sense. Two strands of argumentation can be identified to be the reason of the missing interlinking.

Media and informational technologies appear as a threat to children and adolescents in mass media. "Fat, stupid and lazy" kids were proclaimed as the most probable product of media consumption. Several surveys back up this discussion in the mass media (e.g. Common Sense Media, 2008; Marshall, Biddle, Gorely, Cameron, & Murdey, 2004; Mössle, Kleimann, & Rehbein, 2007, 2009). Therefore, media and technology in general are not connected to a healthy life style and a huge amount of physical activity either. Physical education seems to serve as an opposite construct against media consumption, wherein students can compensate their lack of physical activity of their daily life (Morgan, Beighle, & Pangrazi, 2007). Though media is seen to somehow block the intention of bringing students back to physical activity, physical education should focus on exercise and movement itself, being the subject in school predestined for this intention. In this argument, media within physical education is held as a foreign object, which is contrary to the physical activity tasks and attitude. This is the first reason.

The second reason lies in the perceived importance of physical education in comparison to other school subjects. Physical education is not a major subject (Lai & Wong, 2006). Throughout the big international comparative studies concerning educational outcomes, physical education is not considered. Neither the well known and famous PISA (Program for International Student Assessment) (Organisation for Economic Co-Operation and Development: OECD, 2006a, 2006b) nor PIRLS (Progress in International Reading Literacy Study) (Mullis, Martin, Kennedy, & Foy, 2007) and TIMSS (Trends in Mathematics and Science Study) (Mullis, Martin, Gonzales, & Chrostowski, 2004a; Mullis et al., 2004b) put physical education into focus. Similar to art or music, physical education belongs to the minor subjects at school (Lai & Wong, 2006). In addition, media studies in the field of school research have not taken any interest in physical education at all. For instance, the international study SITES (Second Informational Technology in Education Study) (Law, Pelgrum, & Plomp, 2008) is more concerned with school subjects from the domain of natural sciences, mathematics, and language acquisition. Due to the missing presence in the research field of ICT (Information and Communication Technology), and therefore not being subject of research in important international studies, physical education consequently lacks of importance and reputation, when it comes to terms of media use and implementation.

Nonetheless, physical education immanently offers a lot of possibilities for the use of digital media, just as well as other school subjects do. Physical education has the task to develop 21st century skills like media and computer literacy (Buckingham, 2003; Mohnsen, 1999), as each school subject intends. Though integrating technology into schools is important for the development of those skills, technology has to be integrated into physical education as well (Mitchell, McKethan, & Mohnsen, 2004). Thus, the great question arises, how technology can be embedded into physical education. The forthcoming answer may hopefully produce a notion of a sensible pedagogical connection between the two worlds of sports and technology usage within school.

For the revealing of the pedagogical potentials of the use of digital media in physical education, the first step is to describe old-fashioned and obsolete physical education, which may be called Physical Education 1.0. The second step is to enlighten the concept of Physical Education 2.0 by giving a brief overview of useful technical devices, software and internet offers, which can easily be embedded in pedagogically sensible scenarios by the physical educator. Therefore, exemplary and categorical examples of these pedagogical scenarios are posited, including a framework for a didactical

design for generating further implementations of digital media in physical education. The third step is to imagine future pedagogical scenarios through describing hypothetical physical education development. The fourth and last step is to depict implementation areas, wherein the terms and conditions of a straightened usage of digital media can be boosted, including gymnasium development, curriculum development, and teacher education development. Finally, future prospects are given, that try to anticipate further (research) development of physical education integrating digital media, stating the wide scope for development within this specific subject.

Hence, the aim of the paper is to give an introduction and overview of the wide field of integrating digital media into physical education, that is still in need to be explored, supported, and developed further.

BACKGROUND

Consulting the benchmarking (English written, international) educational text books used within the academic studies of sport science and physical education teacher education (e.g. Graham. Holt/ Hale, & Parker, 2007; Kirk, Macdonald, & O'Sullivan, 2006; Lumpkin, 2007; Siedentop, 2008; Siedentop, Hastie, & van der Mars, 2004), one cannot put away the fact that the use of digital media within physical education is even more than underrepresented. Actually, there is no clue for a connection of digital media and physical education at all. Therefore, the sensible use of digital media within physical education has not played a significant role within in the academic discourse at first sight. Nonetheless, literature review states a few monographs that try to establish a relationship between digital media and physical education (Mitchell & McKethan, 2003; Mitchell, McKethan, & Mohnsen, 2004; Mohnsen, 1999; 2008).

However, physical education research was occupied with the technology theme since the upcoming turning of the century (David, Bouthier, Marsenach, & Durey, 1999; Mohnsen, 1999). Literature review can state a few articles on the topic of technology connected to the area of physical education, physical education teacher education, and higher education.

With reference to physical education teacher education, a group of papers focus on perception, attitude, technology competence, and use of technology of physical education teachers (Ince, Goodway, Ward, & Lee, 2006; Thomas & Stratton, 2006; Yaman, 2008; Yaman, 2007b, 2009). On the other hand, only two papers deal with the student's view. Yaman (2007a) surveys the perceptions of physical education students towards the internet, while Gubacs (2004) describes the student's view within a project-based learning scenario integrating technology.

Within the field of higher education, Bennett and Green (2001) examine sport science students learning outcomes in an online environment, but cover only theoretical classroom courses. So do Nichols and Levy (2009); the authors discuss e-learning courses for college student-athletes.

Only a few papers focus mainly on physical education teacher education. While Tearle and Golder (2008) examine physical education teacher education in the United Kingdom, Fiorentino and Castelli (2005) tend to inform physical education teachers of digital video editing and producing. Schell (2004) is concerned with giving physical education teacher education students the right advice for their instructions in technology involved settings. Bredel, Fischer, and Thienes (2005) describe selected didactical arrangements containing digital media within physical education teacher education.

Regarding coach education, Stewart (2006) informs about a concept of integrating online education in traditional coach education. Leser, Uhlig, and Uhlig (2008) present a blended learn-

ing concept using an online tool for soccer coach education, while Keller (2008) provides a blended learning concept for physical education teacher education for track and field.

According to curriculum, several papers standardize technology use in physical education, mostly trying to combine the NASPE (National Association for Sport & Physical Education) standards for physical education (NASPE, 2004) with technology use (Mitchell, 2001; Mitchell, 2006; Mohnsen, 2005a, 2005b, 2005c).

Concerning internet offers, Pennington and Graham (2002), and Pennington, Wilkinson, and Vance (2004) analyze the postings by physical education teachers of the mailing list NASPE-L, which is the official mailing list by NASPE. Elliot, Stanec, McCollum, and Stanley (2007) inform about which internet resources are of relevance for physical education teachers and how they can use them. Sturm (2008) describes open learning online resources from the field of human movement and training, while Danisch, Müller, and Schwier (2006) illustrate the development of an online environment for the didactics of sport games.

Computer game studies can be found at Hebbel-Seeger (2008b), who states the benefit of sailing simulation software for the progress of real skill development in sailing. While Kretschmann (2008a) focus on a competence model in general, Hayes and Silberman (2007) provide the use of video games in physical education. Trout and Zamora (2005) give an example of using the game "Dance Dance Revolution" (Konami) in physical education class.

Strategy documents were developed and discussed by Baca, Hanke, Hebbel-Seeger, Igel, Vohle, and Wiemeyer (2007), Borkenhagen, Igel, Mester, Olivier, Platen, Wiemeyer, and Zschorlich (2006), and Hebbel-Seeger (2008a). These papers provide a strategy for the broadening of digital media use within the field of sports and sport science.

Finally, articles directly referring on physical education and integrated technologies can be found. Though Ladda, Keating, Adams, and Toscano (2004) proclaim to give an overview of the use of technology in physical education, including the use of heart rate monitors, pedometers and software offers, other authors focus on specific technology use in physical education. PDAs (Personal Digital Assistant) (DerVanik, 2005; McCaughtry & Dillon, 2008; Wegis & van der Mars, 2006) and pedometers (Cagle 2004; Dunn & Tannehill, 2005; McCaughtry, Oliver, Dillon, & Martin, 2008) are covered most frequently. Dober (2003, 2004), and Thienes, Fischer, and Bredel (2005) give an overview of digital media for and within physical education, but only from the national German perspective.

In addition, some authors focus on special topics. Butler (2004) is dealing with interactive whiteboards in comparison with chalk and blackboard. Dober (2006) shows a way of integrating laptops into physical education class. Fischer, Thienes, and Bredel (2005) evaluated CD-ROMs for physical education and physical education teacher education. Hastie and Sinelnikov (2007) outline the use of web-based portfolios in physical education. Woods, Karp, Shimon, and Jensen (2004) describe the pedagogical use of web-quests in physical education.

In conclusion, literature review does not show a tabula rasa, but only little research done in the field of physical education and technology. Due to the importance of 21st century skills for today's students, the mission is to bring the relatively small strand of digital media and physical education into the main stream academic discourse and educational textbooks. At least one German edited educational text book contains a chapter about new media within physical education (Danisch & Friedrich, 2007): Handbuch Sportdidaktik (engl. Handbook of Sport Didactics) (Lange & Sinning, 2007).

PHYSICAL EDUCATION 2.0: ASPECTS, ELEMENTS, PREMISES

To make a sensible linking of digital media and physical education clearer, it is necessary to draw an image of an old-fashioned physical education. This image is usually being associated by the common body of current adults, which were inevitably socialized by physical education during their school days. Based on that image of Physical Education 1.0, the concept of Physical Education 2.0 can be grounded, whereas its elements, premises, and practical examples will be described next.

The term of Physical Education 2.0 refers to the term "Web 2.0" (O'Reilly, 2005) in two ways. First, there is the shift from the consuming attitude of Web 1.0 to Web 2.0 with user generated content and social networking. This shift mirrors the shift from teacher centered teaching methods of the old-fashioned Physical Education 1.0 concept to Physical Education 2.0 with various teaching methods and a changed teacher role. Second, the appendix 2.0 means an upgrade and further development of a conceptual framework compared to the appendix 1.0. Accordingly, Physical Education 2.0 is the product of further development integration media and technologies, whereas Physical Education 1.0 stands for an obsolete version of physical education concepts without technology.

Physical Education 1.0

Physical education is normally associated with exercise, heading towards certain motor skills and their training. A kind of "drill instructor", supposed to be the physical education teacher, manages the instructions. He or she is standing in front of the class most of the time, giving personal advice where it is needed. Students are supposed to be held "in motion" and physically active for (almost) the whole session. Media in usage are the teacher himself and his or her voice.

The teacher role is iced to a solid instructional one. The physical educator is giving orders which the students have to fulfill. He or she gives the orders in a verbal manner, using intonation and strength of the human voice. On occasion, the exercising is interrupted by technique demonstrations by the teacher himself or herself (e.g. Basketball layup). Students are supposed to draw an own cognitive image of the specific movement, learning by imitation (Nixon & Locke, 1973). The next step is to practice the demonstrated technique over and over. Every now and then the teacher gives advice and hints to some students, who have problems at performing the technique in question. At the end of a lesson a sports game has to be played (e.g. Basketball). In this case the teacher serves as referee and trainer for all participating students.

Like this or something like that, physical education is described and remembered by most people. We all are socialized by physical education (or physical training scenarios) and have made up an individual opinion and attitude towards it. Mostly, one can remember sweating while exercising and learning certain sport techniques. Shortly, this obsolete concept of "Physical Education 1.0" uses the same methods of teaching, orders and organization every lesson throughout the school year. The paradigm of an instructional design theory for physical educators (Vickers, 1990) being a drill instructor is obvious. No media is used at all; the human body is just enough.

In better physical education classes the Physical Education 1.0 setting is sometimes supported by drawn images of the correct technique of a certain sport or a video of an exemplarily good game play. Sometimes students are recorded on video tape and are given instant video feedback according to their motor skills and motor behavior (Hamlin, 2005). For instance, Roberts and Brown (2008) use instructional videos in aquatic education. The latter might be titled as "Physical Education 1.5", if a digital camera is used and the videos are stored and distributed on digital media as well.

Mostly, disregarding and disrespect towards digital media in physical education or even media in general are flanking the Physical Education 1.0 position. This might be accompanied by prejudices of digital media causing "fat, stupid and lazy" children. One might even hear supporters of the concept of Physical Education 1.0 among physical education teachers, being afraid of being replaced by digital media.

Although there is serious development in teaching methods and styles (e.g. Byra, 2006; Kirk & McPhail, 2002), media usage is definitely a minority phenomenon. Cooperative Learning, constructivist approaches including situated learning, TGfU (Teaching Games for Understanding), etc., are not linked to digital media, when it comes to the discussion of good physical education. However, a good physical education can be without digital media, but a modern one includes digital media, which is preparing students for the 21st century (Mohnsen, 1999).

Physical Education 2.0

In the following section technical devices, specific software and internet offers are described, building the basis of possible digital media being used in specific pedagogical scenarios in physical education. Furthermore, a didactical framework for the implementation of digital media in physical education will be developed, which can be used by physical educators to form pedagogical scenarios integrating digital media.

Technical Devices/ Hardware

Mohnsen (2008) lists a huge amount of technological items that have the inner potential of a use in physical education. For technical devices the following selected components can be listed:

- Computers and laptops: The main advantage of laptops compared to desktop computers is portability. Laptops can be used anywhere in the gymnasium, even without a power socket, at least for the maximum battery run duration.
- LCD projectors, digital video and digital photo cameras: Portable LCD projectors can be used to display content of a laptop or digital video and digital photo cameras. The latter ones mostly include the feature of recording a large amount of time on a digital storage. The disadvantage of LCD projectors is the need for a power socket and a projection screen. Usually they are very rare at common schools, especially for gymnasium application. Of course, digital cameras can be connected to normal TVs. The exclusive usage of digital cameras allows only a few students to watch recorded (movement) performances due to the small size of the LCD screens manufactured into these devices.
- Audio equipment (MP3-players, HiFi racks): Rhythm and dance education within physical education classes are usually supported by audio equipment.
- Heart monitors: Heart monitors are used to maintain the heart rate in a certain heart rate zone. The heart rate is measured by a chest strap which gives the student instant feedback about his or her heart rate while exercising.
- Pedometers: Pedometers are counting steps over a certain amount of time. Steps can be a measure for the physical activity level.
- Handhelds (mobile phones, PDAs, GPS devices): Software applications can be installed on handhelds which can be used for the assessment of human movement performance, for instance (e.g. movement diaries, game statistics, exercise results). GPS devices can be used for orienteering races.
- Video game consoles (Playstation, Sony Computer Entertainment; Eye Toy, Sony Computer Entertainment; Wii, Nintendo),

dance mats (Dance Dance Revolution, Konami), and Gamebike (Cateye): Video game consoles provide several user interfaces that involve human movement as a method for playing a virtual game character. These so called exergames increase the physical activity level while playing video games. Dance mats are a specific kind of these interfaces: a digital mat is used as game pad, whereas the player has to perform dance moves on the mat which are measured by the mat itself and transformed into digital game play. The Gamebike (Konami) is an interactive video-based exercise bicycle. The exercise bicycle is connected to a gaming console, whereas the biker has to solve different tasks and levels on a virtual track.

- Makoto Fitness Arena (Makoto): The Makoto Fitness Arena (Makoto) is a standalone device that requires the user to react to sounds and lights. The user is placed in the center of the device, which consists of three corner poles. The user has to tap randomly litting lights on each of the poles as fast as possible.

Technical devices as listed above should and can truly be considered to be used within physical education. Linking technical devices with physical education could be held as the initial starting point for getting over the concept of Physical Education 1.0. Though it seems that most physical educators and sport pedagogues do not know of technical devices meant to be used in physical activity contexts, enlightment in the sense of generating and improving knowledge about the existence of these devices is the key for fostering up-to-date thinking in terms of modern physical education (Mitchell et al., 2004; Mohnsen, 1999).

Software and Internet

After gathering knowledge about technical devices to be considered within physical education, the next step will be taking a closer look at software and internet offers in the field of sport to forward the development of the Physical Education 2.0 concept.

Software

Though it is possible to identify the benchmarking international educational textbooks in the area of sport science and physical education pedagogy, this procedure can't be replicated for the field of sport software. Educational sport software is produced by national or regional developers and is normally very hard to access from other countries or regions. Due to this kind of circumstances, mainly national examples from Germany and a few international accessible examples will be given.

The following list can be posited to represent software offers exemplarily:

- „Fußball/ Schwimmen/ Volleyball – Bausteine für einen sicheren und attraktiven Unterricht" (Friedrich, 2004; Bredel, 2003; Fischer, 2005) (engl. "Soccer/ Swimming/ Volleyball – Building blocks for a secure and attractive education") (three CDs/ DVDs developed by the Department of Sport and Sport Science at the University of Dortmund, Germany, and the Department of Sport Science at the University of Giessen, Germany)
- "Basketball Elements" (Richter, 2007)
- "Simi Scout" (SIMI Reality Motion Systems) (Scouting and game play analysis software)
- "Simi Motion" (SIMI Reality Motion Systems) (3D analysis of human movement)

- Playbook series for basketball, American football, soccer, water polo, volleyball, and hockey (Jes-Soft) (playbook software)
- Digital sports-games (computer and video games: e.g. NBA Live, Electronic Arts; FIFA, Electronic Arts, etc.)

There are three kinds of sports software to differentiate. First, there is educational software that is supposed to be used in educational contexts as physical education or physical education teacher education (e.g. "Fußball/ Schwimmen/ Volleyball – Bausteine für einen sicheren und attraktiven Unterricht", Friedrich, 2004; Bredel, 2003; Fischer, 2005). This software normally includes videos of the specific sport techniques and/ or game tactics, including theoretical information based on the academic knowledge of sport science. Methods, drills and hints for teaching classes are also embedded. Beginners should use the information to boost their learning process.

Second, there is software that is meant to be used in the field of professional sports, either to analyze game play (e.g. Simi Scout, SIMI Reality Motion Systems) or to analyze human movement itself (e.g. Simi Motion, SIMI Reality Motion Systems). Coaches, exercise scientists, and sport scientists (and also students of sport science) are usually aware of dealing with these contents and constraints.

Third, there is commercial gaming software that does not intend to educate, but to entertain. The approach of Digital Game-Based Learning (Prensky, 2001) tries to use the motivational and immersive power of video games in educational affairs. For digital sports-games, Hayes and Silberman (2007), Hebbel-Seeger (2008b), Kretschmann (2008a), and Trout & Zamora (2005) tried to employ those games for pedagogical learning outcomes.

Internet

The world-wide-web provides almost endless information about almost everything. Though there is no international database which includes internet resources addressed to physical educators, the procedure will be equal to the one of the software section. Thus, present national offers are followed by a few international ones. Treadwell (2001) listed and commented internet sites for educational purposes, including some for physical education teachers. A list of English spoken websites, relevant to physical education teachers, can be found at Elliot et al. (2007).

The following list can be posited, representing internet offers exemplarily:

- www.sportpaedagogik-online.de (engl. "sport pedagogy online") (offer for physical education teachers for planning physical education)
- www.spingate.de (table tennis) (developed by the German Sport University Cologne)
- www.5min.com (video archive covering training in selected sports)
- Wikipedia Sports Portal (in different languages) (information about certain sports and sport in general, and materials for sport education)
- www.youtube.com (archive of sport events, sports culture, e.g. the Philippine folkdance tinikling).

Regarding the internet offers, one can differentiate between two different kinds of offers. On the one hand, educational use is intended and proclaimed (e.g. www.sportpaedagogik-online.de). On the other hand, informing about a certain sport or sport phenomenon is intended. In this case, the offer (e.g. Wikipedia) addresses to a specific community (e.g. gamers, surfers, etc.) or social group that is not necessarily related to physical education. Nonetheless, these materials can easily be embedded in pedagogical scenarios to support learning processes within physical education.

Indubitable, both lists could be drawn much longer, but an (international) compendium that includes all software and internet offers for sports

and physical education is still missing. The intention is just to give a brief overview. The amount of internet offers is still increasing, whereas physical educators should be observant.

Learning management systems (LMS) (e.g. Moodle, Blackboard, etc.) can be an option either, that unify both software and internet offers by providing a platform that can be formed and filled up with educational content by the physical educator, since the technical infrastructure is available and media literacy is of an adequate level.

Pedagogical Scenarios: Present

Literature review (Bennett & Green, 2001; Bredel et al., 2005; Butler, 2004; Cagle 2004; Danisch, 2008; Danisch et al., 2006; DerVanik, 2005; Dober, 2003, 2004, 2006; Dunn & Tannehill, 2005; Elliot et al., 2007; Fischer et al., 2005; Hebbel-Seeger, 2007; McCaughtry & Dillon, 2008; McCaughtry et al., 2008; Mitchell & McKethan, 2003; Mitchell et al., 2004; Mohnsen, 2008; Stewart, 2006; Thienes et al., 2005; Wegis & van der Mars, 2006) allows identifying four main pedagogical scenarios integrating digital media within physical education: Homework and theory, informational input (plenum) (LCD projector and laptop), learning stations (with one or several stations integrating digital media), and feedback.

Homework and Theory

Learning within physical education class does not only take place during face-to-face lessons. Students are demanded to prepare forthcoming lessons and rework passed sessions (Bennett & Green, 2001). In these cases digital media can support the preparation or reworking (Danisch et al., 2006; Stewart, 2006). For example, students can use a CD/ DVD (e.g. "Basketball Elements", Richter, 2007) to prepare a specific sports technique (e.g. set shot in Basketball) that is planned to be tackled in the next lesson. So they can start at a higher level in the (motor) learning process, because they have already gained knowledge about a certain technique (Bredel et al., 2005; Thienes et al., 2005). This prevents students from being overstrained in face-to-face lessons by trying to manage motor control and motor knowledge simultaneously.

Knowledge about rules, tactics, and game play can be acquired by students on their own, as homework for instance (Mitchell et al., 2004). The physical educator can also use podcasts, that can include both knowledge and theory, and technique and game play videos (Danisch, 2008; Hebbel-Seeger, 2007).

Therefore, internet offers can be employed for preparation for or reworking of a physical education lesson (Dober, 2003, 2004; Elliot et al., 2007).

Web-based portfolios, wherein students can arrange their learning and exercise achievements, can also be used as a homework task (Hastie & Sinelnikov, 2007). In this case the students with the best portfolio designs or results might be given prizes. This can lift motivation towards engaging in digital media.

Moreover, web-quests can be a sensible activity for homework (Woods et al., 2004). For instance, students can inform themselves about the history of Basketball (e.g. rules, founder, international development, etc.), working on sensible tasks in a playful setting. But the preparation of a web-quest takes time and has to be done carefully, though it is a serious damage to the educational process if links are broken or a URL is badly misspelled (Zheng, Perez, Williamson, & Flygare, 2008).

Outsourcing theoretical contents gives physical educators more time for physical activity contents and actual movement within the lessons. However, the main advantage of this scenario is that students can adapt their own learning tempo according to the software or internet offer.

Informational Input

Using an LCD projector that is connected to a laptop gives the physical educator the opportunity to provide information to all students at the same time

(Bredel et al., 2005; Fischer et al., 2005; Thienes et al., 2005). Content is provided digitally on the laptop (e.g. software, videos, and internet offers if W-LAN is available). For example, the teacher can employ embedded videos of educational software (e.g. "Volleyball – Bausteine für einen sicheren und attraktiven Unterricht", Fischer, 2005) to show the students the "right" technique from different angles using slow-motion and freezing in addition (Mohnsen, 2008). The teacher could also display specific tactical behaviors (e.g. offensive plays in volleyball), that is provided by animations within the software. Innovative technology like interactive whiteboards can also be used to provide information and support the interactive discussion process with the students about the provided information (Butler, 2004).

The advantage of this scenario is that all students can be reached at the same time and can benefit from the same educational software (or offer). The disadvantage of this scenario lies in the reduction of actual time of physical activity and movement within a lesson. Therefore, the theoretical input must not last too long; otherwise the time for putting theory into praxis might be too short.

Learning Stations

Within arranged learning stations one or more station(s) can consist of a digital media offer (Dober, 2006). For example, one station stages a laptop including specific software (e.g. "Basketball Elements", Richter, 2007) for analyzing videos for the smash), whereas the other stations provide well known drills for practicing a technique (Bredel et al., 2005; Dober, 2004; Thienes et al., 2005). Normally, groups of students pass through each station while working at each station for a given time period. Thus, working together in groups encourages cooperative learning (Johnson, Johnson, & Holubec (1990).

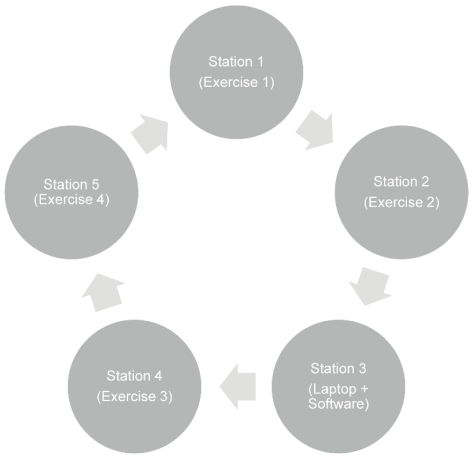
Mobile podcast devices for video content (either web streaming or memory card storage) can also be part of a station. The handheld can display videos of the right sport technique, giving students advice in terms of demonstration (Danisch, 2008; Hebbel-Seeger, 2007).

The critical thing about the arrangement of learning circles is the selection and order of each station, duo to each student group has to pass through all stations. Each station has to be a possible and sensible starting and ending point of a loop (Schmoll, 2007).

Feedback

In this scenario digital media is used to give students instant feedback relating to their motor skills. A laptop, a LCD beamer, a digital video camera, and video delay software (e.g. "Simi VidBack", SIMI Reality Motion Systems) are needed. For example, pairs of students perform an exercise relating to a specific technique (e.g. digging in volleyball). While exercising the digital video camera records the performance. The camera is connected to the laptop whereas the video delay software is running. The software delays the playing of the recorded performance by 60 seconds. The laptop screen is duplicated via the LCD projector, so the students get a bigger screen view of their recorded performance. After having exercised 60 seconds, the exercising

Figure 1. Learning stations



student pair moves on to the projection screen and the students give instant feedback to each other relating to motor skill development. In the mean time the next student pair is exercising and being recorded (Bredel et al., 2005).

Students are required to have a certain knowledge and skill level, so that the feedback becomes sensible feedback. Furthermore, students have to be aware of the critical issues of the technique in question and need to be used to be recorded on video, including watching themselves and other students on video.

In a different case, students can be recorded on video tape, whereas the video is digitalized and edited by the physical educator (Fiorentino & Castelli, 2005). The benefit lies in the edited content. Certain sections of the whole recording can be cut out and reunited to a new sequence. This sequence may contain typical errors of a student, performing a sports game. Hints can be added in a digital text document by the physical educator. Finally, the videos and hints can be given to the student via CD/ DVD or USB memory stick. The difference to Physical Education 1.5 lies in the post-editing of the video material and the distribution on digital media.

In another case, PDAs (McCaughtry & Dillon, 2008; DerVanik, 2005; Wegis & van der Mars, 2006) and pedometers (Cagle 2004; Dunn & Tannehill, 2005; McCaughtry et al., 2008) can be embedded in a feedback scenario. PDAs can be used by the teacher or by the student to assess exercise data or game performance (Wegis & van der Mars, 2006).

Didactical Design

Forming pedagogical scenarios integrating digital media in physical education to fulfill the concept of Physical Education 2.0 is not easy. The following figure intends to illustrate issues to be recognized while generating pedagogical scenarios within this field.

Regarding the setting, learning theory (e.g. constructivism, situated learning), learning target(s) (e.g. motor skill development, social awareness), curriculum (e.g. national standards), and individual school resources (e.g. availability of technical devices, money) have to be considered.

Regarding lessons, planning, analyzation, and realization in connection and involvement of the relevant persons (teacher and/ or student), technical devices, software and internet offers (technology) have to be integrated in a coherent comprehensive manner.

Pedagogical Scenarios: Future

Utopias and science fiction imaginations of the future are recommended by mass media and therefore part of our daily life. However, researchers and serious writers tried (and still try) to imagine the future. For instance, Beare (2001) was trying to reinvent school, while Horx (2006) describes potential school development within the future society.

Figure 2. Feedback scenario (adapted from Bredel et al., 2005)

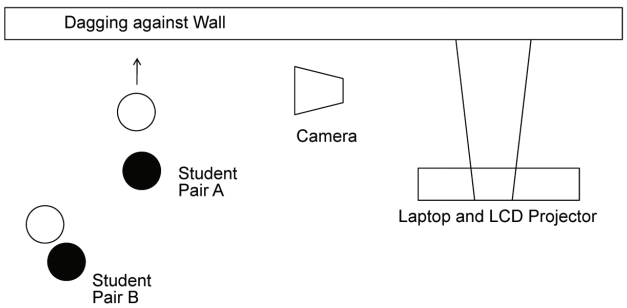
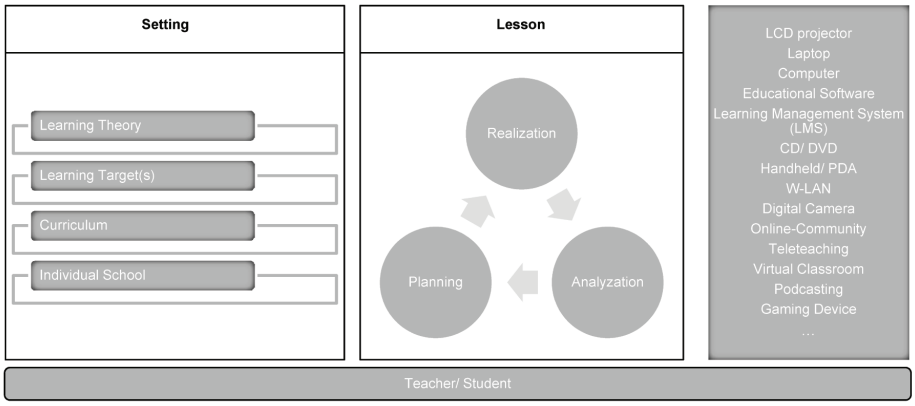


Figure 3. Framework for the use of digital media in physical education (adapted from Kretschmann, 2008b)



Having displayed pedagogical scenarios of the present, including a didactical design model, one might turn to the future of sports and physical education. Due to the theoretical concept of future research and imagination being a serious and fruitful business, one might employ our imagination to draw alternative images of the future (Bell, 1996). Mohnsen (2008) gives a brief description of future physical education in the year 2015, when digital media (devices, software and internet offers) are accessible for students 24 hours a day, seven days a week. They participate daily in physical activities on their own by using the devices. Thus a blended learning concept is established, whereas students are to learn virtually in online courses. Students do not need to attend physically all the time. Physical education is no longer a physical attendance based subject.

In any case, how will physical education look like in the far future? The following hypothetical scenarios try to outline possible physical education development. The intention is to establish awareness for future physical education development and technology. This awareness might serve as a basis for reflection upon physical education itself.

Face-to-Face and Distance Education

Following the future scenario of Mohnsen (2008), physical education only uses sporadic face-to-face lessons. In these lessons the teacher only gives feedback to the students about their motor development and achievements. The whole class obligatory meets at the beginning and the end of the school year. At the beginning of the school year, learning goals of the curriculum are introduced and discussed. At the end of the school year the students are assessed using some motor tests for grading. Devices as heart rate monitors, pedometers, and accelerometers are accessible for all students, so students practice and train on their own. Thus, students can documents their achievements electronically using a virtual learning online environment. The virtual learning online environment allows communication with other students through portable devices (PDA, smart phone), so students can support each other during the learning process. If necessary, students can contact selected physical education teachers and talk with them via video conferencing in real time to be given immediate feedback (e.g. heart rate monitor results: Wills, 2006).

Theoretical content of the sub disciplines of sport science (e.g. sport psychological interven-

tions) and of certain topics of the curriculum (e.g. theory of basketball and its techniques) can be learned online. An expert software system with online lectures and tests informs the students and gives advice to their current fitness and training conditions. Technology assisted self learning with few attendance education at school is the major approach to physical education, containing a strong aspect of responsibility of the individual.

Teacher Role

In this scenario the teacher role has finally shifted from instructor to advisor (Hartnell-Young, 2003; Scrimshaw, 1997). Students try to solve their problems on their own. The consuming mentality has changed to a self learning one. Students even choose their individual learning goals (e.g. fitness development, improving tactical skills). The curriculum offers various options for the students, so students can choose the ones that individually fit best. Due to the amount of possible curriculum content options, the teacher is only accessible for students when they need advice. Therefore, students can date the teacher, so they can talk via video conference or even face to face, in case the teacher decides that the problem needs to be discussed physically attendant. The teacher is something like a mentor to the student, who helps if he or she is needed. Teachers do not need to demonstrate sport techniques anymore, because students can get this content from virtual learning environments. Furthermore, teachers do not have to organize face-to-face lessons or teams for sport games. Students have to do this by themselves. Only if students ask for support by the teacher, when they meet to play a sports game (e.g. Basketball), for instance, the teacher comes over as a "watcher". If he or she is asked to give hints for better game play he or she will help out.

If there is any problem with software or devices, technical stuff is responsible for this and will be contacted by the students. However, the teacher has to be familiar with the devices and software, but he or she has to be a pedagogical expert, not a technical one.

E-Sports

The E-Sports community has already established an international league and competition system, wherein "professional" gamers compete against each other, playing commercial computer games. E-Sports is "an area of sport activities in which people develop and train mental or physical abilities in the use of information and communication technologies" (Wagner, 2006, p. 439).

Following this wide E-Sports definition two different scenarios are possible. First, video and computer games, with "traditional" user interfaces (keyboard and gamepad) will gain real sports status and will be held as a sport among physical sports (e.g. basketball). Therefore, gaming is part of physical education, though not in the gymnasium, but in normal classrooms, wherein special gaming computers and devices are accessible for students. All kinds of computer game genres are relevant for physical education (e.g. shooters, digital sports-games, simulations, etc.). Students do not need to change clothes for that part of physical education. They can attend in regular daily clothes. Real exercise has not vanished, but is only one part among E-Sports and informal leisure sports outside school. In this case it is also plausible that commercial digital sports-games are used to assist motor learning for certain sports (Hayes & Silberman, 2007; Hebbel-Seeger, 2008b; Kretschmann, 2008a).

Secondly, physical education is enhanced through video and computer games, which are commercially produced for the use within physical education. Following the usage of dance mats (Dance Dance Revolution, Konami) and Wii (Nintendo), the so called exergames (games that provide exercise by different user interfaces) (Chamberlin & Gallagher, 2008) will be employed to assist motor learning. The technology for movement measuring will be that good, that fine motor

activities can be measured and used as input for the digital game play. Therefore, the whole body comes in, while both gross and fine motor skills are trained throughout the gaming experience (Kretschmann, 2008a). Some lessons will be held as distance education, wherein students meet at a certain time to compete virtually against each other. In this case every student has got the needed equipment at home, including enough space for spatial movement.

Abolition of Physical Education

In this scenario physical education has vanished from the canon of school subjects (Vertinsky, McKay, & Petrina, 2004). This may appear as a dystopia from the sport pedagogue's point of view. Actually, this scenario is a utopia, because future society and students have gathered an awareness of a healthy lifestyle; and this lifestyle contains physical activity, of course. Gymnasiums at school still exist, but they are only used for sport events like school team competitions. Several sport competence centers exist, where students are allowed to participate in various motor activities for free. Striking refunds, gratification and prizes are given to those students, who are notably healthy according to motor testing and examination. The sport competence centers also provide serious information about sport science theory, working closely together with sport science departments at universities.

In an alternative version of this scenario there are no sport centers at all. Students and the whole population have to train themselves at home on their own. Only rich people can employ a fitness coach for advice. Due to urbanization, only few gymnasiums exist, which are owned by private clubs or fitness centers. Of course, students have to pay money to participate in the gymnasium offers. The fitness market has reacted and created training devices for home usage. Thus, this is the way students train themselves. The manufactured training devices include expert system software, which has actually replaced the physical educator or trainer.

Actuating Elements, Cyborg, and Motor Program

In this scenario one can differentiate between three kinds of treatment in the motor learning process. They are subsumed according to their approach of enhancing the natural human body with technology.

The first case is placed in the area of sports technology, equipment, and clothing. Among sports goods one might find clothing that is enhanced by actuating elements. These so called actuating elements react according to a biophysical signal. This signal might be sweat, and the reaction might be starting a cooling system embedded in a running jacket. Thinking further, the signal might be muscle tone, and the reaction might be muscle stimulation. Or the signal might be some visual input (e.g. an integrated camera and microprocessor to analyze environmental data) or spatial data (e.g. accelerometer data, GPS data), and the reaction might still be muscle stimulation. Hence, this technological enhancement could make sure that the right muscles contract at the right time during the performance of a certain sport technique movement. Imagine doing a somersault in the air, whereas sensors measure height, angles, and speed, activating actuating elements, which cause the right muscle stimulation at the right time to support the adequate performance of the somersault in the air. Following, learning of all sport techniques can be enhanced by such a technology.

The second case is based on the so called "Cyborg Project" by Warwick (2002). An electrode array (a specialized manufactured microchip) was implanted into Warwick's arm. A simulation of a complex neural system made him able to control a robot arm, just using his own arm with the implanted chip. Thus, the robot arm could mimic Warwick's own arm. Following this approach, the

next step could be the construction of a robotic armor. The armor could serve as strengthener of physical energy and power skills of the human body. Imagine a robot armor that can lift a multiple of one's own body weight, and can run faster and jump higher than normal human beings. The development of that technology would change our regards towards competitive elite sports and to physical education as well. Ethical considerations and constraints are strongly involved, too.

The third case is known from science fiction, specifically the movie "The Matrix" (Silver, Wachowski, & Wachowski, 1999). Within the movie a computer program is used to "update" the mindset of a certain person with knowledge and motor skills (e.g. martial arts skills). Imagine an interface to one's brain (e.g. microchip) that can be used as an interface to put new motor programs into your brain. After the procedure one is capable of performing every human movement and sport technique one might think of (e.g. basketball skills). The effectiveness of this special kind of motor learning and control would only be limited to one's individual body constitutions. Thus, this method would revolutionize traditional treatments to establish or modify motor programs (Schmidt, 1980).

Implementation Areas

The implementation process of digital media does not fulfill itself (Dober 2004; Hebbel-Seeger, 2007). Lifting Physical Education 1.0 and 1.5 to Physical Education 2.0 takes time and needs various starting points. Implementation has to begin simultaneously at the lots of gymnasium, curriculum, and teacher education to build the premises for the concept of Physical education 2.0.

The German strategy documents (Baca et al., 2008; Borkenhagen et al., 2006) proclaim strategies for universities and sport science in general. They do not specifically focus on physical education, but some claims foreshadow possible physical education development.

Gymnasium Development

The future gymnasium needs to shift from technology isolated buildings to the integration of W-LAN, LCD projectors, computers, handhelds for every student, and adequate number of power sockets, etc., including separated media rooms with doorways to the gymnasium. Especially, buildings under construction or gymnasiums needing renovation are objects of interest. Hence, the initializing process for the development of a technology friendly gymnasium for future physical education can start. Problems are considered in places, to where certain physical education content is outsourced; that is true to the cases of swimming, track and field, stadium and outdoor sports (e.g. American football, skiing, etc.). Using technology in a swimming hall might come to be an impossible task. Track and field, stadium sports and skiing lack of a power socket in the outdoor environment. In addition, weather can be a concern, whereas laptops and PDAs should be waterproof.

Surely, budget restraints are the most blocking force in this case (Gillard, Bailey, & Nolan, 2008). Nonetheless, development should focus on building the needed infrastructure (Borkenhagen et al., 2006; Holzrichter, 2001).

Curriculum Development

Technology needs to be embedded into the physical education curriculum and standards. Combining or fusing national standards (e.g. NASPE, 2004) with technology standards into another publication, as Mitchell (2001), Mitchell (2006), and Mohnsen (2005a, 2005b, 2005c) do, is not enough. In this case a second standard is created, that will certainly compete with the original standard. The primary standard needs to integrate digital media and its sensible use, so that a secondary document is not needed. Physical education can provide and develop media and computer literacy of students just like other school subjects are supposed to. Thus, the upcoming editions of national (or even interna-

tional) standards for physical education should integrate technology as a natural element.

Teacher Education Development

Digital media needs to be integrated into physical teacher education at universities, and in further and higher education in general. Mitchell and McKethan (2003) give examples of this integration, while Reinmann (2005) claims for integrating digital media in teacher education in general, promoting a blended learning concept using learning management systems (LMS). The latter can easily be adopted for physical education teacher education (Bennet & Green, 2001; Danisch et al., 2006; Keller, 2008; Stewart, 2006). Students should gather early experience with the use of digital media within the field of sport and physical education. Furthermore, students should engage in digital media from the very beginning of their student career at university.

Baca et al. (2007), and Borkenhagen et al. (2006) promote severe production of content for higher education in the field of sport science. This includes and will hopefully generate content for physical education teacher education, too. In addition, Samson, Igel, and Meiers (2006) surveyed professors of sport science departments at university. Surveys like this might help to create an awareness of digital media and its value and importance (Borkenhagen et al., 2006).

FUTURE RESEARCH DIRECTION

Due to 21st century skills and up-to-date-education (Mohnsen, 1999), the dosage of digital media is the key of a sensible, well reasoned and sophisticated Physical Education 2.0, which is embedded and developed using the posited framework. The question of the "right" proportion of media and movement in a blended learning concept cannot be answered yet (Dober, 2004; Nichols & Levy, 2009).

At present, research and academic discourse lacks in several categories (according to Kretschmann, 2008b):

- Curriculum Development: Scanning through national (and available English written) curricula of physical education, digital media is highly underrepresented and needs to be significantly anchored therein.
- Media Database: An (international) database with commentaries to media offers and evaluated usage documentary is still missing.
- Documentation of Digital Media Use: Scanning through literature leads to marginally few reports of a sensible and elaborated digital media use within physical education. In-depth descriptions for digital media use scenarios are highly recommended.
- Empirical Findings: Research crucially lacks of empirical findings integrating digital media within physical education. There is still much work to do, creating the empirical background for the practical use and benefit of technology in physical education.
- Gymnasium Resources: The relationship between technology and gymnasiums still seems to be held as an alienated relationship. Technology in the gymnasium seems to be a foreign object.
- Dissemination of E-Learning Projects within Sport Science: sport scientific projects (e.g. "eBuT", http://www.bewegung-und-training.de) are not put into any context of practical use within physical education. Although this step would be manageable, it is not taken so far.
- (Further) Teacher Education: Digital media needs to be integrated into physical education teacher education and

physical education teacher further education. Although there are selective offers, an elaborated curricula concept lets waiting for it.

- Implementation Strategies: Strategies for the implementation process of digital media into physical education are still missing. Successful and sustainable implementation guidelines and serious advice for a (national) school system and individual schools can't be found.

For the future towards the next upgrade to Physical Education 3.0 one might consider video cube walls technology, that allows to (inter)act in a cube, whose walls consist of screens (scenarios of virtual reality) or electronic devices like ski goggles, that fade in track information (scenarios of augmented reality) (Haggerty, 1997). But in comparison to the outlined future pedagogical scenarios above, this sounds old-fashioned somehow. Hence, the imagination of the future of physical education lets current innovative technologies appear as obsolete and boring, even before they are actually developed further. This is one of the outcomes of drawing possible futures (Bell, 1996). The prize to pay for enlightment and awareness is anticlimax. Nonetheless, future is still to come and it is not set up at the moment.

Further research and discussion might turn to the everlasting theme of surplus value of technology within physical education: what is exactly the benefit of digital media within physical education? For students, teachers, and the society, different answers might be given. Experimental study designs will be needed to research this field. However, recent research inclines an overestimation of multimedia (Wiemeyer, 2003) and motivational increase (Fischer et al., 2005). Anyhow, physical education research is still in need to tackle this question in an elaborated (empirical) way.

CONCLUSION

Finally, the subject of physical education which is apparently little associated with technology, has become a subject of interest for pedagogues associated with media and technology. From the beginning at Physical Education 1.0 (and 1.5) the brief overview of technical devices, software and internet offers lead to the use of such media within physical education class, forwarding the concept of Physical Education 2.0. Different kinds of pedagogical scenarios could have been developed and enhanced by striking examples, leading in a framework that illustrates the areas to be considered while planning digital media use in physical education. During this positing, imaginations of future physical education lead to a deeper awareness of physical education development according to technology. But to implement the concept of Physical Education 2.0 premises in gymnasium development, curriculum development, and teacher education development are still to be fostered.

Obviously, the field of academic research within the intersection of digital media and physical education is almost a tabula rasa that needs to be explored by researches, teachers, students, parents, politicians, and any other interested group of persons.

Hopefully, the aim of the paper to give an overview of the scope of digital media within physical education is achieved. To give an interested reader, who does not necessarily have to come from the field of sport science and physical education, a glimpse of the pedagogical potentials digital media have within the world of physical education, might be a way to intrude into the academic discourse within sport science by employing "outsiders" to take part in and develop further a field that is still up to grow bigger.

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PHYSICAL EDUCATION TEACHERS' SUBJECTIVE THEORIES ABOUT INTEGRATING INFORMATION AND COMMUNICATION TECHNOLOGY (ICT) INTO PHYSICAL EDUCATION

Rolf KRETSCHMANN
Department of Kinesiology, College of Health Sciences, University of Texas at El Paso, United States
kretschmann.rolf@gmail.com

ABSTRACT
As well as other school subjects, physical education (PE) is emerging in terms of integrating information and communication technology (ICT) into regular classes. Such innovative teaching practices that implement ICT in PE involve diverse parties that are affected by these teaching processes. Students, principals, districts, parents, administrators, policy makers, and last but least the PE teachers themselves are involved. Hence, each participating party has its own personal perceptions and attitudes towards ICT and PE. This study examined the subjective theories of PE teachers about integrating ICT into PE. PE teachers' subjective theories that feature the following areas were covered: 1) student, 2) teaching, 3) teacher, 4) equipment, 5) computer literacy, 6) classroom management and organization, 7) social interaction, and 8) innovative and modern teaching. Within the framework of the research program "subjective theories" (RPST), PE teachers' subjective theories were modeled into a questionnaire after being extracted from an expert group discussion. A total of 57 in-service secondary school PE teachers were surveyed using the developed instrument. The data was analyzed using standard statistical procedures. The analysis focused on the subjective theories themselves and their relation to gender, computer literacy, household computer ownership, and professional experience (years in service).

Keywords: Educational Technology, Information Technology, Physical Education, Physical Education Teachers, Subjective Theories, Technology Uses in Education, Teachers Attitudes, Technology Integration

INTRODUCTION

Information and communication technology (ICT) is widely seen as a motor of fostering 21st century skills in nearly all education-related fields, especially schools (Rutkowski, Rutkowski, & Sparks, 2011; Vockley, 2007). ICT has not only become ubiquitous in todays' children's and adolescents' daily lives, it has even been adopted by nearly all school subjects in the meantime – at least within academic discussion and debate (Webb & Cox, 2004). School students are surely so-called "digital natives" (Prensky, 2001), being used to deal with ICT as part of their lifestyle and even expecting it to serve as a surrounding resource throughout their educational and professional career (Prensky, 2008).

Among the school subjects, physical education (PE) has picked up the discussion of technology integration in the modern classroom as well (Kretschmann, 2010). Various teaching hints and pedagogical scenarios have been suggested to give physical education teachers valuable options for integrating technology into PE (Castelli & Fiorentino, 2008; Kretschmann, 2010; Mohnsen, 2012; Whalen & Fiorentino, 2006). The scope of instructional technology in PE ranges from computers, laptops, and tablets (Juniu, 2011; Leight, 2012), physical activity measurement devices (McCaughtry, Oliver, Dillon, & Martin, 2008) to online activities (Martin, Balderson, & Morris, 2012; McNeill, Mukherjee, & Singh, 2010) and active video gaming (Ennis, 2013). On the higher education level, physical education teacher education (PETE) programs have been in the discussion about ICT ever since (Leight & Nichols, 2012).

However, empirical research and evidence in the field of ICT, PE, and PETE is still rare and limited (Kretschmann, 2010). Although pre-service PE teachers and PE students have been in the focus of several studies (Adamakis & Zounhia, 2013; Goktas, 2012; D. L. Jones & Garrahy, 2001; Zorba, 2012), only a few studies emphasized the PE teachers' perspective (Gibbone, Rukavina, & Silverman, 2010; Gibbone & Silverman, 2010; Ince, Goodway, Ward, & Lee, 2006; Kretschmann, 2012), though mainly highlighting the PE teachers' ICT competence level (Liang, Walls, Hicks, Clayton, & Yang, 2006; Lockyer & Patterson, 2007; Thomas & Stratton, 2006; Woods, Goc Karp, Miao, & Perlman, 2008; C. Yaman, 2008; M. Yaman, 2007b).

Hence, the aim of this study was to determine what in-service and established PE teachers think about integrating ICTs into their respective PE classes. The main objective was to assess PE teachers' beliefs, opinions, views, perceptions, and attitudes towards technology integration in PE.

According to prior research findings, technology use in the educational settings is largely affected by the teachers' attitudes towards technology use (Albirini, 2006; Baylor & Ritchie, 2002). Teachers' attitudes appear

as a major predictor of the use of ICT in the educational fields (Albirini, 2006). Therefore, use of ICT in the classroom largely depends on the attitudes of teachers towards technology (Teo, 2008).

To integrate the diverse constructs involved in investigating the PE teachers' perspective, a "subjective theory" scientific framework was selected (Groeben & Scheele, 2000; Müller, Rebmann, & Liebsch, 2008), as the implicit thinking of PE teachers should be revealed. This approach tackles the personal and "subjective" PE teachers' point of view, which can also be called "epistemological beliefs" (Hofer, 2000).

"Epistemological beliefs are, therefore, always personal and consequently also subjective. This raises the question of the connection with subjective theories. Subjective theories can be considered as a person s set of assumptions, motives, suppositions, ideas and cognitions related to his view of himself and the world" (Müller et al., 2008, p. 91).

Blending the scientific framework with the initial study objective, the final study aim can be phrased: The main study objective is to determine the subjective theories of PE teachers about integrating ICT into PE. In a more colloquial formulization: "What do PE teachers think about integrating ICT in PE?"

METHODS AND METHODOLOGY

In order to prepare properly for the field of PE teaching reality, a two-phase research design based on the subjective theory framework was chosen. In the first phase, a group discussion among diverse experts of PE was performed to extract and quantify subjective theories from PE teachers about ICT in PE. In the second phase, the revealed subjective theories from phase one were modeled in a questionnaire to reach a higher amount of PE teachers.

Research Program "Subjective Theories"

The Research Program "Subjective Theories" (RPST) has had a rich impact on clinical and higher education research in Germany (Hermes, 1999; Wagner, 2003). In addition, RPST approaches have been applied to both PE and sports pedagogy research (Casella, 2012; König, 2013; Ommundsen, 2001).

RPST highlights the reflective abilities of the individual in explaining and conducting its own actions. From a metacognitive research perspective, the cognitive phenomenon of intuitive, "naïve", implicit theories about a respective topic or action serves as the starting point of scientific investigation. Explanation, prediction, and application of knowledge can be extracted out of the research subject's verbalized or written thinking, analogue to scientific theories. A subjective theory therefore is a complex cognitive aggregate of the research object by the research subject (Groeben & Scheele, 2000).

Although the majority of studies used qualitative-only approaches, only few studies combined both qualitative and quantitative methods (Richardson & Placier, 2001). As RPST is not restricted to the introspective, individual level, quantitative methodologies are as well appropriate as qualitative methodologies (Trautwein & Ludtke, 2007; Wagner, 2003). Within RPST, a two-phase model is very well included and described, which can therefore combine qualitative and quantitative research methods (Groeben & Scheele, 2000). Following this methodological discussion, this study embraces the two-way model, using a qualitative approach in its first phase and a quantitative approach in its second phase.

Pre-Study

To explore the topic's aspects, an expert focus group was gathered that consisted of two pre-service teachers, two in-service teachers, and two PE researchers that were also lecturers in a PETE program on the higher educational level. The participants had diverse experience using ICT in PE. However, all participants read essential papers (Ince et al., 2006; Kretschmann, 2010; Pittman & Mohnsen, 2005) and skimmed relevant textbooks (Castelli & Fiorentino, 2008; Leight, 2012; Mohnsen, 2012) before the group discussion.

Within this expert focus group, a group discussion was performed (Cohen, Manion, & Morrison, 2011; Greenbaum, 1998). All participants were asked to present their thoughts and views about the integration of ICT in PE. The group discussion was semi-structured and moderated by one of the PE researchers. The following open questions served as a tentative interview guide (Foddy, 1993) to stimulate the discussion:

1. What ICTs do you know?
2. What ICTs can be used in PE?
3. What are the barriers to use ICTs in PE?
4. What is your general opinion about integrating ICT in PE?

The group discussion was recorded using an MP3 voice recorder and transcribed afterwards. The transcribed group discussion was analyzed by the two PE researches that took part in the expert focus group. The relevant discussion outcomes and participants' statements were extracted and rephrased into brief statements that could be used as items in a Likert-scaled questionnaire.

Instrument

The modeled statements that came out of the group discussion were grouped into topics. The evaluated statements were included as items in a questionnaire using a 5-point Likert scale (5=strongly agree, 1=strongly disagree). Eventually, the items could be organized into eight categories:

1. Student-related subjective theories (10 items)
2. Teaching-related subjective theories (8 items)
3. Teacher-related subjective theories (7 items)
4. Equipment-related subjective theories (7 items)
5. Computer literacy-related subjective theories (9 items)
6. Classroom management and organization-related subjective theories (8 items)
7. Social interaction-related subjective theories (8 items)
8. Innovative and modern teaching-related subjective theories (7 items)

In complement to the subjective theories-related part, a socio-demographic part was added to the questionnaire. Age, gender, professional experience (years in service), and multiple items for computer literacy were therefore included. The respective single items of the subjective theories-related topics are shown in Tables 1 to 9.

Data Collection

Conducting a convenient sample, a total of 120 questionnaires were sent to secondary schools in the area code of Stuttgart, Germany. Altogether, 20 secondary schools were involved in the initial sampling strategy. Only 57 questionnaires had been completed and were returned. The return rate was 47.5%.

Sample

The sample consisted of a total of 57 secondary school PE teachers ($M_{(age)}$=48.84 years; SD=1.39). Among the PE teachers, 26 were male and 31 were female. The average of years of experience was 19.67 years (SD=1.41). Therefore, the sample consisted of in-service PE teachers that have been working in their profession for such a long time that they can surely be treated as established and well experienced overall. All PE teachers had at least one PC or laptop in their respective household. There were no statistically significant differences in age or professional experience (years in service) according to gender (t-tests; $p>0.05$). The descriptive characteristics of the sample are shown in Table 1.

Table 1: Descriptive characteristics of study sample

Variables		N	%	Mean (M)	Standard Deviation (SD)
Age	Male	26	45.6	49.80	1.94
	Female	31	54.4	47.56	1.92
	Total	57	100	48.84	1.39
Professional Experience (Years in Service)	Male	26	45.6	16.56	1.96
	Female	31	54.4	18.70	2.10
	Total	57	100	19.67	1.41

Data Analysis

The survey data was analyzed using quantitative-research statistical-analysis methods (frequencies, t-test, reliability analysis, and (one-way) analysis of variance (ANOVA) including Tukey's HSD post-hoc test. The software IBM SPSS Statistics (Version 21) for Mac OS was used to perform the statistical procedures.

RESULTS

The subjective theory-results are presented to the degree of detail that in addition to means and standard deviations, percentages and frequencies for all values are given (Tables 2-9). This modus of presentation allows an in-depth showing of distribution and tendencies for each item within the sample group. Following the comprehensive data-presentation of the assessed subjective theories, the relations of gender, computer literacy, household computer ownership, and professional experience (years in service) to the PE teachers' subjective theories are presented.

Student-Related Subjective Theories

Looking at the subjective theories of the PE teachers in regard to pedagogical benefit generated for the students, the majority of the PE teachers tended to be undecided (S3, S4, S5, S6, S7, S8). The PE teachers rather thought that the use of ICT in PE promotes teamwork, and social and communicative learning (S2, S9). However, the vast majority of the PE teachers agreed that unmotivated students in PE can't be engaged by any ICT setting (S1). Although nearly half of the PE teachers were uncertain whether boys get more into ICT than girls, the other half nearly split their opinion on agreeing and disagreeing for this subjective theory (S10). Nonetheless, there was a slight tendency towards disagreement within S10. The complete findings according to student-related subjective theories are shown in Table 2.

Table 2: Student-Related Subjective Theories

Index	Subjective Theory	Strongly Agree (N) (%)	Agree (N) (%)	Uncertain (N) (%)	Disagree (N) (%)	Strongly Disagree (N) (%)	Mean (M)	Standard Deviation (SD)
S1	Students' study motivation can be increased by integrating ICT.	18 (31.6)	17 (29.8)	17 (29.8)	5 (8.8)	0 (0.0)	3.84	0.13
S2	Working with a Laptop is a team activity.	1 (1.8)	3 (5.3)	24 (42.1)	24 (42.1)	5 (8.8)	2.49	0.18
S3	Students can gather new information on their own.	2 (3.5)	15 (26.3)	30 (52.6)	9 (15.8)	1 (1.8)	3.14	0.19
S4	ICT-supported education is as equal effective in regard to learning outcomes as traditional education.	1 (1.8)	13 (22.8)	21 (36.8)	19 (33.3)	3 (5.3)	2.82	0.14
S5	Instructional tips, hints, and images on the computer make students become more adventurous.	4 (7.0)	8 (14.0)	29 (50.9)	14 (24.6)	2 (3.5)	2.96	0.17
S6	Not actively participating students can be mentors and advisors at PCs.	2 (3.5)	22 (38.6)	16 (28.1)	15 (26.3)	2 (3.5)	3.12	0.14
S7	If students are not motivated, ICT will not motivate them anyways.	20 (35.1)	29 (50.9)	5 (8.8)	2 (3.5)	1 (1.8)	4.14	0.20
S8	ICT integration fosters independent learning.	0 (0.0)	11 (19.3)	32 (56.1)	10 (17.5)	4 (7.0)	2.88	0.19
S9	ICT integration fosters social and communicative learning.	0 (0.0)	3 (5.3)	25 (43.9)	23 (40.4)	6 (10.5)	2.44	0.18
S10	Boys get more into ICT in PE than girls.	2 (3.5)	10 (17.5)	26 (45.6)	15 (26.3)	4 (7.0)	2.84	0.24

Teaching-Related Subjective Theories

Regarding the PE teachers' teacher-related subjective theories, the PE teachers seemed to be satisfied with their current teaching strategies (T1, T3, T6). They clearly favored traditional teaching resources such as images or a blackboard over ICT (T2). The overwhelming majority saw manifold movement, exploration, and free trial as the center of PE (T7). Nevertheless, the PE teachers deemed instructional technology such as animated images and video worthy of being useful in motor learning and feedback processes (T4, T6). A slight majority of the PE teachers would not use internet-searches as homework in PE. However, one third was uncertain about the benefit of internet-searches and close to 20% of the PE teachers would use them for homework in PE (T5). The complete findings according to teaching-related subjective theories are shown in Table 3.

Table 3: Teaching-Related Subjective Theories

Index	Subjective Theory	Strongly Agree (N) (%)	Agree (N) (%)	Uncertain (N) (%)	Disagree (N) (%)	Strongly Disagree (N) (%)	Mean (M)	Standard Deviation (SD)
T1	ICT integration does not lead to better content knowledge.	4 (7.0)	16 (28.1)	23 (40.4)	12 (21.1)	2 (3.5)	3.14	0.21
T2	Media as blackboard and (printed) images are more suitable in physical education.	7 (12.3)	22 (38.6)	16 (28.1)	7 (12.3)	5 (8.8)	3.33	0.19
T3	My teaching in physical education is successful without integrating any technology.	14 (24.6)	20 (35.1)	20 (35.1)	3 (5.3)	0 (0.0)	3.79	0.22
T4	Animated images (or short videos) can illustrate the diverse aspects of a movement or a technique well.	24 (42.1)	25 (43.9)	7 (12.3)	1 (1.8)	0 (0.0)	4.26	0.28
T5	Internet searches (e.g. ball games) are well suited as homework.	1 (1.8)	10 (17.5)	18 (31.6)	22 (38.6)	6 (10.5)	2.61	0.22
T6	Video recordings are better for individual feedback than personal feedback of the PE teacher.	9 (15.8)	13 (22.8)	24 (42.1)	8 (14.0)	3 (5.3)	3.30	0.19
T7	Despite ICT integrating, manifold movement, exploration, and free trial should remain the	45 (78.9)	9 (15.8)	3 (5.3)	0 (0.0)	0 (0.0)	4.74	0.45

	focus of the PE lesson.							
T8	Using educational software, PE content knowledge can be learned playfully.	0 (0.0)	13 (22.8)	26 (45.6)	14 (24.6)	4 (7.0)	2.84	0.25

Teacher-Related Subjective Theories

With regard to their own teaching load, the PE teachers perceived ICT rather as a burden than as a relief (TE2). Using video in PE would mean a thorough time-consuming preparation and post-processing as well as careful and focused guiding within the PE lesson (TE1). The PE teachers thought that ICT is not useful in motivating students (TE4), but saw an advantage in faster processing digital assessment data (TE7). However, the PE teachers tended to understand ICT as an important motor for professional teaching development (TE3). The majority of the PE teachers were uncertain about a gain in reputation with their students when integrating ICT in PE (TE5). They were also undecided about switching to a moderator role while using ICT in PE (TE6). The complete findings according to teacher-related subjective theories are shown in Table 4.

Table 4: Teacher-Related Subjective Theories

Index	Subjective Theory	Strongly Agree (N) (%)	Agree (N) (%)	Uncertain (N) (%)	Disagree (N) (%)	Strongly Disagree (N) (%)	Mean (M)	Standard Deviation (SD)
TE1	Using video in PE means thorough preparation, guidance, and post-processing by the teacher.	24 (42.1)	28 (49.1)	5 (8.8)	0 (0.0)	0 (0.0)	4.33	0.32
TE2	The physical education teacher is relieved through self-reliant learning scenarios using laptops.	0 (0.0)	8 (14.0)	15 (26.3)	31 (54.4)	3 (5.3)	2.49	0.30
TE3	ICT is the building block of the development of new teaching and learning methods.	7 (12.3)	24 (42.1)	23 (40.4)	3 (5.3)	0 (0.0)	3.61	0.26
TE4	I do not need ICT for getting students motivated.	26 (45.6)	19 (33.3)	8 (14.0)	4 (7.0)	0 (0.0)	4.18	0.25
TE5	Using modern teaching methods increases my reputation with the students.	3 (5.3)	13 (22.8)	23 (40.4)	16 (28.1)	2 (3.5)	2.98	0.21
TE6	To give the students more freedom, I gladly switch to the role of a moderator.	8 (14.0)	13 (22.8)	18 (31.6)	17 (29.8)	1 (1.8)	3.18	0.16
TE7	Computer programs facilitate a fast sorting and analyzing of assessment data (e.g. competition results).	37 (64.9)	16 (28.1)	3 (5.3)	1 (1.8)	0 (0.0)	4.56	0.37

Equipment-Related Subjective Theories

Most of the PE teachers perceived their available PE equipment not being outdated (E1), but stated that their school's instructional videos were outdated (E7). Almost half of them disregarded their respective school as a factor in ICT diversity, although the other half split its thoughts about their school to be an ICT diversity facilitator or hinderer (E4). In sum, the prospect of new, modern ICT equipment didn't seem to influence the PE teachers' teaching philosophies and habits (E2, E3, E5, E6). The complete findings according to equipment-related subjective theories are shown in Table 5.

Table 5: Equipment-Related Subjective Theories

Index	Subjective Theory	Strongly Agree (N) (%)	Agree (N) (%)	Uncertain (N) (%)	Disagree (N) (%)	Strongly Disagree (N) (%)	Mean (M)	Standard Deviation (SD)
E1	Most of our school's PE equipment is so outdated that it does not meat current standards.	4 (7.0)	7 (12.3)	18 (31.6)	22 (38.6)	6 (10.5)	2.67	0.20
E2	Our school can't afford to buy new PE equipment.	11 (19.3)	11 (19.3)	15 (26.3)	16 (28.1)	4 (7.0)	3.16	0.13
E3	Even if the equipment were there, I would not use ICT in PE.	7 (12.3)	10 (17.5)	15 (26.3)	17 (29.8)	8 (14.0)	2.84	0.13
E4	Our school supports ICT diversity.	4 (7.0)	15 (26.3)	26 (45.6)	9 (15.8)	3 (5.3)	3.14	0.23
E5	I would absolutely integrate ICT into my PE lessons, if it would be available.	9 (15.8)	9 (15.8)	22 (38.6)	15 (26.3)	2 (3.5)	3.14	0.18
E6	I think it would be more sensible to refurbish or expand our PE-related facilities than purchasing ICT.	21 (36.8)	17 (29.8)	13 (22.8)	5 (8.8)	1 (1.8)	3.91	0.19
E7	The instructional videos at our school are outdated.	21 (36.8)	19 (33.3)	12 (21.1)	2 (3.5)	3 (5.3)	3.93	0.21

Computer Literacy-Related Subjective Theories

The PE teachers felt that they were not as ICT competent as their students (CL9), and that younger teacher colleagues are more self-confident and engaged in using ICT (CL5). Nonetheless, most of the PE teachers were interested in continuing education events that feature ICT and PE (CL6). Although the feeling of not having sufficient knowledge was rather equally distributed (CL1), the majority of the PE teachers thought they had too little knowledge about possible pedagogical scenarios using ICT in PE (CL2). Even if their computer literacy were better, the PE teachers tended to decline using ICT in PE more often (CL3). The vast majority of PE teachers stated that they don't use ICT in PE because they are afraid of making a fool out of themselves in front of their students (CL7). The fact that the PE teachers didn't use ICT in PE frequently to prove their skills accompanies the results in regard to CL7 (CL8). However, most PE teachers believed that there were a lot of useful webpages for PE lessons available (CL4). The complete findings according to computer literacy-related subjective theories are shown in Table 6.

Table 6: Computer Literacy-Related Subjective Theories

Index	Subjective Theory	Strongly Agree (N) (%)	Agree (N) (%)	Uncertain (N) (%)	Disagree (N) (%)	Strongly Disagree (N) (%)	Mean (M)	Standard Deviation (SD)
CL1	I do not have sufficient experience to integrate ICT in PE.	5 (8.8)	12 (21.1)	19 (33.3)	13 (22.8)	8 (14.0)	2.88	0.15
CL2	I have too few knowledge about possible pedagogical scenarios using ICT in PE.	15 (26.3)	20 (35.1)	11 (19.3)	7 (12.3)	4 (7.0)	3.61	0.16
CL3	If my computer literacy were better, I would use ICT in PE more often.	3 (5.3)	9 (15.8)	12 (21.1)	22 (38.6)	11 (19.3)	2.49	0.18
CL4	There are many webpages containing ideas for diversified PE lessons.	11 (19.3)	20 (35.1)	18 (31.6)	6 (10.5)	2 (3.5)	3.56	0.18
CL5	Younger PE teacher colleagues are more engaged into ICT integration.	5 (8.8)	26 (45.6)	15 (26.3)	11 (19.3)	0 (0.0)	3.44	0.23
CL6	I am not interested in continuing education events in the area of ICT and PE.	9 (15.8)	5 (8.8)	12 (21.1)	24 (42.1)	7 (12.3)	2.74	0.19
CL7	I do not use ICT in PE because I am afraid to make a fool out of myself in front of the students.	1 (1.8)	7 (12.3)	3 (5.3)	23 (40.4)	23 (40.4)	1.95	0.22
CL8	I use ICT frequently to prove my ICT skills.	0 (0.0)	2 (3.5)	6 (10.5)	18 (31.6)	31 (54.4)	1.63	0.21
CL9	My students are better in using ICT than I am.	11 (19.3)	15 (26.3)	18 (31.6)	10 (17.5)	3 (5.3)	3.37	0.14

Classroom Management and Organization-Related Subjective Theories

Perceived massive teaching and administration workload is probably one of the reasons that prevent PE teachers from using ICT in PE (C1, C2, C3). Moreover, most of the PE teachers believed that integrating ICT takes away movement time from the PE lesson (C4). On the other hand, the majority of the PE teachers thought that ICT is good for preparing PE lessons (C5). Although the results for the value of using ICT to plan complex PE settings were nearly equally distributed, there was a slight tendency that the PE teachers neglect this statement (C6). Most of the PE teachers stated that ICT in PE is placed best into the last two years of secondary school education (C7). As one third of the PE teachers were undecided whether there is a fair relation between learning outcomes efficiency and ICT preparation effort when using ICT in PE (C8), about 50% of the PE teachers wouldn't say that there was a fair relation (C8). The complete findings according to classroom management and organization-related subjective theories are shown in Table 7.

Table 7: Classroom Management and Organization-Related Subjective Theories

Index	Subjective Theory	Strongly Agree (N) (%)	Agree (N) (%)	Uncertain (N) (%)	Disagree (N) (%)	Strongly Disagree (N) (%)	Mean (M)	Standard Deviation (SD)
C1	I can't integrate ICT because I am under time pressure to include the content standards completely.	5 (8.8)	14 (24.6)	14 (24.6)	17 (29.8)	7 (12.3)	2.88	0.14
C2	If I had smaller class sizes, I could imagine using ICT in PE.	5 (8.8)	21 (36.8)	16 (28.1)	11 (19.3)	4 (7.0)	3.21	0.18
C3	PE class time is too short to use ICT.	15 (26.3)	19 (33.3)	10 (17.5)	12 (21.1)	1 (1.8)	3.61	0.16
C4	The use of ICT decreases PE movement time.	13 (22.8)	18 (31.6)	17 (29.8)	6 (10.5)	3 (5.3)	3.56	0.16
C5	ICT is good for preparing PE lessons.	15 (26.3)	23 (40.4)	12 (21.1)	7 (12.3)	0 (0.0)	3.81	0.20
C6	A complex PE equipment set-up	3	12	17	16	9	2.72	0.16

	can easily be planned using ICT.	(5.3)	(21.1)	(29.8)	(28.1)	(15.8)		
C7	ICT is most likely placed best in the last two years of secondary school PE.	10 (17.5)	30 (52.6)	13 (22.8)	3 (5.3)	1 (1.8)	3.79	0.27
C8	Preparation effort and learning outcome efficiency are in fair relation to each other when using ICT in PE.	1 (1.8)	8 (14.0)	19 (33.3)	26 (45.6)	3 (5.3)	2.61	0.26

Social Interaction-Related Subjective Theories

While about 40% of the PE teachers were uncertain whether students learn to use ICT at home or not, close to 50% agreed that students learn to use ICT at home (SO1). About half of the PE teachers were uncertain whether demonstrating a movement or technique by a student is more efficient than using video (SO2). The other half of the PE teachers spread their opinions regarding SO2 almost equally on agreeing and disagreeing. About 50% of the PE teachers didn't think that working with a laptop in PE increases teamwork among students (SO3), whereas about 40% were uncertain about SO3. A similar distribution was assessed for the PE teachers' opinions about the positive effect of ICT on collaboration among other teacher colleagues (SO4).

Concerning the subjective theories that stated that the student-teacher relationship would suffer when using ICT in PE (SO5) and whether a webpage for their PE classes would be useful (SO6), the PE teachers' opinions were about equally distributed on agreement, disagreement, and uncertainty. Although there was a tendency towards disagreeing that internet forums would be helpful in communicating and comparing notes with PE teachers located at various schools (SO8), the overall distribution was similar to the subjective theories SO4 and SO5. Furthermore, the vast majority of PE teachers (more than 80%) held the opinion that playing sports and movement games increase PE enjoyment and facilitate communication better than ICT (SO8). The complete findings according to social interaction-related subjective theories are shown in Table 8.

Table 8: Social Interaction-Related Subjective Theories

Index	Subjective Theory	Strongly Agree (N) (%)	Agree (N) (%)	Uncertain (N) (%)	Disagree (N) (%)	Strongly Disagree (N) (%)	Mean (M)	Standard Deviation (SD)
SO1	Students learn to use ICT at home.	5 (8.8)	23 (40.4)	23 (40.4)	4 (7.0)	2 (3.5)	3.44	0.25
SO2	Demonstrating a movement or technique by a student is more efficient than using video.	4 (7.0)	14 (24.6)	30 (52.6)	7 (12.3)	2 (3.5)	3.19	0.27
SO3	Letting students work with a laptop in PE fosters their ability to work in a team (collaboration, communication in groups).	1 (1.8)	7 (12.3)	22 (38.6)	22 (38.6)	5 (8.8)	2.60	0.24
SO4	Using ICT in PE facilitates collaboration among teacher colleagues.	1 (1.8)	8 (14.0)	19 (33.3)	25 (43.9)	4 (7.0)	2.60	0.25
SO5	Using ICT in PE frequently makes the personal teacher-student relationship suffer.	5 (8.8)	10 (17.5)	16 (28.1)	20 (35.1)	6 (10.5)	2.79	0.17
SO6	A webpage for our PE classes would be useful.	6 (10.5)	11 (19.3)	16 (28.1)	15 (26.3)	9 (15.8)	2.82	0.13
SO7	Playing sports and movement games increase PE enjoyment and facilitate communication better than ICT.	27 (47.4)	20 (35.1)	9 (15.8)	1 (1.8)	0 (0.0)	4.28	0.27
SO8	Internet forums are helpful for PE teachers located at various schools to communicate and compare notes.	0 (0.0)	15 (26.3)	21 (36.8)	17 (29.8)	4 (7.0)	2.82	0.22

Innovative and Modern Teaching-Related Subjective Theories

The PE teachers' opinions, whether ICT belongs into PE class due to its ubiquitousness in todays' youth's lives, were equally distributed according to agreement, disagreement, and uncertainty (I1). Moreover, the PE teachers were relatively undecided whether modern (PE) teaching promotes ICT or not (I3). The PE teachers' opinions about the increased importance of ICT in PE in the future were also nearly equally distributed (I5). The majority of the PE teachers (75%) stated that they don't believe that ICT can replace traditional teaching, but can very well accompany it successfully (I6). Furthermore, the PE teachers haven't frequently heard from PE teachers from other schools that they used ICT in their respective PE classes (I7).

When it came to using ICT for school projects and after school programs, the majority of the PE teachers would use it for this occasions (I2). About 40% of the PE teachers thought that PETE programs should be infused with

more ICT, as 45% were uncertain about this statement (I4). The complete findings according to innovative and modern teaching-related subjective theories are shown in Table 9.

Table 9: Innovative and Modern Teaching-Related Subjective Theories

Index	Subjective Theory	Strongly Agree (N) (%)	Agree (N) (%)	Uncertain (N) (%)	Disagree (N) (%)	Strongly Disagree (N) (%)	Mean (M)	Standard Deviation (SD)
I1	Even though ICT is ubiquitous in the lives of children and adolescents, it does not belong into PE class.	3 (5.3)	16 (28.1)	17 (29.8)	19 (33.3)	2 (3.5)	2.98	0.20
I2	I could imagine ICT in PE-related school projects or after school programs.	16 (28.1)	24 (42.1)	15 (26.3)	2 (3.5)	0 (0.0)	3.95	0.23
I3	Modern (PE) teaching promotes ICT integration.	3 (5.3)	11 (19.3)	22 (38.6)	17 (29.8)	4 (7.0)	2.86	0.20
I4	ICT should play a bigger role in physical education teacher education programs.	4 (7.0)	21 (36.8)	26 (45.6)	5 (8.8)	1 (1.8)	3.39	0.26
I5	The importance of ICT in PE will increase in the future.	0 (0.0)	15 (26.3)	22 (38.6)	17 (29.8)	3 (5.3)	2.86	0.23
I6	ICT can't replace traditional teaching and learning methods, but complement and accompany it successfully.	14 (24.6)	29 (50.9)	10 (17.5)	3 (5.3)	1 (1.8)	3.91	0.26
I7	I frequently heard from other schools' PE teachers that they use ICT in their respective PE classes.	1 (1.8)	2 (3.5)	7 (12.3)	27 (47.4)	20 (35.1)	1.89	0.26

Gender and Subjective Theories

T-tests were performed to determine whether there was a relation between the subjective theories and gender. Among the 64 subjective theories, eight subjective theories showed statistically significant differences in regard to gender ($p<0.05$). No teaching-related, no equipment-related, and no classroom management and organization-related subjective theory showed statistically significant differences ($p>0.05$). To avoid excessive statistical reporting of statistically insignificant results and to remain brief, only the values of the statistically significant differences regarding gender are reported in Table 10.

Table 10: Gender and Subjective Theories about ICT and PE

Index	Subjective Theory	Gender	N	Mean (M)	Standard Deviation (SD)	t-Value	Significance
S6	Not actively participating students can be mentors and advisors at PCs.	Female	31	2.77	0.809	-2.735	0.008
		Male	26	3.42	1.203		
TE7	Despite ICT integrating, manifold movement, exploration, and free trial should remain the focus of the PE lesson.	Female	31	4.77	0.838	2.715	0.009
		Male	26	4.31	1.181		
M1	I do not have sufficient experience to integrate ICT in PE.	Female	31	3.16	1.272	2.066	0.044
		Male	26	2.54	1.279		
M3	If my computer literacy were better, I would use ICT in PE more often.	Female	31	2.77	0.784	2.117	0.039
		Male	26	2.15	1.321		
SO7	Playing sports and movement games increase PE enjoyment and facilitate communication better than ICT.	Female	31	4.48	0.744	2.019	0.048
		Male	26	4.08	0.832		
I4	ICT should play a bigger role in physical education teacher education programs.	Female	31	3.61	0.801	2.03	0.047
		Male	26	3.19	0.969		
I5	The importance of ICT in PE will increase in the future.	Female	31	2.65	0.864	-2.08	0.042
		Male	26	3.12	0.956		
I7	I frequently heard from other schools' PE teachers that they use ICT in their respective PE classes.	Female	31	1.68	0.881	-2.097	0.041
		Male	26	2.15	0.934		

For the subjective theory S6 (“Not actively participating students can be mentors and advisors at PCs.”), male PE teachers (M=3.42) had a statistically significant higher mean score than female PE teachers (M=2.77) (t=-2.735, p=0.008). For the subjective theory TE7 (“Despite ICT integrating, manifold movement, exploration, and free trial should remain the focus of the PE lesson.”), female PE teachers (M=4.77) had a statistically significant higher mean score than male PE teachers (M=4.31) (t=2.715, p=0.009).

For the subjective theory M1 (“I do not have sufficient experience to integrate ICT in PE.”), female PE teachers (M=3.16) had a statistically significant higher mean score than male PE teachers (M=2.54) (t=2.066, p=0.044). For the subjective theory M3 (“If my computer literacy were better, I would use ICT in PE more often.”), female

PE teachers (M=2.77) had a statistically significant higher mean score than male PE teachers (M=2.15) (t=2.117, p=0.039).

For the subjective theory SO7 ("Playing sports and movement games increase PE enjoyment and facilitate communication better than ICT."), female PE teachers (M=2.77) had a statistically significant higher mean score than male PE teachers (M=2.15) (t=2.117, p=0.039).

For the subjective theory I4 ("ICT should play a bigger role in physical education teacher education programs."), female PE teachers (M=3.61) had a statistically significant higher mean score than male PE teachers (M=3.19) (t=2.03, p=0.047). For the subjective theory I5 ("The importance of ICT in PE will increase in the future."), male PE teachers (M=3.12) had a statistically significant higher mean score than female PE teachers (M=2.65) (t=-2.08, p=0.042). For the subjective theory I7 ("I frequently heard from other schools' PE teachers that they use ICT in their respective PE classes."), male PE teachers (M=2.15) had a statistically significant higher mean score than female PE teachers (M=1.68) (t=-2.097, p=0.041).

Computer Literacy and Subjective Theories

For assessing the PE teachers' computer literacy, a 10-item subscale was used within the questionnaire. The items were 5-point Likert-scaled (5=very good, 1=very poor). The scale returned an excellent reliability score (Cronbach's alpha=0.90). There were no statistically significant differences in gender (p>0.05), except for the item "Installation of Hardware" (t=-3.006, p=0.004). The single item scores are shown in Table 11.

Table 11: PE Teacher's Computer Literacy

Item	Mean (M)			Standard Deviation (SD)		
	Female	Male	Total	Female	Male	Total
Installation of Hardware	2.13	3.08	2.56	0.23	0.21	1.27
Installation of Software	2.90	3.42	3.14	0.20	0.21	1.13
Using Word Processing Software	3.94	3.77	3.86	0.17	0.18	0.92
Using Educational Software	3.10	2.92	3.02	0.19	0.21	1.08
Using the Internet	4.04	3.81	3.93	0.14	0.15	0.75
Designing a Webpage	1.77	1.81	1.79	0.18	0.24	1.11
Graphics Editing Software	2.81	3.19	2.98	0.22	0.23	1.17
Video Editing Software	1.65	2.23	1.91	0.18	0.25	1.14
Audio Editing Software	1.74	2.23	1.96	0.19	0.25	1.16
Knowledge to Include ICT in Education	2.81	2.96	2.88	0.19	0.20	1.02

To investigate the influence of computer literacy on the PE teachers' subjective theories, the PE teachers were grouped into three groups in regard to their computer literacy mean scores (low computer literacy level, average computer literacy level, and high computer literacy level). After that, a one-way analysis of variance (ANOVA) accompanied with a Tukey's HSD post-hoc test was conducted. Among the 64 subjective theories, 13 subjective theories showed statistically significant differences in regard to computer literacy levels (p<0.05). No teaching-related, no teacher-related, and no innovative and modern teaching-related subjective theory showed statistically significant differences (p>0.05).

For the subjective theory S3 ("Students can gather new information on their own."), PE teachers' computer literacy levels differed statistically significantly (F=3.458, p=0.039). PE teachers with an average computer literacy level score showed a statistically significantly higher mean (M=3.41) than PE teachers with a high computer literacy level score (M=2.86) (p=0.036).

For the subjective theory S4 ("ICT-supported education is as equal effective in regard to learning outcomes as traditional education."), PE teachers' computer literacy levels differed statistically significantly (F=4.520, p=0.015). PE teachers with a low computer literacy level score showed a statistically significantly higher mean (M=3.60) than PE teachers with a high computer literacy level score (M=2.57) (p=0.012).

For the subjective theory S5 ("Instructional tips, hints, and images on the computer make students become more adventurous."), PE teachers' computer literacy levels differed statistically significantly (F=6.273, p=0.004). PE teachers with a low computer literacy level score showed a statistically significantly higher mean (M=3.80) than PE teachers with an average computer literacy level score (M=2.85) (p=0.009) and PE teachers with a high computer literacy level (M=2.71) (p=0.004).

For the subjective theory S9 (“ICT integration fosters social and communicative learning.”), PE teachers’ computer literacy levels differed statistically significantly (F=3.923, p=0.026). PE teachers with a low computer literacy level score showed a statistically significantly higher mean (M=2.90) than PE teachers with a high computer literacy level score (M=2.14) (p=0.022).

For the subjective theory E5 (“I would absolutely integrate ICT into my PE lessons, if it would be available.”), PE teachers’ computer literacy levels differed statistically significantly (F=3.923, p=0.026). A Tukey’s HSD post-hoc test didn’t show any statistically significantly differences between the computer literacy level groups.

For the subjective theory CL1 (“I do not have sufficient experience to integrate ICT in PE.”), PE teachers’ computer literacy levels differed statistically significantly (F=13.292, p<0.001). PE teachers with a low computer literacy level score showed a statistically significantly lower mean (M=1.60) than PE teachers with an average computer literacy level score (M=2.85) (p=0.003) and PE teachers with a high computer literacy level score (M=3.52) (p<0.001).

For the subjective theory CL2 (“I have too few knowledge about possible pedagogical scenarios using ICT in PE.”), PE teachers’ computer literacy levels differed statistically significantly (F=15.938, p<0.001). PE teachers with a low computer literacy level score showed a statistically significantly lower mean (M=2.10) than PE teachers with an average computer literacy level score (M=3.73) (p<0.001) and PE teachers with a high computer literacy level score (M=4.19) (p<0.001).

For the subjective theory CL3 (“If my computer literacy were better, I would use ICT in PE more often.”), PE teachers’ computer literacy levels differed statistically significantly (F=4.770, p=0.012). PE teachers with a low computer literacy level score showed a statistically significantly lower mean (M=1.70) than PE teachers with a high computer literacy level score (M=2.95) (p=0.010).

For the subjective theory CL7 (“I do not use ICT in PE because I am afraid to make a fool out of myself in front of the students.”), PE teachers’ computer literacy levels differed statistically significantly (F=4.890, p=0.011). PE teachers with a low computer literacy level score showed a statistically significantly lower mean (M=1.20) than PE teachers with a high computer literacy level score (M=2.38) (p=0.009).

For the subjective theory CL8 (“I use ICT frequently to prove my ICT skills.”), PE teachers’ computer literacy levels differed statistically significantly (F=5.118, p=0.009). PE teachers with a low computer literacy level score showed a statistically significantly higher mean (M=2.10) than PE teachers with a high computer literacy level score (M=1.24) (p=0.013).

For the subjective theory CL9 (“My students are better in using ICT than I am.”), PE teachers’ computer literacy levels differed statistically significantly (F=11.090, p<0.001). PE teachers with a high computer literacy level score showed a statistically significantly higher mean (M=4.14) than PE teachers with a low computer literacy level score (M=2.60) (p<0.001) and PE teachers with an average computer literacy level score (M=3.04) (p=0.001).

For the subjective theory C1 (“I can't integrate ICT because I am under time pressure to include the content standards completely.”), PE teachers’ computer literacy levels differed statistically significantly (F=3.753, p=0.030). A Tukey’s HSD post-hoc test didn’t show any statistically significantly differences between the computer literacy level groups.

For the subjective theory C8 (“Preparation effort and learning outcome efficiency are in fair relation to each other when using ICT in PE.”), PE teachers’ computer literacy levels differed statistically significantly (F=3.460, p=0.039). PE teachers with an average computer literacy level score showed a statistically significantly higher mean (M=2.85) than PE teachers with a high computer literacy level score (M=2.24) (p=0.039).

In reference to the same intention as for Table 10, to avoid excessive statistical reporting of statistically insignificant results and to remain brief, only the values of the statistically significant differences regarding the PE teachers’ computer literacy levels are reported in Table 12.

Table 12: ANOVA for PE Teachers' Subjective Theories and Computer Literacy

Index	Subjective Theory	Computer Literacy Level	N	Mean (M)	F-Value	p-Value	Difference (Tukey)	Difference p-Value
S3	Students can gather new information on their own.	Low	10	3.00	3.458	0.039	Low, Average	0.298
		Average	26	3.41			Low, High	0.876
		High	21	2.86			Average, High	0.036
S4	ICT-supported education is as equal effective in regard to learning outcomes as traditional education.	Low	10	3.60	4.520	0.015	Low, Average	0.055
		Average	26	2.81			Low, High	0.012
		High	21	2.57			Average, High	0.645
S5	Instructional tips, hints, and images on the computer make students become more adventurous.	Low	10	3.80	6.273	0.004	Low, Average	0.009
		Average	26	2.85			Low, High	0.004
		High	21	2.71			Average, High	0.851
S9	ICT integration fosters social and communicative learning.	Low	10	2.90	3.923	0.026	Low, Average	0.302
		Average	26	2.50			Low, High	0.022
		High	21	2.14			Average, High	0.218
E5	I would absolutely integrate ICT into my PE lessons, if it would be available.	Low	10	3.70	3.347	0.043	Low, Average	0.538
		Average	26	3.27			Low, High	0.954
		High	21	2.71			Average, High	0.202
CL1	I do not have sufficient experience to integrate ICT in PE.	Low	10	1.60	13.292	<0.001	Low, Average	0.003
		Average	26	2.85			Low, High	<0.001
		High	21	3.52			Average, High	0.054
CL2	I have too few knowledge about possible pedagogical scenarios using ICT in PE.	Low	10	2.10	15.938	<0.001	Low, Average	<0.001
		Average	26	3.73			Low, High	<0.001
		High	21	4.19			Average, High	0.251
CL3	If my computer literacy were better, I would use ICT in PE more often.	Low	10	1.70	4.770	0.012	Low, Average	0.172
		Average	26	2.42			Low, High	0.010
		High	21	2.95			Average, High	0.218
CL7	I do not use ICT in PE because I am afraid to make a fool out of myself in front of the students.	Low	10	1.20	4.890	0.011	Low, Average	0.162
		Average	26	1.88			Low, High	0.009
		High	21	2.38			Average, High	0.213
CL8	I use ICT frequently to prove my ICT skills.	Low	10	2.10	5.118	0.009	Low, Average	0.478
		Average	26	1.77			Low, High	0.013
		High	21	1.24			Average, High	0.054
CL9	My students are better in using ICT than I am.	Low	10	2.60	11.090	<0.001	Low, Average	0.457
		Average	26	3.04			Low, High	<0.001
		High	21	4.14			Average, High	0.001
C1	I can't integrate ICT because I am under time pressure to include the content standards completely.	Low	10	2.30	3.753	0.030	Low, Average	0.067
		Average	26	3.27			Low, High	0.867
		High	21	2.52			Average, High	0.076
C8	Preparation effort and learning outcome efficiency are in fair relation to each other when using ICT in PE.	Low	10	2.80	3.460	0.039	Low, Average	0.988
		Average	26	2.85			Low, High	0.189
		High	21	2.24			Average, High	0.039

Household Computer Ownership and Subjective Theories

To investigate the influence of household computer ownership on the PE teachers' subjective theories, the PE teachers were grouped into three groups in regard to the number of computers (including laptops) in their household (1, 2, and 3 or more). After that, a one-way ANOVA accompanied with a Tukey's HSD post-hoc test was conducted. Among the 64 subjective theories, only five subjective theories showed statistically significant differences regarding household computer ownership ($p<0.05$). No student-related, no teaching-related, no teacher-related, no social interaction-related, and no innovative and modern teaching-related subjective theory showed statistically significant differences ($p>0.05$).

For the subjective theory E7 ("The instructional videos at our school are outdated."), PE teachers' number of owned household computers differed statistically significantly ($F=4.047$, $p=0.023$). PE teachers with only one owned household computer showed a statistically significantly higher mean ($M=4.64$) than PE teachers with three or more owned household computers ($M=3.58$) ($p=0.018$).

For the subjective theory CL1 ("I do not have sufficient experience to integrate ICT in PE."), PE teachers' number of owned household computers differed statistically significantly ($F=3.277$, $p=0.045$). PE teachers with only one owned household computer showed a statistically significantly higher mean ($M=3.64$) than PE teachers with three or more owned household computers ($M=2.62$) ($p=0.037$).

For the subjective theory CL3 ("If my computer literacy were better, I would use ICT in PE more often."), PE teachers' number of owned household computers differed statistically significantly ($F=5.068$, $p=0.010$). PE

teachers with only one owned household computer showed a statistically significantly higher mean (M=3.27) than PE teachers with three or more owned household computers (M=2.08) (p=0.008).

For the subjective theory CL5 ("If my computer literacy were better, I would use ICT in PE more often."), PE teachers' number of owned household computers differed statistically significantly (F=4.623, p=0.014). PE teachers with only one owned household computer showed a statistically significantly higher mean (M=3.91) than PE teachers with three or more owned household computers (M=23.08) (p=0.024).

For the subjective theory C1 ("I can't integrate ICT because I am under time pressure to include the content standards completely."), PE teachers' computer literacy levels differed statistically significantly (F=3.537, p=0.036). PE teachers with only one owned household computer showed a statistically significantly lower mean (M=2.00) than PE teachers with two owned household computers (M=3.05) (p=0.047) and PE teachers with three or more owned household computers (M=3.00) (p=0.048).

Again, to avoid excessive statistical reporting of statistically insignificant results and to remain brief, only the values of the statistically significant differences regarding the PE teachers' household computers ownership are reported in Table 13.

Table 13: ANOVA for PE Teachers' Subjective Theories and Household Computer Ownership

Index	Subjective Theory	Household Computers	N	Mean (M)	F-Value	p-Value	Difference (Tukey)	Difference p-Value
E7	The instructional videos at our school are outdated.	1	11	4.64	4.047	0.023	1,2	0.245
		2	20	4.00			1, 3 or more	0.018
		3 or more	26	3.58			2, 3 or more	0.368
CL1	I do not have sufficient experience to integrate ICT in PE.	1	11	3.64	3.277	0.045	1,2	0.125
		2	20	3.80			1, 3 or more	0.037
		3 or more	26	2.62			2, 3 or more	0.845
CL3	If my computer literacy were better, I would use ICT in PE more often.	1	11	3.27	5.068	0.010	1,2	0.219
		2	20	2.60			1, 3 or more	0.008
		3 or more	26	2.08			2, 3 or more	0.231
CL5	Younger PE teacher colleagues are more engaged into ICT integration.	1	11	3.91	4.623	0.014	1,2	0.699
		2	20	3.65			1, 3 or more	0.024
		3 or more	26	3.08			2, 3 or more	0.071
C1	I can't integrate ICT because I am under time pressure to include the content standards completely.	1	11	2.00	3.537	0.036	1,2	0.047
		2	20	3.05			1, 3 or more	0.048
		3 or more	26	3.00			2, 3 or more	0.988

Professional Experience (Years in Service) and Subjective Theories

To investigate the influence of the PE teachers' professional experience (years in service) on their subjective theories, the PE teachers were grouped into three groups in regard to the years they were in service (1-10, 11-20, and 21 or more). After that, a one-way ANOVA accompanied with a Tukey's HSD post-hoc test was conducted. Among the 64 subjective theories, only three subjective theories showed statistically significant differences regarding years in service ($p<0.05$). No student-related, no teaching-related, no teacher-related, no social interaction-related, no classroom management and organization-related, and no innovative and modern teaching-related subjective theory showed statistically significant differences ($p>0.05$). The statistically significant ANOVA and Tukey's HSD post-hoc test results regarding PE teachers' professional experience (years in service) and their subjective theories about ICT and PE are shown in Table 14.

Table 14: ANOVA for PE Teachers' Professional Experience (Years in Service) and Subjective Theories

Index	Subjective Theory	Years in Service (Years)	N	Mean (M)	F-Value	p-Value	Difference (Tukey)	Difference p-Value
E5	I would absolutely integrate ICT into my PE lessons, if it would be available.	1-10	20	3.80	7.989	0.001	1-10, 11-20	0.092
		11-20	14	3.07			1-10, 21 or more	0.001
		21 or more	23	2.61			11-20, 21 or more	0.350
CL7	I do not use ICT in PE because I am afraid to make a fool out of myself in front of the students.	1-10	20	1.60	4.616	0.014	1-10, 11-20	0.992
		11-20	14	1.64			1-10, 21 or more	0.022
		21 or more	23	2.43			11-20, 21 or more	0.058
CL9	My students are better in using ICT than I am.	1-10	20	2.90	4.516	0.015	1-10, 11-20	0.682
		11-20	14	3.21			1-10, 21 or more	0.013
		21 or more	23	3.87			11-20, 21 or more	0.182

For the subjective theory E1 ("I would absolutely integrate ICT into my PE lessons, if it would be available."), PE teachers' years in service differed statistically significantly (F=7.989, p=0.001). PE teachers who were 1 to

10 years in service showed a statistically significantly higher mean (M=3.80) than PE teachers who were 21 or more years in service (M=2.61) (p=0.001).

For the subjective theory CL1 ("I do not use ICT in PE because I am afraid to make a fool out of myself in front of the students."), PE teachers' years in service differed statistically significantly (F=4.616, p=0.014). PE teachers who were 1 to 10 years in service showed a statistically significantly lower mean (M=1.60) than PE teachers who were 21 or more years in service (M=2.43) (p=0.022).

For the subjective theory CL9 ("My students are better in using ICT than I am."), PE teachers' years in service differed statistically significantly (F=4.516, p=0.015). PE teachers who were 1 to 10 years in service showed a statistically significantly lower mean (M=2.90) than PE teachers who were 21 or more years in service (M=3.87) (p=0.013).

DISCUSSION AND CONCLUSIONS

This study's aim was to investigate the subjective theories of in-service PE teachers about integrating ICT into PE. Using a RPST scientific framework, a quantitative research instrument was developed and diverse data on the study's subject field was collected and analyzed. In the following, the study's results will be discussed in regard to theoretical aspects and implications, and other findings in the field.

Student-Related Subjective Theories

The PE teachers' overall agreement with the subjective theory that stated that the students study motivation can't be increased by ICT (S1) isn't easy to discuss, as there is not much objective evidence to compare for PE. In general, innovative instructional methods easily raise the motivational level of school students (Brophy, 2010). However, putting a PC into a classroom doesn't make a low quality teaching and motivational climate high quality. For the use of technology (pedometers, heart rate monitors, video analysis, and picture boards) in physical education and physical activity behavior outside school (Cox, Williams, & Smith, 2007), and especially for exergaming in PE (Chen, 2013), there is empirical evidence that student's motivation benefits from ICT involvement. On the other hand, simply putting an isolated teaching tool into an educational context doesn't raise the motivational climate if not in tune with a careful conducted instructional design (Morgan & Kingston, 2005). Speculating about the difference between S1 and the literature, here may be a bias in the PE teachers, either regarding technology as an instructional method and/or the belief that unmotivated students can't be motivated anyways. Although the subjective theory S7 ("If students are not motivated, ICT will not motivate them anyways.") isn't distributed clearly towards one direction, S7 didn't focus on the latter general belief, but on ICT. S7 therefore doesn't help much determining the underlying attitude in question.

The fact that the PE teachers split their subjective theories reports on whether girls or boys get more into ICT (S10) mirrors the common uncertainty and prejudices about gender-related tech-savviness (McGrath, 2004). Although there may be differences in terms of attitude and use with the boys in the clear advantage regarding tech-savviness, especially in regard to computer and video game cultures (Kay, 2007), this study's PE teachers show mixed views. On the one hand, this may state a positive trend towards an equal gender treatment in PE, but may lead to less individual-centered teaching on the other hand. Furthermore, as motivation toward PE differs significantly between boys and girls, with girls showing a large decrease aging (Parish & Treasure, 2003), an interrelation between motivation, and ICT literacy and attitudes might be assumed (Vekiri, 2010). This study's PE teachers showed similar distribution of beliefs about girls' and boy's ICT savviness as in other studies that examined non-PE teachers (Sang, Valcke, van Braak, Tondeur, & Zhu, 2011; Vekiri, 2013; Wikan & Molster, 2011).

The PE teachers' central tendency for the subjective theories S3, S4, S5, S6, S7, and S8 may be caused by a feeling of uncertainty (Meldrum, 2011; Semiz & Ince, 2012) due to their lack in practical experience with the particular ICT topic. Moreover, a lack of content knowledge may prevent most of the PE teachers from a clear decision, as ICT has most likely not been part of their pre-service education (Hetland & Strand, 2010). Unclear facts about individual and team learning in PE in general, and integrated ICT activities (Ranguelov, Horvath, Dalferth, & Noorani, 2011) may add to the PE teachers' central tendency.

Teaching-Related Subjective Theories

The results for the subjective theories T1, T3, T4, and T6 confirm the general findings that (PE) teachers tend to stick to their teaching methods that they have used over the course of their careers (Mosston & Ashworth, 2008; Semiz & Ince, 2012; Strand & Bender, 2011). The results for the subjective theories T4 and T6 may support this explanation, as it can certainly be assumed that video feedback is a common method as well in PETE and PE (Fiorentino, 2004; J. Lim, Henschel Pellett, & Pellett, 2009).

Especially the results for the subjective theory T3 ("My teaching in physical education is successful without integrating any technology") reveal that this study's sample may indeed include a negative bias towards ICT in PE in the PE teachers (Kretschmann, 2012). As the vast majority of the PE teachers is clearly in favor for the subjective theory T7 ("Despite ICT integrating, manifold movement, exploration, and free trial should remain the focus of the PE lesson."), it may be inferred that the study's PE teachers don't think of PE and ICT being connected at first sight. For T3 and T7, the ICT-skeptical bias may as well blend in with the PE teachers' tendency to stick to their established teaching methods and resist to change (Zimmerman, 2006).

The mixed results with a tendency for disagreeing for the subjective theory T5 ("Internet searches (e.g. ball games) are well suited as homework.") are in line with the common approach to only include little or no homework in PE (Zavatto et al., 2005). The PE teachers may not use the Internet for homework, although there are plenty of PE-related webpages available (Elliott, Stanec, McCollum, & Stanley, 2007; Mohnsen & Roblyer, 2013).

Teacher-Related Subjective Theories

The results for the subjective theories T1 and T2 suggest that the PE teachers see ICT in PE as an add that needs special attention, affecting their PE lesson planning, and causing stress and time-management issues. According to other findings, these attitudes are rather common among (PE) teachers (Afshari, Abu Bakar, Luan, Abu Samah, & Say Fooi, 2009; Papastergiou, 2010). However, not only ICT is regarded as an external pressure for change. General curricular, policy, and organizational changes may rather be deemed as a burden as well (Petrie & Hunter, 2011).

The rather negative results for the subjective theory TE4 ("I do not need ICT for getting students motivated.") are expected as S1 and S7 revealed a disbelief in the PE teachers that ICT can have a positive motivational effect in PE. The switch to the introspective personal perspective of the teacher didn't change these aspect-specific results' tendency.

The PE teachers admitted that there are major benefits of digital assessment data (TE7) despite being rather skeptical towards ICT in PE. But digital assessment data may be a special case among technology use in PE. As national and state physical fitness tests implementations have increased (Wilson, 2011), more time and effort has to be spent on assessing and administrating test data. Using ICT for administrating students' test data may be more time- and cost-efficient than traditional paper-pencil methods (Mosier, 2012). As testing is mandatory in most cases and doesn't directly refer to PE class teaching methods, PE teachers may not classify it belonging to their personal PE teaching philosophy and teaching methods context, causing a rather positive attitude towards ICT use in this case.

The PE teachers clearly see the potential of PE development and their personal development (T3) according to ICT. Despite their skeptical attitude, the PE teachers don't neglect the fact of technology development and its increasing infusion into PE programs (Kretschmann, 2010; Mears, 2009a; Papastergiou, 2010). The PE teachers seem to see the direct connection to 21st century skills and policy development (Sanders & Witherspoon, 2012), but seem also to not transfer the ICT motor to their own teaching.

As the PE teachers tend to be undecided whether an increased ICT use in PE would also increase their reputation with the students (T5), teacher credibility issues in regard to ICT in PE (Bouck, Flanagan, Heutsche, Okolo, & Englert, 2011; Hergüner, 2011) may not be clear to PE teachers. Whether a PE teacher gains reputation with the student by using ICT in PE may depend on the teacher, the students, the school culture, or in sum, the case.

Similar to the teaching-related subjective theories T1, T3, T4, and T6, the teacher-related subjective theory TE6 ("To give the students more freedom, I gladly switch to the role of a moderator."), the PE teachers may stick to their known teaching strategies they feel comfortable with. A change in the perceived and intended role when integrating ICT can't be done instantly by most teachers (Schibeci et al., 2008). The PE teachers therefore may be not familiar with a moderator role in PE, being used to a command teaching style (Mosston & Ashworth, 2008) and additionally be not familiar to different roles in ICT implementation (Uibu & Kikas, 2008).

Equipment-Related Subjective Theories

Although lack of equipment is prominent within the PE discussion (Jenkinson & Benson, 2010; Kinnunen & Lewis, 2013), this study's PE teachers perceive their available equipment as not being outdated (E1). However, they regard instructional support-related videos available at their school outdated (E7), which is in line with the findings of Thomas and Stratton (2006) who reported less up-to-date technological equipment in school PE. As the commercial instructional video releases (Mohnsen & Thompson, 1997) have declined, it's less likely that

schools have purchased the latest published ones. The availability of free PE-related instructional videos on the Internet doesn't make expensive commercial videos attractive any more (Quennerstedt, 2013). Limited evidence is available, stating that limited budget influences technology use in PE (Woods et al., 2008). However, the items E1 and E7 didn't differentiate between electronic devices and media, and non-electronic analogue material. Therefore, there is a lack of clarity regarding this distinction within the PE teachers' perceptions.

The PE teachers have a mixed perception of their respective school being a factor in ICT implementation (E4). Nevertheless, literature findings on ICT implementation clearly report the school itself as an influencing factor (Afshari et al., 2009). It may be speculated that at most of the schools, the principal doesn't recognize PE as an ICT-related subject and therefore may not support or hinder PE in technology integration. However, the principals' influence on budget and school-wide curricular integration in terms of PE may not be underestimated (Brockmeier, Sermon, & Hope, 2005; Staples, Pugach, & Himes, 2005).

Equipment-related subjective theories in general (E2, E3, E5, and E6) seem to be independent from the PE teachers' teaching philosophy and habits. For instance, even if technology were available for PE the teachers wouldn't include them (E5). This may be explained by the negative technology use bias of the sample and/or by the lack of the PE teachers' instructional knowledge regarding technology in PE (Johns, 2003; Semiz & Ince, 2012).

Computer Literacy-Related Subjective Theories

The results for the subjective theory CL5 ("Younger PE teacher colleagues are more engaged into ICT integration.") are in line with the findings of Yaman (C. Yaman, 2008), confirming that age is a factor. General findings on teacher's computer and technology competence also state that teachers' age influence teachers' technology adoption (Buabeng-Andoh, 2012).

The fact that PE teachers perceive themselves not being as competent in ICT compared to their students (CL9) may or may not change over the following PE teacher generations. One line of argumentation may proclaim a everlasting gap between teachers' ICT competence level and students' ICT competence level caused by the "natural" age difference (Guo, Dobson, & Petrina, 2008). An alternative line of argumentation may lead to teachers and students being on an equal or at least similar ICT competence level, as future generations of (PE) teachers will be digital natives themselves (Prensky, 2010). However, students' and teachers' perceptions according to computer and ICT literacy, and actual abilities may differ (Grant, Malloy, & Murphy, 2009; Sarfo & Ansong-Gyimah, 2010). This means that the confidence level in the PE teachers on integrating ICT in PE may therefore ground on mere perceptions rather than facts about students' computer and ICT literacy.

The PE teachers' feelings about not having sufficient knowledge and experience according to the pedagogical use of ICT in general and in PE (CL1 and CL2) are most likely influenced by the lack of technology method content within their professional education (Semiz & Ince, 2012; Woods et al., 2008). However, the negative results for the subjective theory CL3 ("If my computer literacy were better, I would use ICT in PE more often.") may confirm the sample's negative technology bias again. It is likely that insufficient knowledge and experience with ICT and PE influences the likelihood of ICT adaption and encouragement of ICT use in PE (C. Yaman, 2008; M. Yaman, 2007b).

The results for the subjective theories CL7 ("I do not use ICT in PE because I am afraid to make a fool out of myself in front of the students.") and CL8 ("I use ICT frequently to prove my ICT skills.") suggest that the PE teachers tend to choose teaching methods they feel safe to use without disruptions, especially in regard to ICT in the classroom (Ertmer, 2005). Non-PE teachers have also reported feeling anxious about using ICT when they think that their students know more about ICT than they do (Balanskat, Blamire, & Kefala, 2006).

The PE teachers seem to be aware of webpages for PE and their usefulness for their profession (CL4). This is not surprising, as the PE teachers' computer literacy level was sufficient to determine the relevant webpages. Nonetheless, there seems to be a gap between the knowledge of available teaching and learning resources and its implementation (Ertmer & Ottenbreit-Leftwich, 2010).

Classroom Management and Organization-Related Subjective Theories

The PE teachers' perceptions about lack of time, curriculum content pressure, and organizational structures like class size in PE that increase teaching stress (C1, C2, and C3) are accompanied by the literature (Afshari et al., 2009; Thomas & Stratton, 2006). The results for the subjective theory C8 ("Preparation effort and learning outcome efficiency are in fair relation to each other when using ICT in PE.") accompany the PE teachers' perceptions about these barriers. The perceived effort in adapting new teaching methods or content is always

judged not being time- and cost-efficient by (PE) teachers (Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Thomas & Stratton, 2006).

The PE teachers' belief that technology use in PE decreases "precious" movement and physical activity time (C4) within PE lessons may be closely connected to an understanding of PE that doesn't promote ICT integration (Kretschmann, 2010). However, the PE teachers are aware about the benefit of using ICT for PE lesson planning and preparation (C5), but were unsure about complex settings in PE (C6). This suggests that PE teachers may tackle ICT integration from a reflective perspective (Tsangaridou & O'Sullivan, 1994), considering ICT for diverse purposes (Tearle & Golder, 2008). Again, (PE) teachers' tendency to stick to known and established teaching methods may as well be related to the PE teachers' uncertainty about complex PE settings, as these settings are perceived as challenging for both expert and beginner teachers (Rich & Hannafin, 2009; Shovala, Erlicha, & Fejgina, 2010). Adding an extra factor such ICT may be perceived as making a complex situation even more complex.

The results for the subjective theory C7 ("ICT is most likely placed best in the last two years of secondary school PE.") suggest that PE teachers' teaching strategies and philosophies are bound to grade level. As it is obvious that primary school PE and secondary school PE need different appropriate teaching approaches (Hastie & Martin, 2005; Himberg, Hutchinson, & Roussell, 2002), teachers are assumed to choose grade level-specific teaching methods. The fact that the PE teachers judged ICT more appropriately placed into the last two years of secondary school may be explained by the belief that students at this stage of their educational attainment have gathered more computer and ICT literacy over their past school career, making them probably more likely to adapt ICT in subjects that are not primary ICT-related. Moreover, students nearing the end of their school education may be in their cognitive and metacognitive prime (Pallrand & Moretti, 1980), potentially allowing a wider range of teaching and learning methods. It may be inferred that the PE teachers think that ICT integration is better suited for more advanced students due to their perception that integrating ICT in PE is more complex than traditional teaching methods. The position statement of the National Association for Sport and Physical Education (NASPE) also proclaims an age-appropriate ICT use (National Association for Sport and Physical Education (NASPE), 2009).

Social Interaction-Related Subjective Theories

The varying results in the subjective theory SO1 ("Students learn to use ICT at home.") may be caused by the PE teachers varying perceptions of their students' computer and media socialization (Daunic, 2011). Although it is widely clear that students are socialized ubiquitously in their home environment (Morimoto & Friedland, 2011), PE teachers perceive regional differences (Ince et al., 2006) and/or may subsume ICT education under school education purposes in general or for their respective school (Vanderlinde, Dexter, & van Braak, 2012; Wastiau et al., 2013).

The varying results for the subjective theory SO2 ("Demonstrating a movement or technique by a student is more efficient than using video.") may be explained by mixed perceptions, knowledge, and skill levels regarding the use of video in PE. The studies conducted by M. Yaman (2007b) and C. Yaman (2008) also featured video and PE, whereas scores for PE teachers' competencies showed similar results. Despite having multiple sources of pedagogical scenarios for video in PE available (Cassidy, Stanley, & Bartlett, 2006; Leight, 2012; J. Lim et al., 2009), the PE teachers may be influenced by a certain understanding of demonstrations in PE. The PE teachers may belief that movements and techniques have to be demonstrated by themselves. Physical demonstration by the teacher may be the preferred method of instruction by PE teachers. Although demonstrations are an essential skill that PE teachers should master (Bailey, 2001), too much emphasis on this skill may lead to an implicit disregard against any other modes of demonstration, including ICT use. Nevertheless, there is clear evidence in the literature that video can be of assistance in motor skill learning in PE (O'Loughlin, Ní Chróinín, & O'Grady, 2013).

The results for the subjective theory SO3 ("Letting students work with a laptop in PE fosters their ability to work in a team (collaboration, communication in groups.") varies as well. The PE teachers may have the prejudiced image of the isolated media-addicted youth sitting alone in front of a computer (Holmes, 2012). Therefore, the PE teachers may interpret laptop work not as a collaborative, social activity but as an isolated individual task. The study by Trimmel and Bachmann (2004) showed that laptop classes didn't enhance social intelligence, whereas a study review by Fried (2008) highlighted the positive effects of laptop use on student learning. However, there are multiple pedagogical arrangements provided in the literature to design collaborative laptop uses in classrooms (Koschmann, Kelson, Feltovich, & Barrows, 1996). Using laptops providing a collaborative feedback scenario in PE is also described by Kretschmann (2010). The integration of laptops in stationary group work is also recommended in another scenario.

The analysis of the subjective theory SO4 ("Using ICT in PE facilitates collaboration among teacher colleagues.") lead to mixed results. On the one hand, teachers mostly regard themselves as isolated entities that usually don't collaborate with colleagues if not forced by external authorities (DuFour, 2011). However, there is evidence of a beneficiary informal collaboration among teachers regarding technology (Stevenson, 2005). For PE teachers, the same tradition of isolation can be stated, though there is a strong development of establishing communities of practice from a professional development perspective (Tozer & Horsley, 2006). PE-focused collaborations between schools and regional communities (France, Moosbrugger, & Brockmeyer, 2011) as well between PETE programs and schools (Parker, Templin, & Setiawan, 2012) are documented in the literature. This study only covered "physical" collaborations at the PE teachers' local school. Nevertheless, long-term collegial interaction was identified as a factor influencing technology use in schools (Mumtaz, 2006). However, there is a huge potential for collaboration and sharing experience using "virtual" online channels such as mailing lists (Pennington & Graham, 2002; Pennington, Wilkinson, & Vance, 2004) or social networks (Sezen Balcikanli, 2012). For such online opportunities, the results for the subjective theories SO6 ("A webpage for our PE classes would be useful."), and SO8 ("Internet forums are helpful for PE teachers located at various schools to communicate and compare notes.") vary as well. Although there are plenty of resources hinting at offerings on the Internet (Elliott et al., 2007; Mohnsen & Roblyer, 2013), the PE teachers were undecided whether to use them or not.

The subjective theory SO5 ("Using ICT in PE frequently makes the personal teacher-student relationship suffer.") mirrors a common teachers' belief that using ICT in the classroom would decrease teacher-student interaction. On the contrary, a study by Tanui, Kiboss, Walaba, and Nassiuma (2008) reported that there was no significant change in teacher behavior according to teacher-student interaction and student-student interaction. Furthermore, pedagogical models for ICT integration in the classroom emphasize a supportive teacher-student relationship (Webb, 2013), and definitely don't intend to change teacher-student interaction in a bad way.

Innovative and Modern Teaching-Related Subjective Theories

The subjective theories I1, I3, and I5 came up with mixed results. These subjective theories were all asking about an understanding of teaching in PE that naturally and mandatory includes technology. The PE teachers show diversity in regard to this innovative teaching philosophy. PE teachers may struggle in how to relate ICT to their teaching philosophy, as this struggle is also documented in other subject teachers (King, 2012). Humphries, Hebert, Daigle, and Martin (2012) developed a technology-related subscale for assessing PE teaching efficacy. In relation to this study, the technology-related aspect of PE teachers' teaching efficacy may also stand for the technology-related part within the PE teachers' teaching philosophy. Thus, it may be inferred that an increase of the PE teachers' technology-related teaching efficacy may as well lead to an enhanced technology-related PE teaching philosophy. Mears (Mears, 2009a) appealed for more tech-savviness in PE teachers.

The mixed results for the subjective theory I5 ("The importance of ICT in PE will increase in the future.") may be caused by the interrelation between the uncertainty of possible PE futures, the PE teachers' personal teaching philosophy and subject understanding, and the upcoming instructional technology developments (Finkenberg, 2008; Sanders & Witherspoon, 2012). The subjective theory I6 ("ICT can't replace traditional teaching and learning methods, but complement and accompany it successfully.") may be affected by the same interrelation, though may be also referring to a general (positive or negative) ICT in PE-bias.

The subjective theory I7 ("I frequently heard from other schools' PE teachers that they use ICT in their respective PE classes.") is related to the subjective theory SO4. The negative trend in the results for I7 may be explained by either non-existent occasions sharing information among PE teachers from different schools and/or by mere non-existent implementation of ICT in PE among PE teachers from different schools.

Despite the varying results for the subjective theory I4 ("ICT should play a bigger role in physical education teacher education programs."), a decent amount of the PE teachers (40%) were in favor of infusing PETE programs with ICT. This positive trend is also mirrored by PETE literature (Ayers & Housner, 2008; Bechtel, 2010; Hetland & Strand, 2010; E. M. Jones, Bulger, Illg, & Wyant, 2012; Kretschmann, 2010; Leight & Nichols, 2012).

Gender and Subjective Theories

Statistically significant gender differences in the PE teachers' subjective theories only showed in personal- or interpersonal-related subjective theories, whereas the teaching-related, equipment-related, and classroom management and organization-related subjective theories didn't show statistically significant differences. As the

empirical evidence for PE teachers in regard to this aspect is very limited, also studies with PETE student group focus are considered for the discussion in this case.

Studies that featured gender differences in PE teachers or PETE students, and ICT reported varying results. Bebetsos and Antoniou (2009) found no gender-related differences in PETE students according to attitudes towards ICT and computer use. For other subject teachers, Dogan (2010) also found no significant gender differences in the teachers' perceptions about the use of educational technologies. Moreover, Bakr (2011) didn't find statistically significant gender differences in regard to attitudes towards computers in education among Egyptian teachers.

On the contrary, C. Yaman (2008) found that female PE teachers use technologies, and technology-related learning and teaching methods such as educational games ($p=0.043$), practice ($p=0.003$), and a behavioral approach ($p=0.004$) meaningfully more than male ones. As practice and behavioral approaches may refer to a personal teaching philosophy and/or a either positive or negative ICT in PE-bias, C. Yaman's results also confirm the gender differences in this study for the subjective theories TE7, SO7, I4, and I5. The results for the subjective theory M1 ("I do not have sufficient experience to integrate ICT in PE.") contradict C. Yaman's report for educational games, as in this study, female PE teachers believe to be less ICT competent, whereas in C. Yaman's study, it is the other way round.

In the study by Goktas (2012), most of the assessed attitudes in PETE showed statistically significant differences. The PE teachers attitudes towards technology may be interpreted as directly connected to the PE teachers' personal teaching and subject philosophy in regard to technology. Therefore, the reported gender differences in Goktas' study are in line with the results of this study regarding statistically significant gender differences for the subjective theories TE7, M1, M4, SO7, I4, and I5. However, the attitudes in Goktas' study only tackled computer-related attitudes explicitly, leaving other ICTs out of the discussion.

As gender differences in attitudes and beliefs of non-PE school subject teachers are common in various studies (Gansmo, 2009; Jamieson-Proctor & Finger, 2006; Kibirige, 2011; Prestridge, 2012), it comes to no surprise that PE teachers share similar differences in their subjective theories about ICT in PE.

Computer Literacy and Subjective Theories

The comprehensive computer literacy level results are similar to the findings in other PE teachers-related studies (Gibbone et al., 2010; Woods et al., 2008; C. Yaman, 2008; M. Yaman, 2007b) and other subject teachers-related studies (Konan, 2010; Ocak & Akdemir, 2008; Oluwatayo, 2012). Therefore, this study's sample of PE teachers is neither a low nor a high computer literacy level loaded sample and doesn't contain a computer literacy bias.

Although other studies stated that PE teachers' computer literacy influences their attitudes towards technology in PE (Gibbone et al., 2010; Ince et al., 2006; Woods et al., 2008), this study's results only showed a small number (13 out of 64) of PE teachers' subjective theories about ICT in PE that are statistically significantly influenced by the PE teachers' computer literacy. However, the aforementioned other studies didn't apply inferential statistical procedures and therefore based their judgment rather on rational argumentation.

It comes to no surprise that most of the statistically significant differences according to the PE teachers' computer literacy level popped up in computer literacy-related subjective theories (CL1, CL2, CL3, CL7, CL8, and CL9). This study's results therefore confirm the postulated relationship between PE teachers' computer literacy levels, and certain attitudes and believes of PE teachers' regarding ICT in PE in previous studies (Gibbone et al., 2010; Ince et al., 2006; Woods et al., 2008). This study's results are also in line with the findings in non-PE teachers that also report a statistically significant relationship between teachers' computer literacy, and their attitudes towards educational technology and its integration into classrooms (Albirini, 2006; Cavas, Cavas, Karaoglan, & Kisla, 2009; Ocak & Akdemir, 2008; Ogunkola, 2008; Sadik, 2006).

Household Computer Ownership and Subjective Theories

The small number (5 out of 64) of statistically significant differences regarding PE teachers' computer ownership in relation to their subjective theories about ICT in PE may be unexpected, as computer ownership has been consistently correlated with teachers' beliefs and attitudes towards ICT (Cavas et al., 2009; Ogunkola, 2008; Roussos, 2007). Additionally, in a rather PE-related context, Goktas (2012) found that computer ownership is a significant factor that affects attitudes in PETE students. Hence, it is not surprising that PE teachers' household computer ownership mostly affected the PE teachers' computer literacy-related subjective theories (CL1, CL3, and, CL5) on a statistically significant level.

As every PE teacher in this study possessed at least one computer or laptop, and multiple computer ownership didn't appear as a major factor that influences the PE teachers' subjective theories, previous studies that only focused on a dichotomous computer ownership (0=don't possess a computer; 1=possess a computer) (Cavas et al., 2009; Monk, Swain, Ghrist, & Riddle, 2003; Ogunkola, 2008) may not be taken into account. Whether there is a computer in the household or not, or personal computer ownership is fulfilled or not appear to be outdated questions and codes, as today's (PE) teachers may all posses computers in the meantime. PE teachers may not be as tech-savvy as their students, but at least possess the computer equipment to potentially be.

Nonetheless, some recent research findings in pre-service teachers show a different picture in regard to computer ownership. PETE students (Goktas, 2012) and non-PE pre-service teachers (Zhou, Zhang, & Li, 2011) still don't all own computers themselves. This fact may be explained according to budget issues in the pre-service teacher population. However, (PE) teacher education students do have regular access to computers and ICTs via their university's and study program's ICT infrastructure (Adamakis & Zounhia, 2013; Sharp, 1996; Zhao & Jiang, 2010), compensating for the lack of possessing an own computer. In addition, pre-service (PE) teachers who don't possess a computer will be able to afford an own computer once they become in-service teachers, leaving budget issues behind.

Professional Experience (Years in Service) and Subjective Theories

Only a small number (3 out of 64) of statistically significant differences regarding PE teachers' years in service in relation to their subjective theories about ICT in PE can be reported. This result aligns with the findings by Dogan (2010) that include no difference in teaching experience among non-PE teachers in regard to technology attitudes. Additionally, Gorder (2008) also found no statistically significant gender differences in perceptions based on years of experience in a non-PE teacher population. Furthermore, the temporal stability (Kolbe & Boos, 2009) of the PE teachers' subjective theories is confirmed by the fact that years in service show very small to no impact on the PE teachers' subjective theories.

On the contrary, other studies reported statistically significant relationships and influences between teachers' years in service and attitudes towards technology (Anderson & Williams, 2012; Bakr, 2011; Kahveci, Sahin, & Genc, 2011; Kibirige, 2011). Therefore, it may be inferred that for the population of PE teachers, years in service have a way smaller to no effect on PE teachers' attitudes, beliefs, and subjective theories in regard to ICT in PE.

PE teachers with lesser years in service tended to be more open to the use of ICT in PE depending on ICT availability, as they stated their intention to include ICT in PE if it were available in the subjective theory E5 ("I would absolutely integrate ICT into my PE lessons, if it would be available.").

Years in service showed a reversed effect in the subjective theory CL7 ("I do not use ICT in PE because I am afraid to make a fool out of myself in front of the students."), as PE teachers with a higher amount of years in service were more concerned about their own ICT performance in regard to their reputation with their students. A similar result appeared for the subjective theory CL9 ("My students are better in using ICT than I am."), as PE teachers with a higher amount of years in service have a stronger believe that their students have a higher ICT competence level than they have themselves. PE teachers' years in service, as they stand for age and teaching experience as well, mainly influenced the PE teachers' computer literacy-related subjective theories. This result is expected, as older teachers usually show less computer literacy compared to younger teachers (Asan, 2003; Cavas et al., 2009).

This study's results in the PE teachers' professional experience (years in service) and subjective theories indicate that this study's sample may have a technology-related bias indeed. Taking the interpretations on the above reported results on various aspects of the PE teachers' subjective theories in this study in consideration, a possible negative bias regarding technology use in PE becomes more likely and can therefore be assumed at this point of analysis and interpretation.

LIMITATIONS

This study's sample size (n=57) can't be regarded as a representative sample size, as it is too low compared to the basic population of PE teachers. In addition, PE teachers appeared to be a group that is hard to research, as the participation (questionnaire return rate=47.5%), interest, and turn around time slowed down the data collection process. Another population-based hinderer for larger sample sizes appears in the fact that very numerous schools would have to be involved in data collection, as only a few PE teachers are employed at a single school. However, the other studies that examined PE teachers in this field didn't have large sample sizes either. Ince et al.'s (2006) study included a total of 47 PE teachers, whereas only 19 PE teachers were assigned to the experimental group. Gibbone et al.'s (2010) study included a total of 92 PE teachers, Kretschmann (2012)

and Woods et al. (2008) both investigated a total of 114 PE teachers, M. Yaman (2007b) included a total of 186 PE teachers, and C. Yaman's (2008) study sample contained a total of 191 PE teachers. Comparing this study's sample size to these other studies' sample sizes, this study's sample size is a rather smaller one, but seems to be appropriate to produce significant and valid results. As PETE students are an easier to access population than PE teachers are, sample sizes in ICT-related studies in that population are significantly higher. For instance, Goktas' (2012) sample counted a total of 154 PETE students, the study by M. Yaman (2007a) contained a total of 159 PETE students, and the study by Adamakis and Zounhia (2013) even featured a total of 313 PETE students.

The study's data collection took place in a single area code (area code of Stuttgart, Germany). Therefore, a regional bias may exist. Referring to Dogan (2010), it can be concluded that regional confounders have to be taken into consideration when interpreting findings regarding teachers and PE. Howley, Wood, and Hough (2011) reported that teachers in rural areas showed greater positive attitudes towards technology. Additionally, as schools themselves are a factor of teacher's technology use in classrooms (Afshari et al., 2009), their location and regional idiosyncrasies might as well influence (PE) teacher's beliefs, attitudes, and subjective theories about ICT. Institutional influences on teachers' perceptions are also highlighted in a recent study by Perrotta (2013).

As this study's focus group consisted of secondary school PE teachers only, this study's results may also be limited to this certain grade level and/or school type. Moreover, there is evidence for school levels being a confounder in ICT attitudes of teachers. In a survey of 500 teachers that included different school types (elementary, intermediate, and secondary school), intermediate and secondary school teachers showed significant differences in their attitudes towards e-learning (Aldhafeeri, Almulla, & Alraqas, 2006).

The "if-then" argumentation is regarded as essential as well for "objective" scientific theories and subjective theories, providing an explanation of reality and actions within the real world (Casella, 2012; Groeben & Scheele, 2000). However, not all featured subjective theories in this study were modeled into an if-then phrased questionnaire item. This strategy was chosen in order to widen the potential implications in the study's field of PE teachers and PE. A narrow focus, only using if-then phrases, would have limited the study's scope and wouldn't have mirrored the group discussion's results appropriately. Furthermore, subjective theories have been successfully modeled into non-if-then items in quantitative research before (Müller et al., 2008).

As mentioned before multiple times, the sample may be biased regarding technology use in PE and/or in general. On the one hand, prior studies in PE teachers (Gibbone et al., 2010; Thomas & Stratton, 2006) and PETE students (Goktas, 2012) reported rather positive attitudes towards ICT in general. In addition, most teacher-focused studies showed general positive attitudes towards ICT in educational settings (Charalambous & Ioannou, 2008). On the other hand, M. Yaman (2007a) and Kretschmann (2012) mentioned a negative tendency of PE teachers in terms of routing against ICT in PE. Nevertheless, research has shown that there is evidence of a significant resistance of teachers to using ICT in educational settings (Jamieson-Proctor, Burnett, Finger, & Watson, 2006). For instance, a fifth of a European teachers sample expressed significant skepticism regarding ICT in schools, as they didn't see "significant learning benefits for pupils" (Korte & Hu sing, 2007). There is also evidence of levels of either "technological affinity" or "technological aversion" in teachers (Kahveci et al., 2011), making an argumentation for a sample-specific bias even more plausible. According to Kretschmann (2012), there may also be a country-specific bias distinguishing German PE teachers from other countries PE teachers. Verifying this thought, there is a huge gap between the number of ICT-related publications in PE-related research and practice journals from Germany compared to the ones from the United States (US), leaving the US publication output roughly ten times higher ahead.

IMPLICATIONS

Previous research on the PE teachers' perspective, including this study, hasn't distinguished between the multiple ICTs available. As the technological development is vividly rapid in its nature, the latest devices and software are also heading into educational uses in the PE setting (Papastergiou, 2010). There is not much to no empirical evidence available on the differences or similarities of PE teachers' views on diverse hardware, software, and their application in PE, although there are plenty of suggestions for PE uses available. For instance, physical measurement devices such as heart rate monitors (Nichols, Davis, McCord, Schmidt, & Slezak, 2009) or pedometers (Cagle, 2004; Pangrazi, 2004), geocaching (Elwood Schlatter & Hurd, 2005), wikis (Hastie, Casey, & Tarter, 2012; Mears, 2009b), social media platforms (Kaluf, 2012), podcasts (Mears, 2009b; Mikat, Martinez, & Jorstad, 2007; Shumack & Reilly, 2011), apps (Cummiskey, 2011), and exergaming (Ennis, 2013; Hicks & Higgins, 2010) are prominent features in recent PE practice literature. The PE teachers' opinions on the use and value in PE for each of these ICT assets may differ as well as its diverse applications.

Previous studies indicated that teachers' beliefs about ICT in the classroom differ from their actual use in the classroom (Ertmer, Ottenbreit-Leftwich, Sadik, Sendurur, & Sendurur, 2012). The same mechanism may be assumed as well for PE teachers. Positive attitudes and proficiency in ICTs don't grant wide and rich ICT integration (Bauer & Kenton, 2005). Thus, the relation of PE teachers' view on using ICT in PE and their actual ICT use in PE is still in need to be shed light on. Furthermore, there is no evidence available about the potential change of PE teachers' teaching methods and styles when integrating ICT compared to traditional non-ICT-integrating PE. However, non-PE teachers were likely to sustain and didn't change their existing patterns of teaching practice when integrating technology in their classes (Cuban, Kirkpatrick, & Peck, 2001).

Tsitouridou and Vryzas (2004) reported that teachers perceive technology adoption as an important strategy for improving educational practices. Although there is evidence for a positive relation between teachers' general pedagogical beliefs and their technology use in classes (C. P. Lim & Chai, 2008; Sang, Valcke, van Braak, & Tondeur, 2010), this relationship may or may not be a direct one (Chai & Lim, 2011). However, teachers showing positive views on potential ICT benefits in educational settings may not perceive themselves having sufficient computer literacy (Gulbahar & Guven, 2008), and may show a difference between ICT literacy and pedagogical ICT competence (Banaji, Cranmer, & Perrotta, 2010). Considering these results, there may also be significant differences between general pedagogical beliefs and subjective theories regarding ICT in education, and regarding ICT in PE in the PE teacher population.

Kretschmann (2010, 2012) postulated PE teacher continuing education and PETE being amongst several developmental areas in the field of technology and PE research. Although there are some suggestions for infusing PETE programs with technology available in recent publications (Ayers & Housner, 2008; Baert, 2012; Bechtel, 2010; E. M. Jones et al., 2012; Leight & Nichols, 2012; Mitchell & McKethan, 2003), evaluations using scientific research methodology haven't been performed and/or made public yet. Additionally, trainings on ICT use in PE for in-service PE teachers haven't been in the focus of PE teachers-related publications so far, although there is plenty of research available for teachers of other subjects (Batane, 2004; Guzman & Nussbaum, 2009; Jung, 2005), as teacher trainings focusing on ICT are regarded as a major factor of ICT implementation in schools (Afshari et al., 2009).

PE teachers may be regarded as a special population among school teachers. PE is the only school subject that explicitly has physical activity as teaching and learning content and method (National Association for Sport and Physical Education (NASPE), 2004). Therefore, teaching philosophies and ideologies of PE teachers may be different from other subject teachers, especially in regard to ICT integration (Kretschmann, 2010). Comparing PE teacher populations with non-PE teacher populations might reveal interesting insights according to the teacher's perspective on ICT use in PE and in the classroom. For instance, constructivist approaches have been prominent in PE research (Wallian & Chang, 2007; Wright, Grenier, & Seaman, 2010; Zhu, Ennis, & Chen, 2011), though not in relation to ICT use in PE. General studies in teaching methods showed that teacher beliefs grounded on constructivist approaches had an impact on using ICT for creative thinking and learner-centered activities in the classroom (Prestridge, 2012). This relationship hasn't been investigated for PE so far. As suggested by Kretschmann (2012), there may be two dichotomous poles, separating PE teacher's approaches to ICT in PE. Roughly speculated, there may be PE teachers who naturally adopt and integrate ICT and PE, opposing PE teachers that decline any use of ICT in PE.

Tondeur, Devos, Van Houtte, Van Braak, and Valcke (2009) found that schools having better structural and cultural characteristics had a higher frequency of ICT use. ICT use is therefore also majorly affected by the supportive organizational culture and a collegial work environment (Deaney & Hennessy, 2007). It is likely that not only the actual school' ICT culture and ICT availability, but also the (PE) teachers perceptions of them, influence ICT use in classes. Despite diverse discussion and debate about PE and school culture (Ennis, 2006; Medcalf, Marshall, Hardman, & Visser, 2011; Tripp, Rizzo, & Webbert, 2007), ICT hasn't played a role within this discussion yet.

Whereas this study tackled the PE teachers' perspective, the students' view on ICT and PE is just as important, as they are the recipients of any educational effort. Overall, students' view on ICT is to be regarded as quite positive, both in relevance in the leisure and professional domains (Sharpe, 2004a, 2004b). Various findings from multiple disciplines and subjects show positive opinions and appreciation of ICI adoption in ICT-enhanced classes for various ICT assets such as multimedia and whiteboards (Hall & Higgins, 2005), or technology in general (Becker & Maunsaiyat, 2002; Kubiatko, Halakova, Nagyova, & Nagy, 2011; Yu, Lin, Han, & Hsu, 2012). The students' perspective of PE has been researched in-depth (Bernstein, Phillips, & Silverman, 2011; Dyson, 2006; Rikard & Banville, 2006), though not with any emphasis on ICT in PE yet. Hence, a future research question may sound like this: "What do PE students think about integrating technology into PE?"

This study has shed some more light on the PE teacher's perspective on ICT in PE. But the lack of empirical research findings in the area of technology and PE that was stated by Kretschmann (2010; 2012) can still be confirmed. Therefore, more empirical research efforts should be made in this area. In conclusion, a statement by Goktas (2012) can be repeated: "Further studies are needed in the same area using different samples so that more valid and reliable conclusions may be drawn."

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PUBLICATION III

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TEACHER EDUCATION

Effect of Physical Education Teachers' Computer Literacy on Technology Use in Physical Education

Rolf Kretschmann

Abstract

Teachers' computer literacy has been identified as a factor that determines their technology use in class. The aim of this study was to investigate the relationship between physical education (PE) teachers' computer literacy and their technology use in PE. The study group consisted of 57 high school level in-service PE teachers. A survey was used to assess the PE teachers' computer literacy and instructional technology and media use in PE. Quantitative statistical procedures were performed to analyze the data. The majority of the PE teachers did not often use technology in PE. PE teachers' computer literacy had an effect on their technology use in PE. PE teachers' use of information and communication technologies (ICTs) such as laptops, Internet, and digital cameras showed statistically significant differences in their computer literacy levels (low, average, and high). The surveyed PE teachers tended to not use technology in PE. However, the higher their computer literacy level was, the more likely they were to include technology in PE.

Rolf Kretschmann is a research associate, Department of Sport and Sport Science, University of Dortmund, Germany. Please send author correspondence to rolf.kretschmann@uni-dortmund.de

Technology has become normal and even ubiquitous in everyday life (Horst, 2012). The tech-savvy so-called digital natives (Bennett, Maton, & Kervin, 2008; Prensky, 2001), also known as the Net generation, "naturally" include diverse technologies in their daily routines. The society-wide technology enhancement also includes educational settings such as school. For school-aged children and adolescents, this means they are accompanied by technology not only in their leisure time, but also in their everyday life at school (Nemcek, 2013).

Technology as an instructional method has conquered school classrooms in the meantime (Calvani, 2009). Technology uses in schools have certainly been increased over the past decade (Wastiau et al., 2013). Among the school subjects, physical education (PE) and physical education teacher education (PETE) have been infused with technology as well, at least within the academic discussion and debate (Kretschmann, 2010; Leight & Nichols, 2012; Mohnsen, 2012; National Association for Sport and Physical Education, 2009).

With regard to research findings in the field of technology and PE, the empirical evidence is limited and few empirical studies are available (Kretschmann, 2010). Especially, the PE teachers' perspective has not been in the center of empirical studies so far. The majority of the studies have been focused on PETE students' information and communication technology (ICT) competency and skills (Adamakis & Zounhia, 2013; Z. Goktas, 2012; M. Yaman, 2007a, 2007b). Not much evidence can be found on in-service PE teachers (Kretschmann, 2012; Levent Ince, Goodway, Ward, & Lee, 2006; Tearle & Golder, 2008; Woods, Goc Karp, Miao, & Perlman, 2008; M. Yaman, 2007a). Although some researchers have reported PE teachers' computer literacy and technology use in PE independently (Thomas & Stratton, 2006; Woods et al., 2008), researchers in previous studies did not examine the direct effect of PE teachers' computer literacy on their technology use in PE.

The significance of a supposed direct relationship between PE teachers' computer literacy and their technology use in PE derives from an evidence-based rationale: The effect of teachers' computer literacy on computer use in the classroom has been researched in depth and in manifold studies (Afshari, Abu Bakar, Luan, Abu Samah, & Say Fooi, 2009; Kreijns, Vermeulen, Kirschner, Van Buuren, & Van Acker, 2013). Lack of (PE) teachers' ICT skills has even been identified as a barrier for ICT implementation in the classroom (Buabeng-Andoh, 2012; Tearle & Golder, 2008). Furthermore, PE

may be special among the other school subjects in regard to the exclusive human movement and physical activity content and methods (Newell, 2011; Tinning, 2011) and may therefore not come to mind at first sight, being judged as a nontechnology-related subject (Kretschmann, 2010; Mohnsen, 1997).

Hence, the aim of this study was to investigate the effect of PE teachers' computer literacy on their technology use in PE. PE teachers' computer literacy levels should be determined. In addition, the frequency of PE teachers' technology use in PE should be documented as well.

Method

The study group consisted of 57 high school level PE teachers (M_{age} = 48.84 years ± 1.39). Among the PE teachers, 26 were male (45.6%) and 31 were female (54.4%). Initially, 120 PE teachers were asked to participate in the study. The PE teachers who turned down the request gave nonparticipating reasons such as lack of time, disinterest in the topic, or disinterest in participating in research in general.

A questionnaire survey was used that contained a section for personal data (age, gender), a section for computer literacy, and a section for instructional technology (old and new media) use in PE. The computer literacy section included 10 items, which average scores were pooled into a subscale (M = 2.88 ± 1.02). The items were on a 5-point Likert-type scale (5 = *very good*, 1 = *very poor*) and included aspects according to computer hardware and software functionalities. Reliability analysis of this subscale returned excellent values (Cronbach's α = .90). In the instructional technology section, the PE teachers were asked about the frequency of including instructional technology and media in PE using a 5-point Likert-type scale (5 = *very often*, 1 = *never*) as well.

For the analysis of the collected data, statistical procedures such as correlations, *t* test, Mann–Whitney U test, one-way analysis of variance (ANOVA), and Fisher's LSD post hoc test were conducted. For all statistical procedures, alpha was set at .05. The statistical procedures were performed using the software IBM SPSS Statistics (Version 21) for Mac OS.

Results

Among the 57 PE teachers, 10 (17.55%) were assessed low-level computer literacy, 26 were on an average computer literacy

level (45.61%), and 21 were grouped into a high level of computer literacy (36.84%). There were no significant differences in the PE teachers' computer literacy regarding gender (*t* test, $p > .05$).

PE teachers' age and computer literacy were significantly correlated (Spearman's rho, $r = .38$, $p < .01$), with a moderate positive relationship. Based on the study groups' average age, this relationship was expected as the emergence of newer ICTs took place after a fair amount of the PE teachers' school and college level education.

The PE teachers' instructional technology-use data clearly highlighted the PE teachers' tendency to not include technology in PE. However, there were two exceptions, namely, stereo systems and images. The PE teachers used them more frequently than other media. Noteworthy, textbooks may have not been regarded as mandatory for PE, as they remained on the same use level as other media and technology. ICT (PC, laptop, and Internet) clearly seemed to be disregarded in terms of integrating in PE classes. Nevertheless, video appeared to have a more prominent standing in regard of usage rate. The complete frequencies of the PE teachers' technology use in PE are shown in Figure 1.

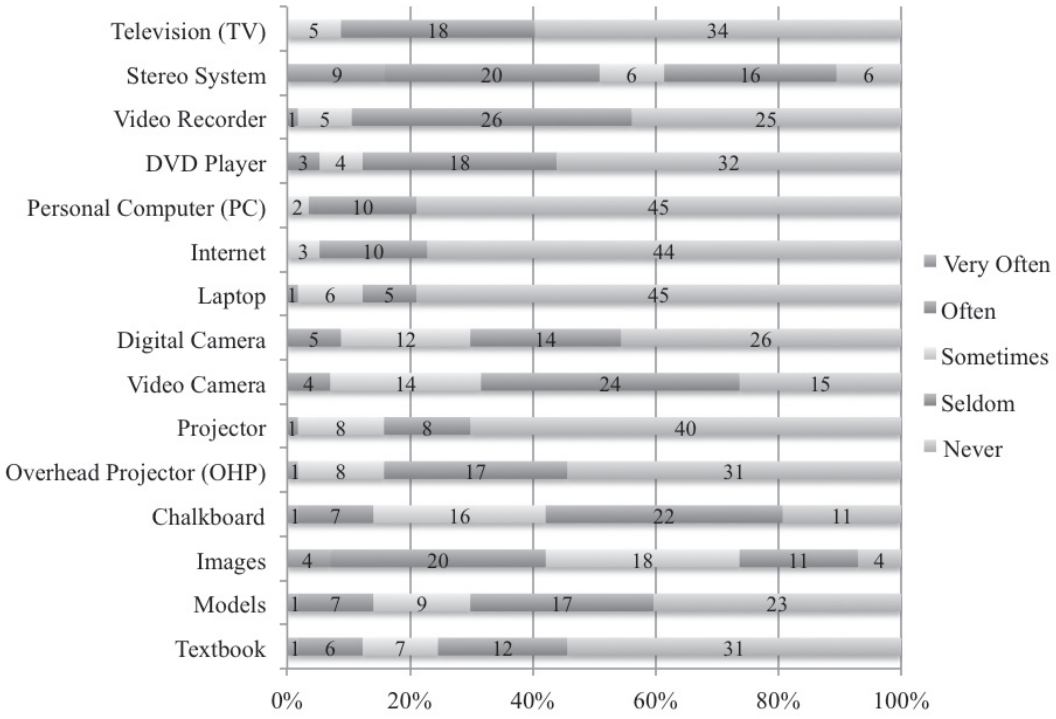

Figure 1. Instructional technology and media use in PE.

In regard to gender, only two of the 15 instructional media showed a statistically significant difference (Mann–Whitney U test, $p < .05$). Stereo system use was significantly different ($U = 100.00$, $z = -5.04$, $p < .001$), as female PE teachers ($M = 3.97 \pm .17$) used stereo systems more frequently than did male PE teachers ($M = 2.23 \pm .17$). Moreover, male PE teachers ($M = 2.00 \pm .19$) used overhead projectors significantly ($U = 241.00$, $z = -2.88$, $p = .004$) more frequently than did female PE teachers ($M = 1.35 \pm .11$).

Among the 15 instructional media, only three (Internet, laptop, and digital camera) showed a statistically significant difference ($p < .05$) according to computer literacy level of the PE teachers. The complete ANOVA results are shown in Table 1.

Table 1
Computer Literacy and Instructional Technology and Media Use in PE

Instructional media	Computer Literacy			*F*	η^2
	Low	Average	High		
Television (TV)	1.48_{a} (.60)	1.38_{a} (.57)	1.80_{a} (.92)	1.472	.03
Stereo System	3.19_{a} (0.13)	3.19_{a} (0.11)	3.10_{a} (.41)	.020	.00
Video Recorder	1.71_{a} (.78)	1.69_{a} (.68)	1.60_{a} (.70)	.088	.00
DVD Player	1.76a (.94)	1.38a (.64)	1.90a (.99)	1.938	.05
Personal Computer (PC)	1.29_{a} (.56)	1.15_{a} (.46)	1.40_{a} (.52)	.942	.01
Internet	1.08_{a} (.27)	1.33_{ab} (.58)	1.70_{b} (.82)	5.351**	.06
Laptop	1.14_{a} (.48)	1.27_{a} (.60)	2.00_{b} (1.15)	5.566**	.11
Digital Camera	1.57_{a} (.93)	1.92_{a} (.89)	2.70_{b} (1.16)	4.747*	.18
Video Camera	2.05_{a} (.86)	2.04_{a} (.82)	2.50 a (1.08)	1.099	.04
Projector	1.38_{a} (.74)	1.35_{a} (.69)	2.00_{a} (1.05)	2.774	.07

Table 1 (cont.)

Instructional media	Computer Literacy			F	η^2
	Low	Average	High		
Overhead Projector	1.43_a (.68)	1.73_a (.78)	1.90_a (1.29)	1.258	.04
Chalkboard	2.00_a (.89)	2.58_a (.81)	2.70_a (1.12)	2.710	.10
Images	2.90_a (1.04)	3.19_a (.98)	3.60_a (1.17)	1.544	.07
Models	1.62_a (.92)	2.38 a (1.10)	2.10 a (1.29)	2.977	.14
Textbook	1.62_a (.86)	1.77_a (1.07)	2.50_a (1.21)	2.323	.11

Note. Standard deviations appear in parentheses below means. Means with different subscripts within rows are significantly different at the $p < .05$ based on Fisher's LSD post hoc paired comparisons.
*$p < .05$. **$p < .01$.

For Internet use, there was a statistically significant difference between low-level computer literacy PE teachers and high-level computer literacy PE teachers as determined by one-way ANOVA, $F(2, 54) = 5.351$, $p = .008$. A Fisher's LSD post hoc test revealed that PE teachers showing high computer literacy ($M = 1.70 \pm .82$, $p = .002$) used the Internet in PE statistically significantly more frequently than did PE teachers showing low computer literacy ($M = 1.08 \pm .27$). There were no statistically significant differences between low-level computer literacy PE teachers and high-level computer literacy PE teachers ($p = .072$) and no statistically significant differences between high-level computer literacy PE teachers and high-level computer literacy PE teachers ($p = .099$).

Regarding laptop use in PE, there was a statistically significant difference between low-level computer literacy PE teachers and high-level computer literacy PE teachers and between high-level computer literacy PE teachers and high-level computer literacy PE teachers as determined by one-way ANOVA, $F(2, 54) = 5.566$, $p = .006$. A Fisher's LSD post hoc test revealed that PE teachers showing high computer literacy ($M = 2.00 \pm 1.15$, $p = .002$) used laptops in PE statistically significantly more frequently than did PE teachers showing low computer literacy ($M = 1.14 \pm .48$) and that PE teach-

ers showing high computer literacy ($M = 2.00 \pm 1.15$, $p = .006$) used laptops in PE statistically significantly more frequently than did PE teachers showing average computer literacy ($M = 1.27 \pm .60$). There were no statistically significant differences between low-level computer literacy PE teachers and high-level computer literacy PE teachers ($p = .535$).

Concerning digital camera use in PE, there was a statistically significant difference between low-level computer literacy PE teachers and high-level computer literacy PE teachers and between high-level computer literacy PE teachers and high-level computer literacy PE teachers as determined by one-way ANOVA, $F(2, 54) = 4.747$, $p = .013$. A Fisher's LSD post hoc test revealed that PE teachers showing high computer literacy ($M = 2.70 \pm 1.16$, $p = .003$) used digital cameras in PE statistically significantly more frequently than did PE teachers showing low computer literacy ($M = 1.57 \pm .93$) and PE teachers showing average computer literacy ($M = 1.92 \pm .89$, $p = .033$). There were no statistically significant differences between low-level computer literacy PE teachers and average-level computer literacy PE teachers ($p = .214$).

Discussion

With regard to the findings of Woods et al. (2008), C. Yaman (2008), and M. Yaman (2007b), the data suggest that PE teachers do not show worse or better computer literacy than other school subject teachers (Albirini, 2006; Al-Zaidiyeen, Mei, & Fook, 2010; Y. Goktas, Yildirim, & Yildirim, 2009; Kibirige, 2011; Wastiau et al., 2013). The PE teachers appear to be neither tech savvy nor total ICT beginners. This opposes an understanding of PE as a contradicting entity to sedentary media-heavy leisure and educational settings. Within this PE philosophy, the human body is regarded as only relevant media, and PE teachers therefore may not need to have computer literacy as they are not intended to integrate technology (Kretschmann, 2010, 2012). Nevertheless, the PE teachers, being "digital immigrants" (Prensky, 2001), show sufficient computer literacy levels regardless of whether such a media-neglecting PE philosophy may be assumed. Another common belief among PE teachers that may cause less technology use is that integrating technology leads to a reduction in movement time (Mears, 2009a; Perlman, Forrest, & Pearson, 2012).

The sample covered mostly established PE teachers who had been in service for several years. Therefore, age appears to be a fac-

tor as the majority of the PE teachers may not have been exposed to technology as an instructional method during their school and college level education (Ayers & Housner, 2008; Hetland & Strand, 2010). Older PE teachers may be stigmatized as digital immigrants, whereas younger teachers are most certainly digital natives (Guo, Dobson, & Petrina, 2008). Following this thought, future generations of PE teachers are expected to show higher levels of ICT competency as well as prospective teachers of other school subjects (Mohnsen, 1997). On the other hand, there may be an alternative approach that deliberately promotes PE as a school subject that gives students, who are constantly exposed to technology, a media-absent break that they may experience as a relief (Acquaviva, Beaudet, & Maina, 2013). As the PE teachers' PE philosophy and ideologies were not surveyed, the relationship between the PE teachers' conceptual understanding of PE and technology use in PE remains unclear.

Despite increased interest of PE teachers in technology stated in previous studies (Gibbone, Rukavina, & Silverman, 2010; Perrotta, 2013; Thomas & Stratton, 2006), the PE teachers in this study tended to not include technology in PE. These results mirror the findings by Kretschmann (2012) that reveal a negative and skeptical attitude to integrating technology in PE. Especially, ICT (PC, laptop, and Internet) is hardly used in PE. A decent level of computer literacy and an (assumed) interest in instructional technology seems not to lead to a trend in integrating more technology (and instructional media in general) into PE. Compared with a PE teacher sample in Gibbone et al. (2010) who had positive attitudes toward technology use in PE, the sample in this study tended to have negative attitudes toward integrating technology in PE.

Statistically significant gender differences were found in only two of the 15 assessed instructional media. This result confirmed other findings that indicate there is no major gender difference in this subject area (Ilomaki, 2011; Vekiri, 2013).

The gender differences in stereo system use may have been caused by a content preference bias of male and female PE teachers (Green, 2008). It may be assumed that female PE teachers tend to cover more dance and rhythmic gymnastics activities in PE than do male PE teachers (Hill & Cleven, 2005). As these activities are usually accompanied by music, female teachers may use stereo systems more frequently. In addition, male teachers may tend to avoid such activities as they may feel uncomfortable with such content (Rustad, 2012).

The gender differences in the use of overhead projectors in PE may have been caused in this study sample because more male PE teachers also taught a natural science subject compared with the female PE teachers. In regard to everyday school practices, it may be assumed that natural science school subject teachers tend to use more visual instructional methods such as overhead projectors than do teachers of other school subjects. A common and established teaching method in a particular subject may therefore be more likely to be used in other subjects taught by the same teacher. However, this is mere speculation and not based on empirical evidence.

In sum, it is not much of a surprise that computer literacy levels in PE teachers influence their actual (digital) instructional technology use, whereas there is no effect on traditional (analogue) instructional media. Common sense may be confirmed by the findings in this study, reporting that the higher the level of PE teachers' computer literacy is, the more likely they will also use instructional technology such as laptops, Internet, and digital cameras in PE.

Statistically significant differences were found between PE teachers' computer literacy levels in regard to instructional technology and media use (ANOVA accompanied by LSD post hoc tests) in only three of 15 instructional media, and this suggests that computer literacy levels do not influence traditional instructional media use, but (portable) ICT use and digital camera use. The statistically nonsignificant varying results for PCs compared with the statistically significant results for laptops may be explained by the laptop being portable. PCs may not be regarded as useful for PE as they are restricted to a single location. In contrast, laptops are portable and can serve in multiple occasions and locations within the PE setting (Juniu, 2011; Kretschmann, 2010; Mohnsen, 2005).

The use of Internet for and in PE has been well documented in the literature (Elliott, Stanec, McCollum, & Stanley, 2007; Leight, 2012; Neal, 2000). The effect of PE teachers' computer literacy on Internet usage rate in and for PE also derives theoretically from the direct connection of Internet and computers/laptops. There is simply no Internet connection possible without a device such as a computer/laptop or handheld with an operating system installed. Moreover, without the necessary computer literacy to use and operate a computer or computer-like device, there will be no access to the Internet. Thus, there was an expected relationship of computer literacy and Internet use based on this explanatory framework.

The influence of the PE teachers' computer literacy level on digital camera use in PE is based on its nature of a human–machine interaction interface and digital storage. The characteristics of these digital cameras are well placed in a computer literacy context as using the operating system on a digital camera may be similar to using an operating system on a computer. Furthermore, several pedagogical scenarios of integrating digital cameras in PE have been provided in the literature (Mikat & Anderson, 2005; Ryan, Marzilli, & Martindale, 2001). As functionalities of digital cameras and video cameras overlap in terms of video capturing, the survey did not include such a distinction. Therefore, it cannot be inferred to which amount the PE teachers used digital cameras for video recordings. In addition, the overlap with smartphone video recording functionalities (Cummiskey, 2011) was not covered in this study.

Only high school level PE teachers participated in this study, and this limits the results. Technology use and related PE philosophies are most likely to be different in school forms and grade levels (Gibbone et al., 2010; Woods et al., 2008). Primary school PE has different structures and principles than secondary school PE (Graham, Holt/Hale, & Parker, 2007), which leads to different technology applications and rationales (LaMaster, Barnes-Wallace, & O'Connor Creeden, 2002; Mitchell, 2001; Sun, 2012).

As mentioned before, it is likely that this study group formed a PE teacher sample who had relatively negative attitudes toward technology use in PE. A PE teacher sample with positive attitudes to PE might lead to different results (Gibbone et al., 2010; Z. Goktas, 2012). Therefore, there might be a study groups' negative bias according to technology use in PE.

The diverse other factors that influence technology use of teachers were not covered in this study. For instance, access to adequate levels of ICT infrastructure cannot be assumed universal among teachers (Burnip, 2006). Especially for PE teachers, it may be difficult to access and transport technology that may be available in the regular classroom to PE facilities. For instance, the mere lack of a power outlet may deem certain technology uses as impossible.

Other factors include parent and community support, availability of vision and plan about contribution of ICT on a particular school's education, availability of time (to experiment, reflect, and interact), available support to computer-using teachers in the workplace, school culture, computer attributes, level and quality of training for teachers and school principals, attitudes to computer,

and effective training program (Afshari et al., 2009; Perrotta, 2013; Prestridge, 2012). This high amount of influencing factors on teachers' technology use in class explains the low effect sizes (η^2 = .06 −.18) of the ANOVA. However, the enormous number of confounders and related factors clearly emphasizes the complexity beyond the technology use by teachers.

Overall, technology use in PE may not be as numerous in reality opposed to the numerous literature finds (Kretschmann, 2010) and seems to be far away from mandatory or ubiquitous. Nevertheless, pressure on PE teachers to integrate technology may increase as the digital native PE students will probably demand the same technologies that ubiquitously surround them in their daily routines for the school classroom and PE facilities as well, which can already be stated for the higher education classroom setting at least (Kinash, Wood, & Knight, 2013). As the instructional technology will likely continue developing, applications for PE will likely do so as well. PE teachers will therefore have plenty of pedagogical uses of technology in PE to experiment on and chances to work on their computer and ICT literacy, too (Woods et al., 2008).

Conclusions

The surveyed high school level in-service PE teachers tended to not use technology and general instructional media in PE. In conclusion, the PE teachers' computer literacy influenced their technology use in PE for (portable) ICTs (laptop, Internet, and digital camera) on a statistically significant level. The higher the PE teachers' computer literacy level was, the more likely they were to integrate the respective technologies in PE.

Future research on the relation between computer literacy and technology use in PE may be focused more on ICT assets such as handhelds, smartphones, and tablets (Cummiskey, 2011; Monsma, 2003; Nye, 2010), podcasts (Nordmeyer & Castelli, 2009; Shumack & Reilly, 2011), wikis (Mears, 2009b), virtual PE (Rhea, 2011), and blended learning scenarios (Vernadakis, Giannousi, & Tsitskari, 2012). The factors influencing teachers' technology use in classes (Afshari et al., 2009) should be integrated into comprehensive study designs to shed more light on their relationships in the PE setting. Practical implications for PETE and PE teachers' continuing education arise as far as that successful programs for the development of computer and ICT literacy should continue to emerge (Bechtel, 2010; Leight & Nichols, 2012), eventually being scientifically evaluated in the process.

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Frankfurt, den 10. November 2015

Rolf Kretschmann