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METHODOLOGY

Technology Preparation for Preservice Physical Education Teachers: A Credit Hour Analysis

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Abstract

Technological knowledge, technological content knowledge), and technological pedagogical knowledge is swiftly becoming a popular topic in the field of physical education teacher education (PETE). The Initial PETE Standards set forth by SHAPE America indicate that preservice physical education teachers (PPETs) should be taught how to use and teach with technology in their K–12 gymnasiums. However, research has indicated that PPETs are not being adequately prepared to teach with technology. This is a major concern seeing as the K–12 student population is becoming more technologically advanced. Additionally, the COVID-19 pandemic has highlighted the need for quality and equitable learning and instruction to occur through online platforms. The purpose of this study was to examine the number of credit hours dedicated to technology across the undergraduate curriculum of PPETs. To help frame the study, we used the 2018 Carnegie Classifications as a guide to see whether there were differences in technology credit hour allocation across varying colleges and universities in the United States. In addition to using the Carnegie Classifications, we broke up technology credit hours into three categories. For example, technology credit hours were offered during either the general education, the professional education, and/or the PETE major phase. Results from a paired-samples

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t test, an analysis of variance, and a multivariate analysis of variance indicated that PPETs take more technology credit hours during the professional education phase of their undergraduate curriculum than during the PETE major phase. Additionally, PPETs enrolled in doctoral institutions take more technology credit hours in the PETE major phase than PPETs enrolled in baccalaureate institutions. The incorporation of technology into PETE coursework, field experiences, and student teaching practicums will better prepare PPETs to deliver quality physical education through online interfaces.

Without a doubt, technology has become a staple in society. Due to its rapid growth, physical education teachers face unique challenges in teaching and connecting with today's "digital natives" (Krause et al., 2017; Prensky, 2001). After all, technology integration enriches teaching and learning (Henderson et al., 2015). Several studies have found positive results for the use of technology in physical education. For example, Legrain et al. (2015) discovered that technology motivates students and increases their cognitive understanding when learning about new skills. Also, technology in physical education increases physical activity levels (Melton et al., 2015) and motor performance (O'Loughlin et al., 2013). When used in a meaningful way, technology can positively affect students (Wyant & Baek, 2019). Therefore, it is imperative that PETE programs mimic current K–12 educational trends and better prepare their PPETs to teach with technology (Juniu et al., 2013). Even though inservice physical education teachers use technology (Gibbone et al., 2010; Juniu, 2011), research has shown that technology is being used from a productivity standpoint rather than being used to teach students (Baek et al., 2018). In addition, inservice physical education teachers have reported technology integration to be a top barrier (Hill & Valdez-Garcia, 2020). To produce a quality 21st century physical educator, PETE programs must educate and inform their PPETs on the uses of technology in physical education (Robinson, 2011). Tondeur et al. (2016) developed the synthesis of qualitative evidence model (SQD-model), which is comprised of six steps: teacher educators must (1) model the use of technology in their teacher education courses, (2) come together as a teacher education program and reflect on the role of technology in education, (3) learn about and operate technology, (4) collaborate with other scholars in the field or other colleges/

departments on campus, (5) implement technology experiences throughout the teacher education program, and (6) be open to giving and receiving feedback related to the uses of technology. PETE programs should not only adopt this model but also include courses dedicated to and lessons on technological knowledge (TK), technological content knowledge (TCK), and technological pedagogical knowledge (TPK; Koehler & Mishra, 2009). Now is a better time, more than ever, to educate PPETs on teaching with and navigating technology, especially amid the COVID-19 pandemic.

The COVID-19 pandemic has affected every aspect of day-to-day life. Lockdown measures have created heightened isolation, unhealthy eating habits, and anxiety among many Americans (Chen et al., 2020; Hammami et al., 2022; Margaritis et al., 2020). Further, the pandemic has changed how education is delivered and how students access learning materials. Quality physical education that engages students in regular physical activity and stress-reducing activities is needed. For example, integrating social-emotional learning (SEL) components into physical education lessons can be beneficial for the students and their well-being during the pandemic (Jiao et al., 2020). The necessity of distance learning and use of technological practices during COVID-19 has underlined the importance of TK, TCK, and TPK. PETE programs should address and prepare future physical education teachers for distance learning, specifically catering to the obstacles facing students (i.e., limited physical activity space at home, internet access, computer issues). Failure to address TK, TCK, and TPK in PETE programs will leave PPETs feeling ill-prepared and less versatile when it comes to using technology during their lessons.

Courses and lessons on TK, TCK, and TPK can provide PPETs with the knowledge necessary to use technology confidently during their coursework, field experiences, student teaching practicum, and beyond. In a study looking at preservice teacher (N = 215) perceptions of their TPACK development in their teacher education program, Baran et al. (2019) found that faculty modeling of technology use and preservice teachers reflecting on technology and its uses in physical education were positively related to strategies implemented by teacher educators and preservice teachers' TPACK. Otero et al. (2005) suggested that technology as a teaching tool is multifaceted and can be used as (a) a cognitive instrument to help students problem solve; (b) an assessment mechanism to evaluate students; (c) a motivational tool to engage students during physical activity; (d) a mode of communication with parents, students, and staff; and (e) an organizational tool to better manage students. Despite the positive impacts of technology integration in physical education, research has suggested that teacher education programs lack sufficient technological training and experiences for preservice teachers to overcome barriers to implementing technology (Chai et al., 2010; Koehler et al., 2013; Koehler et al., 2011; Liang et al., 2006). This lack of preparation contradicts the standards set forth by the International Society for Technology in Education (Crompton, 2017) and Standard 3, component 3.e (planning and implementation) of the 2017 SHAPE America Initial PETE Standards. The ISTE standards for educators focus on the use of technology to improve teaching practices and empower student learning. Standard 3, component 3.e of SHAPE America's (2017) Initial PETE Standards suggests that PPETs should "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). Essentially, PPETs are required to demonstrate proficient technology knowledge and implementation in the gymnasium but are not receiving sufficient support or training to do so.

Although standards have been put in place for PPETs to learn about and implement technology in their teaching, most PETE programs are not satisfying this expectation. An examination of the literature regarding courses and lessons dedicated to technology in teacher education could provide a better understanding of the ways future physical educators are being taught to use and teach with technology in physical education. Technology experiences and varying types of knowledge related to technology (TK, TCK, and TPK) also need to be explored.

The main problem for inservice physical education teachers is applying technologies to their teaching and adopting new approaches to technology integration (Zhamardiy et al., 2019). Moreover, newly inducted physical educators wish they would have learned more about technology during their experiences as a PPET (Hill & Valdez-Garcia, 2020). This lack of preparation is concerning because it appears as if future physical educators are not being equipped to teach the iGeneration (Rosen, 2011). This mismatch with the real world and PPETs' lack of preparation can lead to frustration and, ultimately, teacher burnout (Jones et al., 2017).

Of the 1,283 postsecondary institutions in the United States offering teacher licensure programs, 80% indicated that all or some of their programs require an educational technology course (Gronseth et al., 2010). However, research on stand-alone technology courses has demonstrated inadequacies in the preparation of future teachers to incorporate technology in their instruction (Kopcha, 2012; Zipke, 2018). Technology courses in higher education often target traditional classroom subjects. For example, Baek et al. (2018) explored inservice physical education teachers' perceptions of technology practices. They found that the training these teachers received during their postsecondary education was more applicable to the general education setting and not specific to the physical education setting. This finding showed the limited amount of knowledge that inservice physical educators possessed when integrating technology. In turn, a lack of TPACK made the physical education teachers hesitate to use technology in their gymnasiums. To increase the likelihood of technology adoption among PPETs and inservice physical education teachers, PETE programs must address the needs of teachers (Hicks & Bose, 2019; Wilson et al., 2020). For example, relying on a "show and tell" approach to prepare physical educators for technology integration or merely persuading physical educators to use technology is not going to increase technology adoption (Baek et al., 2018).

The Office of Educational Technology (2016) claimed that school districts are training incoming teachers in the use of technology for teaching and learning because beginning teachers are entering the field ill-prepared. Teacher educators should work to "ensure pre-service teachers' experiences with educational technology are program-deep and program-wide rather than one-off courses separate from their methods courses" (Office of Educational Technology, 2016, p. 14). This suggestion by the Office of Educational Technology has been echoed in the research and findings have shown that students who participate in technology-infused methods courses are better prepared to teach with technology (Foulger et al., 2019). In addition to the incorporation of technology into the curriculum of methods courses, the provision of an expansive focus on the use of technology during field experiences and student teaching practicums has been beneficial (Buss et al., 2018; Gronseth et al., 2010; Hicks & Bose, 2019; Wilson et al., 2020).

Along with exploring the number of technology credit hours offered, we looked at credit hour differences based on the type of institution. Institutional types were identified based on the 2018 Carnegie Classifications. The next section explains the classifications and their differences.

Carnegie Classifications

Institutions of higher education are classified according to the Carnegie Classifications. In 2018, the Carnegie Classification framework was updated to include six types of institutions. For the purposes of this study, PETE institutions were classified by doctoral universities, master's colleges and universities, and baccalaureate colleges. In the United States, there are 418 doctoral institutions (9.6%), 682 master's colleges and universities (15.8%), and 838 baccalaureate colleges (19.5%). Each type of institution has varying classifications. Doctoral institutions vary from Very High and High Research Activity to Doctoral/Professional institutions. Master's colleges and universities vary in size (large, medium, and small), and baccalaureate institutions vary by field. For example, those fields include Arts and Sciences, Diverse Fields, Mixed Baccalaureate/Associate, and Associate's Dominant institutions. This study emphasized the differences between Arts and Sciences and Diverse Fields. For a breakdown on the 2018 Carnegie Classifications, see Table 1.

It is important for researchers to look at the number of technology credit hours required by the type of institution. This is because the curricular structure of these institutions may place more emphasis on technology-driven courses than on other courses because of institutional differences. For example, a baccalaureate institution may offer more courses dedicated to pedagogy, whereas a doctoral institution may offer courses grounded in theory or research, with or without technology. Furthermore, it is important for researchers to know when PPETs are enrolling in technology courses. Whether these courses are situated before or during a PPETs major is worth noting.

Table 1
2018 Carnegie Classifications of Postsecondary Institutions in the United States

Institutional type	Doctoral	Master's	Baccalaureate
Level	Very high research activity	Large	Arts & sciences
	High research activity	Medium	Diverse fields
	Doctoral/professional	Small	
Criterion	20 or more doctoral degrees or 30 or more professional practice doctoral degrees awarded[a]	50 or more master's degrees and fewer than 20 doctoral degrees awarded[a]	50% of the degrees offered are bachelor's degrees[a]

[a]Number of degrees awarded each year.

Three-Phase Pathway in Higher Education

A typical PPET will encounter three phases throughout their experience in higher education. The first phase is general education. This phase typically takes place at the beginning of a person's college education and involves required courses in topics such as English, science, and math. The second phase is professional education. During this phase, PPETs enroll in courses dealing with generalized teaching and learning practices in schools. Often, these courses cater to future classroom teachers, instead of physical educators. Examples of professional education courses include classroom management, introduction to teaching, and psychology in the classroom. The third and final phase is PETE major education. This phase includes specialization courses in the PETE program. Examples of specialization courses include methods in elementary and secondary physical education, assessment in physical education, skill content courses, and technology in physical education. It is unknown at which phase PPETs are introduced to technology, if at all. Additionally, it is undetermined in which phase or across which phases PPETs are required to enroll in technology courses, if at all. Knowing when a PPET enrolls in a technology course or courses is important because technology courses look drastically different in each phase. For example, technology course objectives in general education may require students to familiarize themselves with the operation of software on their desktop, laptop, or tablet such as Excel, PowerPoint, and Word. Objectives related to technology in professional education courses include the broad use of technology in the classroom. Technology courses in PETE cater to using and teaching with technology in physical education. Therefore, it is important to understand how and in what phase PPETs acquire technology credit hours during their time in higher education. The purpose of this study was to examine the number of credit hours dedicated to technology across the undergraduate curriculum of PPETs.

Method

PETE Program Selection Criteria

Through the 2018 Carnegie Classifications, 313 PETE programs in the United States were identified and grouped into their Carnegie

Classifications. Doctoral universities (n = 83) made up 26.5% of the sample, whereas master's colleges and universities (n = 162) constituted 51.8% of the sample and baccalaureate colleges (n = 68) equated to 21.7% of the sample. Google was the main search engine used for data collection, and only undergraduate PETE programs with teaching licensure were included in this study. Curriculum guides, course descriptions, and program checklists were located for all 313 PETE programs. Once found, these documents were saved to the data set for interrater reliability (i.e., cross-checking). This study did not utilize human subjects; therefore, there was no need for IRB approval. These PETE program data were pulled from an existing data set used in a previous study and do not signify program quality.

Data Collection

Technology credit hours were split into the categories of (a) general education credits, (b) professional education credits, and (c) PETE major credits. This breakdown showed whether those credit hours were solely dedicated to the PETE major (i.e., how to use technology in physical education) or required as part of the general education experience (i.e., learning computer skills) or the professional education experience (i.e., incorporating technology in the classroom). Pinpointing where an undergraduate acquired their technology credit hours was important because not all technology credit hours were dedicated to the subject of physical education. Therefore, this method enabled differentiation between the general and educational technology learned and the physical education technology learned.

Interrater reliability was established through random selection of 64 PETE programs (i.e., 20% of the technology credit hour data set). A second coder coded the 64 PETE programs, and the percentage of agreement between the two coders was greater than 80%, which is the cut-point for adequate interrater reliability (Meyers et al., 2017). Error-free coding was ensured through peer debriefing, which provided a double-check of the allotment of technology credit hours based on the category. There were no discrepancies between coders.

Data Analysis

Upon the coding, collecting, and cross-checking of the data, descriptive statistics and frequencies were completed, followed by a paired-samples t test to investigate whether there were significant differences between general education, professional education, and PETE major technology credit hours across institutions. Effect sizes were considered for all significant tests by computation of Cohen's *d*. Cohen (1988) suggested a *d* of small (0.2), medium (0.5), and large (0.8) effect sizes. In particular, the paired-samples *t* test required a Cohen's *d* computation. Differences in technology credit hours offered across the Carnegie Classifications were examined through an analysis of variance (ANOVA). Main effects were followed up with an LSD post hoc analysis. A multivariate analysis of variance (MANOVA) was also completed for examination of variations in noncombined variables. It checked for differences in the average values of general education, professional education, and major education technology credit hours based on the Carnegie Classifications. The Statistical Package for the Social Sciences (SPSS) software, version 26.0 was used in the data analysis. A p value $< .05$ for ANOVA and MANOVA (Meyers et al., 2017) and a p value of $< .001$ for the paired-samples t test indicated a significant difference.

Results

Description of Mean Technology Credit Hours for General Education, Professional Education, and PETE Major Credits

Mean technology credit hours varied on the basis of PPETs' pathway phase (i.e., general education, professional education, and PETE major education). For example, technology credit in the general education phase ($M = .29$, $SD = 1.13$) was lower than in both the professional education phase ($M = .95$, $SD = 1.39$) and the PETE major education phase ($M = .42$, $SD = 1.005$). The minimum number of technology credits offered was the same across all three pathways—zero credits. Maximum technology credit hours offered for general education credits (10 credits), professional education credits (6 credits), and PETE major credits (4 credits) varied. Approximately 5.8% of technology credits offered in the general education phase was 3 credits, 22.3% of technology credits offered in the professional education phase was 3 credits, and 10.4% of technology credits offered in the PETE major phase was 3 credits. Table 2 shows the technology credit hour frequencies for each educational pathway. On the contrary, 260 of the 309 PETE programs did not offer any technology credits as part of their graduation requirements. This finding makes up 81.4% of the study sample.

Table 2
Technology Credit Hour Frequencies and Percentages for All Three Educational Pathways

Credit hours	General education	Professional education	PETE major
0	283 (91.6%)	203 (65.7%)	260 (84.1%)
1	3 (1%)	5 (1.6%)	5 (1.6%)
2	1 (.3%)	26 (8.4%)	10 (3.2%)
3	18 (5.8%)	69 (22.3%)	32 (10.4%)
4	1 (.3%)	3 (1%)	2 (.6%)
5		1 (.3%)	
6	1 (.3%)	2 (.6%)	
10	2 (.6%)		
Total	309	309	309

Note. Numbers 7, 8, and 9 were not included in the table because those numbers of credit hours were not offered.

Differences in Mean Credit Hours for General Education, Professional Education, and PETE Major Credits

The paired-samples *t* test revealed a statistically significant difference (specified at the .001 level) in technology credit hours between professional education credits and PETE major credits, $t(308) = 5.08$, $p = .000$, ES = .436. The ANOVA test result showed a statistically significant difference in PETE major technology credit hours between doctoral institutions and baccalaureate institutions, $F(2, 308) = 3.028$, $p = .05$, ES = .402. The post hoc results revealed that PPETs take more technology credit hours in their PETE major when attending a doctoral institution than when attending a baccalaureate institution. The MANOVA confirmed that technology credit hours within PETE programs statistically significantly differed between doctoral institutions and baccalaureate institutions, $F(3, 308) = 2.928$, $p = .034$; Roy's Largest Root = .029. Table 3 highlights the mean technology credit hours within each educational pathway across doctoral, master's, and baccalaureate institutions.

Table 3
Mean Technology Credit Hours Across the Carnegie Classifications

Institution type	General education	Professional education	PETE major
Doctoral	.29	.66	.63*
Master's	.35	1.05	.40
Baccalaureate	.15	1.04	.22*

*$p < .05$.

Discussion

The purpose of this study was to examine the number of credit hours dedicated to technology throughout the undergraduate education of PPETs. The 2018 Carnegie Classifications were used as a guide for differences in the amount of technology credit hours offered across varying institutional levels. Findings from this study contribute to the understanding of PPETs and their technological experiences and preparation in and outside of the PETE program. This was accomplished through the use of a large sample size of colleges and universities with undergraduate PETE programs across the United States. Results from this study may help PETE faculty to shift from traditional values (i.e., teaching and learning without technology) to technological values (i.e., using tablets, smartphones, and computers to teach and learn) to better prepare PPETs to teach with technology. The time has come for PETE programs to mirror technology's growth in society by digitizing the curriculum (Wyant & Baek, 2019). To our knowledge, this was the first study to explore the allocation of technology credit hours as it relates to the postsecondary education of PPETs. This was done through an exploration of the amount of technology credit hours PPETs are required to take in each educational pathway (i.e., general, professional, and PETE major). Two results from this study are worth noting. First, PPETs take more technology credit hours during their professional education phase than they do in their PETE major phase. This finding is concerning as most courses in the professional education phase are dedicated to classroom pedagogy, rather than physical education pedagogy. Even though PPETs are learning to use and teach with technology, it may not be in the context of physical education and physical activity. Second, the findings indicate that PPETs enrolled in a doctoral institution take more technology credit hours than PPETs enrolled in a baccalaureate institution. This finding may be attributed to different institutional philosophies and focuses. For example, research on technology integration may steer the amount of TPACK taught at a doctoral institution due to the large amount of research activity that has to take place, when compared to a baccalaureate institution, which is more teaching focused.

Professional Education Versus Physical Education Teacher Education Technology Credits

The amount of technology credit hours required in professional education and PETE courses significantly differed, with the majority of the technology credit hours being offered during the professional education phase. Courses in this phase include, but are not limited to, classroom management, technology in the classroom, disabilities in the classroom, and psychology in the classroom. Regardless, most courses taken during the professional education phase are dedicated to classroom teachers, as opposed to physical education teachers. Although we want to prepare our future teachers to utilize technology as a form of instruction (Peterson-Ahmad et al., 2018), TPACK needs to be taught from a holistic perspective (Polly et al., 2010), not just for the satisfaction of future classroom teachers.

Within the last decade, TPACK has been used as a blueprint in the design of teacher education programs (Mishra & Koehler, 2006). Situating PPETs' practical knowledge with TPACK practice and teaching experiences needs to be conceptualized (Yeh et al., 2014) in both professional education and PETE courses for the development of a better prepared physical educator who is ready and willing to teach today's learner (Jones et al., 2017; Robinson, 2011). However, even though this is a typical suggestion that has been put forth by researchers, findings have demonstrated that the majority of PPETs and inservice physical education teachers lack adequate technological training and experiences in the gymnasium during their postsecondary experiences (Baek et al., 2018; Gibbone et al., 2010; Juniu et al., 2013). These findings may be due to an amalgamation of barriers, such as lack of administrative support, inadequate budget, faculty buy-in, and lack of technology-enriched experiences during student teaching and other various teaching practicums (Krause & Lynch, 2018). To curb this problem, PETE faculty need to prepare technologically proficient physical education teachers by incorporating educational technology instruction and modeling technology skillfulness and expertise (Duran et al., 2007). For a little over a decade, researchers in the field of physical education have come up with the same findings and recommendations. The time has come for programmatic change that aims to address TPACK levels among PPETs in PETE, especially given the circumstances of the COVID-19 pandemic and the mandatory urge for online instruction. Physical education teachers need to not only be competent in technologies that are inherent of online interfaces but also have the TPACK to implement effective teaching practices. With the increase of mental anxieties, stress, and isolation during the COVID-19 pandemic, students need physical education instruction to get them out of their chairs and moving at home. By incorporating technologies into PETE programs, particularly during field experiences and student teaching practicums, physical educators can confidently deliver quality physical education instruction through online platforms. Readjusting the number of credit hours sounds easier than it may seem; however, steps can be taken in the right direction through educational policy change (Office of Educational Technology, 2016). Even if changes are steadfast in PETE programs, PETE faculty can always team up with teacher education faculty to produce meaningful TPACK opportunities for the PPETs enrolled in those professional education courses (McMullen et al., 2014).

PETE Major Technology Credit Hour Differences Across Doctoral and Baccalaureate Institutions

The significant difference in PETE major technology credit hours by the type of institution indicates that doctoral institutions offer more technology credit hours than baccalaureate institutions. This finding suggests that research-heavy institutions have either read about or conducted research on technology and its importance in K–12 physical education and, therefore, choose to incorporate technology courses into their PETE programs to better prepare PPETs'

TPACK for future teaching practices. Doctoral institutions may also try to mimic technology's role in society within their PETE programs (Wyant & Baek, 2019), seeing as technology adoption has become a major topic in the field of physical education (Casey et al., 2017). Additionally, doctoral institutions typically bring in more research money than do baccalaureate institutions. This financial difference may account for the ability of institutions to offer technology courses taught by technology experts in the field. That is, baccalaureate PETE programs may not have the money to hire or sustain a technology expert. Furthermore, these teaching-based institutions may not have state-of-the-art technology tools readily available for their PPETs to use and may face more barriers to accessing technology than would doctoral PETE programs (Ertmer, 1999). In turn, this lack of access to technology may steer PETE faculties' beliefs, attitudes, and values toward the incorporation of technology within a baccalaureate PETE program (O'Neil & Krause, 2019). After all, exposure to technology training in PETE programs can influence a physical education teacher's technology implementation, thus mediating their beliefs on their technology competency (Woods et al., 2008).

This study does not go without its limitations. First, the methodology for this study was a secondary data analysis. This type of analysis takes data that are electronically and readily available on the internet. Access to this data does not account for whether the data are current. Moreover, this study did not represent whether technology courses were required or merely offered (as an elective) as part of PPETs' higher education experience.

PPETs take the majority of their technology credit hours outside of the PETE major. More specifically, PPETs take the most amount of technology credit hours during the professional education phase of their college experience. This finding is concerning as it indicates that future physical educators are not getting the training necessary to teach with technology specifically in physical education. Technology credit hours offered outside of the PETE major are broad with a focus in navigating technology, rather than how to teach with technology. These findings are contrary to Standard 3 of the 2017 SHAPE America Initial PETE Standards, in which PPETs are required to demonstrate proficient technology implementation in the gymnasium. Findings from this study warrant the need for more technology-based courses within the PETE major as well as more TPACK instruction specific to physical education in the technology courses outside of the PETE major. For future, researchers should look up the instructor of record for said technology courses to address the type of content being taught or discussed. Other future studies may include a measurement tool as a data collection technique to explore TPACK-related content and technology-driven learning experiences being offered to PPETs in and outside of the PETE major.

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