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The Effects of Role Modeling on Technology Integration within Physical Education Teacher Education

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Abstract

The national standards for physical education teacher education (PETE) in the US state that teacher candidates should be able to plan and implement technology infused lessons that meet lesson objectives and enhance learning in physical education (standard 3.7). Research shows that role modeling of technology integration can have a positive impact on the attitudes teacher candidates have in relation to integrating technology that as a result will enhance learning (Mishra & Koehler, 2006). The purpose of the study was to examine the perceptions of physical education teacher candidates on the integration of technology within a large PETE program that does not require pre-service teachers to take an undergraduate technology course; rather, technology is embedded within the program. In addition, the effects of role modeling by current and past university professors on technology integration were evaluated. This study used the Technological, Pedagogical, and Content Knowledge (TPACK) framework as the theoretical foundation and examined the effect of role modeling on the seven different constructs that make up the TPACK framework (Mishra & Koehler, 2006) using a survey adopted from Schmidt et al. (2009). Results showed that pre-service teachers perceived high levels of TPACK. Role modeling of technology made a significant impact on their perceived levels of technological knowledge (TK), technological content knowledge (TCK), technological pedagogical knowledge (TPK) and technological, pedagogical content knowledge (TPACK). The types of technologies modeled within the PETE program were focused around computer technologies, physical activity monitoring, and video feedback. Further research is encouraged to evaluate and compare perceived and actual TPACK levels of pre-service teachers.

Keywords

TPACK, PETE, technology, physical education, pre-service, role modeling

Category

Original Research

The Effects of Role Modeling on Technology Integration

The benefits of infusing technology within education can be endless when technology is properly infused within the instructional process. Many teachers in the US have found ways where technology can aid in enhancing learning and teaching, including within physical education. Research shows that pedometers, heart rate monitors, and digital video are examples of physical education technologies that provide K-12 students with instant feedback and can help them become more efficient movers (Bechtel, 2010; Juniu, 2013). However, when not implemented appropriately, technologies can also hinder the learning process (Baert, 2011). The benefits and barriers to including technology within K-12 physical education has encouraged national organizations such as the Council for the Accreditation of Educator Preparation (CAEP, formerly known as NCATE), and the Society for Health and Physical Education (SHAPE, formerly known as AAHPERD/NASPE), to adopt standards that will include appropriate technology use within physical education teacher education (PETE) programs. In PETE programs, technology was first adopted in the 2001 PETE standards for pre-service teachers and adjusted in 2008 to address the need for "teacher candidates to demonstrate knowledge of current technology by planning and implementing learning experiences that require students to use technology appropriately to meet lesson objectives" (National Association for Sport and Physical Education, 2008, p.15). Guidelines addressing proper technology inclusion adhering to the national standards were put in place to ensure that teachers gain the necessary skills and knowledge to use technology effectively to improve learning (NASPE, 2009).

Guided by the national standards, it is important to evaluate the level of integration of technology within PETE programs (Kirschner & Sellinger, 2003). Since the beliefs, efficacy and dispositions towards using technology has an impact on the application of technology within teaching (Abbitt, 2011; Holden & Rada, 2011; Zhao & Frank, 2003), it is crucial to evaluate the perceptions of pre-service teacher candidates on their level of technology knowledge and application. The broader purpose of this study was to examine the perception of the level of technology integration within a PETE program.

When adding technology to a teacher education curriculum, various models have shown various benefits: an stand-alone, introductory course in technology (Gunter, 2001), technology integrated within the program (Bechtel, 2010), combining the technology course within a program where technology is also embedded with the program (Sherry, 2000) and technology embedded within field-based practice (Pope, Hare, & Howard, 2002). A common complaint of offering a generic introductory course in technology for teacher educators is that it may not provide pre-service teachers with the necessary skills they need to teach developmentally appropriate lessons infused with technology (Hargrave & Hsu, 2000; Willis & Mehlinger, 1996). Reasoning behind this is that introductory technology courses focus mainly on generic technological knowledge and skills instead of context specific content or pedagogical concepts (Adamy & Boulmetis, 2006).

In 2011, Baert conducted a national survey of technology integration within PETE programs and 48% of programs reported that PETE students were required to take a technology course, while 39.5% reported the opposite and 12.5% of PETE faculty did not know whether the PETE students were required to take a technology course. This study did not specifically ask whether the course was a general introductory teacher education technology course or whether it was a PETE specific course. The findings did show that 97% of faculty saw the need to integrate technology throughout the program and 85% felt there was a need for a department wide technology plan to stimulate technology integration. Baert (2011) found that while there was support for technology integration within PETE programs, the data showed that only 50% of faculty believed a specific PE technology course should be embedded. However, these findings could have been due to the lack of knowledge of what such a course looks like. The findings sparked the author to question whether or not technology integration throughout the program without a specific PE technology course would be enough. According to Bechtel (2010), technology should not be confined to a particular course in a PETE program but should be threaded throughout the program. To provide pre-service teacher candidates with the necessary competency for effective technology integration, teacher educators must model appropriate practices where technology, content, and pedagogy are shown to enhance teaching and learning (Adamy & Boulmetis, 2006). Furthermore, in order to show how technology can enhance teaching and learning, it is recommended that teacher education programs infuse technology within pedagogy courses in the content area teacher candidates will teach. Since physical education is mostly taught within a gymnasium or the outdoors, pre-service teachers should learn to infuse technological enhanced lessons that support the practice of pedagogical skills within that specific context (Bechtel, 2010). Whether technology applications are taught within stand-alone courses or embedded within the program, the need to investigate the beliefs, knowledge, and attitudes of pre-service teachers is necessary since these impact their future teaching practices (Abbitt, 2011).

“A commonly cited obstacle to the integration of technology by teachers is the lack of teachers content, knowledge and technological knowledge” (Vrasidas & Glass, 2005, p.4). Teacher education programs should be a vehicle for the development of content and pedagogical knowledge and skills. Therefore, appropriate technology infusion is defined as the type of integration where the technology is embedded within the instruction and complements the pedagogical skills of the teacher as well as aids in the distribution of content (Mishra & Koehler, 2006). Consequently, technology should be modeled within both content specific and pedagogical specific courses within teacher education and those programs should be systematically evaluated to observe its affects. Evaluation studies are important for the development, implementation and support of teacher development models (Vrasidas & Glass, 2005). The purpose of this study was to evaluate the perceptions of teacher candidates on how technology is embedding throughout pedagogical courses within one large physical education teacher education program. A second aim of this study was to examine whether or not teacher candidates have the technological knowledge and skills to adequately implement technology within PE and produce developmentally appropriate lessons that benefit student learning. To evaluate the perceptions of pre-service teachers on their level of technology integration to impact learning, the Technological Pedagogical, and Content Knowledge (TPACK) Framework was used.

TPACK

The TPACK model is an extension of the original “Pedagogical Content Knowledge” framework created by Shulman in 1986. Shulman (1986), conceptualized that teaching is complex and that three knowledge systems need to work together to create a quality learning environment. Content knowledge (knowledge of content that is taught), pedagogical knowledge (teaching practices) and pedagogical content knowledge (understanding of topics that can be organized and adapted to various learners) make up this learning and teaching system. Mishra and Koehler (2006) extended Shulman’s framework to articulate the relationship between technology, content, and pedagogy (See Figure 1). The TPACK model explains that using technology effectively requires “an understanding of pedagogical techniques that use technologies in constructive ways to teach content” (Mishra & Koehler, 2006, p. 1029). The TPACK model consists of seven constructs (See Figure 1).

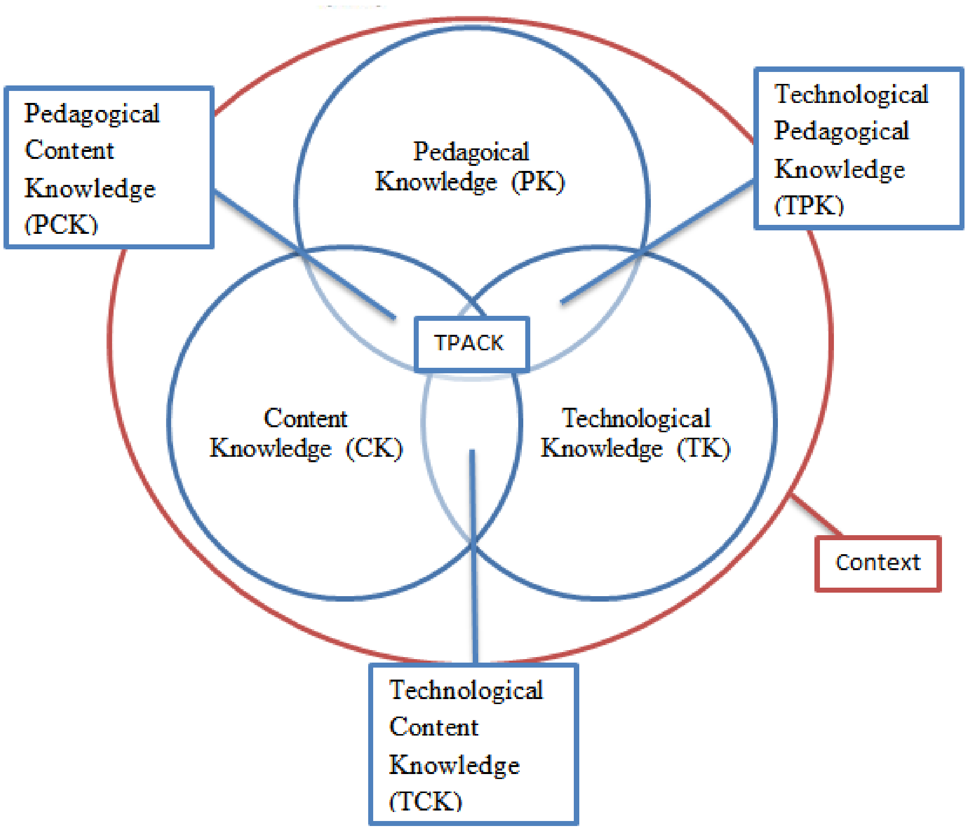


Figure 1. The TPACK model (Mishra & Koehler, 2006)

Table 1 outlines the definition of each of the seven constructs and provides examples specific for physical education. With the understanding that technology can aid or hinder the learning of students, it is crucial to teach pre-service teachers this relationship in order to ensure appropriate practices of technology within education (Baert, 2011). This study questioned whether TPACK could be developed in pre-service teachers where technology in not offered as a separate course but rather embedded within the PETE program. Furthermore, the authors questioned whether pre-service teachers were able to understand the relationship and inter-play between content, pedagogy and technology.

Table 1

Definitions and Examples of the Seven Constructs within the TPACK Model

Constructs	Definition	Examples for PETE
Pedagogical Knowledge (PK)	Knowledge about the students' learning, instructional methods, different educational theories, and learning assessment to teach a subject matter without references towards content	Knowledge about how to use different teaching styles
Content Knowledge (CK)	Knowledge of the subject matter without consideration about teaching the subject matter	Knowledge about anatomy, biomechanics, gymnastics, …
Technological Knowledge (TK)	Knowledge about how to use ICT hardware and software and associated peripherals	Knowing how to use digital tools (E.g. blogs, wikis)
Pedagogical Content Knowledge (PCK)	Knowledge of representing content knowledge and adopting pedagogical strategies to make the specific content/topic more understandable for the learners	Knowledge of using command style when teaching dance
Technological Content Knowledge (TCK)	Knowledge about how to use technology to represent/research and create the content in different ways without consideration about teaching	Knowledge about using fitness apps to track your progress
Technological Pedagogical Knowledge (TPK)	Knowledge of the existence and specifications of various technologies to enable teaching approaches without reference towards subject matter	The notion of using excel to manage attendance
Technological Pedagogical Content Knowledge (TPACK)	Knowledge of using various technologies to teach and/represent and/ facilitate knowledge creation of specific subject content	Knowledge about how to use video analysis apps to assess students' movements in physical education

Note. Definitions adapted from A Review of Technological Pedagogical Content Knowledge

(Chai, Koh & Tsai, 2013)

The rational for this particular study is to evaluate the level of TPACK of physical education pre-service teachers to find out whether the current coursework adequately prepares teacher candidates for creating technology infused developmentally appropriate lessons. Research has shown that a separate course in technology does not necessarily provide future teachers with the adequate experiences to integrate technology effectively (Gunter, 2001; Milken Exchange on Education Technology, 1999). Prior to implementing a new undergraduate course or constructing a strategic plan to help professors teach courses that model appropriate technology integration, the study aimed to evaluate the current state of TPACK in order to find the most appropriate way for new teachers to learn how to integrate technology effectively.

Method

The study was descriptive and evaluative in nature. Evaluation studies within education are complex due to the many variables it encompasses. Because of its complexities, evaluation studies often use various methods to understand and analyze the processes that make up an educational system, in this case a curricular framework. While the main purpose of research is to answer the questions the researcher poses, this study also aimed to check the effect of using a pre-existing TPACK framework and adopted survey within the context of a program that does not have a technology course. Using mixed methods allowed for more diverse views to be presented while observing possible discrepancies within the research design as well.

Research Questions

This study asked: “What are the perceptions and experiences of physical education pre-service teachers on the inclusion of technology within their physical education program?” The following sub-questions guided the research:

1. What are the current perceived levels of TPACK and its constructs of current pre-service teachers within a PETE program?
2. How to the levels of TPACK and its constructs between pre-service teachers differ at various levels within the program?
3. How do pre-service teachers perceive the level of technology integration among current professors and cooperating teachers?

Participant selection

Data were collected following IRB approval from three different PETE courses at different levels to identify the differences and similarities between the different levels: an introductory freshman physical education course, a junior level methods course, and a senior seminar course. The courses were chosen for convenience only and did not include instruction focused on technology. The survey was completely voluntary and students completed the survey at the end of the specific class with permission from the instructor. The research protocol was explained and students received a paper survey. All surveys were administered and coded by the research assistant, and data was analyzed anonymous. It is important to note that the PETE students did not receive any mandatory training in technology or the TPACK model.

Instrumentation

Several survey instruments are currently available to measure teacher TPACK (Archambault, & Crippen, 2009; Jamieson-Proctor, Finger, Albion, 2010; Koehler & Mishra, 2005; Schmidt, Baran, Thompson, Koehler, & Shin, 2009). The survey of pre-service teacher knowledge of teaching and technology (TKTT) created by Schmidt, Baran, Thompson, Mishra, Koehler & Shin (2009) was most suitable for adoption within this study since it measured pre-service TPACK levels. However, Schmidt et al. (2009) studied childhood majors while this study examined physical education majors. The survey was adapted to fit the different major by changing the subject from "mathematics" for example, to "physical education". Reliability measures ranges between .85 to .92 (Schmidt et al., 2009).

The survey measured the six parts of the TPACK Framework (see Figure 1) among the undergraduate students within a 4 year PETE program:

- TK: Technology Knowledge (6 items)
- CK: Content Knowledge (3 items)
- PK: Pedagogy Knowledge (8 items)
- PCK: Pedagogy Content Knowledge (1 item)
- TCK: Technology Content Knowledge (14 items)
- TPACK: Technology Pedagogy and Content Knowledge (1 item)

In addition, participants were asked to rate (9 items) and comment (3 questions) on how TPACK has been modeled by their instructors and cooperating teachers in the field. The survey was scored on a 5-point likert-scale where a score of 1 is assigned to strongly disagree and a score of 5 is assigned to strongly agree. The scores within each construct were then averaged and the average constitutes the score for that construct. The three open ended questions asked students to explain specific examples of modeling of appropriate integration of technology within K-12 PE by an instructor, a cooperative teacher, and themselves. These questions allowed the researcher to evaluate the extent of how much students understood about appropriate technology integration in PE, as well as provide examples of modeling of technology integration within the program. The survey also included nine demographic questions.

Data Analysis

Data was entered and analyzed in Excel using basic statistical measures. Response rate and demographic information was analyzed. Percentages and means were used to display demographical information. Patterns among the qualitative data were grouped. TPACK data was organized and analyzed using means, ranges, and percentages comparing each of the seven constructs. Stata Version 12 was used to create scatter plots that show the relationship between demographic data and each of the seven TPACK constructs were analyzed for any significant relationships. Linear regressions were used to model the relationships between variables that showed a positive relationship. The effect of modeling was analyzed within each construct and in conjunction with the qualitative findings.

Results

Demographics

Combining the enrollment numbers of all three courses resulted in a sample of 275 students. In total, 220 students participated in the survey, providing a response rate of 80%. Table 2 provides an outline of the breakdown of demographics. Given that some students who transferred into the PETE program attended the introductory PETE course (a requirement for all freshman and transfers), the data was organized and analyzed according to different levels, not the specific course they attended. The 42 freshman and 7 sophomores were combined as one group since these students did not start their first pedagogy course yet and the sophomore sample was too small. There were 102 juniors and 69 seniors. Of those participating, most were between 18-22 years old. There were a total of 161 males and 59 females.

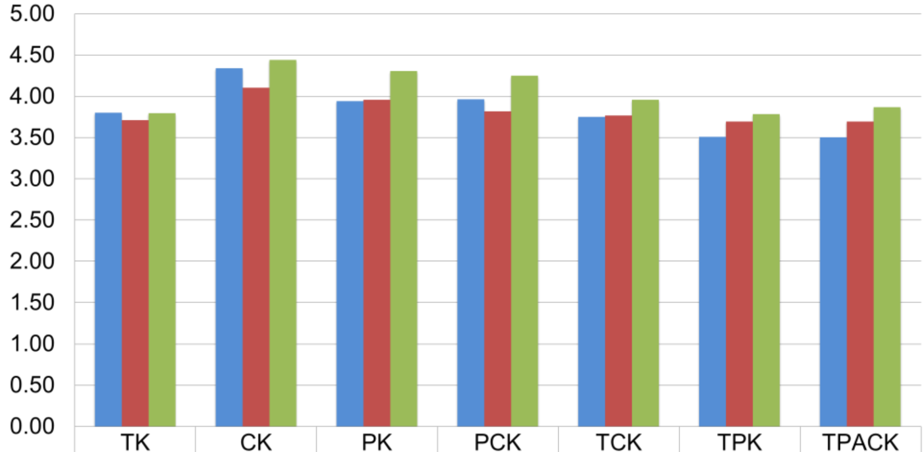
Table 2

Demographics

Level		Age				Gender	
	n	18-22	23-26	27-32	>32	Males	Females
Freshman/ Sophomore	49	49	0	0	0	36	13
Juniors	102	92	10	1	0	75	27
Seniors	69	62	6	0	1	50	19
Total	220	203	16	1	1	161	59
		(92.3%)	(7.3%)	(.45%)	(.45%)	(73.2%)	(26.8%)

Perceived TPACK Levels

Figure 2 shows the perceived mean levels of the seven constructs within the TPACK model. All pre-service teachers reported high levels of all constructs within the model regardless of their level in the program with mean scores all on or above 3.5. In addition, they perceived their content knowledge to be the highest of all seven constructs. Except for technological knowledge, senior level students perceived the highest mean level of confidence in all other six constructs. Freshman and sophomore reported higher level of perceived technological knowledge than juniors and seniors.



	TK	CK	PK	PCK	TCK	TPK	TPACK
Freshman & Sophomore	3.80	4.34	3.94	3.96	3.75	3.51	3.50
Juniors	3.71	4.10	3.96	3.81	3.77	3.69	3.69
Seniors	3.79	4.44	4.30	4.25	3.96	3.78	3.87

Figure 2. Perceived level of seven constructs within the TPACK model compared between three levels.

Role Modeling

Role modeling of technology by professors and cooperating teachers has a significant effect on technological knowledge (β = .31, $p < .001$), technological content knowledge (β = .35, $p < .001$), technological pedagogical knowledge (β = .45, $p < .001$) and technological pedagogical content knowledge (β = .47, $p < .001$) while accounting for practice, years, and gender (see Table 3). In addition, role modeling of technology has an effect, although smaller, on the content knowledge (β = .12, $p < .05$) pedagogical knowledge (β = .17, $p < .01$) of pre-service teachers. When accounting for gender and year in college, practicum experience has an effect on pedagogical knowledge (β = .19, $p < .05$). Role modeling of technology did not have a significant effect on pedagogical content knowledge (β = .07, n.s.) of pre-service teachers within the program. Other relationships were analyzed but there were no significant effects of gender or years in college on any of the seven constructs within the TPACK model.

Table 3

Linear Regression Results of CK, PK, and PCK

	CK			PK			PCK		
Variable	β	95% Conf. Interval		β	95% Conf. Interval		β	95% Conf. Interval	
Gender	.00	-.15	.15	-.02	-.18	.13	0.03	-.17	.22
Year	-.02	-.11	.05	.05	-.03	.13	0.05	-.05	.15
Practicum	.13	-.04	.29	.19*	.03	.36	0.10	-.10	.31
Role Modeling	.12*	.01	.23	.17**	.06	.28	0.07	-.07	.21
Constant	3.84	3.40	4.27	3.24	2.80	3.68	3.52	2.98	4.07
R^2	.03			.11			.03		
F for change in R^2	.02			.09			.00		

p < .05*, *P* < .01**, *P* < .001***

Table 4

Linear Regression Results of TK, TCK, PCK, and TPACK

	TK			TCK			TPK			TPACK		
Variable	β	95% Conf. Interval		β	95% Conf. Interval		β	95% Conf. Interval		β	95% Conf. Interval	
Gender	.10	-.10	.30	.03	-.15	.20	.11	-.05	.28	.03	-.19	.25
Year	-.05	-.15	.05	-.01	-.09	.09	.05	-.03	.14	.05	-.06	.17
Practicum	.03	-.19	-.19	.09	-.11	.28	-.03	-.21	.15	.05	-.19	.29
Role Modeling	.31***	.16	.16	.35***	-.22	.48	.45***	.33	.57	.47***	.31	.63
Constant	2.70	2.13	2.13	2.52	2.01	3.03	1.82	1.34	2.30	1.79	1.15	2.43
R^2	.08			.13			.23			.16		
F for change in R^2	.06			.11			.22			.14		

P > .05*, *P* > .01**, *P* > .001***

Examples of Technology Integration

The qualitative questions posed in the survey asked for examples of how professors and cooperating teachers exemplified technology use within their classes (See Table 5). Low numbers of participants responded to the qualitative questions and those who did respond focused mainly on the technologies used by their teachers. The results showed that PowerPoint was most often modeled and pre-service teachers reported using PowerPoint themselves to present information in class. Video was frequently mentioned due to the fact that in one of the methods courses, all pre-service teachers are video taped in four teaching labs. Technologies modeled specifically for the context of physical education were YouTube videos to demonstrate movement patterns, pedometers, heart rate monitors and a mobile movement analysis app called "Coaches Eye".

Table 5

Percentage of Technologies Modeled by Professors and Cooperating Teachers

Technology	%
PowerPoint	13.69
Video	11.90
YouTube	7.74
Pedometers	7.14
Heart Rate Monitor	5.95
Coaches Eye	5.36
Excel	3.57

Discussion

The results showed that senior students have a higher perceived level of TPACK than juniors. However, freshman and sophomores perceive their TK, CK, and PCK to be higher than those from juniors. This may be a result of the skewed perception freshman may have in relation to content and teaching in physical education since they have not yet entered their first teaching methods course. Overall, all students perceived their content knowledge to be the highest of the seven constructs. Hammond and Manfra (2009) reported that pre-service teachers' prior experience and conceptions about technology use contributes to their current applications and preferences. Most pre-service teachers in this study appeared to perceive a high level of all seven constructs, including the technology infused constructs. While no pre-service teachers participated in a technology course, all were confident in their ability to use technology and perceived to understand how technology can be used to learn content and integrate technology to enhance learning. The researcher questions whether or not the pre-service teachers understood all the components within the survey, were able to reflect and analyze their own level of TPACK, or if their level of TPACK was sole contributed through role modeling of technology by their teachers or how much did their own experiences outside the program contribute. Niess (2011) acknowledged that pre-service teachers might have difficulty recognizing the relationship and interplay between content, pedagogy, and technology even when technology has been infused within a teacher education program. Further more, the survey was unable to distinguish between those pre-service teachers who understood appropriate technology integration and modeling and those who perceived technology integration as appropriate while it may not have been. A limitation of using this survey on its own was that the survey did not measure whether the role modeling by their teachers included role modeling of appropriate integration of technology. Understanding appropriate integration of technology requires a unique knowledge base that pre-service teachers may not have obtained if this relationship was never explained within the program (Baert, 2011; Neiss, 2005; Voogt, Fisser, Pareja Roblin, Tondeur, & van Braakt, 2013).

Using a linear regression model, the results showed that role modeling of technology by professors and cooperating teachers had a significant correlation at $p < .001$ towards five of the constructs (TK, PK, TCK, TPK, and TPACK) while not significant towards CK and PCK. This study showed that the amount of role modeling a teacher candidate receives within teacher preparation classes can predict their perceptions and self-confidence of their own ability to use and integrate technology into their own classroom. Since pre-service teachers rely on good role modeling to show pedagogically sound practices, these results show evidence for the need to provide support to PETE faculty so that they are comfortable and knowledgeable in role modeling such appropriate practices. Within this specific program, technology is included within the strategic plan, yet not yet systematically implemented. However, congruence meetings between faculty teaching similar courses has ensured that many pre-service teachers receive similar pedagogical instructions, including the use of technology within the courses. For example, during the entry-level methods course, all pre-service teachers used video to record themselves, and to analyze and reflect on their teaching. Within the assessment course, all students used Excel to analyze student-learning data. The congruence between instructors may have contributed to the examples the pre-service teachers indicated within the survey.

While role modeling had an effect on TPACK perceptions, in contrary of what other research showed (Jimoyiannis & Komis, 2007), personal factors such as gender, year in program, and teaching experience (practicum) had no significant impact on TPACK perceptions.

The types of technologies modeled within the PETE program were focused around computer technologies, physical activity monitoring, and video feedback. These results were similar than those found in other studies (Baert, 2011 & DelTufo, 2000). Within K-12 physical education, computer technologies such as PowerPoint and Excel can be extremely useful in planning, instructing, and assessing learning (DelTufo, 2000). Provided that K-12 physical education teachers are in the business of creating physically literate individuals, pedometers and heart rate monitors are useful tools to measure the level of physical activity (Beighle, Morgan, & Pangrazi, 2004; Butcher, Fairclough, Stratton, and Richardson, 2007; Grissom, Ward, Martin, & Leenders, 2005; Mears, 2010; Rowe, Mahar, Raedeke, & Lore, 2004). Using video and movement analysis tools has also been seen as powerful tools to enhance motor skill development within K-12 (Banville & Polifko, 2009; Del Rey, 1971; Knudson & Kluka, 1997). The results of this study showed strong similarities to the vital tools currently advocated for within K-12 physical education. While there is no guarantee, this may suggest that the participants may be comfortable using these tools within their student teaching experiences and beyond. On the other hand, other technologies may be useful as well, and this study showed that many technologies are not included within the program (examples such as exergames, web 2.0 tools, fitnessgram software, QR codes, and other emerging technologies). The question worth posing would be: "What different technologies are necessary for K-12 physical educators to learn?" Furthermore, how will such technologies be included within PETE programs? Program administrators can answer these questions by reviewing, analyzing, and re-evaluating the strategic plan. Finally, research is needed to evaluate whether TPACK levels have an effect on the actual appropriate inclusion of technology within student teaching and beyond.

The results from the qualitative questions indicated a very "tool" orientated view on technology integration. While the survey asked pre-service teachers to provide specific examples on "how" technology has affectively engaged student learning, the answers were focused on the tools used. Such responses made it difficult for the researcher to analyze whether or not pre-service teachers provided appropriate examples of technology integration. The qualitative portion was helpful to find out what tools were being used with the program but refrained from addressing whether or not such tools were used appropriately or not. This is concerning and further research is needed to explore the appropriate use of technology within the program. The findings also showed that in order for PETE students to answer these questions, they should understand the difference between appropriate and inappropriate use of technology. For example, a teacher can use video to show students how they move, yet video analysis combined with reflective practice can engage students in active learning about their movement to consequently enhance their movement. It will be important to gain a deeper understanding of what pre-service teachers perceive as appropriate practices in using technology in physical education. In addition, if student engagement and learning comes first, the focus of technology integration should shift from learning the tool to learning about technology-enhanced learning (Jaipai Jamani & Figg, 2013)

Conclusion

Positive attitudes and perceptions about appropriate technology integration practices in physical education are important for pre-service teachers to obtain prior to entering the work field. Results showed that pre-service teachers have perceived high levels of technological, pedagogical content knowledge. This may positively contribute to the practical application of technology infused lessons within K-12 physical education. A challenge noted within the literature on TPACK exists around the context of which pre-service teachers learn about technology and the interplay of technology, content and pedagogy (Abbitt, 2010). Therefore, it is vital to consider various research methods within various contexts to measure TPACK. Results from this study showed support to add more research and encourage a mixed methods and context approach (e.g. measuring perceived and actual TPACK levels) to measure TPACK in order to eliminate the ambiguity around the meaning of TPACK. The next phase of this research is to measure the actual TPACK levels of pre-service teachers within their student teaching experience and compare the "perceived" with the "actual" TPACK levels.

Continuous research investigating TPACK levels of beginning teachers will be necessary to evaluate the transfer of TPACK as new teachers enter the field. This study showed that common yet appropriate technologies are modeled within the PETE program. Increasing professional development for PETE faculty may assist in modeling other appropriate technologies as well. Results showed that role modeling of technology has an impact on the perceived confidence level of TPACK.

To enhance teacher candidates' self-efficacy in regards to technology integration, increasing the quality, quality and spread of role modeling physical education specific technologies should occur at various levels within physical education teacher preparation programs. While the program has frequent course congruency meetings, technology congruency and integration should be discussed across the curriculum. A systematic review of current and possible technology applications within specific PETE pedagogy courses may determine and encourage program-based coherence to develop TPACK. In return, pre-service teachers will gain more knowledge and skills on how to infuse technology to create developmentally appropriate physical education lessons.

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