

PEDAGOGY

Preservice Physical Education Teachers' Technological Pedagogical Content Knowledge

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Abstract

Effective technology integration within all areas of education is an objective in most schools given the amount of time students are using technology personally and at school. PE teachers have been challenged to find innovative ways to integrate technology to enhance student learning. A specific type of knowledge is necessary for integration entitled technological pedagogical content knowledge (TPACK; Koehler & Mishra, 2008). TPACK provides the theoretical framework for this study and defines the type of knowledge PETE candidates must possess to be prepared to meet the needs of their students and national and state standards. Online instrumentation of a modified version of Pre-Service Teachers' Knowledge of Teaching and Technology (Semiz & Ince, 2012) was completed by 91 preservice PETE candidates from several universities in the Northeast. A 5-point Likert-type scaling technique and open-ended responses were used on the 39-item inventory to assess the seven types of knowledge that PETE candidates may possess, along with specific open-ended questions regarding modeling of technology by professors, cooperating teachers, and what the PETE candidates have used thus far. Analyses revealed a significant association between the amount of TPACK that preservice teachers

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perceived having and the technology that PETE faculty modeled, including various methods for implementation. Open-ended responses indicated that PETE faculty were likely to use traditional forms of technology (PowerPoint and video); however, cooperating teachers were using more current technology including SMART Boards and iPads. This study has shown that PETE programs are creating opportunities for technology to be integrated; however, more examples using current technologies need to be modeled by PETE faculty and cooperating teachers. Therefore, preservice teachers will be well trained in implementing technology within a lesson.

Implementing technology within all areas of education is an objective that can be found in strategic plans at all levels of education. Embedded within the 2008 National Initial Physical Education Teacher Education Standards (National Association for Sport and Physical Education [NASPE], 2009), Standard 3: Planning and Implementation states that physical education candidates must “demonstrate knowledge of current technology by planning and implementing learning experiences that require students to appropriately use technology to meet lesson objectives” (NASPE, 2008, p. 2). This creates a need for PETE programs to find ways to integrate technology into their courses while supplying PETE candidates with appropriate learning experiences with technology. Learning experiences need to include not only content knowledge regarding technology, but also pedagogical knowledge of implementation in planning and executing lessons in which technology is used appropriately (Arslan, 2015).

Previous research has shown that physical education teacher education (PETE) candidates possess a positive attitude for technology (Gotkas, 2012) and that the more they are exposed to technology, the greater their affinity for implementing it (Clapham, Sullivan, & Ciccomascolo, 2015; Ince, Goodway, Ward, & Lee, 2006; Kul, 2013). Males and females have shown similar amounts of technology use (Kul, 2013); however, females use it more for games and practice (Yaman, 2008). PETE programs need to capitalize on this inherent motivation and use and adapt to meet the technological needs of their students (Arslan, 2015). By doing this, PETE programs will be moving toward meeting the national standard requiring implementation of technology to meet lesson objectives (NASPE, 2009).

Prior research has shown that using technology (heart rate monitors, pedometers, apps) can increase activity in physical education (Clapham et al., 2015; Duncan, Birch, & Woodfield, 2012) and increase student learning (Woods, GocKarp, & Hui, 2008). With school districts adopting more resources for technology such as SMART Boards, iPads, and Chromebooks, physical education teachers have more access to technology that can be integrated into their classrooms and gymnasiums to enhance instruction, assist with assessment, and create more efficiency in record keeping. NASPE (2009) provided a position statement delineating specific guidelines for technology integration in physical education. These guidelines provide a framework for how to use technology within physical education so it is effective and can supplement and enhance the learning goals, while working toward meeting the national and state standards for physical education. PETE programs are encouraged to be active in introducing and integrating technology resources that assist in meeting lesson objectives and positively affect student learning.

Previous research suggests that effective technology integration with specific subject matter requires teachers to apply their knowledge of curriculum content, general pedagogies, and technologies (Koehler, Mishra, & Yahya, 2007; Roth, 2014). This approach, known as the “technological pedagogical content knowledge” (TPACK) model (Koehler & Mishra, 2008), is grounded in Shulman’s (1987) concept of teacher knowledge. Shulman (1987) suggested that a teacher needs to possess (a) content knowledge, (b) pedagogical knowledge, and (c) pedagogical content knowledge (see Table 1). These areas of knowledge do not exist in isolation, but need to work in unison so the teacher can create an optimal learning environment (Roth, 2014). PETE programs are responsible for supplying PETE candidates with all three types of knowledge in a variety of areas, including technology.

Table 1*Definitions of Types of Knowledge*

Type of knowledge	Definition
Content Knowledge (CK)	Knowledge about the subject matter that is to be learned or taught
Pedagogical Knowledge (PK)	Knowledge about the processes and practices or methods of teaching
Technology Knowledge (TK)	Knowledge about both standard and advanced technologies
Pedagogical Content Knowledge (PCK)	Knowledge of pedagogy that is applicable to the teaching of specific content (Shulman, 1986)
Technological Content Knowledge (TCK)	Knowledge about the manner in which technology and content influence and constrain one another
Technological Pedagogical Knowledge (TPK)	Knowledge about how teaching and learning change when particular technologies are used
Technological Pedagogical Content Knowledge (TPACK)	Knowledge that emerges from an understanding of content, pedagogy, and technology knowledge

The TPACK model suggests that the technology employed must also work in conjunction with pedagogical knowledge and content-specific knowledge to enhance instruction and be appropriate to the characteristics of the students and the learning environment (Koehler & Mishra, 2008). In physical education, contextual factors may be a challenge for physical educators when integrating technology (Roth, 2014). There are inherent contextual factors to teaching physical education such as not always having access to a power source or WiFi, especially if physical educators are teaching outside or in the gymnasium, which may limit opportunities and methods of integration. The safety of devices may also be an issue given the nature of how lessons are designed and the dynamic environment of physical education. These factors need to be addressed accordingly.

Because physical education is usually taught in a gymnasium or outdoors, it is important for PETE programs to prepare teachers to infuse technology in a way that will support the pedagogical strategies used in those settings. Teachers need to learn and practice teaching skills in a context as similar as possible to the one they will teach in later. For example, using exercise equipment to assess physical activity (e.g., accelerometers, iPads, heart rate monitors, pedometers, interactive dance machines), body composition (e.g., bioelectrical impedance devices, electronic skinfold calipers), and video analysis equipment used for analyzing movement and motor skill performance. Physical education programs need to integrate technology, and physical educators need to think creatively, employing their TPACK, for opportunities to integrate technology to create enriching learning experiences for their students (Pyle & Esslinger, 2014).

PETE programs are responsible for creating opportunities for PETE candidates to use technology within their classes and to develop their TPACK. Previous research has shown that PETE candidates possess a positive attitude for technology (Gotkas, 2012) and that the more exposure they have to technology, the greater their affinity for implementing it (Clapham et al., 2015; Ince et al., 2006; Kul, 2013). PETE programs need to capitalize on this and adapt to meet the technological needs of their students (Arslan, 2015). Finding ample appropriate methods for instructing preservice teachers about technology is a challenge that many programs face. The purpose of this study was to examine preservice PETE candidates' technological and pedagogy skills and their beliefs about and implementation of technology in their classes in an effort to assess which methods of instruction about technology might provide for the greatest learning. The following research questions were addressed in this investigation:

- What was the technology literacy level of PETE candidates?
- What was the relationship between the technological pedagogical content knowledge and the students' perceptions of professors modeling computer use?
- What were the differences between PETE candidates based on gender on their technological pedagogical content knowledge?

Method

Participants

This study was descriptive in nature. The participants in this study included 91 preservice PETE candidates from 11 universities located in the Northeast. After IRB approval was ascertained, letters were e-mailed to the physical education program chairs/coordinators at each university asking if they would agree to have their PETE candidates participate in the study. Once confirmation of agreement to participate was received, a letter explaining the study was e-mailed to the program chair/coordinator, which they then directly e-mailed to the PETE candidates within their program. PETE candidates were reminded that their responses would be anonymous and participation was voluntary and had no bearing on their academic success. A link to the online survey that allowed them access to participate in the study online was included in the PETE candidate e-mail.

Demographics

Study materials were placed online using an online survey program. Once participants read the consent form and agreed to participate, they were then taken directly to a demographic sheet and survey instrument. The demographic questions included gender; age range; year in college; if they completed a K-12 practicum experience; and if they planned on student teaching, what semester they would be conducting that.

Instrument

A modified version of the original Survey of Pre-Service Teachers' Knowledge of Teaching and Technology (TPACK; Schmidt et al., 2009) was used to ascertain PETE candidates' knowledge regarding technology. The modified version (Semiz & Ince, 2012) included changes to the wording to be specific to physical education. The instrument assesses seven types of technology knowledge including content knowledge, pedagogical knowledge, technology knowledge, pedagogical content knowledge, technological content knowledge, technological pedagogical content knowledge, and technological pedagogical content knowledge. See Table 1 for definitions of the types of knowledge. Internal consistency coefficients (Cronbach's al-

pha) for TPACK subscales were 0.85 for Technological Knowledge (TK), 0.79 for Content Knowledge (CK), 0.89 for Pedagogical Knowledge and Pedagogical Content Knowledge (PK + PCK), 0.77 for Technological Pedagogical Knowledge and Technological Content Knowledge (TPK + TCK), 0.85 for Technological Pedagogical Content Knowledge (TPCK), and last, 0.94 for the whole TPACK survey, therefore demonstrating instrument validity.

The instrument uses a 5-point Likert-type scaling technique addressing statements for which participants choose whether they *strongly agree* or *strongly disagree*. See Table 2 for examples of questions. At the end of the instrument, there are three open-ended questions for which participants are asked to specify examples (a) when they had seen appropriate content, technology, and pedagogy modeled by a professor; (b) when they had seen appropriate content, technology, and pedagogy modeled by a cooperating teacher; and (c) when they had personally modeled pedagogy by combining content and technology.

Table 2
Sample Questions From the Modified Pre-Service Teacher's Knowledge of Teaching and Technology Survey

Questions	Scale
I know how to solve my own technical problems.	5 4 3 2 1
I am thinking critically about how to use technology in the classroom	5 4 3 2 1
I can choose technologies that enhance the content for a lesson	5 4 3 2 1
My professors outside of education appropriately model combining content, technologies, and teaching approaches in their teaching	5 4 3 2 1

Note. 5 = *strongly agree*; 4 = *agree*; 3 = *uncertain*; 2 = *disagree*; 1 = *strongly disagree*.

Several independent variables were used throughout data analysis including *gender* (male and female), *college year status* (freshman, sophomore, junior, senior, graduated, post-BA), and *enrolled in the*

teacher education program (yes and no). The dependent variables assessed in this study included students' content knowledge, pedagogical knowledge, technological knowledge, pedagogical content knowledge, technological content knowledge, and technological pedagogical content knowledge (TPACK), and students' perception of professors modeling the implementation of technology in their classes.

Data Analysis

Ninety-one complete responses were recorded and analyzed using the Statistical Package for the Social Sciences (SPSS 21). Descriptive analyses were performed on all dependent variables. Independent samples *t* tests were used to compare differences between gender and between students enrolled in the program on the variables related to knowledge acquired during coursework and perception of professors modeling computer use. Chi-square tests were conducted to examine the association between students' types of knowledge and model of TPACK by faculty.

Findings

Frequency and percentage data of the responses indicated that 55 participants were males and 36 respondents were females. Of the 91 students, 44 were enrolled in the program and 47 were not enrolled.

Differences Between Males and Females

A *t* test ($\alpha = .05$) was conducted to evaluate differences between male and female students' technological content knowledge. From the results, it can be concluded that there is a statistically significant difference between male and female students' technological content knowledge, $t(88) = -2.146, < .05$. It can be further concluded that male students ($\bar{X} = 3.48$) were more likely to have more technological content knowledge than were female students ($\bar{X} = 3.43$).

Differences Between Students in the Program and Students Not in the Program

A *t* test was conducted to evaluate differences in pedagogical knowledge between students in the program and students not in the program. The *t* test results indicated that students in the program ($\bar{X} = 4.21$) were likely to have more pedagogical knowledge, $t(88) =$

-2.346, $< .05$, than were students not in the program yet ($\bar{x} = 3.95$). From the results, it can be concluded that there is a statistically significant difference between the students in the program and those not in the program

Association Between Type of Knowledge and Model of TPACK by Faculty

The association between *pedagogical knowledge* and *model of TPACK by faculty* was significant, $\chi^2 (6, N = 90) = 18.991, p < 0.01$. Thirty-six out of 90 students agreed that their pedagogical knowledge was associated to professors modeling computer use in the classroom.

The association between *pedagogical content knowledge* and *model of TPACK by faculty* was significant, $\chi^2 (9, N = 89) = 26.389, p < 0.01$. Thirty-three out of 89 preservice teachers perceived that the amount of pedagogical content knowledge was associated to professors modeling computer use in the classroom.

The association between *technological content knowledge* and *model of TPACK by faculty* was significant, $\chi^2 (9, N = 89) = 52.711, p < 0.001$. Thirty-five out of 90 students agreed that their *technological content knowledge* was associated to professors modeling computer use in the classroom.

The association between *technological pedagogical content knowledge* and *model of TPACK by faculty* was significant, $\chi^2 (9, N = 90) = 32.252, p < 0.001$. Forty-two out of 90 students agreed that their *technological pedagogical content knowledge* was associated to professors modeling computer use in the classroom.

There was an association between *technological pedagogical content knowledge* and *the PETE faculty modeled* including various methods for implementation, $\chi^2 (12, N = 89) = 61.738, p < 0.01$.

Data analyses revealed a significant association between the amount of TPACK preservice teachers perceived having and the technology that PETE faculty modeled, including various methods for implementation. These results are supported by 50% of the students agreeing that over 60% of the PETE faculty provided an effective model of combining content, technologies, and teaching approaches in their teaching. Fifty-nine percent of the respondents indicated that 50% or more of their PETE professors provided an ef-

fective model of combining content, technologies, and teaching approaches in their teaching.

Forty-four percent of the respondents perceived that 50% or more of their cooperating teachers provided an effective model of combining content, technologies, and teaching approaches in their teaching.

Thirty-five percent of the respondents perceived that professors outside the PETE program provided an effective model of combining content, technologies, and teaching approaches in their teaching.

Results of a linear regression analysis conducted to predict *technological pedagogical content knowledge* based on *faculty model of TPACK* show a significant equation, $F(3, 86) = 15.40, p < .01$ with an R^2 of .35. It was found that *model of TPACK by faculty* predicted *technological pedagogical content knowledge* ($\beta = .586, p < .001$). It can be concluded that faculty modeling of TPACK explains the students' technological pedagogical content knowledge regardless if the student was or was not in the program.

Types of Technology Modeled by Professors

After the open-ended responses were examined, the frequencies and percentages were calculated for the types of technology modeled by professors, the types of technology modeled cooperating teachers, and what PETE candidates had implemented. Results indicated that PowerPoint was the most common type of technology being modeled and implemented by all three groups (41.90%, 38.00%, and 45.80%, respectively). Apps specifically designed for physical education were used infrequently by professors (6.40%), and SMART Boards were used in schools and by PETE candidates, however at a low frequency (14.20% and 8.30%, respectively). Similar technologies modeled by cooperating teachers were observed as being implemented by PETE candidates. See Table 3 for more results.

Table 3*Type of Technology Modeled*

Type of technology	Frequency	%
Type of technology modeled by professor or instructor		
PowerPoint/Prezi	13	41.90
Heart rate monitors	7	22.50
Videos	6	19.30
PE apps	2	6.40
Other (wikis, EMG, music)	5	16.10
Type of technology modeled by cooperating teacher		
Video (YouTube, animation)	5	23.80
PowerPoint	8	38.00
SMART Board	3	14.20
Music	3	14.20
Other (Wii Fit, Kinect, iPad)	2	9.50
Type of technology implemented by preservice teacher		
Video (YouTube, animation)	5	20.80
PowerPoint	11	45.80
SMART Board	2	8.30
Music	3	12.50
iPad	3	12.50

Discussion

This study examined preservice PETE candidates' technological and pedagogy skills and their beliefs about and implementation of technology in their classes in an effort to assess which methods of instruction about technology might provide the greatest learning. The results of this investigation provide information about ways to integrate technology in physical education that will assist in creating more efficiency and greater understanding of concepts. If a teacher uses an iPad for assessment or demonstrates skill analysis in real time on a SMART Board, along with having students practice the skill within progressive learning tasks, and follow up with an on-line learning assignment for homework, students will gain a deeper understanding of content (Woods et al., 2008). Student success in

physical education has been shown to “increase with the aid of audiovisual materials” (Yaman, 2008, p. 2), therefore reinforcing the concept that blended learning, including technology, will increase student learning and satisfaction (Vernadakis, Giannousi, Tsitskari, Antoniou, & Kioumourtzoglou, 2013).

Previous research has shown that PETE teacher candidates possess a positive attitude about technology (Gotkas, 2012) and teachers develop a greater affinity for technology use if they have training (Gibbone, Rukavina, & Silverman, 2010; Ince et al., 2006). This study resonates with these findings and provides significant findings that technology is being used; however, equity is not always represented within implementation. Both males and females in this study possess technological content knowledge, but males reported greater content knowledge than females did, which may affect implementation. PETE programs need to ensure equity when discussing resources and expectations for integration. PETE candidates arrive in classes with motivation to integrate and use technology (Semiz & Ince, 2012); therefore, PETE programs need to cultivate this motivation and foster learning experiences for it to grow.

Overall, this study has shown that a sample of PETE programs is aligning more closely with NASPE’s (2009) vision of technology integration in physical education. However, more examples of integration of current technologies need to be modeled more readily by PETE faculty and cooperating teachers. This may enhance TPACK for PETE candidates so they are well trained in implementing a variety of technologies within a lesson to enhance instruction and assessment.

Greater exposure to technology will increase PETE candidates’ competence with technology and therefore yield greater implementation in the schools (Arslan, 2015). The knowledge acquired during coursework affects the students’ preparation to integrate technology. Role modeling of a variety of specific technological skills is essential by PETE teachers and cooperating teachers during student teaching; however, it is lacking (Semiz & Ince, 2012). New methodologies need to be experimented with so that PETE students are well equipped to provide optimal learning experiences.

As technology changes, and because new advances are being made at such a quick pace, PETE faculty need to be conscious of the TPACK framework. They need to ensure that they are providing

many opportunities for technology integration in a variety of ways (Arslan, 2015). The TPACK framework helps to delineate what specific content knowledge, pedagogical knowledge, and technological knowledge is necessary to meet student needs. Professional development for PETE faculty regarding technology, along with mentoring, may assist them in gaining new ways to integrate technology and reduce anxiety related to technology in physical education (Martin, McCaughy, Kulinna, Cothran, & Faust, 2008).

These findings may encourage PETE programs to seek effective ways to prepare high quality physical education teachers to meet the technological challenges in the gymnasium. In essence, the need resides in redirecting the educational strategies and in adopting new educational models to integrate technology that links the main components that intervene in the educational process. This includes the knowledge on the relations among the most appropriate technology (TK) and the most effective teaching (PK) to make the educational content (CK) more accessible to the students (Koehler & Mishra, 2008).

To optimize technology-based models of teaching and learning, PETE candidates should be able to apply the content knowledge in a pedagogically sound way that is adaptable to the characteristics of students and the educational context (e.g., the gymnasium). The key challenge is to prepare educators to incorporate technological features into the teaching and learning process effectively and efficiently. Educators need to make connections between the purpose of the educational technology and the learning outcome expected. Other recommendations include reviewing the physical education curriculum for each program to address the pedagogical uses of discipline-specific technologies and developing a digital environment appropriate to preservice physical education students.

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