

## PEDAGOGY

# The Impact of Role Models and Experiences on Physical Education Teacher Education Students' Technological, Pedagogical, and Content Knowledge

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### Abstract

*Preparing future physical education teachers to effectively integrate technology is a responsibility of physical education teacher education (PETE) programs. The purpose of this study was to examine 124 PETE students' Technological, Pedagogical, and Content Knowledge (TPACK) levels, role models for TPACK, and first-hand experiences with TPACK. Participants completed the Survey of Preservice Physical Education Teachers' Knowledge of Teaching and Technology. Descriptive statistics, analysis of variance, and stepwise regression were used to determine TPACK levels, differences among participants, and predictors of TPACK. Results indicated that PETE students had high levels of TPACK ( $M=4.0$ ,  $SD = .76$ ) and that PETE faculty modeling was the most significant predictor of TPACK. TPACK was observed and experienced mostly with video analysis/demonstrations and activity monitoring.*

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Due to technology's growing role in education, teacher preparation programs are being held ever more accountable for preparing teachers to use it to enhance teaching and learning. The International Society for Technology in Education (ISTE) has established and continues to revise technology integration standards for students, educators, and administrators to equip their schools and classrooms for digital-age learning. ISTE Standards for Educators (2017) state that teachers should be learners, leaders, citizens, collaborators, designers, facilitators, and analysts, all while using technology to enhance these roles. Physical education teachers are not excluded from these technology standards. In fact, physical education teachers are in a unique position to integrate a multitude of technology options to enhance teaching and learning that extend beyond technology used in the general classroom, including the use of video, internet, mobile devices and applications, activity monitors, and more (Yu et al., 2018). The Society of Health and Physical Educators (SHAPE) America has also recognized the potential and importance of technology integration and has started education and awareness efforts directed toward it. Specifically, the National Standards for Initial Physical Education Teacher Education (SHAPE America, 2017) have technology's role being specifically woven into planning and implementation, instructional delivery and management, and professional responsibility:

- 3.e Plan and implement learning experiences that require students to use technology appropriately in meeting one or more short- and long-term plan objective(s) (p. 3).
- 4.e Analyze motor skills and performance concepts through multiple means (e.g., visual observation, technology) in order to provide specific, congruent feedback to enhance student learning (p. 4).
- 6.c Describe strategies, including the use of technology, for the promotion and advocacy of physical education and expanded physical activity opportunities (p. 6).

PETE students, which will increasingly consist of digital natives who experience diverse technology in their everyday lives both in and out of school (Nemcek, 2013), will likely have more technology knowledge than previous cohorts of students. It is, however, the responsibility of PETE programs to model best practices in a vari-

ety of pedagogical behaviors, one being technology integration. It is necessary to teach these students how to appropriately integrate technology with physical education content and pedagogy to use it effectively.

Though there have been several recent investigations on PETE students' beliefs and experiences with technology (Admiraal et al., 2017; Baek et al., 2018; Jones et al., 2017; Krause, 2017; Krause & Lynch, 2018), few researchers have explored the complex interplay of technology integrated with physical education content and pedagogy. Of the limited literature that is present, PETE students reported: (a) an absence of exposure and socialization toward technology in pre-service teachers' own K-12 years in physical education (Baek et al., 2018; Gawrisch et al., 2020); (b) a higher percentage of time was spent on TK rather than how technology can enhance student learning (Baek et al., 2018; Jones et al., 2017); (c) faculty modeling of technology is essential in developing TPK (Baert & Stewart, 2014; Krause & Lynch, 2018; Scrabis-Fletcher et al., 2016; Semiz & Ince, 2012); (d) being overwhelmed by the number of technology uses possible in physical education and how to infuse such technology within instruction (Baek et al., 2018; Jones et al., 2017); and (e) meaningful hands-on practice with technology (both in the classroom and field experiences) had impact on changing PETE students' perceptions towards technology (Baek et al., 2018; Krause 2017; Krause & Lynch, 2018; Semiz & Ince, 2012).

Prior to the introduction of modern technology into education, Shulman (1987) presented several categories of the knowledge base for teachers, and of special interest was "the blending of content and pedagogy into an understanding of how particular topics, problems, or issues are organized, represented, and adapted to the diverse interests and abilities of learners, and presented for instruction" (p. 8), known as Pedagogical Content Knowledge, or PCK. Extended from Shulman's (1987) idea of PCK, Mishra and Koehler (2006) introduced the idea that effective technology integration involves pedagogy employed around subject matter content, delivered with suitable technology. This conceptual framework displayed in Figure 1, known as Technological, Pedagogical, and Content Knowledge (TPACK), "captures the essential qualities of teacher knowledge required for technology integration in teaching, while addressing

the complex, multifaceted, and situated nature of the knowledge” (Mishra & Koehler, 2006). Three key forms of knowledge are the fundamental basis of TPACK, including Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK), which intersect with one another to form Pedagogical Content Knowledge (PCK), Technological Content Knowledge (TCK), and Technological Pedagogical Knowledge (TPK), and finally at the core, Technological Pedagogical Content Knowledge (TPACK). Each of these knowledge types is defined as follows (Koehler & Mishra, 2009):

- CK – Knowledge about the subject matter to be learned or taught
- PK – Knowledge about processes, practices, or methods of teaching and learning
- TK – Knowledge about working with technology tools and resources
- PCK – Knowledge of pedagogy related to teaching specific content
- TCK – Knowledge of how technology and content impact and limit one another
- TPK – Knowledge of how teaching and learning can transform when technology is integrated in a specific way
- TPACK – Knowledge about pedagogy employed around subject matter content, carried out with appropriate technology

While the TPACK framework involves the interplay of these types of knowledge, the success of technology integration depends on teachers’ knowledge of the individual forms of knowledge. For example, if a teacher is lacking in one or more areas of PK, CK, or PCK, adding technology to the mix may “hinder or distract from learning” (Jones et al., 2017). Some may argue that younger generations who have grown up with technology may be able to more successfully integrate technology; however, even simply having low PK limits teachers’ technology integration success, even with high levels of TK (Pamuk, 2012; Pierson, 2001).

There are many ways to integrate technology (i.e., demonstrate TPACK) in physical education. For example, within a basketball les-

son on dribbling and passing skills, a teacher may use a mobile application to video record and analyze their skill performance during small-sided games. In this example, the teacher combines content knowledge of dribbling and passing with pedagogical knowledge of assessment, and with the enhancement of technology knowledge through a mobile application. The teacher is able to teach the content of dribbling and passing with the help of technology, which may enhance the lesson for the teacher and students alike.

Due to the uniqueness of physical education, including the dynamic environment, added barriers to technology integration (Jones et al., 2012; Roth, 2014), and expansive variety of technology tool opportunities, PETE programs must go above and beyond most other subject area teacher preparation programs to provide opportunities for their students to develop TPACK. To date, technology integration or TPACK levels and experiences with TPACK among PETE students have varied, possibly due to a seemingly inconsistent approach among PETE programs (Krause & Lynch, 2018; Scrabis-Fletcher et al., 2012).

Hands-on experiences with and modeling of technology integration into teaching are two ways to enhance the TPACK levels of preservice teachers. For example, Banas and York (2014) found that authentic learning experiences enhanced motivation and self-efficacy to integrate technology among health and physical education preservice teachers. Hands-on learning and modeling of technology use have been shown to be effective ways to develop PETE students' knowledge, attitudes, and perceptions, and future use of technology integration (Hsu, 2012; Mills, 2014; Wyant et al., 2015). Krause and Lynch (2018) found that modeling of technology among PETE faculty occurred more with programs that had access to technology, and PETE students recognized modeling as a way to help them learn to integrate technology. Scrabis-Fletcher et al. (2016) found significant associations between faculty role modeling and PETE students' TPACK and faculty-modeled technologies, such as PowerPoint and heart-rate monitors while cooperating teachers modeled video. Physical education applications and iPads were among the lowest-modeled technologies. However, Semiz and Ince (2012) found that university instructors were not good role models for technology

integration in physical education teacher education programs in Turkey.

Due to the importance of technology integration set forth in several sets of standards (ISTE, 2018; SHAPE America, 2017) and its potential to enhance teaching and learning in physical education, it is important to understand the status of PETE students' knowledge of the components of TPACK. Additionally, given the importance of role models and experience with regard to developing students' TPACK, there is a need to investigate the experiences of students during their PETE programs. Therefore, the purpose of this study was to determine the TPACK levels among PETE students, the level and sources of TPACK modeling for these students, and the potential impact role modeling had on their TPACK.

## Method

A survey design was employed to determine the TPACK levels and modeling experiences among PETE students. The first author's university's institutional review board approved this study and informed consent was obtained from all participants.

## Sample

As part of the sampling process, all 124 programs accredited by the National Council for Accreditation of Teacher Education (NCATE) and the Council for the Accreditation of Educator Preparation (CAEP) were invited to participate in the study. NCATE/CAEP accredited programs were selected due to their inclusion of the National Standards for Initial Physical Education Teacher Education (SHAPE America, 2017), which include technology integration. The final pool of participants in this study consisted of 124 PETE students (53.2% female, 46.8% male; aged 18-64,  $M = 22.5$ ,  $SD = 5.4$ ), representing 20 different NCATE/CAEP accredited PETE programs (16.1% of programs invited) from 14 different states within the United States. States with the highest response rate were New York ( $n = 37$ ), Pennsylvania ( $n = 21$ ), and New Jersey ( $n = 14$ ). Of all invitations sent, 20 PETE Program Coordinators agreed to help distribute the survey via e-mail to all their current pre-service students. The resulting 124 PETE student participants reported year within their programs, with 48.4 % ( $n = 60$ ) seniors, 19.4% ( $n = 24$ ) juniors, 16.9 % ( $n = 24$ ) sophomores, 8.9% ( $n = 11$ ) freshmen, and

6.5% ( $n = 8$ ) in a post-bachelor program. Finally, 71% ( $n = 88$ ) of the respondents were currently enrolled or had already completed a practicum experience in a K-12 physical education setting.

## **Instrumentation**

Instrumentation in this study consisted of the Survey of Preservice Physical Education Teachers' Knowledge of Teaching and Technology, which is a modification of the previously validated and reliable Survey of Preservice Physical Education Teachers' Knowledge of Teaching and Technology (Schmidt et al., 2009). The original survey was intended to measure preservice teachers' self-assessment of the seven knowledge domains in TPACK. The survey, through two-factor analyses, demonstrated strong internal consistency reliability (coefficient alpha; .75 to .92) for the seven subscales. The survey consisted of 30 Likert-scale [Strongly Disagree (1) to Strongly Agree (5)] TPACK questions, which were sectioned by TPACK subscales: TK ( $n = 6$ ), CK ( $n = 5$ ), PK ( $n = 7$ ), PCK ( $n = 1$ ), TCK ( $n = 1$ ), TPK ( $n = 9$ ), and TPACK ( $n = 1$ ). The modified instrument for the current study included revised wording and content to reflect physical education that was derived from the 2008 National Standards for Initial Physical Education Teacher Education; however, the overall format was not changed. Note that at the time of survey development, the current (2017) standards had not yet been released. A sample revised CK question was, "I have sufficient knowledge about physiological and biomechanical concepts related to skillful movement, physical activity, and fitness." A sample PCK question was, "I can select effective teaching approaches to guide student thinking and learning in physical education." The survey also included seven demographic questions, five questions regarding models of TPACK (e.g., "My K-12 cooperating teachers appropriately model combining content, technologies and teaching approaches in their teaching."), three questions regarding what percentage of PETE instructors, instructors outside of PETE, and K-12 cooperating teachers provided effective modeling of TPACK, and three open-ended questions where students could share examples of observing and demonstrating TPACK (e.g., "Describe a specific episode where a physical education teacher education professor or instructor effectively demonstrated or modeled combining content, technologies and teaching approaches in a classroom lesson. Please include in your description what content

was being taught, what technology was used, and what teaching approach(es) was implemented.”). All these additional questions were slightly modified from the original survey to include “physical education.”

The modification process consisted of guidelines in scale development (DeVellis, 2012), including considering content and expert review. Considering the content of an item depends upon defining the construct it is intended to measure, and often reflects the underlying construct of the targeted theory (DeVellis, 2012; Gorin, 2006). This clearly defined construct helps to “... maintain the focus of item and test development on the ability or trait of interest” (Gorin, 2006). The initial form of the survey was sent for review to two experts in the field of PETE to provide evidence of face validity. The two experts were faculty members in PETE programs in the United States who had experience in conducting survey research in the field of physical education teacher education and instructional technology and were not members of the research team. Experts were asked to critique the readability, clarity, conciseness, and layout of each section of the survey, thus leading to content validity evidence (DeVellis, 2012). Based on feedback from the experts, items, definitions, and formatting were revised as appropriate, which included only minor changes. The revised survey was then administered to a convenience sample of five PETE major students to gather further evidence of face validity by completing the survey, commenting on the readability, clarity, and format, and evaluating the extent to which survey items were representative of the wide range of tasks teachers must demonstrate in the domain of interest. Minor revisions to the items and format of the survey were made as deemed appropriate.

The modified TPACK instrument resulted in strong internal consistency reliability (coefficient alpha) overall for the full model ( $\alpha = .93$ ). In addition, all subscales independently reported strong internal consistency: TK ( $\alpha = .90$ ), CK ( $\alpha = .86$ ), PK ( $\alpha = .89$ ), TPK ( $\alpha = .93$ ), and TPACK Modeling Behavior ( $\alpha = .88$ ). The alpha level of .70 has been widely noted as being acceptable in survey research (Bandura, 2006; Cronbach, 1951).

## **Procedures**

The researchers identified the email addresses of PETE faculty through college/university websites (predetermined by the NCATE/

CAEP accreditation list). Study invitation messages were sent via email to faculty requesting that they forward the email message and corresponding website link for the online survey, to students within their PETE program. A follow-up survey was sent two weeks later as a reminder. All participants provided informed consent prior to proceeding to the survey.

## Data Analysis

Descriptive results and *t*-tests were conducted to determine if there were significant differences in TPACK perceptions between males and females, as well as those who have/have not completed a practicum field experience. A multiple comparison post hoc analysis test in ANOVA was used to find significant differences in TPACK perceptions based on the self-identified year of their program. A stepwise regression analysis was conducted to see which sub-variables accounted for the variability in overall TPACK. In addition, two other linear regression analyses were conducted to predict students' overall perceived TPACK based on TPACK role model variables, as well as the effect TPACK modeling had on predicting each sub-variable. Open-ended questions were analyzed using open and axial coding (Strauss & Corbin, 1990) by type and purpose of technology among each group (i.e., faculty, cooperating teacher, and student).

## Results

### TPACK Scores

The mean score for participants' TPACK was 4.0 (on a 1-5 scale), as well as for all knowledge constructs with all mean scores being at or above 3.9 (Table 1). Pedagogical knowledge (PK) and pedagogical content knowledge (PCK) showed to have the overall highest scores with means of 4.29 ( $SD = .48$ ) and 4.12 ( $SD = .61$ ), respectively. Gender differences were also explored compared to all seven constructs. Males self-reported to have higher overall TPACK scores on five out of the seven constructs, however none of these differences in scores were significant (all  $p > .05$ ). An independent samples *t*-test showed that those who had practicum experience had significantly higher perceptions of their TPACK in the areas of content knowledge (CK)  $t(3.88)$ ,  $p < .001$  and technology content knowledge (TCK)  $t(2.71)$ ,  $p = .008$  than those who did not have practicum experience.

A one-way analysis of variance showed that the effect grade level was significant for all constructs excluding technology knowledge (TK)  $PK: F(4,119)= .46, p < .001$ ;  $CK: F(4,119)= 11.54, p < .001$ ;  $TPK: F(4,119)= 3.98, p = .005$ ;  $TCK: F(4,119)= 4.26, p = .003$ ;  $PCK: F(4,119)= 6.28, p < .001$ ;  $TPACK: F(4,119)= 5.23, p = .001$ ). Post-hoc analyses using Scheffé post hoc criterion indicated the following statistically significant differences (all  $p$ 's  $< .05$ ):

- PK- Both juniors ( $M = 4.39, SD = .44$ ) and seniors ( $M = 4.42, SD = .46$ ) were significantly higher than freshman ( $M = 3.73, SD = .37$ )
- CK- Seniors ( $M = 4.06, SD = .43$ ), juniors ( $M = 4.03, SD = .59$ ), sophomores ( $M = 3.86, SD = .49$ ), and post-bachelors ( $M = 4.0, SD = .44$ ), were all significantly higher than freshman ( $M = 2.96, SD = .7$ )
- TPK- Both juniors ( $M = 4.19, SD = .39$ ) and seniors ( $M = 4.0, SD = .63$ ) were significantly higher than freshman ( $M = 3.39, SD = .75$ )
- TCK- Seniors ( $M = 4.13, SD = .79$ ) were significantly higher than freshman ( $M = 3.36, SD = .67$ )
- PCK- Seniors ( $M = 4.33, SD = .51$ ) were significantly higher than both juniors ( $M = 3.88, SD = .61$ ) and freshman ( $M = 3.55, SD = .82$ )
- TPACK- Both juniors ( $M = 4.29, SD = .55$ ) and seniors ( $M = 4.13, SD = .72$ ) were significantly higher than freshman ( $M = 3.27, SD = .90$ )

A stepwise regression was conducted to evaluate whether PK, CK, TK, TPK, PCK, and TCK are necessary to predict overall TPACK. At step 1 of the analysis, TPK entered the regression equation and was significantly related to TPACK perceptions ( $F(1, 122) = 141.43, p < .001$ ).  $R^2$  values indicated that TPK accounted for 73% of the variance in TPACK scores. Step 2 saw the addition of the predictor variable PK  $F(2, 121) = 81.7, p < .001$ , and step 3 added TCK  $F(3, 130) = 60.3, p < .001$ . Step 2 (TPK, PK) accounted for 75.8% of the total variance in TPACK scores, while step 3 (TPK, PK, and TCK) accounted for 77.5%. TK, CK, and PCK scores did not enter in to the

equation at step 2 or step 3 (*TK*:  $t = -1.36, p = .18$ ; *CK*:  $t = -.54, p = .59$ ; *PCK*:  $t = -.21, p = .83$ ).

## **Role Modeling**

Participants also rated their instructors' and cooperating teachers' skills to act as models for TPACK. Overall, students found all collective university faculty and cooperating teachers to be positive TPACK role models ( $M = 3.72, SD = .65$ ). Specific examination of faculty technology role modeling showed that students rated PETE faculty as having the highest modeling behaviors ( $M = 3.88, SD = .75$ ), followed by educational foundations faculty ( $M = 3.75, SD = .78$ ), instructional technology faculty ( $M = 3.71, SD = .80$ ), and faculty outside of PETE/teacher education ( $M = 3.64, SD = .81$ ), with K-12 cooperating teachers rated the lowest ( $M = 3.58, SD = .88$ ).

A multiple-linear regression was calculated to predict students' overall perceived TPACK based on TPACK role model variables (PETE faculty, instructional technology faculty, educational foundations faculty, faculty outside of PETE/teacher education, and cooperating teachers). Of the five variables tested in the regression against overall TPACK, only PETE faculty technology modeling was found to be a significant predictor ( $\beta = .410, t(123)=3.35, p = .001$ ).

Finally, all the TPACK construct variables were run in a linear regression to see the effect TPACK modeling had on predicting each variable. Only the variables of TPK ( $\beta = .336, t(123) = 2.12, p = .036$ ) and TPACK ( $\beta = .304, t(123) = 2.85, p = .005$ ) showed to be significantly predicted by faculty role modeling.

## **Observations of and First-Hand Experiences With TPACK**

Participants were also asked to describe specific episodes of effective demonstrations or modeling by faculty and cooperating teachers, as well as their own experience with demonstrating the combination of content, technology, and pedagogy. Participants shared more quantity and variety of examples from faculty than cooperating teachers and shared the least amount and variety of examples of their own first-hand experiences. The most common types of technology observed and used included video for assessment, video for demonstration, and activity monitoring. Other types of technology mentioned included general use of tablets (e.g.,

iPads) and applications (e.g., QR code readers, behavior management apps, and fitness apps), podcast creation, Google applications (e.g., Forms, Docs, Sheets, etc.), and exergaming (e.g., Dance Dance Revolution). Approximately 88% of participants stated that the cooperating teachers they observed did teach using technology, and 10% stated that they did not have any first-hand experience teaching with technology. The following sections include examples provided by participants of observations of faculty and cooperating teacher modeling, as well as their own firsthand experiences.

### *Video for Assessment*

Video for Assessment was the most mentioned example provided by participants, particularly among observations of faculty demonstration of TPACK. These were mainly divided among video analysis applications and the simple use of video recording and viewing.

As a class, we were learning the proper volleyball fundamentals. My professor used the Coaches Eye App to assess our ability to properly perform these skills. We were able to break down our own movements and make corrections based on what we saw. (Faculty Model)

One of my K-12 field-based teachers used iPads to video students while assessing her students. She did a pre and posttest after showing the student their form of shooting a basketball. Most students improved over the 3-week unit because they were able to get direct, immediate feedback to correct their mistakes. (Cooperating Teacher Model)

In a Frisbee lesson, students were asked to video record each other. During the class, I walked around and gave feedback to students and showed them what I was talking about in the video. At the end of class I emailed students the video and for homework they watched it and wrote down their strengths and areas for improvement. I then gave them feedback on what they thought and added more ideas for them to focus on the following class. (Student First-Hand Experience)

### *Video for Demonstration*

Observation of using video for the purpose of the demonstration was the second-most overall used technology example shared by participants and was the most frequent type of technology mentioned for first-hand use among participants.

My class was learning how to bump the ball in volleyball. My teacher discussed with us the critical elements of bumping, as well as commonly made beginner mistakes. She used a projection system to display a video of herself incorrectly performing a volleyball bump, with missing critical elements, for the entire class to view several times. Then, we decided which critical elements were missing from the performance. Afterwards, we practiced individually bumping the ball to ourselves, to a partner, in different settings, etc. Finally, we competed against others in our class to execute successful volleyball bumps. (Faculty Model)

Using iPads in an elementary setting. 4th graders went around to fitness stations and read/watched videos on how to properly do the exercise. (Cooperating Teacher Model)

I was able to integrate technology into my lesson by showing Zumba dancing videos in class. Having the dances up on the screen in the gym, allowed me time to walk around and help any students struggling on any specific dance. This helped the students because they got both a demonstration model from the video, as well as one-on-one instruction from me. (Student First-Hand Experience)

### *Activity Monitors*

Participants provided examples of the use of a variety of activity monitors, including heart rate monitors, pedometers, and other activity trackers. There was a much higher number of examples of the use of heart rate monitors and pedometers by faculty than by cooperating teachers and students.

In a movement core class, I had a professor use a lesson based around pedometers. We would reset our pedometers at each station and record total number of steps after the station was complete to compare movement for various activities. (Faculty Model)

In a locomotor/group games unit for elementary school students, the teacher had some pedometers to use to see how many steps they were taking within the allotted time they had with it. (Cooperating Teacher Model)

I used heart rate monitor watches during a fitness game called Fitness Monopoly. I taught the students how to find their heart rate without the watch and with it. During the game, they filled in a worksheet on their heart rates by using the watch. (Student First-Hand Experience)

## **Discussion**

This study sought to determine the TPACK of PETE students and the modeling offered by their instructors and cooperating teachers and first-hand experiences regarding TPACK. In addition, the intention of this study was to continue to add to the literature surrounding how well PETE programs are meeting the increasing technology emphasis on national teacher preparation standards (i.e., SHAPE America, ITSE). The Survey of Preservice Physical Education Teachers' Knowledge of Teaching and Technology, modified from Schmidt et al. (2009) was used to measure TPACK among PETE students.

Quantitative results showed that overall, PETE students agreed (rating of 4 on a 5-point scale) that they were able to integrate technology into their instructional practices. These high scores are supported by similar research conducted by Baert and Stewart (2014) and Scrabis-Fletcher et al. (2016) and show that PETE students have an overall high rating of their ability to integrate technology in their instructional practices. Having completed a formal practicum experience, as well being a university upperclassman (e.g., junior or senior) also showed to have a significant impact on almost all TPACK

variables. These findings are in line with previous research supporting increased exposure, experience, and training with technology throughout a PETE program having a significant impact on pedagogy integration (Araslan, 2015; Krause & Lynch, 2018; Kretschmann, 2015). It is notable, however, that further research is needed in this area to determine actual technology integration behavior in comparison to students' perceived knowledge and abilities.

A stepwise regression was conducted to examine subscale predictor variables on overall TPACK. Results showed that TPK accounted for the highest percentage (73%) of the overall variance in TPACK, providing further support for the notion that it is essential for pre-service teachers to grasp a clear understanding of how technology can influence and enhance learning (Baek et al., 2018; Koehler & Mishra, 2009). Baek et al. (2018) noted that TPK is of specific importance because it establishes the invaluable link between *technology* and improving *student learning*. To implement TPK effectively, teachers must think beyond what technologies are available and novel and more toward building a foundation of technology as a learning tool with a pedagogical purpose (Baek et al., 2018; Koehler & Misra, 2009).

Both quantitative and qualitative analyses were conducted to examine students' perceptions of the modeling of technology behaviors demonstrated by university faculty and K-12 cooperating teachers. Quantitative results showed that students rated all role models positively specific to technology, with PETE faculty being rated the highest, and cooperating teachers the lowest. The qualitative responses directly supported the quantitative data showing that PETE students perceived faculty members as stronger technology models compared to cooperating teachers. Further research should explore if this is due to the time spent with PETE faculty working with technology best practices, or if they had limited exposure to technology application in their field experiences. In addition, a regression analysis showed off all potential technology role models associated with physical education teacher education students, only PETE faculty role modeling showed to be a significant predictor of overall TPACK. Though other research has found students to rate PETE faculty high overall (Scrabis et al., 2016; Semiz & Ince, 2012),

no research to date has found PETE faculty as a significant predictor of overall TPACK.

Though these findings support the fact that PETE faculty are shown to be positive technology models, there still appears to be a clear disconnect between faculty and cooperating teachers' technology application. PETE students appear to perceive they are having technology-rich experiences in the university classroom with applications, such as assessment apps, video recording, and activity monitoring, but are not seeing all these applications in their field experiences. Future research should aim to shed light on additional demographics of the K-12 CTs who serve as models as a way to explore if or how variables, such as career stage and access to technology-focused professional development, have a bearing on their modeling/use of technology when observed by PETE students. Though the notion PETE faculty's teaching best practices (ideal situations) cannot always be replicated in the field is not specifically new, it is of specific concern with the new technology-enhanced education emphasis placed on teacher education programs (e.g., SHAPE, CAEP, and ISTE). Baert and Stewart (2014) raised two important questions in response to the disconnect between PETE programs and in-service teachers, asking: What technology platforms are needed, and especially practical, in K-12 physical education classrooms to enhance student learning, and how can PETE programs best include and emphasize those technology platforms?

These two questions are not only relevant, timely, and still of specific concern today, but they provide an opportunity for further research to look at the alignment of technology application and practice within PETE programs to that of the SHAPE National Standards for Initial Physical Education Teacher Education (2017). In addition, these two questions raised by Baert and Stewart (2014) bring light to the fact that K-12 teachers and PETE programs need to do a much better job of being on the same page about quality, realistic, and timely TPACK application (Baert, 2015). There is a need for greater alignment and collaboration between K-12 and university teacher preparation faculty/programs. These discussions will help close the gap between what is presented as theoretically possible (PETE faculty), compared to what is practically feasible (K-12 teachers). Furthermore, it may be necessary for governing bod-

ies, such as SHAPE America, to help bring this conversation to the top of programming and promoted efforts. Many physically literate adults today use items such as activity monitors and fitness/wellness apps on a regular basis. Yet, our physical education community has yet to bring technology applications such as these to the forefront of educational efforts.

Since PETE faculty are shown to be a high influencing factor for future student technology application, it is imperative that said faculty see themselves as active agents for future technology change. Additionally, the Teacher Educator Technology Competencies (TETCs) (Foulger et al., 2017) call all teacher education faculty to address the need to develop technology-proficient preservice teachers. Thus, there is an increasing need for training in doctoral programs and professional development for PETE faculty to stay abreast of technology advances and pedagogical strategies. Future research related to this study should focus on the impact of technology integration experiences in school settings, professional development for and implementation of technology among in-service/cooperating teachers, and the PETE faculty development and achievement of the Teacher Educator Technology Competencies (2017).

### **Limitations**

One of the first limitations of the study is the sample size. A larger sample size would have helped show representation from a more diverse and generalized sample. Second, the use of a survey questionnaire to collect data specific to faculty technology modeling was addressed collectively and did not address specific technology applications used by PETE faculty or K-12 mentor teachers. Though the purpose of this study was to look at TPACK and technology modeling from a global perspective, future research should address specific technology applications and their influence on pre-service technology perception and use.

### **Conclusion**

The results of this study suggest that PETE students generally possess high levels of TPACK, are influenced primarily by their PETE program faculty, and encounter many of their experiences with technology integration in their PETE program courses and less in-field experiences. PETE programs are encouraged to provide

TPACK training for their faculty, boost modeling and hands-on in-class and field experiences with technology in coursework, and develop stronger partnerships with cooperating teachers to ensure technology-rich field experiences for their students.

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