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Technology Adoption of PE Teachers: Basis for an Enhanced Teacher Training Program

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Long Hai Tao, ORCID No. 0009-0005-5218-6171
Doctor of Education Major in Educational Management, National University, 551 Dapitan Street, Sampaloc, Manila, Philippines

Abstract

This study investigates the level of technology adoption among Physical Education (PE) teachers in Chinese universities using the Technological Pedagogical Content Knowledge (TPACK) framework. With the rapid advancement of digital technologies such as artificial intelligence, big data, and mobile learning, PE teachers face growing pressure to integrate technology into their instructional practices to enhance teaching effectiveness and student outcomes. The research explores current challenges in technology adoption, identifies strategies to improve adaptability, and proposes an enhanced teacher training program tailored to PE teachers' specific needs. A mixed-methods approach was employed to gather data on the technological competence, pedagogical strategies, and content knowledge integration of university PE teachers. Findings indicate that while many PE teachers are aware of the potential of digital tools, significant barriers – including lack of professional development opportunities, resource disparities, and inadequate support systems – hinder its effective implementation. Based on the results, the study proposes a comprehensive training model grounded in the TPACK framework to improve technical adaptability and teaching effectiveness. This research contributes to the development of a more modern, interactive, and personalized PE curriculum, supporting the long-term goal of advancing educational quality in the digital era.

Keywords: technology adoption, physical education (PE), technological pedagogical content knowledge (TPACK), teacher training, digital technologies

INTRODUCTION

Globally, the education sector is undergoing profound changes triggered by the information technology revolution. With the rapid development of the Internet, artificial intelligence, big data, mobile learning, and other technologies, educational models and learning methods are undergoing significant changes. In this context, the technological adaptability of teachers has become a key variable, which not only relates to the improvement of educational quality but also serves as a significant driving force for promoting educational innovation. Educational institutions and policymakers worldwide are actively exploring how to improve teaching effectiveness and learning experience by enhancing teachers' technological adaptability.

In China, with the continuous advancement of educational informatization, the issue of technical adaptability of physical education teachers is becoming increasingly prominent. The Chinese government has set forth the goal of improving the quality of education and comprehensively enhancing the comprehensive quality of students in the "National Medium- and Long-Term Education Reform and Development Plan Outline (2010-2020)" and emphasized the importance of building a high-quality teacher team, strengthening the construction of teacher professional ethics, and improving the professional level of teachers.

As the direct implementers of school physical education teaching activities, physical education teachers' technical adaptability is directly related to improving students' physical fitness and developing their physical and mental health. However, there are still some challenges and problems for Chinese physical education teachers regarding technical adaptability.

Firstly, physical education teachers have varying levels of acceptance and application of new technologies, and some teachers cannot master and apply information technology (Lasica et al., 2020). Secondly, the professional development opportunities for physical education teachers are limited, and there is a lack of systematic technical training and support (Burson et al., 2021). Furthermore, the uneven distribution of physical education teaching resources and insufficient modernization of teaching facilities also hinder the improvement of physical education teachers' technical adaptability (Chiu, 2022). In response to these issues, China's education administrative departments and schools need to take adequate measures, such as strengthening the information technology training of physical education teachers, improving the modernization level of teaching facilities, and promoting the balanced allocation of physical education teaching resources, to improve the technical adaptability of physical education teachers and promote in improving the physical education teaching quality (Simonton et al., 2020).

From this, the technical adaptability of physical education teachers is a global issue that not only relates to the improvement of educational quality but also serves as an essential driving force for promoting educational innovation. China is facing unique challenges and opportunities in this field and needs to make multiple efforts to improve the technical adaptability of physical education teachers to meet the development needs of educational informatization (Corbin, 2021).

In the context of globalization and informatization, the technical adaptability of teachers in physical education is crucial. Firstly, technological adaptability is an inevitable requirement for physical education teachers to adapt to the development needs of the times (Howley, 2021). With the advancement of technology and the development of society, new concepts and technologies in the field of physical education are constantly emerging (Huang et al., 2022). Physical education teachers can only keep up with the pace of the times by constantly learning and updating their knowledge structure and skill system (McGarr & Gallchóir, 2020). Secondly, technological adaptability is a crucial factor in enhancing the quality of physical education teaching (Tondeur et al., 2019). By utilizing modern information technology, physical education teachers can present teaching content more intuitively and vividly, stimulating students' learning interest and motivation, thereby improving teaching effectiveness and students' learning experience (Valério et al., 2022). Finally, technological adaptability is also an important means of promoting the professional growth of physical education teachers (Sevimli-Celik, 2020). In adapting and applying new technologies, physical education teachers can constantly reflect, summarize, and innovate to enhance their professional competence and teaching ability (Chang et al., 2020).

Given the importance of the technical adaptability of physical education teachers, strengthening teacher training programs has become a key measure to enhance the overall quality of physical education teachers (Arufe-Giráldez et al., 2023). By establishing a comprehensive training system, optimizing training content and methods, and strengthening practical training and assessment measures, physical education teachers' technical adaptability and information literacy can be effectively improved (Ward, 2021).

At the same time, teacher training programs should also focus on aligning with international standards, drawing on advanced educational concepts and teaching experiences, and providing more diverse learning resources and opportunities for physical education teachers (Meng et al., 2020). This can not only broaden the international perspective and cross-cultural communication ability of physical education teachers but also promote international cooperation and exchange in physical education, jointly promoting the prosperity and development of global physical education (Barba-Martín et al., 2020). In summary, the transformation of physical education under globalization and

informatization has put forward higher requirements for the technical adaptability of teachers in the field of physical education. Strengthening teacher training programs and enhancing the technical adaptability and information literacy of physical education teachers are important ways to promote physical education reform and improve teaching quality (Valverde-Berrocoso et al., 2021). In the future, researchers should continue to deepen their research and practical exploration of the technical adaptability of physical education teachers, contributing to the cultivation of more high-quality and professional physical education teachers.

The researcher examines the current state of physical education teachers' technological adaptability and identifies several key gaps and shortcomings. Firstly, physical education teachers generally lack sufficient technical training and development opportunities, which limits their ability to effectively utilize technology in teaching. Especially in physical education, the demand for such training is even more urgent, as physical education teachers need to master specific technical tools and platforms to improve teaching effectiveness. Secondly, many physical education teachers have an insufficient understanding of emerging educational technologies, which limits their ability to innovate and effectively apply these technologies in teaching. Additionally, there are significant differences in the allocation of physical education teaching resources and technical facilities among different regions and schools. Some schools may have advanced facilities and abundant resources, while others may lack basic technical support.

These gaps highlight the challenges faced by physical education teachers in terms of technical adaptability and identify areas that require further research and improvement. By identifying these gaps, researchers and educational decision-makers can design and implement more effective targeted intervention measures to improve the technical adaptability of teachers of physical education, thereby enhancing teaching quality and students' learning experiences.

Statement of the Problem. With the rapid development of information technology, the education sector is undergoing unprecedented changes. Physical Education (PE), as an integral component of the education system, also needs to adapt to this trend of change and integrate modern technology into teaching practices to enhance teaching effectiveness and students' learning experiences. However, physical education teachers face many challenges in terms of technical adaptation. This paper aimed to explore in depth the current situation, challenges, adaptation strategies, and how to develop enhanced teacher training programs for physical education teachers through the TPACK (Technological Pedagogical Content Knowledge) framework, providing a reference for the professional development of physical education teachers. The research questions of the study were as follows:

1. What is the level of technology adoption of PE teachers using the TPACK framework?

2. What are the challenges of PE teachers in adopting technology?

3. What are the strategies for PE teachers to adapt technology?

4. What enhanced teacher training program can be developed?

In summary, based on the TPACK framework, this study proposed four specific research questions regarding the technical adaptation of physical education teachers. By examining these issues, this study aims to provide valuable references and insights for the professional development of physical education teachers, promote the deep integration of physical education and information technology, and enhance the quality and effectiveness of physical education teaching.

Theoretical and Conceptual Framework. Theoretically, the study is anchored from the Technological Pedagogical Content Knowledge (TPACK) – a framework that aims to enable physical education teachers integrate technology into their teaching by balancing

content, methods, and technical knowledge. Teachers must understand technical details, physiological principles, and the latest trends and use of technology for practical operations (Moreno-Guerrero et al., 2020). A training program can enhance teachers' technical adaptability and teaching skills, promoting efficient, interactive, and personalized learning (Batez, 2021).

The application of the TPACK framework in physical education teacher training is also a research gap. The TPACK framework integrates content knowledge, pedagogical knowledge, and technological knowledge, which is of great value in guiding teachers on how to effectively integrate technology into their teaching. However, there is currently a lack of research on how to effectively integrate the TPACK framework into teaching and how to enhance teachers' technical adaptability and teaching skills through such training.

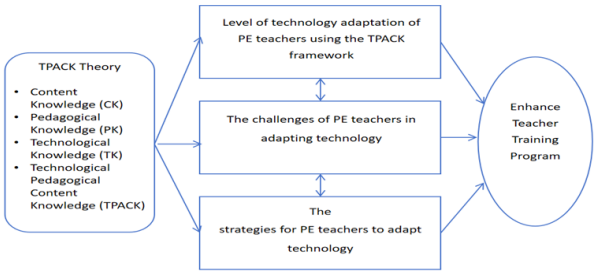

Figure 1
Conceptual Framework of Technology Adaptation of PE Teachers

Conceptually, the study is also grounded in the Technological Pedagogical Content Knowledge (TPACK) framework, which serves as a comprehensive model for evaluating and understanding the level of technology adaptation among Physical Education (PE) teachers. The TPACK framework is an intersection of three primary forms of knowledge: Content Knowledge (CK), Pedagogical Knowledge (PK), and Technological Knowledge (TK). Each of these domains is critical for the effective integration of technology into teaching, and their intersection provides a holistic view of the competencies required by teachers in the digital age.

Content Knowledge (CK) refers to the teacher's expertise in the subject matter, specifically physical education. It encompasses the understanding of principles, concepts, and skills specific to PE, including anatomy, physiology, sports techniques, and fitness (Qushem et al., 2021). Pedagogical Knowledge (PK), on the other hand, encompasses the methods and strategies used in teaching, including classroom management, student engagement, and assessment techniques. Technological Knowledge (TK) involves the understanding and application of various digital tools and technologies that can enhance teaching and learning (Almusawi et al., 2021). When combined, these knowledge areas form the TPACK framework, which is essential for teachers to effectively incorporate technology into their teaching practices (Ramírez-Montoya et al., 2021).

Aligning the above framework to the research problem, the first research question examines the level of technology adaptation among physical education (PE) teachers using the TPACK framework. The second research question addresses the challenges PE teachers face in adapting technology. The third research question focuses on identifying strategies that can help physical education (PE) teachers adapt to technology. Finally, the fourth research question aimed to develop enhanced teacher training programs based on the findings related to the current level of adaptation technology, challenges, and strategies identified.

This conceptual framework not only guides the research process but also serves as a foundation for understanding how technology can be effectively integrated into physical education. By focusing on the intersection of CK, PK, and TK, this study aims to provide valuable insights into how PE teachers can overcome challenges, adopt effective strategies, and participate in professional development programs that enhance their ability to incorporate technology into their teaching practices, ultimately improving student engagement and learning outcomes in physical education.

Scope and Limitations. The scope of this paper comprehensively examined the current state and prospects of technology integration in Physical Education (PE) teacher practice. It delves into four key areas: (1) assessing PE teachers' technology adaptation levels through the TPACK framework; (2) identifying the significant challenges faced by PE teachers in adapting technology; (3) exploring strategies to overcome these challenges and successfully integrate technology into teaching; and, (4) proposing recommendations for developing enhanced teacher training programs tailored to the technology adaptation needs of PE teachers. Several limitations should also be acknowledged such as the challenges and strategies identified may be highly context-specific, influenced by factors such as local resources, institutional support, and cultural norms. Therefore, the generalizability of the findings to other settings may be limited. The study focused primarily on cross-sectional data, which provided a snapshot of the current situation but did not capture changes over time. Longitudinal studies would provide a more comprehensive understanding of the evolution of technology adaptation among PE teachers.

Significance of the Study. With the rapid development of information technology, the education sector is undergoing unprecedented changes. Physical Education (PE), as an important component of the education system, also needs to keep pace with the times and integrate modern technology into daily teaching. The technical adaptability of physical education teachers is not only related to the improvement of teaching quality but also a key factor in cultivating students' comprehensive qualities and promoting the development of a healthy lifestyle. Therefore, in-depth research on the ability of physical education teachers to accept and adapt to technology is of great significance for promoting the modernization process of physical education.

For educators, the rapid development of information technology requires the integration of modern teaching methods into the physical education curriculum. Enhancing their technical adaptability is crucial for improving teaching quality and cultivating students' comprehensive skills. For students, the improvement of their educators' technological adaptability has a direct impact on their learning experience. In technology-enabled teaching, students can expect more interactive and dynamic physical education courses that meet their individual needs. For administrators, investing in the technical adaptability of physical education teachers is crucial for maintaining a cutting-edge educational environment. It ensures that institutions remain relevant in the digital age and can provide innovative educational experiences.

The improvement of technological adaptability is an inevitable requirement for enhancing teachers' professional competence. In the context of the information age, mastering and utilizing information technology for teaching design, resource integration, and effectiveness evaluation has become one of the basic skills for modern teachers. For PE teachers, mastering advanced technologies such as smart wearable devices, virtual reality, and augmented reality can not only enrich teaching methods and make physical education classes more engaging and interesting, but also accurately monitor students' physical fitness data, providing a scientific basis for personalized teaching. Therefore, studying the improvement path of technological adaptability has a profound impact on building a high-quality and professional team of physical education teachers.

LITERATURES

Technology Integration. The significance of technology integration in physical education (PE) has reached new heights as educational institutions strive to revolutionize teaching and learning experiences for students. The incorporation of technology not only revitalizes traditional PE methodologies but also fosters an environment that is both engaging and results oriented. The existing literature highlights the pivotal role technology plays in transforming physical education (PE) by offering a plethora of innovative tools that captivate student interest, meticulously track performance metrics, and

propel the teaching process toward a more interactive and data-driven paradigm (Ho et al., 2023).

The integration of technologies such as wearable fitness trackers, augmented reality (AR) systems, and sophisticated video analysis tools has been shown to significantly enhance student motivation and comprehension. For instance, wearable fitness trackers provide real-time feedback on physical activity, encouraging students to set and achieve personal goals while fostering a deeper understanding of their bodies and fitness levels. AR technology, on the other hand, creates immersive learning experiences that bring complex physical concepts to life, making them more accessible and enjoyable to grasp (Huang et al., 2022). Video analysis tools, meanwhile, enable students and teachers alike to analyze and refine techniques, leading to more efficient skill development and a heightened sense of achievement.

In conclusion, the integration of technology in PE represents a game-changing shift that is reshaping the landscape of physical education. By harnessing the power of innovative tools and digital platforms, educators are empowering students to learn, grow, and thrive in an increasingly connected and dynamic world.

Digital Tools Use. As educators increasingly recognize the potential of digital tools in enriching and expanding learning experiences, the emerging trend of incorporating digital tools into physical education (PE) highlights a transformative shift in teaching practices. The surge in literature highlights the countless ways in which digital tools can elevate sports beyond traditional boundaries. From innovative applications designed for motion tracking to online fitness challenges that capture students' interest, and even virtual reality simulations that immerse learners in fitness environments, these tools provide unprecedented avenues for cultivating student engagement and skill development (Blain et al., 2022). Additionally, they can achieve an adaptive learning experience, dynamically adjusting the speed and ability of each student, ensuring that everyone can progress at the optimal pace (Chiu, 2022).

In addition to formal courses, digital tools have also made significant contributions to promoting physical activities outside of the classroom. By utilizing interactive challenges, social sharing features, and gamification elements, these tools motivate students to participate in extracurricular sports activities, thereby extending the benefits of sports beyond their spare time (Cojocaru et al., 2022). This cultivates a comprehensive approach to fitness and health, encouraging students to dedicate their lives to physical activities.

Teacher Training. Teacher training in technology integration for physical education (PE) is the cornerstone of cultivating educators who can master the digital environment and effectively utilize digital tools in their teaching methods. A large body of literature emphasizes the necessity of professional development plans, which go beyond mere technical proficiency and instill teaching wisdom in teachers to integrate technology in a meaningful and student-centered manner (Daly-Smith et al., 2021).

Therefore, an effective teacher training program must embody a holistic approach, ensuring that participants not only acquire necessary technical skills but also gain a deep understanding of how to seamlessly integrate technology into their teaching practices. The practical experience of using various digital tools is crucial as they enable teachers to directly explore an experiment with various platforms and applications, thereby gaining practical mastery of their functions and potential applications in physical education classrooms (Phelps et al., 2021).

In addition, these courses must teach strategies for integrating technology into the entire curriculum, creating an environment where digital tools enhance rather than disrupt traditional teaching methods. Continuous support is equally crucial, enabling teachers to try new methods, reflect on their practices, and refine their strategies in a constantly evolving technological environment.

Technology Adoption. Technology adoption is one of the important driving forces for the reform and development of physical education. Firstly, Technology Adoption, as an important topic in the field of educational technology, extensively involves the acceptance, use, and integration of new technologies by educational practitioners in educational practice. In the field of education, the adoption of technology is not limited to upgrading teaching tools and platforms but also involves profound changes in educational concepts and teaching models. For Physical Education (PE), the adoption of technology is equally important as it can promote innovation in physical education teaching, improve teaching effectiveness, and better meet the diverse and personalized learning needs of students (Mocanu et al., 2021).

Secondly, physical education teachers face various challenges and opportunities in the process of technology adoption. On the one hand, physical education teachers need to overcome obstacles such as technological unfamiliarity and habitual teaching methods, actively learning and mastering new technologies, including smart wearable devices and motion analysis software, to enrich their teaching methods and improve teaching interactivity. On the other hand, the adoption of technology has also provided more teaching resources for physical education teachers, such as online courses, instructional videos, virtual laboratories, etc., which helps broaden their teaching horizons and improve teaching quality (Howley, 2021).

Research progress on the concept of "teaching effectiveness". Physical education teachers have long been regarded as decisive factors in teaching effectiveness, teaching quality, and student sports performance. Therefore, many concepts associate "teaching effectiveness" with "teacher," known as "teacher teaching effectiveness." The theory of teaching effectiveness was first proposed from Rutter's perspective on social learning, and later, combined with Bandura's self-efficacy and Berman's research on efficacy, it began to gain widespread recognition. For nearly half a century, scholars at home and abroad have expressed their own opinions on the definition of teaching effectiveness. Different disciplines have studied teaching effectiveness and obtained their perspectives, but a unified definition of teaching effectiveness has not been established. There is no clear definition of "teaching effectiveness" in reference books such as the Education Dictionary in China. After the proposal of “teaching effectiveness", scholars have proposed different definitions of "teaching effectiveness" from different perspectives, combined with their theories.

In the past two decades, teacher teaching efficacy has referred to their perception and belief in their ability to effectively complete teaching tasks and achieve teaching objectives in teaching activities. It is related to factors such as teaching monitoring ability, teaching strategies, and teaching behavior. The effectiveness of teachers should lie in the process of removing outdated educational concepts and values, abandoning outdated teaching methods and means, and comprehensively improving their teaching effectiveness with new methods. Teachers systematically improve teaching content, processes, and methods based on traditional concepts to enhance the quality of student learning. Many locally distinctive achievements have been made in the concept, model, influencing factors, and mechanism of teaching efficacy. Future research still needs to focus on three aspects. Firstly, the scale of teaching efficacy should be further revised in conjunction with reality. Secondly, research on the connection between teacher teaching and specific disciplines should be strengthened. Thirdly, practical strategies for improving teacher efficacy should be further explored.

METHODOLOGY

Research Design. This study employed a mixed-method research design, focusing on both quantitative and qualitative approaches to assess the technical adaptability of physical education teachers. The general research design involved using questionnaires for quantitative data collection and interviews for qualitative insights. Specifically, the study

explores the integration of technology in teaching and its impact on teaching effectiveness and student learning.

Context and Participants. This study focused intensely on the specific educational environment of Hunan University of Technology. As a higher education institution with distinct characteristics and extensive influence in Hunan Province, China, the integration of teaching quality and educational technology has always been a focus of attention from all sectors of society.

The core participants of this study are 308 physical education teachers at Hunan University of Technology. They came from different age groups, professional backgrounds, and teaching experiences, which can comprehensively reflect the current technical adaptation status of the school's physical education teacher team. Purposive sampling was used to select physical the core participants. The selection of this sampling method is based on its unique advantages, which can ensure the pertinence and depth of the research results.

Research Instrument. A survey questionnaire was the main tool used in this study to collect quantitative data on the technical adaptation level of physical education teachers. By designing a series of questions closely related to the TPACK framework, this study quantitatively evaluated teachers' technical adaptation in different dimensions. The questionnaire included a basic information section (such as age, teaching experience, education, etc.) and a technology adaptation assessment section. The technology adaptation assessment section covers four dimensions: technical knowledge (TK), pedagogical knowledge (PK), subject content knowledge (CK), and subject teaching knowledge that integrates technology (TPACK). Each dimension has multiple specific questions and is scored using a 5-point Likert scale (Table 1).

The researcher conducted a pre-test to a small target audience before the formal study to evaluate the preliminary version of the survey questionnaire through feedback. Based on the results of pre-testing and preliminary analysis, the researcher made necessary revisions to the tool. This involved rephrasing issues, adjusting scales, or deleting items that do not align with research objectives.

Table 1
5-point Likert scale

Scale	Range	Verbal Interpretation	Modified Description
5	4.50 – 5.00	Strongly Agree	Very High
4	3.40 – 4.49	Agree	High
3	2.60 – 3.39	Undecided	Moderate
2	1.80 – 2.59	Disagree	Low
1	1.00 – 1.79	Strongly Disagree	Very Low

The researcher ensured that the questionnaire covers all relevant research areas and is closely related to the research objectives and questions. This usually involves consulting with experts in the field to ensure that the items in the tool appropriately represent the research concept. After all revisions were completed, the researcher conducted a final round of testing to confirm that the tool could effectively collect the required data and that participants could understand and comfortably complete the questionnaire. Reliability of the tool was also done, including internal consistency, stability, and consistency. Based on the results of the pilot testing, the instrument yielded 0.8 Cronbach alpha indicating that the instrument is highly reliable.

For qualitative data, a semi-structured interview was used. This aimed to gain a deeper understanding of the specific experiences, feelings, challenges, and coping strategies of physical education teachers in the process of technological adaptation. Through interviews, this study can obtain richer, more detailed, and in-depth qualitative data. The interview outline is designed around research questions, including open-ended questions and introductory questions. The interview is conducted in person or via phone/video conference, depending on the interviewee's convenience and preferences. During the interview process, this study maintained an open and flexible attitude, adjusting interview questions in a timely manner based on the respondents' answers to obtain the most authentic and comprehensive information.

Data Gathering Procedure. The data collection process followed a series of detailed steps to ensure the rigor of the research and the validity of the results. Firstly, the researcher clarified the research objectives and questions, and chose a mixed-methods research design, which involves the collection of both quantitative and qualitative data. Subsequently, the researcher defined the target population and employed appropriate sampling methods to select participants. The development of research tools is the next step, including the design of questionnaires and interview guidelines, which have been adjusted as necessary after the pre-test to ensure their effectiveness and reliability. After obtaining approval from the relevant ethics committee and permission from the educational institution, the researcher began collecting data. The questionnaire was distributed to physical education teachers through both online platforms (such as Wenjuanxing) and offline paper forms to ensure the breadth and representativeness of the data while qualitative data is obtained through face-to-face or online interviews.

After data collection was completed, the researcher organizes and cleans the data to ensure its completeness and accuracy. In the data analysis stage, quantitative data is analyzed through statistical software, while qualitative data is encoded and subjected to thematic analysis. Subsequently, the researcher integrated quantitative and qualitative results to obtain a more comprehensive perspective. The research results were recorded in detail during the writing of the report and paper and were thoroughly discussed in the paper.

Data Analysis. The data analysis process was systematic and gradual to ensure the accuracy and reliability of research results. First, the researcher used statistical software to perform descriptive statistical analysis on the quantitative data. This was done by calculating the means, standard deviations, frequencies, and percentages. Meanwhile, qualitative data was analyzed through content analysis to identify themes and patterns.

The next step in data analysis was the integration of quantitative and qualitative results to obtain a more comprehensive perspective. The researcher compares the analysis results with existing literature and theories, explains the significance of the research findings, and discusses the trends, patterns, and anomalies found in the data. In addition, the researcher conducted validation, and reliability checks to ensure the accuracy of the analysis results and enhances the rigor of through peer review or expert consultation.

Ethical Consideration. During the process of conducting this study, the researcher consistently placed ethical considerations at the core. Firstly, the researcher ensured that all participating physical education teachers fully understand the research objectives, contents, methods, and potential risks and benefits. Upon acquiring their conformity, they were asked to sign the informed consent forms. Secondly, the researcher strictly adheres to the principle of confidentiality and kept all collected personal information and interview contents confidential and promised not to disclose any information when the research results are published. Finally, the researcher strived to avoid any form of psychological or physical harm to participants. At the same time, the researcher also focused on the fairness and justice of the research, ensuring that the research results benefited all stakeholders and provided valuable references for improving the technical adaptability of physical education teachers and the quality of teacher training programs.

RESULTS

Technology Adaptation of PE Teachers Using the TPACK Framework. Table 2 presents the technology adaptation of PE teachers measured across the four variables of the TPACK framework. Firstly, the technical knowledge (TK) of the PE teachers gained the highest mean level of 3.54, the best performing indicator among the four variables. This indicates that physical education teachers have a high level of proficiency and confidence in the use and mastery of technology and can flexibly apply various educational technology tools to assist

teaching. This discovery not only reflects the importance of technological integration in modern education but also reflects the positive attitude of physical education teachers in adapting to and adopting new technologies.

Table 2
Mean Distribution of Technology Adaptation of PE Teachers

Variable	M	SD	VI
1. Content Knowledge (CK)	3.14	1.02	ML
2. Pedagogical Knowledge (PK)	3.36	1.03	ML
3. Technological Knowledge (TK)	3.54	1.05	HL
4. Technological Pedagogical Content Knowledge (TPACK)	3.36	0.83	ML
Composite Mean	**3.35**	**0.86**	**ML**

Furthermore, the mean values of Pedagogical Knowledge (PK) and Technical Pedagogical Content Knowledge (TPACK) are both 3.36, falling within the Medium Level (ML) range and tied for second place. Pedagogical knowledge refers to the ability of teachers to effectively teach students the knowledge and skills, while technical pedagogical content knowledge is the ability to combine technology, pedagogy, and subject content. The high scores of these two indicators indicate that physical education teachers have a certain foundation in teaching methods and strategies, and can also integrate technology into teaching, but there is still room for further improvement.

In contrast, the mean of Content Knowledge (CK) is lower, at 3.14, and although it is also in the Medium Level (ML) range, it ranks last. Content knowledge refers to the degree to which teachers have mastered the professional knowledge in the subject area they teach. This discovery may indicate that physical education teachers are relatively weak in their professional knowledge of sports, or they are more conservative in their self-assessment. This also reminds us that while strengthening technical training and teaching method guidance, we cannot ignore the consolidation and improvement of sports professional knowledge. The composite mean of technology adaptation is 3.35, which also fall in the medium level (ML) range. This indicates that although physical education teachers have achieved certain results in technical adaptation, there is still room for improvement overall. This conclusion provides important reference for us to develop more comprehensive and effective teacher training plans. Based on the standard deviations reflected in the table, each indicator is relatively close, indicating that the data distribution is relatively uniform and there are no obvious outliers.

The research results show that the technical adoption level of physical education teachers, measured by the TPACK framework, varies in different knowledge domains. Content knowledge (CK) and pedagogical knowledge (PK) are at a moderate level, while technical knowledge (TK) is at a high level. This is consistent with the study of Gorozidis et al. (2020), which emphasized the importance of balancing subject content knowledge, teaching method knowledge, and technical knowledge for effective integration of technology. The moderate levels of CK and PK indicate that although physical education teachers have a good understanding of subject content and teaching strategies, they may need further support to integrate technology. Teachers' confidence in their own technical skills directly affects their ability to integrate technology into teaching practice. And physical education teachers have outstanding technical knowledge, while teaching methods and content knowledge have been moderately improved. The content knowledge is relatively weak. In summary, the results in Table 2 reveals the status of the technical adaptation level of physical education teachers using the TPACK framework. Technical knowledge is outstanding, while teaching method knowledge and technical teaching method content knowledge are at a moderate level, hence, need improvement. On the other hand, content knowledge is relatively weak. These data not only provide detailed information about the technical adaptation of physical education teachers but also indicate the direction for developing targeted teacher training plans.

The researcher analyzed the technical adaptability level of physical education teachers

based on the TPACK (Technical Teaching Content Knowledge) framework and found that they performed well in technical knowledge (TK) and pedagogical knowledge (PK) but faced challenges in integrating this knowledge with subject content knowledge (CK) to form technical teaching content knowledge (TPACK). These results are consistent with the theoretical expectations of the TPACK framework, which emphasizes the need for teachers to integrate technology, teaching methods, and subject content knowledge to form effective teaching practices. The study also revealed the challenges faced by physical education teachers in the process of technological adaptation, such as resource constraints and insufficient professional development opportunities, which require further training and support to help teachers overcome these obstacles and more effectively achieve the integration goals proposed in the TPACK framework.

Challenges of PE Teachers in Adapting Technology. In Table 3, Resource and Equipment Challenges variable gained the highest mean of 3.59, indicating that this is the main obstacle that physical education teachers face in the process of technological adaptation. This challenge encompasses the shortcomings of schools in teaching technology facilities, digital resources, and hardware equipment, directly affecting teachers' ability and effectiveness in integrating technology into physical education teaching. The high variability index also indicates significant differences in resource equipment among different schools, further exacerbating the complexity and urgency of this challenge.

Table 3
Mean Distribution of Challenges of PE Teachers in Adapting Technology

Variable	M	SD	VI
1. Resource and Equipment Challenges	3.59	0.92	HL
2. Technical Proficiency and Confidence Challenges	3.42	1.05	HL
3. Professional Development and Teaching Design Challenges	3.43	0.99	HL
Composite Mean	**3.48**	**0.93**	**HL**

Secondly, the mean (M=3.42) of Technical Proficiency and Confidence Challenges closely follows, indicating that teachers also face significant difficulties in improving their technical abilities and building confidence. This challenge involves multiple aspects such as teachers' mastery of new technologies, troubleshooting abilities, and confidence in effectively using technology in the classroom. Although the standard deviation (SD=1.05) indicates that there are some differences in teachers' perceptions in this area, overall, it is still in the high level (HL) range and needs to be given sufficient attention.

Furthermore, the mean (M=3.43) of Professional Development and Teaching Design Challenges is also in the high level (HL) range, ranking second. This challenge mainly focuses on the professional development needs and instructional design abilities of teachers in the context of technology integration. Teachers generally report a lack of sufficient professional development opportunities and support, as well as difficulties encountered in designing sports teaching courses that integrate technology. These challenges not only affect teachers' teaching innovation ability but may also have a negative impact on students' learning experiences and outcomes.

Finally, the composite mean of the challenges in adaptation of technology is 3.48 revealing a high level (HL) range. This confirms the severe challenges faced by physical education teachers in the process of technical adaptation. The relatively low standard deviation (SD=0.93) indicates that these challenges are widespread and consistent among the physical education teacher community.

The challenges faced by physical education teachers when adopting technology are multifaceted, ranging from resource and equipment limitations to issues of technical proficiency and confidence. These findings are consistent with the research findings of Papastergiou et al. (2020), who emphasized the differences in available technical resources for teachers and their impact on technology integration.

The high average score for resource-related challenges indicates that physical education teachers often work in environments that are not adequately prepared for technology integration. Limited technology access and outdated facilities are distinct barriers to technology adoption in education. Physical education teachers face challenges in terms of technical adaptation and need to take comprehensive measures such as technical training, professional development, and teaching design to improve their technical adaptability and teaching effectiveness.

In summary, Table 3 deeply reveals the complexity and diversity of challenges that physical education teachers face in the process of technological adaptation. The results not only reveal areas where physical education teachers need further support and training in terms of technical adaptability but also provide theoretical basis for future teacher professional development plans to help teachers overcome these challenges, improve their technical adaptability and teaching quality. Therefore, to enhance teachers' technical adaptability and teaching effectiveness, schools and education departments need to take comprehensive measures, starting from multiple aspects such as resource equipment, technical training, professional development, and teaching design, to provide teachers with comprehensive support and assistance.

Strategies for PE Teachers to Adapt Technology. Table 4 shows the general responses and corresponding generated themes with respect to the strategies of PE teachers in adapting technology. The first theme generated was Professional Development (PD). This is actually a crucial aspect. This theme emphasizes that by participating in technical training and seminars, physical education teachers can continuously improve their technical abilities and become proficient in the latest educational technology tools and platforms. In the process of mastering new technologies, teachers will constantly explore how to integrate technological elements into physical education teaching, thereby creating more innovative and vivid teaching methods (Hsu & Lin, 2020).

Table 4
Thematic Analysis of the Strategies of PE Teachers in Adapting Technology

Response	Theme	Code
Participating in technology training and workshops	Professional Development	PD
Collaborate with tech-savvy colleagues and experts	Collaboration & Networking	CN
Integrate technology into lesson plans, activities, and assessments	Curriculum & Assessment Integration	CAI
Continuously learn and adapt to new technologies and trends	Continuous Learning & Adaptation	CLA
Use technology to enhance student engagement, motivation, and learning outcomes	Student-Centered Learning Enhancement	SCLE

The second theme is Collaboration and Networking (CN). This is another key factor in promoting teachers' technological adaptability. Teachers need to actively establish connections with colleagues, experts, and other educators with technical expertise, share experiences and solve problems through cooperation and communication, and jointly explore innovative applications of technology in teaching. This interdisciplinary collaboration helps to break down information barriers and promote the dissemination and sharing of knowledge. In the process of cooperation and communication, teachers can learn from each other, draw on each other's successful cases and teaching methods, and continuously improve their teaching concepts and strategies. In addition, participating in various educational forums, seminars, and exhibition activities, teachers can establish connections with a wider range of educators, share their teaching experiences and achievements, and enhance their visibility and influence (Sargent & Casey, 2019). This not only helps teachers gain more opportunities and development space in their careers but also contributes to the progress and development of the entire education field.

Curriculum and Assessment Integration (CAI) is also one of the core strategies for technology adaptation. As the third generated theme, physical education teachers need to seamlessly integrate technology into their teaching plans, activities, and evaluations to enrich teaching content, enhance teaching effectiveness, and

provide students with more personalized and diverse learning experiences. By utilizing digital tools and platforms, teachers can organize and manage teaching resources more efficiently, achieving flexibility and dynamism in the teaching process. For instance, teachers can also use technological tools to record students' learning processes and performance, providing data support for subsequent evaluations. During the evaluation phase, teachers can provide timely feedback and evaluation of students' learning outcomes through technological platforms (Huang et al., 2022). This evaluation method is not only more objective and accurate but also provides personalized improvement suggestions and guidance for students. In summary, the integration of curriculum and assessment (CAI) is one of the important strategies to promote the technical adaptability of physical education teachers.

Another generated theme is Continuous Learning and Adaptation (CLA). This is also an important quality that every physical education teacher should possess. In this rapidly changing era, new technologies are constantly emerging, and teachers need to maintain keen insight, constantly learn and adapt to new technologies and trends. Only in this way can they keep up with the pace of the times and provide students with the most cutting-edge and effective education. Continuous learning means that teachers need to maintain a thirst and pursuit for new knowledge and skills. Meanwhile, adapting to change is also one of the essential abilities for teachers. Faced with the impact of new technologies and trends, teachers need to maintain an open attitude, be brave enough to try and accept new things. They should dare to break free from traditional teaching modes and conceptual constraints, actively explore and practice new teaching methods and means. In the process of adapting to changes, teachers can not only enhance their teaching abilities, but also stimulate students' interest and creativity in learning, laying a solid foundation for their comprehensive development.

Ultimately, as the last generated theme, Student-Centered Learning Enhancement (SCLE) is the goal of technological adaptation. Physical education teachers need to use technology to enhance students' participation, motivation, and learning outcomes. By designing interesting and interactive teaching activities and utilizing technological tools to promote students' self-directed and collaborative learning, teachers can better meet students' personalized needs, stimulate their learning potential, and help them achieve comprehensive development. Firstly, teachers need to design diverse teaching activities to attract students' attention and stimulate their interest. These activities can include gamified learning, simulation experiments, online interactions, etc., which enable students to participate more actively in the classroom through different forms. At the same time, teachers can also use technological tools to enrich teaching content, such as using multimedia resources such as videos, animations, and images, to make the classroom livelier and more interesting. Secondly, teachers need to utilize technology to promote students' self-directed and collaborative learning. By providing online learning resources and platforms, students can learn anytime and anywhere, and make personalized adjustments based on their interests and progress. In addition, teachers can also organize students for group cooperative learning, using technological tools for remote collaboration and communication, to cultivate students' teamwork and communication skills. Finally, teachers need to pay attention to students' personalized needs and provide them with customized learning support. By understanding the differences in students' learning styles, interests, and learning abilities, teachers can design personalized learning plans and teaching strategies for them.

In summary, the five themes and their corresponding strategies in Table 3 provide comprehensive guidance for PE teachers to adapt to technology. By actively participating in professional development, strengthening cooperation and communication, integrating curriculum and assessment, maintaining continuous learning and adaptation, and enhancing student-centered learning, PE

teachers will be able to more effectively utilize technology to improve teaching practices, enhance teaching quality, and create a better future for students.

Proposed Enhanced Teacher Training Program. The enhanced physical education teacher training program proposed in this study demonstrates innovation in multiple aspects. Firstly, the program provides a comprehensive technical training module, which not only includes the improvement of basic technical operation skills but also covers practical guidance on how to integrate these technical tools into physical education teaching. Secondly, the training program provides personalized learning paths based on the teacher's technical proficiency and personal needs. This personalized approach recognizes the diversity of teachers in the process of technological adaptation and provides customized training content for each teacher. The program also focuses on practical application training, through simulated teaching scenarios and case studies, allowing teachers to practice and reflect in real or simulated teaching environments, thereby deepening their understanding of technology applications. These innovative highlights not only reflect a profound understanding of the technical adaptability challenges faced by physical education teachers but also demonstrate a commitment to enhancing teachers' professional abilities through innovative methods. Through these innovative measures, the training program aims to provide a comprehensive, flexible, and continuous learning platform for physical education teachers to support their success in teaching practices in the digital age.

Table 5 presents the “Matrix of Enhanced Teacher Training Program.” This proposed program has been meticulously crafted to address the ever-evolving needs of the education landscape. Anchored from the themes generated from the challenges in adapting technology, this program emphasizes Professional Development (PD) through cutting-edge techniques and best practices, fostering Collaboration & Networking (CN) opportunities that bridge gaps between educators, while deeply integrating Curriculum & Assessment (CAI) to ensure learning outcomes align with student progress. At their core, they embrace Continuous Learning & Adaptation (CLA), encouraging teachers to stay abreast of pedagogical advancements and tailor their approach to suit diverse learners. Ultimately, these programs prioritize Student-Centered Learning Enhancement (SCLE), empowering teachers to design engaging, personalized learning experiences that ignite curiosity and foster lifelong learning skills in every student. The following are the comprehensive measures.

Table 5
Matrix of Enhanced Teacher Training Program

Module	Objective	Activities	Outcomes
Professional Development (PD)	Equip PE teachers with necessary technical skills and knowledge.	- Workshops on educational technology. - Hands-on training with digital tools. - Seminars on tech trends.	- Teachers can operate digital tools confidently. - Understanding of tech integration in teaching strategies.
Collaboration & Networking (CN)	Foster a collaborative environment for knowledge sharing.	- Establish a network for PE teachers and tech experts. - Organize meetups and forums. -Promote cross-departmental collaboration.	- Support system for technology integration. - Collaborative strategies for tech use in PE.
Curriculum & Assessment Integration (CAI)	Enable seamless integration of technology into lesson plans and assessments.	- Guidance on tech-integrated lesson planning. - Training in digital assessment tools. - Showcase best practices.	- Effective lesson plans incorporating technology. - Innovative assessment strategies using tech tools.
Continuous Learning & Adaptation (CLA)	Encourage continuous learning and adaptation to new technologies.	- Continuous education program with annual updates. - Encourage participation in online courses. - Provide resources for exploration.	- Teachers stay updated with tech advancements. - Adaptation of new technologies in teaching methods.
Student-Centered Learning Enhancement (SCLE)	Use technology to enhance student engagement and learning outcomes.	- Training on interactive and gamified activities. - Guidance on personalizing learning experiences. - Strategies for enhancing student motivation.	- Engaging and interactive PE lessons. - Personalized learning support using tech tools.

DISCUSSION

Grounded within the TPACK (Technological Pedagogical Content Knowledge) framework, this study delved into the intricate landscape of PE (Physical Education) teachers' adaptability and expertise across various knowledge domains. It reveals a nuanced picture, wherein PE educators demonstrate a commendable, albeit moderate, level of proficiency in Content Knowledge (CK), embodying a solid grasp of the principles, concepts, and curricula central to physical education. This underscores their ability to impart fundamental skills and understanding to students, fostering physical literacy and wellness. Simultaneously, their Pedagogical Knowledge (PK) also exhibits a

moderate level of adaptation, indicating a solid foundation in instructional strategies, methods of assessment, and classroom management tailored specifically for PE settings. This proficiency enables them to create engaging and effective learning environments that cater to the unique needs of physical education, fostering motivation and achievement among students. However, where PE teachers truly shine is in their Technological Knowledge (TK). Attaining a high level of technological proficiency, they demonstrate a keen understanding of the latest digital tools, platforms, and resources available for enhancing teaching and learning experiences. This proficiency not only reflects their willingness to embrace technological advancements but also highlights their ability to leverage these tools to enhance the delivery of physical education content. The study further highlights that while PE teachers possess a strong foundation in both CK and PK, there lies an opportunity for growth and enhancement, particularly in the seamless integration of technology with both content and pedagogy. This moderate performance in these areas suggests that while the foundation is solid, there is room to deepen the understanding of how technology can amplify the effectiveness of physical education instruction, making it more interactive, personalized, and efficient. To this end, the study underscores the pressing need for further initiatives and efforts aimed at bridging the gap between technological proficiency and its effective integration into PE teaching practices. This includes ongoing professional development programs tailored to the unique needs of PE teachers, focusing on best practices for integrating technology, fostering collaboration among educators, and encouraging experimentation and innovation in the classroom. By addressing this gap, PE teachers can harness the full potential of technology to revolutionize physical education, creating dynamic and impactful learning experiences for all students.

In conclusion, while PE teachers demonstrate varying levels of adaptation to technology, the identified challenges and opportunities for improvement point to the need for strategic interventions and enhanced teacher training programs. By addressing these challenges through targeted strategies and comprehensive training, educational institutions can empower PE teachers to fully embrace technology and transform their classrooms into dynamic, student-centered learning environments.

Based on the research results, the following are the recommended measures for different beneficiary groups:

For Physical Education Teachers (PE Teachers). Firstly, PE teachers should maintain enthusiasm in learning new technologies, actively participate in various educational technology training and seminars, and continuously improve one's technical application abilities. Secondly, be brave enough to explore the application of new technologies in teaching practice, and design innovative and interactive physical education teaching plans based on students' actual situations. Finally, pay attention to students' feedback, constantly reflect and adjust teaching strategies, and ensure the maximization of the effectiveness of technology application.

For Students. Firstly, students shall accept the application of new technologies in physical education teaching with an open mind and actively participate in various technical support teaching activities designed by teachers. Secondly, utilizing technological tools for self-monitoring and evaluation, understanding one's physical condition and athletic ability, and developing personalized exercise plans. Finally, be brave enough to try new sports methods and challenges in sports teaching supported by technology.

For Education Management Departments and School Leaders. Firstly, institutions should increase their investment in educational technology training for physical education teachers in order to provide sufficient resources and financial support, and ensure that teachers can receive high-quality training. Secondly, relevant policies and measures should be formulated to encourage teachers to actively apply new technologies in physical

education teaching, and outstanding teachers should be commended and rewarded. Finally, establish a scientific evaluation mechanism to regularly assess the effectiveness of technology adaptation, and adjust training content and direction in a timely manner based on the evaluation results.

For Educational Researchers and Developers. Firstly, conducting in-depth research on the actual needs and pain points of physical education teachers in the process of technological adaptation provides a solid foundation for product development and research. Secondly, strengthen cross-border cooperation and exchanges with experts in other fields to jointly explore the application prospects and development directions of educational technology in physical education teaching. Finally, focus on continuous iteration and optimization of the product, adjust product features and performance in a timely manner based on user feedback and market changes, and meet user needs.

For Parents and the Society. Firstly, they should pay attention to the latest developments and trends in educational technology and understand its application and practical effects in physical education teaching. Secondly, they should actively support teachers in applying new technologies in physical education teaching, understand and recognize teachers' innovative practices. Finally, to actively disseminate successful cases and positive impacts of educational technology in teaching through media and other channels and create a favorable social atmosphere that supports educational innovation and technology application.

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