



Article

## Modeling the Process of Using Innovative Pedagogical Technologies in Preparing Students' Professional and Ethical Readiness

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**Abstract:** The paper is about training the professional and ethical readiness of the students majoring in physical education by means of advanced pedagogical technologies. During the last few years, professional training of future physical education teachers has been concerned not only with formation of physical, methodological and pedagogical skills but also ethical knowledge, professional responsibility and moral capacity to make necessary decisions. Simultaneously, rapid inclusion of digital and cutting-edge educational technologies in HE has had a profound effect on pedagogy within the PE sector. However, current literature on technology-enhanced learning emphasizes technological competency, instructional effectiveness or employability in isolation and pays limited attention to a systematic connection with ethical readiness. The current study aims to fill this gap by engaging in a systematic professional analysis of modern empirical work on innovative pedagogical media in PETE. Recent systematic reviews, quantitative modeling studies on technology influence and process-oriented pedagogical research are reviewed in order to identify the dominant technological tools, educational methodologies and professional outcomes. Given this synthesis, we present a theoretically driven and empirically informed process model. Professional and ethical readiness is regarded as a dynamic, round-up process that includes five interconnected stages: technology selection and integration, instructional competence formation, motivational and affective engagement, professional and ethical reflections, as well as holistic readiness outcomes.

**Keywords:** Innovative pedagogical technologies; physical education teacher education; professional readiness; ethical readiness; TPCK; technology-enhanced learning; pedagogical modeling.

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### 1. Introduction

Recently, the preparation of physical education teachers has been expanded to focus on ethical and moral readiness for professional practice in addition to developing their physical, methodical and instructive competences. Academics argue that PE teachers stand in a special relation to the status of moral agents due to the close presence of children, competitive atmospheres and value-laden nature of instructional activity [1]. As a result, the lack of an ethical readiness in the training of future physical education professionals may have on students' development for their personal and fair play, inclusiveness and professional practice in terms of educational and sports activities. Concomitantly, the explosion of new pedagogical technologies in physical education has transformed how instruction is conducted at the collegiate level. Digital tools, technology-rich pedagogies and practice interventions rooted in technological pedagogical content knowledge (TPCK) have been found to enhance teaching effectiveness, active student engagement and

professional competency development for PE teachers [2]. Research findings suggest that technological professionalism and pedagogical innovation are now regarded as integral to being professionally ready in teaching physical education.

However, the burgeoning empirical evidence base in respect of innovative pedagogical technologies and professional competencies in physical education tends to be fragmented with studies typically being limited to technological skills development [3], instructional effectiveness or employability outcomes [4]. Fewer are the studies that focus on a systematic analysis of how innovative pedagogical technologies can be combined to prepare in a unified pedagogical process the professional and ethical readiness of physical education students. Further, the lack of model based on processes restricts potential transfer to practical applicability in teacher education programs [4]. Accordingly, a theoretical and evidence-based model to explain the process of using innovative pedagogical technologies in order to develop professional-ethical preparation of future teachers of physical education is necessary. This type of model can help advance both pedagogical practice in PE departments and further empirical validation by synthesizing and organizing the outcomes of recent studies.

## 2. Materials and Methods

The research is qualitative in nature and systematic literature review combined with theoretical modelling approach is used. The methodological perspective is based on a combination of narrative synthesis, comparative analysis and conceptual modelling, to analyse how innovative pedagogical technologies are integrated into the development of professional and ethical physical education discourses.

First, we performed a comprehensive search of literature for current empirical studies. The literature that is reviewed in evidence-based findings were systematic reviews, quantitative studies using structural equation modeling, and mixed-methods or design-based research centred on 2014-2026. In selecting articles, we centred criteria around (a) the relevance to physical education teacher preparation and (b) explicit incorporation of innovative pedagogy or digital technology – more broadly defined as those technologies integral to PE teacher culture--to examine professional, motivational, or ethical perspectives on teaching practice.

Second, the studies retrieved were interpreted by thematic and comparative analysis. Relevant variables, technology used, pedagogical methods and findings were identified and classified to identify common denominators as well as strengths and limitations of the studies. Special attention was paid to how technological competence, motivation, professional development and ethical thinking were developed.

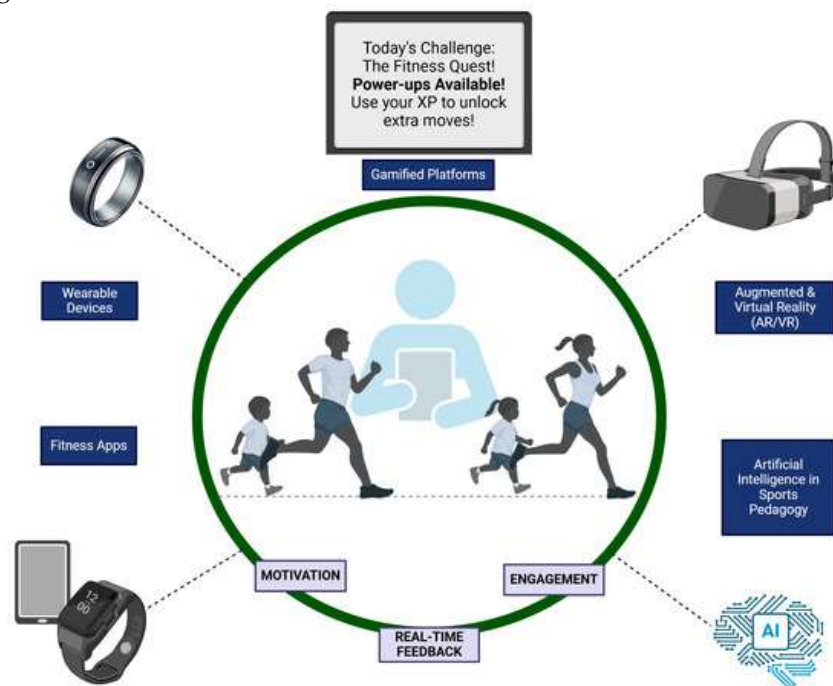
Lastly, using synthesized results a process-based conceptual model was constructed. The model combines empirical evidence with pedagogical treasury for the characterization of innovative pedagogical technology use as a dynamic and iterative process towards professional and ethical preparedness. The model is not established empirically in this study, but it does serve as a theoretical model on which curriculum can be designed and future empirical investigations of physical education teacher education can be conducted.

## 3. Results

This article provides an analysis of research on the use of innovative pedagogical technology in physical education within the context of a model that was developed to generate and test literature based claims regarding physical education. The selected works for review were chosen for their empirical methodology, connection to physical education teacher education, and explicit attempt to unveil technological, professional, and ethical aspects of pedagogical practice. The results are synthesized narratively, methodologically examined and comparatively discussed using tables and a graphical display presenting the studies findings as well as common patterns, main approaches and pedagogic consequences for developing professional and ethical readiness of this cohort of students [5].

Martín-Rodríguez and Madrigal-Cerezo carried out a systematic review of technology augmented pedagogy in physical education (PE), systematically synthesizing insights from 151 empirical studies, systematic reviews, and meta-analyses that appeared since 2010 until early 2025. Their purpose was to examine how digital technologies support student engagement, motor learning outcomes, cognitive outcomes and self regulated learning in PE. Structured search in major academic databases (PubMed, Scopus, Web of Science) was performed based on explicit inclusion criteria for interventions using wearable devices and gamified platforms; mobile and fitness applications; augmented and virtual reality (AR/VR); Artificial Intelligence (AI) Tools. Thematic analysis was utilized for qualitative synthesis allowing consistent themes, pedagogical advantages and barriers to be extracted across different study designs and populations [6].

Technological tools are classified into five main categories, and their pedagogical functions are emphasized (Fig. 1). Many of the studies used wearable technology (e.g. text messaging, pedometers and smartphones) to monitor activity levels in real-time as well as provide real-time feedback and promote individualized learning. Physical activity levels, self-monitoring and engagement were reported as improved in 50-60% of wearable studies. Goal setting, tracking and reflecting on performances was supported by mobile, fitness applications (e.g. Strava and Pacer), which contributed to self-regulated learning. In about 65% of the relevant studies, it was reported that gamification platforms (i.e., exergames and interactive game-based learning tools) could have a positive effect on student motivation, participation and enjoyment when engaging in PE activities. Research that incorporated AR and VR technologies reported increased motor skill learning and tactical understanding in over 50 % of the interventions that were reviewed, providing participants with life-like yet risk-free practice environments [7]. Finally, AI-based platforms also offered adaptive feedback and recommended, personalized resources; however, this feature was permeating only a few studies (around 10–15%) to boost learning.

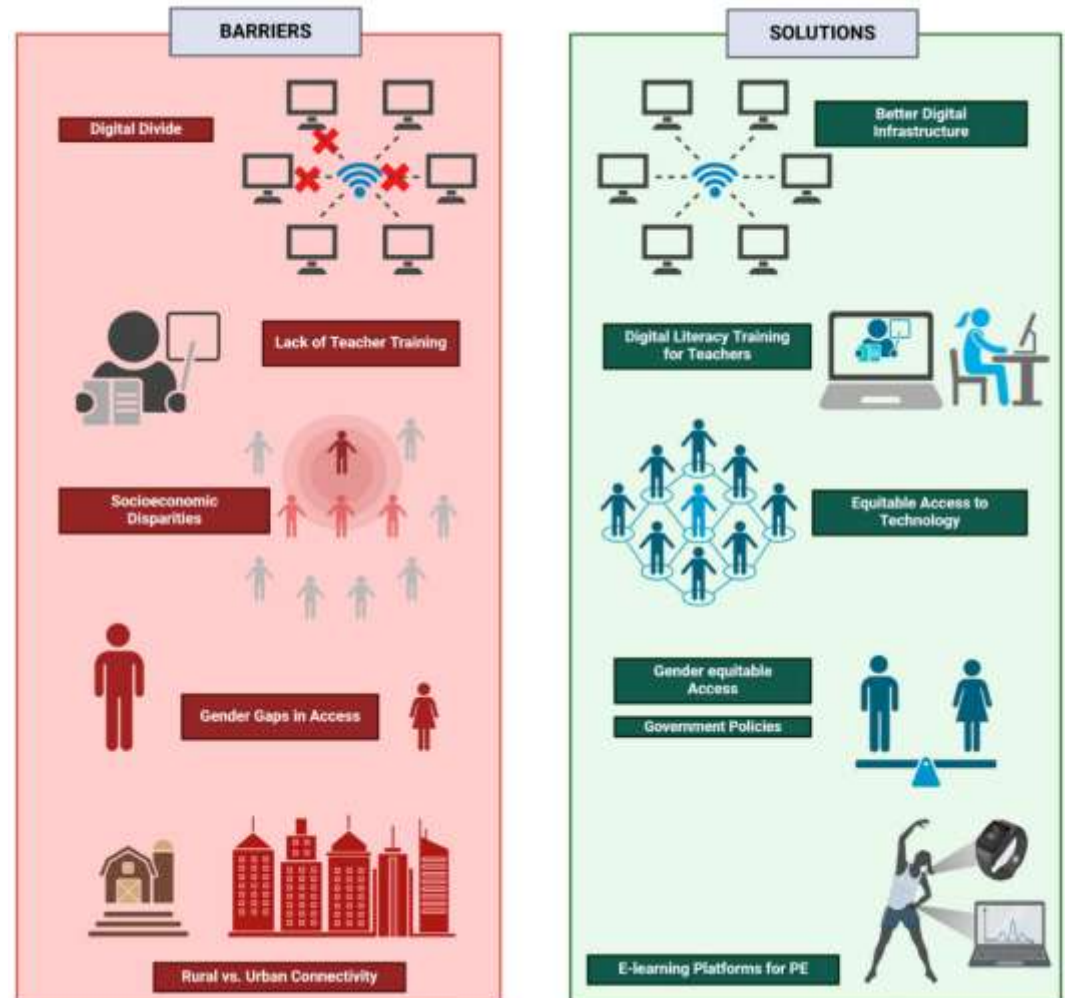


**Figure 1.** Technological tools in PE

In all of the categories the review highlights that a useful feature of such tools revolves around intentional instructional design, teacher guidance, and linkage to reflective and/or ethical learning activities.

Obstacles and persisting challenges The include point authors also described barriers. Key themes in successful technology adoption BOTH EMTEZ with HEMLINKAC performed a content analysis of literature review included teacher preparation and digital competence, poor preparation having negative consequences for pedagogical effects.

Digital disparities, such as limited access to devices and the internet were identified as barriers to and inequalities in implementation. Ethical issues, especially with regard to student privacy, use of biometric information and data collection were also widely cited as important factors for the implementation of digital tools [8]. Further, variability in inclusion and exclusion criteria, the sample sizes studied, and outcomes assessed among the primary studies restrict the generalization of findings. This also emphasizes the importance of longitudinal large scale methodologically sound research (Fig.2).



**Figure 2.** Barriers vs. solutions in PE technology development and usage

Theoretically, the review locates technology-enhanced PE under constructivist and self-determination lenses of learning where interactive and personalized digital spaces could support autonomy, competence and relatedness cornerstones for a meaningful learning. Although Martín-Rodríguez and Madrigal-Cerezo did not report their own empirical data, there is an evidence-based framework i.e., a systematic compilation of quantitative outcomes (in detailed percentages with particular advantages) for use in PE teacher preparation to integrate pedagogical as well as ethical goals with technological innovation [9].

This reflects the growing evidence base regarding the value of innovative pedagogical technologies in PE, however Yu and Alibakhshi go further to empirically explore how cohesive teacher competence 'using' technology translates into wider professional justifications [10]. Instead of examining merely instructional efficacy, they explore the structural relationship between TPCK, technology integration self-efficacy, job passion and employability – thereby taking professional readiness as a multi-dimensional construct which includes cognitive, technological, affective and career-related dimensions [11].

The design of the study followed a cross-sectional survey, and used Partial Least Squares Structural Equation Modeling (PLS-SEM) to empirically test theorized hypotheses. The participants were 340 in-service physical education teachers recruited from different learning organizations throughout Yunnan Province, China [12]. The sample was heterogeneous with regard to demographic variables (gender, ages, teaching experience and educational level), obtaining a representative picture of the professional profiles inside physical education teaching staff. Although a convenience sample was obtained, participants were clearly sufficient to assure statistical power and model stability in the SEM [13].

Data were collected by means of four validated Likert-type instruments that addressed the core professional constructs: TPCK; technology integration self-efficacy; job passion and employability. The TPCK scale measured teachers' the ability to incorporate technology tools into pedagogical approach and content knowledge. The technology integration self-efficacy scale was designed to assess teacher confidence in the use of technology strategies and instructional practices. Job passion was measured using harmonious passion and obsessive passion dimensions indicating teachers' affective commitment to their work and employability referred to perceived adaptability, potential of development, and technological competitiveness [14].

As reported in Table 1, descriptive statistics revealed that mean scores were generally high for all the constructs, indicating that participants tend to believe they are technologically competent and motivated as well profession-ally prepared. The reliability and convergent validity of each measure were good in that Cronbach's alpha was greater than 0.80, and the AVE values surpassed the acceptable cut-off score of 0.50. These results support the suitability of the measurement model for further analysis.

**Table 1.** Descriptive Statistics and Reliability of Study Constructs  
(TPCK, Technology Integration Self-Efficacy, Job Passion, Employability)

Construct	No. of items	Mean (M)	SD	Cronbach's $\alpha$	AVE
<b>Technological Pedagogical Content Knowledge (TPCK)</b>	16	3.80	0.60	0.89	0.56
<b>Technology Integration Self-Efficacy (TIS)</b>	12	4.20	0.50	0.91	0.59
<b>Job Passion</b>	14	4.00	0.70	0.88	0.54
<b>Employability</b>	10	3.90	0.80	0.86	0.52

The hypothesized structural model was tested using PLS-SEM. Model fit indices indicated a satisfactory fit between the theoretical model and the observed data (CFI = 0.95; TLI = 0.94; RMSEA = 0.045; SRMR = 0.041), supporting the appropriateness of the proposed relationships.

The results of the structural path analysis are presented in Table 2. TPCK exerted a strong and statistically significant effect on technology integration self-efficacy ( $\beta = 0.48$ ), indicating that integrated technological, pedagogical, and content knowledge constitutes a foundational determinant of teachers' confidence in technology use. Both TPCK ( $\beta = 0.49$ ) and technology integration self-efficacy ( $\beta = 0.51$ ) demonstrated significant positive effects on job passion, suggesting that professional competence is closely associated with affective engagement in teaching [15].

Employability was directly influenced by TPCK ( $\beta = 0.48$ ), technology integration self-efficacy ( $\beta = 0.50$ ), and job passion ( $\beta = 0.27$ ). These findings indicate that technological competence and confidence contribute substantially to teachers' perceptions of professional readiness and career adaptability.

**Table 2.** Structural Path Coefficients and Hypothesis Testing Results

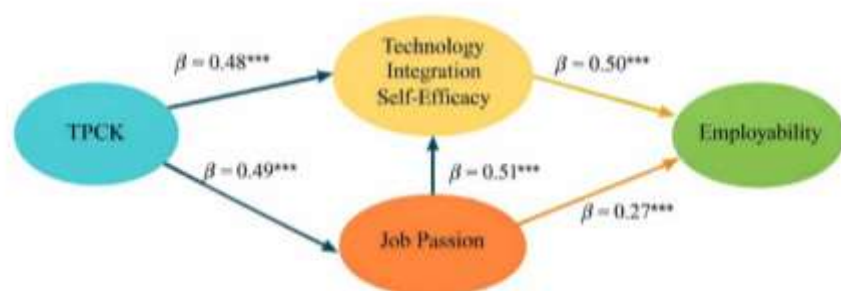
Hypothesized Path	$\beta$	t-value	p-value
<b>TPCK → TIS</b>	0.48	9.21	< .001
<b>TPCK → Job Passion</b>	0.49	8.87	< .001
<b>TIS → Job Passion</b>	0.51	9.64	< .001
<b>TPCK → Employability</b>	0.48	8.43	< .001
<b>TIS → Employability</b>	0.50	9.02	< .001
<b>Job Passion → Employability</b>	0.27	4.95	< .001

In order to have a better understanding of the underlying mechanisms, we had then to look at two mediation analyses which will focus on indirect effects of TPCK and technology integration self-efficacy on employability through job passion. As presented in Table 3, work passion partially mediated both links. Each of the indirect effects of TPCK and technology integration self-efficacy on employability through job passion was statistically significant ( $b = 0.27$ ), suggesting that affective engagement indeed represents an important motivational mechanism through which technological competence is translated into one's professional preparedness.

**Table 3.** Direct, Indirect, and Total Effects in the Mediation Model

Independent Variable	Mediator	Dependent Variable	Direct Effect ( $\beta$ )	Indirect Effect ( $\beta$ )	Total Effect
<b>TPCK</b>	Job Passion	Employability	0.48	0.27	0.75
<b>TIS</b>	Job Passion	Employability	0.50	0.27	0.77

To create conceptual structure, the proposed structural model is visualized in Figure 3. The model depicts the structural associations between TPCK, technology integration self-efficacy, job passion, and employability with standardized path coefficients for all significant effects presented in Figure 2. This graphical visualization of the results is a supplement to tables that can help take in information on the interrelationships among technology, motivation, and professional outcome variables as a whole.

**Figure 3.** Structural equation model of technological competence, job passion, and employability

Yu and Alibakhshi's results make a novel contribution to the literature as they empirically show that professional readiness includes more than technical proficiency in innovative pedagogical technologies in physical education. Having both TPCK and technology integration self-efficacy not only directly influence employability, but also through job passion together indirectly repercussions professional outcomes. This

integrative model highlights the need for not only cognitive and technological dimensions but also affective dimension to be considered collectively in TE/PD.

As they apply to the formation of tomorrow's physical education teachers, the results lend some empirical support for process-oriented models that situate technology proficiency within more general motivational and moral commitments. It therefore provides an important empirical basis for conceptual models designed to promote the professional and ethical development of physical education students through novel pedagogical technologies.

Though Yu and Alibakhshi (2016) provide explanation between structural aspects of technological competence, motivational engagement, and employability, there has been an attempt in follow up research to explore how these skills may be intentionally developed using constructed learning experiences within teacher education. Rahman makes a contribution to the literature in that as opposed to correlational modeling approaches, he orients his analysis around the process-oriented integration of an emerging pedagogical technology into physical education teacher education. Instead of considering technological competency or ethical preparedness as disconnected endpoints, the research sees them as interconnected components that must be nurtured over time via iterative pedagogical design, reflective practice, and technology mediated instructional circumstances.

Rahman used design-based research mixed method to explore how a creative pedagogical technology could be progressively integrated into PE praxis to develop professional capabilities and moral reasoning. The empirical element featured pre-service physical educators (PETs) in teacher education who engaged with technology-mediated learning modules facilitating access to digital spaces, reflective e-portfolios and situation based tasks. The interventions were purposefully designed to make the student respond not just with technicalities but also pedagogical decisions and ethical judgements in a teaching-like setting.

For the quantitative data, there were significant and positive improvements in students' professional decision making self-efficacy and pedagogical confidence (confidence) and ethical sensitivity after partaking of the technology-supported learning intervention. Qualitative data also indicated that iterative reflection and guided feedback were instrumental to participants' ability to critically appraise the values underpinning their pedagogical decisions, especially in terms of fairness, inclusivity and professional responsibility. Rahman's investigation reveals that digital technologies were most successful when integrated into a holistic pedagogical approach that valued critical reflection, shared learning, and ethical questioning rather than presented as an independent instructional imperative.

Combined, these results further earlier empirical work by showing that both professional and ethical development in this area can be actively enhanced through process-driven models of technology integration. In contrast to previous research that generally focus on competency, self-efficacy or the employability implications of e-learning, Rahman demonstrates an argument for a model based on development in which new pedagogic technologies play a mediating role in a more generalised educational process. This view supports the idea of models of teacher education that place technological innovation in alignment with pedagogical intentionality and ethical formation, providing a critical foundation upon which professional and ethical praxis are modelled with physical education students.



**Figure 4.** Conceptual relationships identified in prior empirical studies

Notwithstanding, a detailed synthesis of the studies reviewed throws light on several unaddressed limitations which still prevent the integration of innovative technologies in physical education both at practical and theoretical level. On the one hand, research may combine technological tools and outcomes at descriptive level, model the relationships between technological competency as well as technology-related motivation and professional outcomes or focus on technology-supported pedagogical processes. Yet these fields of investigation are still disconnected. There are few models that present a comprehensive and process-focused model capturing how innovative pedagogical technologies can be purposefully employed to promote an integrated development of professional competence and ethical preparedness in relation to different stages of teacher preparation. In addition moral education is commonly addressed tacitly, or as a by-product rather than being principal in technology-enabled pedagogical practice. In turn, teacher education programs do not have a cohesive structure to weave technology innovation as part of pedagogical intentionality, informed motivation engagement, and ethical responsibility. This discrepancy can be addressed through the construction of a model, grounded in theory and data, that theorizes the use of new pedagogical technologies as an organized process that contributes to shaping the morally professional readiness of physical education students (Fig. 4).

Extending a synthesis of current empirical research, the emergent process model brings together technological, pedagogical, motivational and ethical aspects to support the development of professional and ethical readiness in PETE students. As depicted in Figure 5, the model is designed as a circular dynamic system with five interrelated stages (technology selection and integration, instructional competence development; motivational-affective engagement; ethical-professional reflection; holistic readiness outcomes), which jointly contribute to professional competence development and ethical awareness.



**Figure 5.** Circular process model of using innovative pedagogical technologies to enhance professional and ethical readiness of physical education students

All stages are tied directly to evidence-based instruments and technology applications such as wearables, augmented reality (AR) and virtual reality (VR), gamified learning environments, learning management systems (LMS) and reflective discussion boards. Small callouts in the figure also draw attention to what is capable of being measured (improvements in technological competence, motivation, and ethical reflection). Arrows are iterative and represent the feedback nature of the model, with asterisks highlighting that professional and ethical readiness is not a linear outcome but rather develops through sustained interaction, reflection, and development over time. Illustrating the intersection of pedagogical stages, technological tools, and empirical outcomes, Figure 5 offers an overall practical framework for educational practitioners and researchers to enable the implementation and evaluation of innovative pedagogical technologies in physical education teacher preparation programs.

In sum, the suggested model of process provides a structured and integrative view of the use of innovative pedagogical technologies for development of students' professional pedagogical and ethical readiness in physical education. Unlike studies that treat technological competence, motivation or ethical development as independent outcomes the model views these factors as interdependent parts of an ongoing pedagogical process. In synthesizing evidence and theoretical insights about these dimensions of teaching from current literatures, the model explicates how instructional practices which leverage technology can support pedagogical skill and transforming dispositions toward pedagogy by grounding definitions within a comprehensive view of what it means to use technology in instruction. At the same time, it is intentionally flexible model that can be adapted by context -institutional setting, state of technology infrastructure and curriculum priorities. Although the current research does not empirically validate the model, it sets forth a theoretically-based structure to inform curriculum development, instructional decision-making, and empirical testing. Based on this assessment, the final section of the paper synthesizes key contributions and discusses implications for PETE and future research.

#### 4. Conclusion

The purpose of this investigation was to explore the impact of innovative pedagogical technologies for professional and ethical preparation of physical education pre-service teachers by synthesizing, through systematic review, literature in the field. As a means to overcome the shortcomings of such fragmented ways in prior literature, this article suggested a comprehensive process model that encompasses technological-pedagogical-

motivational-ethical (tPmE) aspects of teacher education. The principal contribution of the study is a theoretically-based, empirically driven process model that reconceptualizes professional & ethical readiness by positioning it as a dynamic, recursive outcome that emerges from technology-integrated pedagogical practice. The model connects phases of technology selection, learning task competency development, motivation engagement, and ethical reflection and pushes the current understanding of how innovative pedagogical technologies can be intentionally integrated with professional and ethical goals in physical education teacher education. The model also provides some useful implications related to curriculum design and pedagogical strategies at the higher education level. However, the study lacks empirical testing of the model it introduces. Implications for the future include the empirical testing and validation or refinement of this model in a variety of educational and cultural contexts, investigating which technologies are effective at different points along the model, and further development into the ethical terrain of TEL within physical education. Collectively, these initiatives could advance evidence-based practice and enrich the development of competent and ethical members of the physical education teaching profession.

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